Recommendation for Space Data System Standards

CROSS SUPPORT TRANSFER SERVICE—SPECIFICATION FRAMEWORK

PROPOSED REVISED RECOMMENDED STANDARD

CCSDS 921.1-P-1.1

Draft Pink Book

September 2018
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# DOCUMENT CONTROL

<table>
<thead>
<tr>
<th>Document</th>
<th>Title</th>
<th>Date</th>
<th>Status</th>
</tr>
</thead>
</table>
# CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1</strong> INTRODUCTION</td>
<td>1-1</td>
</tr>
<tr>
<td>1.1 PURPOSE</td>
<td>1-1</td>
</tr>
<tr>
<td>1.2 SCOPE</td>
<td>1-1</td>
</tr>
<tr>
<td>1.3 APPLICABILITY</td>
<td>1-1</td>
</tr>
<tr>
<td>1.4 RATIONALE</td>
<td>1-2</td>
</tr>
<tr>
<td>1.5 DOCUMENT STRUCTURE</td>
<td>1-2</td>
</tr>
<tr>
<td>1.6 DEFINITIONS, NOMENCLATURE AND CONVENTIONS</td>
<td>1-6</td>
</tr>
<tr>
<td>1.7 REFERENCES</td>
<td>1-20</td>
</tr>
<tr>
<td><strong>2</strong> DESCRIPTION OF CROSS SUPPORT SERVICES</td>
<td>2-1</td>
</tr>
<tr>
<td>2.1 OVERVIEW</td>
<td>2-1</td>
</tr>
<tr>
<td>2.2 CROSS SUPPORT REFERENCE MODEL</td>
<td>2-3</td>
</tr>
<tr>
<td>2.3 SERVICE MANAGEMENT</td>
<td>2-5</td>
</tr>
<tr>
<td>2.4 ELEMENTS OF THE CSTS SPECIFICATION FRAMEWORK</td>
<td>2-6</td>
</tr>
<tr>
<td>2.5 PRINCIPLES OF USING THE CSTS SPECIFICATION FRAMEWORK</td>
<td>2-11</td>
</tr>
<tr>
<td>2.6 PROTOCOL DESCRIPTION</td>
<td>2-13</td>
</tr>
<tr>
<td><strong>3</strong> COMMON OPERATIONS</td>
<td>3-1</td>
</tr>
<tr>
<td>3.1 OVERVIEW</td>
<td>3-1</td>
</tr>
<tr>
<td>3.2 GENERAL CONSIDERATIONS</td>
<td>3-1</td>
</tr>
<tr>
<td>3.3 STANDARD OPERATION HEADER</td>
<td>3-6</td>
</tr>
<tr>
<td>3.4 BIND (CONFIRMED)</td>
<td>3-10</td>
</tr>
<tr>
<td>3.5 UNBIND (CONFIRMED)</td>
<td>3-15</td>
</tr>
<tr>
<td>3.6 PEER-ABORT (UNCONFIRMED)</td>
<td>3-16</td>
</tr>
<tr>
<td>3.7 START (CONFIRMED)</td>
<td>3-19</td>
</tr>
<tr>
<td>3.8 STOP (CONFIRMED)</td>
<td>3-21</td>
</tr>
<tr>
<td>3.9 TRANSFER-DATA (UNCONFIRMED)</td>
<td>3-22</td>
</tr>
<tr>
<td>3.10 PROCESS-DATA (UNCONFIRMED / CONFIRMED)</td>
<td>3-24</td>
</tr>
<tr>
<td>3.11 NOTIFY (UNCONFIRMED)</td>
<td>3-26</td>
</tr>
<tr>
<td>3.12 GET (CONFIRMED)</td>
<td>3-28</td>
</tr>
<tr>
<td>3.13 EXECUTE-DIRECTIVE (ACKNOWLEDGED)</td>
<td>3-33</td>
</tr>
<tr>
<td><strong>4</strong> PROCEDURES</td>
<td>4-1</td>
</tr>
<tr>
<td>4.1 OVERVIEW</td>
<td>4-1</td>
</tr>
<tr>
<td>4.2 COMMON PROCEDURES BEHAVIOR</td>
<td>4-1</td>
</tr>
<tr>
<td>4.3 ASSOCIATION CONTROL</td>
<td>4-4</td>
</tr>
<tr>
<td>4.4 UNBUFFERED DATA DELIVERY</td>
<td>4-11</td>
</tr>
<tr>
<td>4.5 BUFFERED DATA DELIVERY</td>
<td>4-16</td>
</tr>
<tr>
<td>4.6 DATA PROCESSING</td>
<td>4-41</td>
</tr>
<tr>
<td>4.7 BUFFERED DATA PROCESSING</td>
<td>4-59</td>
</tr>
<tr>
<td>4.8 SEQUENCE-CONTROLLED DATA PROCESSING</td>
<td>4-72</td>
</tr>
<tr>
<td>4.9 INFORMATION QUERY</td>
<td>4-91</td>
</tr>
<tr>
<td>4.10 CYCLIC REPORT</td>
<td>4-95</td>
</tr>
<tr>
<td>4.11 NOTIFICATION</td>
<td>4-107</td>
</tr>
</tbody>
</table>
4.12 THROW EVENT ...........................................................................................................4-119

ANNEX A IMPLEMENTATION CONFORMANCE STATEMENT PROFORMA
(NORMATIVE) .....................................................................................................................A-1
ANNEX B PRODUCTION STATUS (NORMATIVE) ..........................................................B-1
ANNEX C QUALIFIED PARAMETERS (NORMATIVE) ......................................................C-1
ANNEX D OBJECT IDENTIFIERS DEFINITION (NORMATIVE) .............................D-1
ANNEX E COMPOSITION OF PARAMETER, EVENT, AND DIRECTIVE NAMES
AND PARAMETER AND EVENT LISTS (NORMATIVE) ..............................................E-1

ANNEX F DATA TYPES DEFINITION (NORMATIVE) ......................................................F-1
ANNEX G SERVICE STATE TABLES (NORMATIVE) ......................................................G-1
ANNEX H SECURITY, SANA, AND PATENT CONSIDERATIONS
(INFORMATIVE) .............................................................................................................H-1

ANNEX I INFORMATIVE REFERENCES (INFORMATIVE) ...........................................I-1
ANNEX J INDEX TO DEFINITIONS (INFORMATIVE) ......................................................J-1

ANNEX K ABBREVIATIONS (INFORMATIVE) .................................................................K-1

ANNEX M PUBLISHED IDENTIFIERS FOR FUNCTIONAL RESOURCES
REGISTERED UNDER THE CROSS SUPPORT FUNCTIONALITIES
NODE (INFORMATIVE) ......................................................................................................L-1

Figures

1-1 Cross Support Service Documentation .....................................................................1-4
2-1 CSTS Specification Framework Concept ..................................................................2-3
2-2 Service and Procedure States (Stateful Prime Procedure) ......................................2-14
2-3 Service and Procedure States (Stateless Prime Procedure) ......................................2-15
2-4 Communications Realization of a Cross Support Transfer Service ..........................2-18
4-1 Services Using a Buffered Data Delivery Procedure .............................................4-19
4-2 Real-Time and Complete Buffered Data Delivery Service Instances and Supporting
Buffering Mechanisms .................................................................................................4-20
B-1 Production Status Diagram ....................................................................................B-1
D-1 CSTS and Cross Support Resources Root Object Identifier Tree ..........................D-2
D-2 ‘procedures’ Subtree ...............................................................................................D-6
D-3 ‘fwProceduresFunctionalities’ Subtree ..................................................................D-8
D-4 ‘services’ Subtree ....................................................................................................D-10
D-5 ‘service procedures’ Subtree ..................................................................................D-11
D-6 ‘crossSupportFunctionalities’ Subtree .................................................................D-13
D-7 ‘agenciesFunctionalities’ Subtree ...........................................................................D-15
K-1 Cross Support Services Part of the CCSDS Object Identifiers Tree ......................K-1
K-2 CSS Object Identifiers Tree ...................................................................................K-1
K-3 CSTS Object Identifiers Tree ................................................................................K-2
K-4 CSTS Specification Framework Object Identifiers Tree .......................................K-4
K-5 CSTS Services Object Identifiers Tree ...................................................................K-4
K-6 CSTS Published Identifiers—Object Identifiers Tree ............................................K-6
L-1 Example Cross Support Functional Resources ......................................................L-3
L-2 Subcarrier Related Parameters of the Rtn401SpaceLinkCarrierRecept Functional Resource…………………………………………………………………… L-3

Tables

2-1 Common Operations Defined by the CSTS Specification Framework ..............2-7
2-2 Common Procedures Defined by the CSTS Specification Framework ..............2-9
2-3 Use of Operations by Common Procedures ..................................................2-10
3-1 Standard Confirmed Operation Header Parameters .......................................3-7
3-2 Standard Unconfirmed Operation Header Parameters .................................3-7
3-3 BIND Operation Parameters .........................................................................3-10
3-4 UNBIND Operation Parameters ....................................................................3-15
3-5 PEER-ABORT Operation Parameters ............................................................3-16
3-6 START Operation Parameters ........................................................................3-20
3-7 STOP Operation Parameters ..........................................................................3-21
3-8 TRANSFER-DATA Operation Parameters ....................................................3-22
3-9 PROCESS-DATA Operation Parameters .......................................................3-24
3-10 NOTIFY Operation Parameters .....................................................................3-26
3-11 GET Operation Parameters ...........................................................................3-31
3-12 EXECUTE-DIRECTIVE Operation Parameters ..............................................3-34
4-1 Association Control Procedure Required Operations .....................................4-8
4-2 Association Control Procedure Configuration Parameters ..........................4-8
4-3 Association Control Procedure State Table .....................................................4-9
4-4 Procedure State Table Incoming Event Description References .....................4-10
4-5 Procedure State Table Predicate Descriptions ..............................................4-10
4-6 Procedure State Table Simple Action References .........................................4-10
4-7 Procedure State Table Compound Action Definitions ....................................4-10
4-8 Unbuffered Data Delivery Procedure Required Operations ..........................4-13
4-9 Unbuffered Data Delivery Procedure State Table ..........................................4-14
4-10 Procedure State Table Incoming Event Description References ..................4-14
4-11 Procedure State Table Predicate Descriptions .............................................4-14
4-12 Procedure State Table Boolean Flags ............................................................4-15
4-13 Procedure State Table Simple Action References ........................................4-15
4-14 Buffered Data Delivery Procedure Required Operations .............................4-26
4-15 START Extension Parameters .......................................................................4-27
4-16 Buffered Data Delivery Procedure Configuration Parameters .....................4-32
4-17 Buffered Data Delivery Procedure State Table .............................................4-33
4-18 Procedure State Table Incoming Event Description References ....................4-35
4-19 Procedure State Table Predicate Descriptions .............................................4-36
4-20 Procedure State Table Boolean Flags ............................................................4-36
4-21 Procedure State Table Simple Action References ........................................4-37
4-22 Procedure State Table Compound Action Definitions ....................................4-38
4-23 Data Processing Procedure Required Operations ..........................................4-48
4-24 PROCESS-DATA Extension Parameter .......................................................4-49
4-70 Throw Event Procedure Required Operations ................................................. 4-122
4-71 Throw Event Procedure State Table .............................................................. 4-123
4-72 Procedure State Table Incoming Event Description References .................. 4-124
4-73 Procedure State Table Predicate Definitions ............................................. 4-124
4-74 Procedure State Table Simple Action References .................................... 4-124
A-1 Identification of PICS .................................................................................. A-4
A-2 Identification of Implementation Under Test ............................................... A-4
A-3 Identification of Supplier ............................................................................ A-4
A-5 Required Procedures ................................................................................... A-5
A-6 Required PDUs ............................................................................................. A-6
A-7 BIND Invocation Parameters ....................................................................... A-7
A-8 BIND Return Parameters ........................................................................... A-8
A-9 PEER-ABORT Invocation Parameters ......................................................... A-9
A-10 UNBIND Invocation Parameters ................................................................. A-9
A-11 UNBIND Return Parameters ...................................................................... A-10
A-12 EXECUTE-DIRECTIVE Invocation Parameters .......................................... A-11
A-13 EXECUTE-DIRECTIVE Acknowledgement Parameters ............................. A-13
A-14 EXECUTE-DIRECTIVE Return Parameters ................................................ A-14
A-15 GET Invocation Parameters ...................................................................... A-16
A-16 GET Return Parameters ............................................................................ A-17
A-17 PROCESS-DATA Invocation Parameters .................................................. A-18
A-18 PROCESS-DATA Return Parameters ......................................................... A-20
A-19 START Invocation Parameters ................................................................... A-22
A-20 START Return Parameters .......................................................................... A-24
A-21 STOP Invocation Parameters ..................................................................... A-27
A-22 STOP Return Parameters ........................................................................... A-27
A-23 NOTIFY Invocation Parameters ................................................................. A-29
A-24 TRANSFER-DATA Invocation Parameters ................................................. A-31
B-1 Production Status Semantic ......................................................................... B-2
B-2 Production Status Transitions ...................................................................... B-3
G-1 State Table for CSTSes with a Stateless Prime Procedure Instance ............ G-2
G-2 State Table for CSTSes with a Stateless Prime Procedure Instance: Event Description References ................................................................. G-2
G-3 State Table for CSTSes with a Stateless Prime Procedure Instance: Predicate Descriptions ....................................................................................... G-3
G-4 State Table for CSTSes with a Stateless Prime Procedure Instance: Compound Action Definitions ............................................................................... G-3
G-5 State Table for CSTSes with a Stateful Prime Procedure Instance ............. G-4
G-6 State Table for CSTSes with a Stateful Prime Procedure Instance: Event Description References .............................................................. G-5
G-7 State Table for CSTSes with a Stateful Prime Procedure Instance: Predicate Descriptions ....................................................................................... G-5
G-8 State Table for CSTSes with a Stateful Prime Procedure Instance: Compound Action Definitions ............................................................................... G-6
L-1 Specification of the Subcarrier Level Estimate Parameter ............................................. L-5
L-2 Specification of the Subcarrier Lock Status Parameter..................................................... L-5
1 INTRODUCTION

1.1 PURPOSE

The purpose of this Recommended Standard is to define the various logical components, also known within this Recommended Standard as procedures that are required for specifying Cross Support Transfer Services (CSTSe).

1.2 SCOPE

1.2.1 This Recommended Standard defines, in an abstract manner, a CSTS in terms of:

a) the procedures necessary to provide the service;

b) the states of the service;

c) the behavior of each procedure;

d) the states of the procedures;

e) the operations necessary to constitute the procedures; and

f) the parameters associated with each operation.

1.2.2 It does not specify:

a) individual application services, implementations, or products;

b) the implementation of entities or interfaces within real systems;

b) the methods or technologies required to acquire data;

d) the methods or technologies required to provide a suitable environment for communications; or

e) the management activities required to schedule and configure services.

1.3 APPLICABILITY

1.3.1 APPLICABILITY OF THIS RECOMMENDED STANDARD

This Recommended Standard provides a basis for the specification and development of Cross Support Services that are intended to be used for developing real systems that implement such services.

Implementation of a service based on the CSTS procedures defined in this Recommended Standard in a real system additionally requires the availability of a communications service to convey invocations and responses of the CSTS operations between the service user and the service provider.
This Recommended Standard requires that such a communications service provides a reliable protocol, i.e., that it ensures that invocations and responses of operations are transferred:

a) in sequence;

b) completely and with integrity;

c) without duplication;

d) with flow control that notifies the application layer in the event of congestion or backpressure; and

e) with notification to the application layer in the event that communications between the service user and the service provider are disrupted, possibly resulting in a loss of data.

It is the specific intent of this Recommended Standard to define the CSTS independently of any particular communications services, protocols, technologies, or formatting of the data content.

1.3.2 LIMITS OF APPLICABILITY

This Recommended Standard specifies the CSTS procedures that may be used for the definition of Cross Support Transfer Services. It does not intend to specify a Cross Support Transfer Service.

1.4 RATIONALE

The goal of this Recommended Standard is to create a standard for interoperability between various Agencies’ tracking stations or ground data handling systems and the consumers or producers of spacecraft data and related monitor and/or control information.

1.5 DOCUMENT STRUCTURE

1.5.1 ORGANIZATION OF THIS DOCUMENT

This document is organized as follows:

a) section 1 presents the purpose, scope, applicability, and rationale of this Recommended Standard and lists the definitions, conventions, and references;

b) section 2 provides an overview of the CSTS Specification Framework;

c) section 3 specifies the common operations to be used by Cross Support Transfer Services;

d) section 4 specifies the procedures to be used by the Cross Support Transfer Services;
e) annex A contains the proforma of the Protocol Implementation Conformance Statement;

f) annex B provides a formal specification of the production status;

g) annex C provides a formal specification of what a qualified parameter is;

h) annex D provides a formal specification of the Object Identifiers and the management of their allocation;

i) annex E defines the composition of Functional Resource Names, Parameter Names, Event Names, Parameter Lists, and Event Lists using Published Identifiers of the appropriate types;

j) annex F provides a formal specification of data types for Protocol Data Units (PDUs) for common operations using Abstract Syntax Notation One (ASN.1);

k) annex G provides a description of the service provider states;

l) annex H contains considerations related to security, SANA, and patents;

m) annex I provides a list of informative references;

n) annex Fehler! Verweisquelle konnte nicht gefunden werden. lists selected terms used in this Recommended Standard and identifies where they are defined;

o) annex J lists acronyms used in this document;

p) annex K provides an informative list of Object Identifiers used by this Recommended Standard;

q) annex L illustrates by means of examples the concept of Published Identifiers.

1.5.2 CROSS SUPPORT TRANSFER SERVICES DOCUMENTATION

The basic organization of the Cross Support Services documentation and the relationship to CSTS documentation is shown in figure 1-1.

The Cross Support Architecture is documented in:

a) Space Communications Cross Support—Architecture Description Document (reference [Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 8, Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll.8]): An Informational Report describing an architecture in terms of CCSDS-recommended configurations for secure space communications cross support. This architecture is intended to be used as a common framework when CCSDS Agencies a) provide and use space communications cross support services, and b) develop systems that provide interoperable space communications cross support.
b) Space Communications Cross Support—Architecture Requirements Document (reference [Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 8, Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll.9]): A Recommended Practice defining a set of requirements for CCSDS-recommended configurations for secure Space Communications Cross Support architectures.

![Cross Support Documents Diagram]

Figure 1-1: Cross Support Service Documentation

Common to all Cross Support Services:

c) Space Communication Cross Support Service Management suite (references [Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 8, Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll.4], [Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 8, Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll.6] and [Fehler! Verwenden Sie die Registerkarte}
Common to the Transfer Services, i.e., SLE Transfer Services and Cross Support Transfer Services:

d) *Space Link Extension—Internet Protocol for Transfer Services* (reference [2]): A Recommended Standard that defines a protocol for transfer of PDUs defined in the Cross Support Transfer Services. This Recommended Standard was originally developed to support SLE transfer services (hence the title), but it is also applicable to use by Cross Support Transfer Services.

The concept, the reference model and the SLE Transfer Services as such are documented in:

e) *Cross Support Concept—Part 1: Space Link Extension Services* (reference [2]): A report introducing the concepts of cross support and the SLE services. Many of the concepts for the SLE transfer services have been adopted for the CSTSes (see k) below).

f) *Cross Support Reference Model—Part 1: Space Link Extension Services* (reference [1]): A Recommended Standard that defines the framework and terminology for the specification of SLE services. Much of the framework and terminology of this reference model has been adopted or adapted for CSTSes (see 1.6.1.3 and 2.2).

g) The *SLE Transfer Services suite*: The SLE Transfer Services are a suite of Cross Support Services that are used to transfer specific telecommand and telemetry protocol data units. The SLE Transfer Services are closely related to the CSTS suite in that they collectively define the set of operations that are the basis for the CSTS Specification Framework. However, because of history (the SLE Transfer Services were already specified and implemented prior to development of the CSTS Specification Framework) the SLE Transfer Services are separated from CSTSes.

The documents specific to Cross Support Transfer Services are:

h) *Cross Support Transfer Services Specification Framework* (this Recommended Standard): A Recommended Standard that defines the specification of the Cross Support Transfer Service procedures;

j) Cross Support Transfer Services Concept (reference [Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 8, Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll.5]): A Report that provides tutorial material on the objectives and concepts of the CSTS specification;

k) Cross Support Transfer Services Suite: The set of specifications for actual CSTSes built from the procedures in the CSTS Specification Framework and in accordance with the CSTS Guidelines.

1.6 DEFINITIONS, NOMENCLATURE AND CONVENTIONS

1.6.1 DEFINITIONS

1.6.1.1 Definitions from Open Systems Interconnection (OSI) Basic Reference Model

This Recommended Standard makes use of a number of terms defined in reference [3]. The use of those terms in this Recommended Standard shall be understood in a generic sense, i.e., in the sense that those terms are generally applicable to technologies that provide for the exchange of information between real systems. Those terms are:

a) abstract syntax;
b) application entity;
c) application layer;
d) flow control;
e) real system.

1.6.1.2 Definitions from Abstract Syntax Notation One

This Recommended Standard makes use of the following terms defined in reference [4]:

a) Abstract Syntax Notation One (ASN.1);
b) Object Identifier;
c) (data) type;
d) (data) value.

NOTE – In annex F of this Recommended Standard, ASN.1 is used for specifying the abstract syntax of service operation invocations and responses.

1.6.1.3 Definitions from Cross Support Reference Model

This Recommended Standard makes use of the following terms defined in reference [1]:
a) binding;
b) initiator;
c) invoker;
d) operation;
e) performer;
f) physical channel;
g) responder;
h) service agreement;
i) service provider;
j) service user;
k) space link.

1.6.1.4 Terms Defined in the Space Communications Cross Support Architecture Description Document (reference [Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 8,Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll.8])

a) Cross Support Service System (CSSS);
b) Earth Space Link Terminal (ESLT);
c) Earth User CSSS;
d) Element Management (EM)
e) Provider CSSS;
f) Provision Management (PM) of the Provider CSSS;
g) Utilization Management (UM) of the Earth User CSSS.

1.6.1.5 Definitions from CCSDS SANA Registry Management Policy

This Recommended Standard makes use of the following terms defined in reference [6]:
a) OID Registry;
b) owned by Agencies;
c) owned by xxx Area;
d) Review Authority;
e) Service Site and Aperture Registry;
f) Spacecraft Registry.

1.6.1.6 Definitions from SANA Role, Responsibilities, Policies, and Procedures

This Recommended Standard makes use of the following terms defined in reference [7]:

a) delegation;
b) registration rules;
c) registry;
d) SANA Steering Group.

1.6.1.7 Additional Definitions

1.6.1.7.1 abstract service: the specification of the common operations and behavior of CSTSes that is not directly implementable because service-specific specifications are still missing. Real CSTSes can be derived from such abstract service.

1.6.1.7.2 acknowledgement: A confirmation that the invocation sent by the invoker was accepted by the performer and will now be acted upon.

a) An acknowledgement with a negative result is also called a negative acknowledgement.

b) An acknowledgement with a positive result is also called a positive acknowledgement.

1.6.1.7.3 association: A cooperative relationship between a service-providing application entity and a service-using application entity. An association is formed by exchanging service protocol data units using an underlying communications service.

1.6.1.7.4 communications service: A capability that enables a CSTS-providing application entity and a CSTS-using application entity to exchange information.

1.6.1.7.5 confirmed operation: An operation that requires the performer to return a report of the operation outcome to the invoker. Confirmed operations are further classified as two-phase operations and three-phase operations.

1.6.1.7.6 Cross Support Service: A set of capabilities that an object that belongs to one Space Agency provides to objects that belong to other Space Agencies by means of one or more ports, in support of spacecraft operations. A Cross Support Service can also be used within a given Space Agency.

1.6.1.7.7 Cross Support Transfer Service (CSTS): A subclass of Cross Support Service that provides reliable, access-controlled transfer of spaceflight mission-related data between ground element entities, realized through the invocation and performance of defined
operations in accordance with defined procedures. A CSTS is qualified by the kind of data it transfers (e.g., telemetry frames, tracking data). A CSTS may optionally have capabilities to coordinate and observe the behavior of the production with which this service is associated.

1.6.1.7.8 Cross Support Transfer Service instance: An instance of a specific Cross Support Transfer Service type by means of which an Earth Space Link Terminal (ESLT) provides the capability to the service user to transfer the service-type specific spaceflight mission-related data. There may be CSTSes that operate in other Provider CSSS nodes than an ESLT. In such cases “Element Management” would refer to the management functions that have local purview over the provision and production of those CSTSes.

1.6.1.7.9 Cross Support Service production: Performing of the data acquisition process and/or the data transformation as necessary for the given type of Cross Support Transfer Service.

1.6.1.7.10 Cross Support Utilization Management: The abstraction of the entities within a real Earth User CSSS that on behalf of the cross supported mission interacts with the Provision Management of the Provider CSSS to arrange for the required Cross Support Services.

1.6.1.7.11 Cross Support Service provision: Exposing the operations necessary so that the service user can obtain the service. Provision involves the interface between the service user and the service provider.

1.6.1.7.12 data acquisition process: The means by which service production provides the capability to a service provider to access data required for service provisioning or to access information on service production processes (e.g., physical channel of the space link).

1.6.1.7.13 derivation: A mechanism that allows extending (see 1.6.1.7.19) or refining (see 1.6.1.7.44) an operation or the behavior of a procedure.

NOTE – Derivation can also be applied to a Cross Support Transfer Service.

1.6.1.7.14 Directive Identifier: In the context of a CSTS, the unique identifier of a directive defined for service provision or service production. A Directive Identifier is defined as a Published Identifier (see D6).

1.6.1.7.15 Directive Name: A data structure consisting of a Directive Identifier that represents an individual directive type, and a Functional Resource Name that represents the Functional Resource with which the specific instance of that directive type is associated.

1.6.1.7.16 Event Identifier: In the context of a CSTS, the unique identifier of an event defined for service provision or service production. An Event Identifier is defined as a Published Identifier (see D6).

1.6.1.7.17 Event Label: (See E8 for the detailed definition.)
1.6.1.7.18 Event Name: (See E5 for the detailed definition.)

1.6.1.7.19 extension: The act of extending operations or procedures. Operations are extended by a) adding new parameters to the invocation or response message or b) extending the range of values for already existing parameters or c) changing an unconfirmed operation into a confirmed operation. Procedures are extended by a) adding new operations or b) extending the used operations.

1.6.1.7.20 Framework: A set of generic behaviors (called common procedures) and the constituent common operations used to simplify the specification of systems providing or using CSTSes.

1.6.1.7.21 Functional Resource Instance: An instance of a Functional Resource Type.

1.6.1.7.22 Functional Resource Instance Number: An integer index used to identify an instance of a Functional Resource Type.

1.6.1.7.23 Functional Resource Name: The unique identifier of an instance of a Functional Resource. A Functional Resource Name is made of a Functional Resource Type and a Functional Resource Instance Number.

1.6.1.7.24 Functional Resource Type: A logical function or related set of functions that characterizes a unique instance of service provider or production capability. A Functional Resource Type is defined as a Published Identifier (see D6).

1.6.1.7.25 invocation: The making of a request by an entity (the invoker) to another entity (the performer) to carry out the invoked operation.

1.6.1.7.26 Label List: A data structure that specifies the name of a list of Parameter Labels or Event Labels, indicates if the given list is the default list, and contains all Parameter Labels or Event Labels represented by that Label List name.

1.6.1.7.27 Label List Set: The set of Label Lists accessible by the user of the given service instance.

1.6.1.7.28 object: A functional entity that interacts with other objects. Objects are of different types, which determine their function and behavior. Objects are characterized by their interfaces, which are called ports. One object may provide multiple ports.

1.6.1.7.29 operation: A task that the invoker requests the performer to execute. Depending on the type of operation, the performer may or may not report the result of the operation to the invoker. Service user and service provider interact by invoking and performing operations.

1.6.1.7.30 parameter: In the context of an operation, data that may accompany the operation’s invocation, acknowledgement, or return.
NOTE – The term parameter is also used to refer to mission-dependent configuration information used in the production or provision of the service.

1.6.1.7.31 Parameter Identifier: In the context of a CSTS, the unique identifier of a parameter type defined for service provision or service production. A Parameter Identifier is defined as a Published Identifier (see D6).

1.6.1.7.32 Parameter Label: (See E7 for the detailed definition.)

1.6.1.7.33 Parameter Name: (See E4 for the detailed definition.)

1.6.1.7.34 performance: In the context of an operation, the carrying out of the operation by an object (the performer).

1.6.1.7.35 port identifier: Identifier of a source or a destination in a communications system.

NOTE – For purposes of the communications mapping, the endpoints of a CSTS association are identified by port identifiers, namely, an ‘initiator port identifier’ and a ‘responder port identifier’. The port identifiers represent all the technology-specific addressing information needed to establish communications between service user and service provider and to route CSTS PDUs between them.

1.6.1.7.36 procedure: A specified series of actions performed using operations which have to be executed in order to implement a specified behavior.

1.6.1.7.37 procedure configuration parameter: A configuration parameter for a procedure type. If a service permits multiple instances of a procedure type, each such procedure instance will have its own instances of (and values for) the procedure configuration parameters for that procedure type. Unless explicitly specified otherwise in the Framework definition of a procedure type, the method(s) by which the values of the procedure configuration parameters are set is (are) delegated to the service using the procedure or to a derived procedure which may delegate setting of procedure configuration to service management (see 1.6.1.7.50 and 2.3). Some procedure configuration parameters may be dynamically modifiable (see 1.6.3.2.6). Dynamic modification of procedure configuration parameter values is performed by the user of the service that uses that procedure. Unless explicitly specified otherwise in the Framework definition of a procedure type, the method(s) by which the values of dynamically modifiable procedure configuration parameters are modified is (are) delegated to the service using the procedure or to a derived procedure.

NOTE – The method a service may use to set the value of dynamically modifiable procedure configuration parameters is the THROW-EVENT procedure (see 0). A derived procedure may comprise the EXECUTE-DIRECTIVE operation (see 3.13) as the method to set dynamically modifiable procedure configuration parameter values.

1.6.1.7.38 production status: The aggregate status of the production processes that generate or process the data that is transferred by the transfer service instance.
1.6.1.7.39 **protocol abort**: A communications failure event.

NOTE – In case of communications disruption, the underlying communications service will report a communications failure event to the application. Occurrence of the communications failure event is referred to as a ‘protocol abort’.

1.6.1.7.40 **Provision Management**: The authority of a Provider CSSS that negotiates the provision of service packages with Utilization Management of an Earth User CSSS and controls and monitors the production and provision of the Cross Support Transfer Service instances by the Functional Resources belonging to the ESLT via ESLT Element Management (EM).

1.6.1.7.41 **Published Identifier**: A unique identifier that allows identification of a spacecraft, a facility where a CSTS provider is located, a Functional Resource Type, procedure type, a parameter, a directive, or an event. Published Identifiers are allocated by the Space Assigned Numbers Authority (SANA) and registered in standard SANA registries for use in CCSDS services and protocols, including but not limited to CSTSes.

1.6.1.7.42 **real-time data**: Data that can be accessed by the service user as soon as it is collected or generated by the service provider.

1.6.1.7.43 **recorded data**: Data that has been collected and stored by the service provider for access by the service user at some later time.

1.6.1.7.44 **refinement**: The act of refining operations or procedures. Operations are refined by constraining the values of parameters or by detailing the parameter semantics. Procedures are refined by modifying, e.g., narrowing, their semantics or defining their behavior or states in more detail.

1.6.1.7.45 **registered parameter**: A parameter that has been assigned a Published Identifier that is registered with SANA as specified in more detail in annex E.

1.6.1.7.46 **response**: A report, from the performer to the invoker:

a) of the acceptance of the invocation sent by the invoker; such response is referred to as acknowledgement; or

b) of the outcome of the performance of the invoked operation; such report is referred to as return.

1.6.1.7.47 **return**: A report, from the performer to the invoker, of the outcome of the performance of the operation.

a) A return with a negative result is also called a negative return.

b) A return with a positive result is also called a positive return.
1.6.1.7.48 **service-original procedure**: A procedure that is defined specifically for a particular service on the basis of one or more of the operations specified in this Recommended Standard. A service-original procedure is not derived from any other procedure.

1.6.1.7.49 **service instance provision period**: The time during which a service is scheduled to be provided by this instance.

1.6.1.7.50 **service management parameter**: A configuration parameter of a CSTS for which the initial value is set by Service Management methods, e.g., through a Utilization Request (see reference [Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 8,Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll.6]). Some CSTS configuration parameters are explicitly defined to be service management parameters by this Recommended Standard. In addition, a service using a procedure or a derived procedure may specify some or all of the procedure configuration parameters (see 1.6.3.2.6) of that (derived) procedure to be service management parameters. For each procedure configuration parameter that the service using the procedure/derived procedure specifies as being a service management parameter, Service Management will set one value for that procedure configuration parameter, which will apply to every instance of that (derived) procedure.

1.6.1.7.51 **service package**: The set of Cross Support Transfer Service instances, which may be of different service types, together with the specification of the characteristics of the production of those Cross Support Transfer Service instances that are provided by one ESLT to one or more Earth User CSSS as agreed between the Utilization Management (UM) function of the Earth User CSSS and the Provision Management (PM) function of the Provider CSSS.

1.6.1.7.52 **started procedure**: A procedure placed in the ‘active’ substate by a successful START operation.

NOTE – ‘started’ applies to a stateful CSTS procedure that has START and STOP operations. A started procedure is placed in the ‘active’ substate by a successful START operation and remains active until the procedure is (a) placed in the ‘inactive’ substate by a successful STOP operation, (b) terminated in response to a protocol error, or (c) terminated by the Association Control procedure.

1.6.1.7.53 **stateful procedure**: A procedure with two substates: ‘inactive’ and ‘active’.

1.6.1.7.54 **stateless procedure**: A procedure without substates.

1.6.1.7.55 **three-phase operation**: An operation that requires the performer to return to the invoker an initial acknowledgement of the acceptance of the invocation in addition to the report of the execution of the operation.

1.6.1.7.56 **two-phase operation**: An operation that requires the performer to return to the invoker the report of the execution of the operation.
1.6.1.7.57 unconfirmed operation: An operation for which the performer does not return a report of its outcome to the invoker.

1.6.2 NOMENCLATURE

1.6.2.1 Normative Text

The following conventions apply for the normative specifications in this Recommended Standard:

a) the words ‘shall’ and ‘must’ imply a binding and verifiable specification;
b) the word ‘should’ implies an optional, but desirable, specification;
c) the word ‘may’ implies an optional specification;
d) the words ‘is’, ‘are’, and ‘will’ imply statements of fact.

NOTE – These conventions do not imply constraints on diction in text that is clearly informative in nature.

1.6.2.2 Informative Text

In the normative sections of this document, informative text is set off from the normative specifications either in notes or under one of the following subsection headings:

– Overview;
– Background;
– Rationale;
– Discussion.

1.6.3 CONVENTIONS

1.6.3.1 Specification of Operations

1.6.3.1.1 General

Section 3 of this Recommended Standard specifies the common operations that can be used by CSTSes. The specification of each operation is divided into subsections as described in 1.6.3.1.2 and 1.6.3.1.3.
1.6.3.1.2 Behavior Subsection

The Behavior subsection provides a brief description of the operation. Additionally, it indicates whether the operation may be invoked by the service user, service provider, or both; and whether there are any constraints on when the operation may be invoked.

NOTE – Whether the operation is confirmed, unconfirmed, or acknowledged is specified in the title of the section specifying the operation.

1.6.3.1.3 Invocation, Response, and Parameters Subsection

The Invocation, Response, and Parameters subsection describes the parameters associated with each operation, including their semantics. A table accompanying the description of each operation lists all parameters associated with the operation and, for the invocation, the acknowledgement (if applicable) and the return, whether the parameter is always present, always absent, or conditionally present.

For parameters that are conditionally present, the parameter description specifies the conditions for the presence or absence of the parameter. The condition is generally based on the value of another parameter in the same invocation, acknowledgement, or return; for example, in the return of an operation, the diagnostic parameter is present if and only if the value of the result parameter is ‘negative’. For a conditional parameter in a return, the condition may be based on the value of a parameter in the corresponding invocation.

In the table, the following convention is used to indicate whether a parameter is always present, always absent, or conditionally present:

a) M  Mandatory, i.e., always present;
b) C  Conditionally present;
c) Blank  Always absent.

NOTE – Even though a parameter is characterized as always present, its description may specify that its value may be left unspecified. Given that in ASN.1 a parameter value not set to a specific value is mapped to the NULL type (see annex F), this by convention in this document is expressed as this parameter having the value ‘null’.

1.6.3.2 Specification of Procedures

1.6.3.2.1 General

Section 4 of this Recommended Standard specifies the procedures that can be used by CSTSeS. The specification of each procedure is divided into subsections as described in 1.6.3.2.2 through 1.6.3.2.6.
Each procedure section follows a common template covering a descriptive and a prescriptive part.

1.6.3.2.2 Version Number Subsection

The version number of the procedure is identified in the Version Number subsection and is used by the service using that procedure.

1.6.3.2.3 Discussion Subsection

The descriptive part covers the purpose and the concept of the procedure. This part provides the reader with an overview of the procedure.

1.6.3.2.4 Behavior Subsection

The prescriptive part introduces the sequence of activities that describes the behavior of the procedure, e.g., starting, running, and ending the activities. The operations required by the procedure are listed, and for each of them the procedure identifies those operations that are extended and/or refined by the procedure. For those operations that require extension or refinement, the details are provided. For those operations that do not require extension or refinement, the operations are not repeated as they fully conform to the common definition of the common operations (see section 3) or to the specification of the procedure from which the described procedure is derived (e.g., the Cyclic Report procedure is derived from the Unbuffered Data Delivery procedure).

The prescriptive part ends with the service provider state transition table applicable to the procedure.

1.6.3.2.5 Required Operations Subsection

This Required Operations subsection identifies the operations used by the procedure.

1.6.3.2.6 Configuration Parameters Subsection

This Configuration Parameters subsection lists the parameters that need to be configured in the context of this procedure.

This subsection also identifies those parameters that may be accessed (read) by the service user of any service that includes a procedure that contains a GET operation. For each configuration parameter, this subsection provides cross references to the use of the parameter in the specification of the procedure and also identifies the Parameter Identifier to be used in reporting the value of the parameter (see 1.6.1.7.33).
Furthermore, this subsection specifies which, if any, of the configuration parameter values may be dynamically modified while the service that is executing the procedure is bound. If one or more configuration parameters are dynamically modifiable, the subsection identifies the event that is used to notify (by means of the NOTIFY operation) when such a modification has occurred.

1.6.3.2.7 Procedure State Table Subsection

Each stateful procedure is complemented with a state transition table describing the behavior of the service provider implementing the procedure. The state tables follow the following rules:

a) The state tables specify operation interactions and state transitions for the procedures on the service provider side in its role as either invoker or performer.

b) The leftmost column simply numbers the rows of the table.

c) The second column of the state table lists all incoming events. Where these events correspond to the arrival of an incoming PDU, the ASN.1 type defined for this PDU in annex F is indicated in parentheses (( )).

d) Where an event is internal to the service provider, its description is put in single quotation marks (‘ ’).

e) The following columns (one column per state) on the right side of the table specify the behavior the service provider will exhibit, which depends on the current state and the incoming event. In some cases, the behavior additionally depends on Boolean conditions, also referred to as predicates. Such conditions are put in double quotation marks (“ ”). The predicates are defined in a table following the procedure state table. Predicates that are simple Boolean variables set only by that state machine itself are referred to as Boolean flags. The dependency on a predicate is presented in form of an IF <condition> THEN <action> [[ELSEIF <condition> THEN <action>] ELSE <action>] ENDIF clause.

f) If the action given in the table is simply to send a specific PDU, that is indicated by the appearance of the name of ASN.1 type of the PDU to be sent in parentheses (( )). If that PDU is a return or an acknowledgement, the name may be preceded by the plus symbol (+) to indicate that result is ‘positive’ or by the negative symbol (−) to indicate that result is ‘negative’. Where several actions are to be taken (referred to as a ‘compound action’), the name of the compound action is put in curly braces ({ }). The individual actions making up each compound action are identified in a table following the procedure state table. Where a simple action is to be taken, the name of the action is put in single quotes (‘ ’).

g) ‘Not applicable’ is stated where the given event can only occur in the given state because of an implementation error on the service provider side.
h) Where the consequences of an incoming event are not visible to the service user because the service provider does not send any PDU in reaction to the given event, the action is put in square brackets ([ ]).

i) State transitions are indicated by an arrow and the number of the state that will be entered; for example, ‘\( \rightarrow 1 \)’ indicates the transition to state 1.

j) The actions to be taken and the state transition are considered to be one atomic action. The sequence in which the actions shown in the table are executed is irrelevant except that the sending of PDUs shall be performed in the sequence stated in the table.

k) Whenever the service user invokes a confirmed operation with \texttt{invoke-id} set to \texttt{<n>}, it starts an associated return \texttt{<n>} timer. Should this timer expire before the return \texttt{<n>} is received, the service user is expected to invoke PEER-ABORT with the diagnostic set to ‘return timeout’.

l) Whenever a procedure is derived from another procedure (also called parent procedure), the following applies:
   1) the derived procedure’s state table contains at least the same incoming events as the parent procedure, but may have additional ones;
   2) whenever the behavior in a given state and for an incoming event is fully identical to that of the parent procedure, its description is copied from the parent procedure, but the text is italicized to highlight that the behavior is fully inherited from the parent procedure;
   3) whenever the behavior in a given state and for an incoming event is not fully identical to that of the parent procedure,
      \begin{itemize}
      \item the behavior copied from the parent procedure is written in italic typeface; and
      \item the behavior specific to the derived procedure is written in plain text;
      \end{itemize}
   4) the same convention applies to all tables directly associated with the state table.

\textbf{1.6.3.3 Typographic Conventions}

\textbf{1.6.3.3.1 Operation Names}

Names of service operations appear in uppercase.

\textbf{1.6.3.3.2 Procedure Names}

The names of procedures appear with initial capital letters (e.g., Buffered Data Delivery).
1.6.3.3 Parameter Names

In the main text, names of parameters of service operations generally appear in lowercase and are typeset in a fixed-width font (e.g., responder-port-identifier). The same convention is applied to parameters that are not service operation parameters, but are elements of a complex type parameter that is a service operation parameter. In annex F, the corresponding name is formed by omitting any hyphens contained in the name and using mixed-case (e.g., responderPortIdentifier).

1.6.3.4 Value Names

The values of many parameters discussed in this Recommended Standard are represented by names. In the main text, those names are shown in quotation marks (e.g., ‘no such service instance’). The corresponding name in annex F is formed by omitting any hyphens or white space contained in the name and using mixed-case (e.g., noSuchServiceInstance). The actual value associated with the name is constrained by the type of the parameter taking on that value. Parameter types are specified in annex F of this Recommended Standard.

NOTE – The name of a value does not imply anything about its type. For example, the value ‘no such service instance’ has the appearance of a character string but might be assigned to a parameter whose type is ‘integer’.

1.6.3.5 State Names

This Recommended Standard specifies the states of service providers. States may be referred to by number (e.g., state 2) or by name. State names are always shown in single quotation marks (e.g., ‘active’).

1.6.3.6 PDU Names

The names of PDUs appear in mixed-case (e.g., BindInvocation).

1.6.3.7 Data Type Definitions

Data type definitions are presented in annex F in the form of a set of ASN.1 modules. Regardless of the conventions used elsewhere in this Recommended Standard, the text of the ASN.1 modules is typeset entirely in a fixed-width font.

1.6.3.8 Normative Mechanism and Data Structure Names

The names of normative mechanisms and data structures appear with initial capital letters (e.g., Cross Support Transfer Service, Functional Resource Name, Published Identifier). Such
mechanisms and data structures have defined roles in the functioning of operations and procedures.

1.7 REFERENCES

The following publications contain provisions which, through reference in this text, constitute provisions of this document. At the time of publication, the editions indicated were valid. All publications are subject to revision, and users of this document are encouraged to investigate the possibility of applying the most recent editions of the publications indicated below. The CCSDS Secretariat maintains a register of currently valid CCSDS publications.

NOTE – A list of informative references is provided in annex I.


2 DESCRIPTION OF CROSS SUPPORT SERVICES

2.1 OVERVIEW

Cross Support Transfer Services (CSTSes) provide for reliable, access-controlled transfer of spaceflight mission related data between ground element entities. A Cross Support Service is characterized by the kind of data it transfers (e.g., telemetry data, tracking data, service production monitoring data), and therefore different CSTSes need to respond to specific requirements that may demand specific solutions. On the other hand, all CSTSes defined by CCSDS apply the same basic communications patterns in order to simplify specification, implementation, and operation of these services. The basic approach applied to CSTSes is that they are realized through invocation and performance of operations in accordance with well-defined procedures.

This Recommended Standard provides a Specification Framework for CSTSes with the objective to:

a) maximize the commonality between CCSDS CSTSes;

b) simplify specification of new CCSDS CSTSes; and

c) enable the design and implementation of reusable software components with the potential of simplifying the implementation of CSTSes.

NOTE – While this specification strives for enabling the design and implementation of reusable software components, it does not intend to provide a specification for such components.

This Recommended Standard defines basic building blocks from which services can be constructed. The companion Recommended Practice, Guidelines for Specifications of Cross Support Transfer Services (reference [Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 8,Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll.3]), defines the rules to be used for the specification of CSTSes.

Building blocks defined by the CSTS Specification Framework include:

a) data types for information exchanged between service user and service provider;

b) common operations that are invoked by one entity and performed by the other entity and as such implement the basic elements of interaction between service user and service provider; and

c) common procedures which define the behavior and protocol for the invocation and performance of a set of operations to achieve a well-defined objective.

A CSTS may be defined by combining a set of procedures specified in the CSTS Specification Framework in a manner that best suits the objective of the service.
To be generally applicable, parameters, operations, and procedures defined by the CSTS Specification Framework are sufficiently abstract that they may or may not be directly usable for real services. For cases where the building blocks are not directly usable, new operations or procedures can be derived from those defined in the CSTS Specification Framework.

Taking the concept of generic definitions one step further, this Recommended Standard supports the concept of abstract services (see reference [Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 8,Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll.5]) that specify the common operations and behavior of CSTSes but are not directly implementable because service-specific specifications are still missing. Real CSTSes can be derived from such abstract services.

NOTE – An example of an abstract service could be a CSTS Return Link Service from which real services such as CSTS RAF, CSTS RCF, and CSTS ROCF could be derived. These CSTSes would be equivalent to SLE RAF, SLE RCF, and SLE ROCF.

The relationships between the elements of the CSTS Specification Framework and example CSTSes based on the Framework are illustrated in figure 2-1.
2.2 CROSS SUPPORT REFERENCE MODEL

2.2.1 INTRODUCTION

CCSDS Cross Support Transfer Services are defined within a framework that is a logical extension of the Cross Support Reference Model (reference [1]) that was originally defined for Space Link Extension (SLE) services. The following subsections summarize concepts from the reference model that are supported by the CSTS Specification Framework and to which later sections in this Recommended Standard refer. Formal definitions of terms are provided in 1.6.

Before a Cross Support Transfer Service can be used, an association needs to be established between service user and service provider by binding the ports associated with the specific CSTS. To that end, the initiator issues the request to bind to the responder. If the responder can complete the binding, the required association is established and service user and service provider can invoke and perform the operations of the given CSTS type. Depending on the
type of operation, the performer may or may not report the result of the operation to the
invoker.

2.2.2 SERVICE PRODUCTION AND PROVISION

2.2.2.1 General

The Cross Support Reference Model (reference [1]) distinguishes between service production
and service provision.

Cross Support Service production refers to the common processes performed by service
production of an ESLT associated with the provision of one or more Cross Support Services.

An ESLT is said to provide a service when it makes available to the service user the
capability to obtain the service via one or more of its ports. Provision involves the interface
between the service user and the service provider, and is characterized by the type(s) of data
transferred and the quality of service with which they are transferred (e.g., completely,
reliably, etc.).

The CSTS Specification Framework deals primarily with service provision. Service
production is generally very specific for specific services or a class of services, and therefore
the CSTS Specification Framework makes only very general assumptions on service
production.

2.2.2.2 Service Production Status

The status of production resources is reported by means of the resource-status
parameter of each of the associated Functional Resources except those Functional Resources
that represent CSTS instances. The latter each have a production-status parameter.
The CSTS specifies how the production-status value shall be determined based on the
CSTS instance as such and on the resource-status parameters of the Functional
Resource Instances involved in the service production. This Recommended Standard defines
the permissible values of production-status and the transitions between these values in
abstract terms (see annex B); these values may be refined by service specifications based on
the CSTS Specification Framework. Service specifications may also define substates for one
or more of the production-status values where appropriate.

Production status changes may be notified to the service user via any procedure that includes
the NOTIFY operation (3.11), e.g., the Notification procedure (see 4.11). As for any other
parameter, the current value of the production-status parameter may be obtained
using (a) the Cyclic Report procedure defined in 4.10, if that is supported by the service, or
(b) the GET operation, if any procedure of the service (including the Information Query
procedure) uses the GET operation.
The production-status values and the permissible transitions, and the effects of these production-status values on common operations are defined in annex B.

2.3 SERVICE MANAGEMENT

For all CSTSes, service management determines the number and schedule of service instances to be provided, the resources required to enable those service instances, and the initial configuration of all service instances and their supporting resources. Configuration parameters that have their initial values set through Service Management are called service management parameters (see 1.6.1.7.50). Cross Support Service Management is the subject of separate CCSDS Recommended Standards (see references [Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 8,Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll.6] and [Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 8,Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll.7]).

Service management parameters may refer to service provision or to service production. Explicit specification of service management parameters in this Recommended Standard is confined to a small set of service provision parameters, including

a) identities of the service initiator (i.e., the service user) and the service responder (i.e., the service provider);

b) identity of the port at which the service is made available;

c) the service instance provision period.

For some procedures this Recommended Standard identifies procedure configuration parameters that are known to the service user and the service provider but the definition of how their values are determined is delegated to the service specification. The service specification may specify these values, or designate them to be service management parameters. Reference [Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 8,Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll.3] provides guidelines on how service management parameters shall be handled in derived service specifications.

For service management parameters that correspond to procedure configuration parameters, Service Management will configure all instances of a given procedure type being associated with a given service instance equally.

Some procedure configuration parameters of individual procedure instances may be updated dynamically at any time while the service instance executing the procedure instances is bound. The dynamic modification of such procedure configuration parameters is outside the scope of Service Management and must be carried out within the CSTS instance itself, e.g., through a Throw Event procedure that is part of that service. The particular method(s) by which dynamic modifications of procedure configuration parameters are performed is left to the definition of the services that use such dynamically modifiable procedure configurations.
2.4 ELEMENTS OF THE CSTS SPECIFICATION FRAMEWORK

2.4.1 COMMON OPERATIONS

An operation is a task that the invoker requests the performer to execute and as such presents
the basic interaction pattern between the service user and the service provider. The invocation
of an operation may include parameters that specify further details of the task to be
performed.

Operations are further classified by the number of interactions required to complete the
operation:

a) An unconfirmed operation is invoked by the invoker and performed by the
performer, but there is no report on the outcome of the operation.

b) For a confirmed operation the performer provides a report (the ‘return’) to the
invoker on success or failure of the operation. Operation returns comprise an
indication of success (result has the value ‘positive’) or failure (result has the
value ‘negative’) and, in case of failure, a diagnostic that further specifies the
reason for the failure. Confirmed operations are further classified as:

1) two-phase operations, for which the performer returns a single report to the
invoker;

2) three-phase operations, for which the performer provides an initial response in
the form of an acknowledgement when receiving the invocation and subsequently
issues the return when the operation has completed. This type of operation is
typically used for operations where the task to be performed requires non-
negligible time to complete. The acknowledgement confirms that the invocation
has been received and understood and that the general preconditions for the
operation are fulfilled.

NOTE – In labeling confirmed operations, the designation (CONFIRMED) identifies a
two-phase confirmed operation, and (ACKNOWLEDGED) identifies a three-
phase confirmed operation.

Confirmed operations are further classified as blocking or non-blocking with respect to the
procedure that uses the operation. When a blocking operation has been invoked, no further
operation of the same procedure instance can be invoked before the return to the invocation
has been received. Non-blocking operations do not impose any constraints with respect to
invocation of further operations.

The CSTS Specification Framework defines standard operation headers for unconfirmed and
confirmed operations and a set of common operations for use within CSTS. To be of general
use, the operations of the CSTS Specification Framework are rather abstract and might not all
be directly usable within a procedure used by a specific CSTS. However, all operations used
in a procedure of a CSTS that conforms to this Recommended Standard are derived directly or indirectly from the operations specified herein applying the rules described in 2.5.

The common operations defined by the CSTS Specification Framework are listed in table 2-1. Section 3 of this Recommended Standard provides the detailed specification of these operations.

Table 2-1: Common Operations Defined by the CSTS Specification Framework

<table>
<thead>
<tr>
<th>Operation</th>
<th>Invoked By</th>
<th>Purpose</th>
<th>Confirmed Ack.</th>
<th>Confirmed Ret</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIND</td>
<td>service user</td>
<td>Establishment of an association with the peer.</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>UNBIND</td>
<td>service user</td>
<td>Release of an association previously established by a BIND operation.</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>PEER-ABORT</td>
<td>service user or service provider</td>
<td>Notification to the peer that the local application detected an error that requires the association to be terminated.</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>START</td>
<td>service user</td>
<td>Request that the service provider start performing activities associated with the procedure using the operation.</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>STOP</td>
<td>service user</td>
<td>Request that the service provider stop performing activities associated with the procedure using the operation.</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>TRANSFER-DATA</td>
<td>service provider</td>
<td>Transfer of a data unit to the service user.</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>PROCESS-DATA</td>
<td>service user</td>
<td>Request that the service provider process the data received.</td>
<td>No</td>
<td>No/Yes (see NOTE)</td>
</tr>
<tr>
<td>NOTIFY</td>
<td>service provider</td>
<td>Sending of a notification of an event to a service user.</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>GET</td>
<td>service user</td>
<td>Ascertainment of the value of (a) service parameter(s).</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>EXECUTE-DIRECTIVE</td>
<td>service user</td>
<td>Request that the service provider perform a predefined action.</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

NOTE – For the PROCESS-DATA operation, both an unconfirmed and a confirmed variant exist. It is at the discretion of the procedure using this operation to specify if the unconfirmed or confirmed variant is used.
2.4.2 COMMON PROCEDURES

Procedures define the protocol and the expected behavior for the invocation and performance of a set of operations to achieve a well-defined objective. A CSTS may be specified by assembling a given set of procedures to handle specific aspects of the service.

For instance, a service that forwards telemetry received on the space link can be broken down into a number of procedures that handle association establishment and release, actual transfer of telemetry data units, status reporting, and querying of the service configuration parameters. All of these procedures except for telemetry data transfer can also be used for a service that supports reception and radiation of telecommands, where only a subset of the parameters in the reports differs.

The specification of a procedure includes:

a) a description of the objective of the procedure including all assumptions that are made with respect to the type of data to be transferred and the service production process (descriptive);

b) a definition of the behavior of this procedure (prescriptive);

c) a definition of the operations that constitute this procedure (prescriptive);

d) a description of behavior expected of the service provider supported by a service provider side state matrix, where applicable (prescriptive).

As far as the protocol is concerned, procedures can be stateful or stateless. A stateful procedure supports the states ‘inactive’ and ‘active’ with transitions between these states triggered by well-defined operation invocations or responses. Typically the transition from ‘inactive’ to ‘active’ is triggered by a START invocation and the transition from ‘active’ to ‘inactive’ is triggered by a STOP return. However, other transitions may exist. For instance, procedures using three-phase operations might transition from ‘inactive’ to ‘active’ with the operation invocation and back to ‘inactive’ with the final return.

NOTE – The Association Control procedure is an exception to the above rules. The Association Control procedure does not belong to any class (stateful or stateless) and is required to manage the association.

A CSTS will typically use more than one procedure in addition to the Association Control procedure and may require more than one procedure of the same type to be active at the same time, e.g., to transfer different data streams concurrently. Therefore this Recommended Standard distinguishes between the procedure type and the procedure instance. The procedure type corresponds to the specification of the procedure or the supporting program that implements the procedure specification. A procedure of a given type can be instantiated once or several times as part of the instantiation of the service using this procedure. Different instances of the procedure are distinguished by a ‘procedure instance identifier’ that is assigned by service management when creating the service package and included in all operation invocation and response headers.
NOTE – Further information on how a service uses predefined procedures is provided in 2.5. Normative rules for this purpose are specified in reference [Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 8,Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll.3].

The CSTS Specification Framework defines a set of common procedures that cover typical tasks of a CSTS. In order to be commonly usable, the procedure definition and in particular the purpose and semantics specification are reasonably abstract, such that the specifications as provided by this Recommended Standard may sometimes not be directly usable. For those cases, reference [Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 8,Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll.3] specifies methods to derive more specific procedures from these common procedures.

Table 2-2 identifies the common procedures included in this CSTS Specification Framework and table 2-3 shows the operations that are used by these procedures. Section 4 of this Recommended Standard provides the detailed specification of these procedures.

**Table 2-2: Common Procedures Defined by the CSTS Specification Framework**

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Purpose</th>
<th>Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Association Control</td>
<td>Establishment and release of an association between a service user and a service provider.</td>
<td>N/A</td>
</tr>
<tr>
<td>Unbuffered Data Delivery</td>
<td>Best effort transfer of bulk data, structured into data units, sent from the service provider to the service user in real-time delivery mode.</td>
<td>SF</td>
</tr>
<tr>
<td>Buffered Data Delivery</td>
<td>In-sequence transfer of bulk data, structured into data units, sent from the service provider to the service user. In real-time mode, low latency is given priority over data completeness. In complete mode, data completeness is given priority over low latency.</td>
<td>SF</td>
</tr>
<tr>
<td>Data Processing</td>
<td>Processing of individual data units in the sequence as sent by the service user to the service provider and reporting of processing progress.</td>
<td>SF</td>
</tr>
<tr>
<td>Buffered Data Processing</td>
<td>Processing of data units contained in buffers in the sequence as sent by the service user to the service provider and reporting of processing progress. Processing may be in complete mode at the expense of latency or in timely mode at the expense of data loss.</td>
<td>SF</td>
</tr>
<tr>
<td>Sequence-Controlled Data Processing</td>
<td>Processing with full flow control of individual data units in the sequence as sent by the service user to the service provider and reporting of processing progress.</td>
<td>SF</td>
</tr>
<tr>
<td>Information Query</td>
<td>Query by the service user of the value of one or more parameters related to the service provider or service production behavior.</td>
<td>SL</td>
</tr>
<tr>
<td>Cyclic Report</td>
<td>Periodic reporting of parameter values from the service provider to the service user.</td>
<td>SF</td>
</tr>
<tr>
<td>Notification</td>
<td>Notification of the service user by the service provider of events of interest to the service user.</td>
<td>SF</td>
</tr>
<tr>
<td>Procedure</td>
<td>Purpose</td>
<td>Class</td>
</tr>
<tr>
<td>-----------------</td>
<td>-------------------------------------------------------------------------</td>
<td>-------</td>
</tr>
<tr>
<td>Throw Event</td>
<td>Signaling to the service provider the occurrence of an event requiring</td>
<td>SF</td>
</tr>
<tr>
<td></td>
<td>a configuration change action and report of the result of the action</td>
<td></td>
</tr>
<tr>
<td></td>
<td>back to the service user.</td>
<td></td>
</tr>
</tbody>
</table>

NOTE – ‘SF’ and ‘SL’ indicate ‘stateful’ and ‘stateless’, respectively.

Table 2-3: Use of Operations by Common Procedures

<table>
<thead>
<tr>
<th>Operation</th>
<th>Association Control</th>
<th>Unbuffered Data Delivery</th>
<th>Buffered Data Delivery</th>
<th>Data Processing</th>
<th>Buffered Data Processing</th>
<th>Sequence-controlled Data Processing</th>
<th>Information Query</th>
<th>Cyclic Report</th>
<th>Notification</th>
<th>Throw Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIND</td>
<td>B</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UNBIND</td>
<td>B</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PEER-ABORT</td>
<td>NB</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>START</td>
<td>B</td>
<td>B</td>
<td>B</td>
<td>B</td>
<td>B</td>
<td>B</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>STOP</td>
<td>B</td>
<td>B</td>
<td>B</td>
<td>B</td>
<td>B</td>
<td>B</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRANSFER-DATA</td>
<td>NB</td>
<td>NB</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>NB</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PROCESS-DATA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GET</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NOTIFY</td>
<td>NB</td>
<td>NB</td>
<td>NB</td>
<td>NB</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EXECUTE-DIRECTIVE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NOTE – ‘B’ and ‘NB’ indicate that the operation is ‘Blocking’ or ‘Non-Blocking’, respectively.
2.5 PRINCIPLES OF USING THE CSTS SPECIFICATION FRAMEWORK

2.5.1 OVERVIEW

The CSTS Specification Framework provides a set of reusable building blocks for the specification of CSTSes and defines general rules by which such building blocks can be extended and refined to match the specific requirements of a CSTS.

The specification of a CSTS can be constructed by composition of procedures that either are fully predefined within the CSTS Specification Framework or are derived from those defined in the Framework. Specification of a completely new service-specific procedure using common operations or operations derived from the common operations is permissible but is not recommended.

The rules for derivation of operations and procedures have been rigorously applied to the specification of the CSTS Specification Framework itself:

a) The common procedures specified in section 4 present the most abstract and general version; several procedures defined within the CSTS Specification Framework derive extended operations, which may be further derived by services using these procedures.

b) Some of the procedures defined within the CSTS Specification Framework are derived from more basic procedures also defined in the Framework. For instance, the Cyclic Report procedure is derived from the Unbuffered Data Delivery procedure.

The derivation rules can be further applied to operations and procedures that have been derived from the operations and procedures defined within the CSTS Specification Framework. It is envisaged that such operations and procedures might eventually be included in the Framework if they prove to be useful for more than one service type.

The normative specification of the rules for derivation of operations and procedures and for composition of services can be found in reference [Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 8, Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll.3]. The following subsections provide a brief summary.

2.5.2 DERIVATION OF OPERATIONS AND PROCEDURES

Derivation of operations and procedures from the building blocks defined in the CSTS Specification Framework encompasses two dimensions:

a) extension, by which new data or behavior are added to a specification; and

b) refinement, by which the range of values may be constrained or the semantics of parameters may be specialized.

Operations may be extended in the following ways:
a) New parameters may be added (syntax and semantics specification) to an operation invocation or response; unless explicitly specified otherwise, all operations defined in the CSTS Specification Framework can be extended in this way.

b) In some cases additional values may be defined for an existing parameter (e.g., additional diagnostic values or additional types of notification).

c) In some cases, the format and content of a parameter may have to be specified by the service using the corresponding operation. This is necessary because, for some operations, there are parameters whose structure is unspecified.

Operations may be refined by narrowing the value range of a parameter or by specializing the meaning of a parameter. For instance, the generation-time parameter of the TRANSFER-DATA operation in the Buffered Data Delivery procedure may be refined for a procedure dealing with transfer of telemetry by stating that the generation-time is the Earth Receive Time of the telemetry frame being transferred.

Procedures may be extended in the following ways:

a) extension of the operations used by a procedure as described above;

b) addition of operations defined in the CSTS Specification Framework or derived from operations defined in the Framework.

Procedures may be refined by narrowing the specification of the semantics associated with the procedure or by adding more detail to the behavior description or the state table. The refinement of a procedure does not imply the definition of a new procedure.

As an example, a Telemetry Delivery procedure could be derived from the Buffered Data Delivery procedure by extension and refinement of the operations START and TRANSFER DATA and by refinement of the semantics associated with the data to be transferred and the parameters of the operations. The extension of a procedure implies the definition of a new procedure (derived procedure).

2.5.3 SPECIFICATION OF SERVICES BY COMPOSITION OF PROCEDURES

A CSTS can be specified by composition of procedures defined in the CSTS Specification Framework, derived from procedures in the Framework or derived from an existing CSTS.

Every service includes the Association Control procedure (see 4.3). Only a single instance of the Association Control procedure exists throughout the lifetime of a transfer service instance.

In addition to the Association Control procedure a service may comprise any number of further procedure types and may use one or more instances of each procedure type. However, one single procedure instance is designated the prime procedure of the service. All other procedure instances are referred to as secondary procedures.
NOTE — The prime procedure (instance) can be of the same type as one or more secondary procedure instances.

The prime procedure (instance) of a service should reflect the primary purpose of the service. In practical terms it determines the state of the service and as such determines the orderly association release as detailed in 2.6.

2.6 PROTOCOL DESCRIPTION

2.6.1 STATES OF THE SERVICE PROVIDER

The service user and service provider of a Cross Support Transfer Service can interact as soon as the associated service ports are bound by establishment of an association between them. Binding is achieved by the Association Control procedure that is included in every CSTS.

Once the service instance is bound other procedures used by the service can be operated according to their specific protocol.

NOTE — This Recommended Standard does not specify any interdependencies between the procedures that constitute a service. However, the service specification may specify dependencies that must be observed, e.g., with respect to the sequence in which procedures are started.

When the service instance is bound the service state is further determined by the state of the prime procedure (instance). If the prime procedure is stateful the state ‘bound’ has two substates, ‘ready’ and ‘active’. When the prime procedure is ‘inactive’, the service instance is in the state ‘bound.ready’, and when the prime procedure is ‘active’, the service instance is in the state ‘bound.active’. If the prime procedure is stateless then the service state ‘bound’ has no substates.

A service instance having a stateful prime procedure can be unbound by the service user in an orderly manner only while in the state ‘bound.ready’, i.e., while the prime procedure is ‘inactive’. Service instances with a stateless prime procedure can be unbound at any time. Finally a service instance may be aborted by either entity at any time by invoking the PEER-ABORT operation.

Any stateful secondary procedure has a state machine of its own but has no effect on the overall service instance state. This implies that the UNBIND operation can be invoked while one or more stateful secondary procedures are in the state ‘active’. Therefore, for a stateful secondary procedure, unbinding has the same effect as PEER-ABORT.

Any stateless secondary procedure is unaffected by the overall service instance state. The operations of any stateless secondary procedure instance may be invoked whenever the service instance is in the ‘bound.ready’ or ‘bound.active’ state if the prime procedure of that service is stateful or the service instance is in the ‘bound’ state if the prime procedure of that service is stateless.

NOTE — The prime procedure (instance) can be of the same type as one or more secondary procedure instances.

The prime procedure (instance) of a service should reflect the primary purpose of the service. In practical terms it determines the state of the service and as such determines the orderly association release as detailed in 2.6.

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Any stateless secondary procedure is unaffected by the overall service instance state. The operations of any stateless secondary procedure instance may be invoked whenever the service instance is in the ‘bound.ready’ or ‘bound.active’ state if the prime procedure of that service is stateful or the service instance is in the ‘bound’ state if the prime procedure of that service is stateless.
The overall relationship of the states of the service instance, the prime procedure, and secondary procedures is illustrated in figures 2-2 and 2-3 for a stateful and a stateless prime procedure, respectively.

NOTE – The diagrams in figures 2-2 and 2-3 do not present state diagrams in a formal sense, as they present different state machines in a synoptic view. The corresponding normative statements can be found in annex G.

![Diagram of service and procedure states](image)

**Figure 2-2: Service and Procedure States (Stateful Prime Procedure)**

NOTE – The activation and deactivation of stateful procedures is further specified in 4.2.4.
2.6.2 ASSOCIATION MANAGEMENT

Establishment and release of an association between the service user and the service provider is handled by the Association Control procedure specified in 4.3. All other procedures rely on the presence of such association and therefore establishment and release of the association must be coordinated between the procedure instances within a service instance.

An association is established by means of the BIND operation (see 3.4) which is always invoked by the service user. Before the BIND operation is completed, i.e., the BIND return is issued by the service provider, no further operation can be invoked. The only exception to this rule is the PEER-ABORT operation, which can be invoked by the service user if the BIND return is not received in good time. Once the association is established, other procedures used by the service can be operated according to their defined protocol.
During the lifetime of the association, the prime procedure (instance) of the service instance and the Association Control procedure instance must cooperate to determine the applicable substate of the state ‘bound’ and the transitions between these states (see 2.6.1).

An association is released normally when an UNBIND operation is invoked by the service user (the initiator) and accepted by the service provider (the responder). An association may be aborted by either the service user or the service provider by means of the PEER-ABORT operation. An association may also be aborted because of a failure in the underlying communications system. Such failures are signaled to the local application entity by the ‘protocol abort’ event described in 4.3.3.1.11.5.

Conceptually, invocations of the operations UNBIND and PEER-ABORT will be received by the Association Control procedure, which will

a) verify the validity of the event according to the defined protocol and react accordingly;

b) inform all other procedures of the event;

c) respond to the event as defined by the protocol, e.g., by issuing an UNBIND return;

d) terminate the underlying communications connection, if applicable.

If a procedure needs to abort the association, e.g., because of a protocol error, it forwards this request to the Association Control procedure, which will invoke the PEER-ABORT operation and will inform all other procedures.

All procedures are expected to close down and release all resources associated with the service instance when they are notified of the termination event.

When an association is released or aborted, no further operations can be exchanged between the service user and the service provider. The systems may re-establish an association via a new BIND operation if that is consistent with the service instance provision period. However, status information from the prior association is not preserved unless specified differently by the service specification.

2.6.3 TECHNOLOGY SPECIFIC ASPECTS

This Recommended Standard defines building blocks for the specification of CSTSes. Provision of a CSTS in a real system also requires a specification of how the service is mapped to a communications service such that all invocations and responses of the service operations can be conveyed between the service user and the service provider. In order not to restrict the applicability of service specifications based on this Recommended Standard to a specific communications technology, as few assumptions as possible have been made about the characteristics of the underlying communications service (see 1.3.1).
NOTE – While this Recommended Standard makes only a few assumptions on the underlying communications service, reference [2] specifies a communications service that is assumed to be used by default for CSTSes.

Elements of the CSTS interface between the service user and the service provider are specified in this Recommended Standard in terms of the operations that the service implements. These operations are realized by mapping the service operation invocations, acknowledgements, and returns to protocol data units that can be conveyed by means of the underlying communications service. This Recommended Standard conceptualizes such mapping in two parts:

a) operation invocations, acknowledgements, and returns are mapped to CSTS PDUs defined in annex F;

b) CSTS PDUs are conveyed by means of an underlying communications service.

Typically one CSTS PDU corresponds to the invocation, acknowledgement, or return of an operation. There is one exception in which multiple TRANSFER-DATA or PROCESS-DATA invocations are deliberately buffered and subsequently mapped to a single CSTS PDU (see 4.5.2.2.2.2 and 4.7.3.2.1). From the point of view of the service provider or service user application, the interaction between the service user and service provider is in terms of operations, but from the point of view of the application entities that implement the CSTS protocol, what is exchanged are CSTS PDUs.

The mapping of CSTS PDUs to an underlying communications service is intentionally outside the scope of this Recommended Standard. In order to achieve interoperability, the service user and service provider must conform not only to the service specification based on this Recommended Standard but also to an agreed-upon specification of the mapping of the service to the underlying communications service. The specification of a mapping of the service onto a particular communications service must address such points as:

a) selection of communications network(s) to ensure connectivity;

b) compatible configuration of protocol stacks (e.g., timeout values);

c) specification of port identifiers, and their translation onto the communications technology;

d) specification of security-related information.

Figure 2-4 illustrates a communications realization of a CSTS that results from such a mapping. The specification of a suitable mapping for CSTS to the Transmission Control Protocol (TCP) and the Abstract Syntax Notation One (ASN.1) is provided in reference [2].

The procedures specified in section 4 have each their individual state tables giving the impression that the interaction between service user and service provider in the context of a given procedure is mutually independent of any concurrently executing procedures. However, this is not the case because all PDUs exchanged in the context of a given service instance
share the same communications channel. The consequence is that should one procedure create backpressure by not reading from the transport layer socket, this backpressure affects all PDUs being exchanged in the context of the given service instance regardless of the procedure instance emitting the PDU.

Figure 2-4: Communications Realization of a Cross Support Transfer Service
3 COMMON OPERATIONS

3.1 OVERVIEW

This section specifies the operations that are used by the procedures defined in this Recommended Standard. Subsection 3.2 and 3.3 specify behaviors that are generally applicable to all operations. Subsections 3.4 through 3.13 specify individual operations that are used by the procedures defined in this Recommended Standard.

3.2 GENERAL CONSIDERATIONS

3.2.1 COMMON OPERATION BEHAVIOR

3.2.1.1 All invokers of confirmed operations shall implement a timer for the acknowledgement in case of three-phase operations or the return in case of two-phase operations. In case the timer expires, the invoker may issue a PEER-ABORT with the diagnostic set to ‘response timeout’.

NOTE – This Recommended Standard does not specify any confirmed operation being invoked by the service provider. Therefore such PEER-ABORT operation will never be invoked by the service provider, but it may be received from the service user.

3.2.1.2 On reception of the acknowledgement in case of three-phase operations or the return in case of two-phase operations, the invoker of the corresponding confirmed operations shall stop the timer.

3.2.1.3 All acknowledgements and returns shall include a result parameter that indicates whether the outcome of the operation was successful (result has the value ‘positive’) or unsuccessful (result has the value ‘negative’).

3.2.1.4 If result reported in an acknowledgement is ‘negative’, no return shall be generated.

3.2.1.5 If result reported in an acknowledgement or return is ‘negative’, the acknowledgement or return shall also include a diagnostic parameter, the value of which is descriptive of the reason for the negative result.

3.2.1.6 For certain values of the diagnostic parameter it shall be complemented by:

   a) a visible string which value shall start with the diagnostic name identified in this Recommended Standard or in the service definition using this Recommended Standard;

   b) additional diagnostic information whenever required by this Recommended Standard.
NOTES

1 Possible values of the diagnostic parameter are listed in the specification of each operation.

2 The visible string diagnostic is for troubleshooting purpose in order to allow implementers to add information to the diagnostic and to accommodate service-type or implementation-specific information. The value of the string, apart from the diagnostic name, shall be chosen by the implementers or defined in the CSTS specification.

3 The presence or absence of a visible string complementing the diagnostic value is specified in annex F.

3.2.1.7 The diagnostic parameter value may be extended by derived operations, procedures and services to support dedicated diagnostic values.

3.2.1.8 Unless otherwise specified, all operation invocations, acknowledgements, and returns defined in this Recommended Standard can be extended.

NOTE – The extension capability is not explicitly mentioned in the rest of the document and is to be considered implicit for all operations.

3.2.2 PARAMETER TYPES

The types of all parameters shall conform to the abstract syntax specified in annex F.

NOTES

1 Some parameter types in annex F are chosen such that an extension is possible. For example, the diagnostic parameter can be extended so that a service can define its own diagnostic values.

2 The syntax specified in annex F ensures the possibility of extension by defining fields that can be, whenever required, defined externally to the proposed syntax (e.g., operations extension).

3.2.3 PARAMETER CHECKING AND PDU VALIDATION

3.2.3.1 Validity checks shall be performed on the values of parameters associated with an operation.

NOTE – Rules governing the validity of parameter values are included in the specification of individual operations. General reasons for regarding a parameter value as invalid are specified in the following paragraphs.
3.2.3.2 A parameter value shall be treated as invalid if it is outside the range or not in the set of values permitted by the operation using the given parameter.

NOTE – A conforming implementation is capable of supporting the full range or set of values as specified in annex F and applicable to the service using this Recommended Standard.

3.2.3.3 A parameter value shall be treated as invalid if it is in conflict with the value of another parameter in the same invocation.

NOTE – For example, the value of the start-time parameter in the invocation of an operation is invalid if it is later than the value of the stop-time parameter.

3.2.3.4 If a parameter value is not valid, the operation shall not be performed and, for confirmed operations, a report of the negative result shall be returned to the invoker.

3.2.3.5 While this Recommended Standard does not prescribe the sequence of checks for the parameters, the implementer shall document the implemented sequence.

3.2.3.6 A PDU shall be treated as invalid if:

a) it contains an unrecognized operation type or a parameter of the wrong type;

b) it is otherwise not decodable;

c) the procedure identifier is not one of the specified service procedures identifiers;

d) the incoming PDU violates the procedure’s state table, i.e., the PDU is not permitted in the present procedure state;

e) the value of the invoke-id parameter is the same as the invoke-id value of another operation still being performed;

f) procedure type specific constraints apply that the incoming PDU violates.

NOTE – An example of such constraint is the the maximum number of PROCESS-DATA invocations contained in the forward buffer PDU that the Buffered Data Processing procedure is configured to accept (refer to 4.7.3.2.1.4).

3.2.3.7 In the case of an invalid PDU, the service provider shall abort the association using a PEER-ABORT with the corresponding diagnostic value (see 3.6.2.2.1).
3.2.4 AUTHENTICATION

NOTE – Requirements for security depend on the application and the system environment (e.g., whether closed or public networks are used or if access is only from physically restricted areas). In many environments, security may be provided by the communications service, transparently to the application. This Recommended Standard does not preclude the use of security features that are provided by the communications service or the local environment, nor does it assume the availability of such features.

3.2.4.1 The service shall provide the following options with respect to the level of authentication of invocations and responses of operations:

   a) ‘all’: all invocations, acknowledgments, and returns, except the invocation of PEER-ABORT, shall be authenticated;

   b) ‘bind’: only the BIND invocation and return shall be authenticated;

   c) ‘none’: neither invocations nor responses shall be authenticated.

3.2.4.2 The UM function of the Earth User CSSS and the PM function of the Provider CSSS shall agree on the level of authentication to be required for a given service instance and shall configure service user and service provider accordingly.

3.2.4.3 The UM function of the Earth User CSSS and the PM function of the Provider CSSS shall agree on the algorithm used to generate and check credentials parameters and shall make this algorithm known to the service user and service provider together with associated parameters such as passwords or keys as necessary for the selected algorithm.

NOTES

1 The specification of the algorithms themselves is outside the scope of this Recommended Standard. However, the SLE Internet Protocol for Transfer Services (ISP-1, reference [2]), which is the default underlying communication protocol for CSTSes, specifies a particular algorithm for the generation of credentials. Any implementation that uses ISP-1 will use the credentials algorithm specified therein.

2 The initiator-identifier and responder-identifier parameters of the BIND operation identify the service user and service provider and therefore the applicable authentication level and algorithm necessary to generate and check credentials.

3.2.4.4 For operations for which authentication is required by the terms of the agreement between PM and UM of the CSSSes:

   a) invocations shall include an invoker-credentials parameter to permit the performer to authenticate the invocation;
b) responses shall include a **performer-credentials** parameter to permit the invoker to authenticate the response.

### 3.2.4.5
For operations for which authentication is not required, the **invoker-credentials** and **performer-credentials** parameters should be set to the value ‘unused’ to signify that the invocation or response does not carry credentials.

#### 3.2.4.5.1
An incoming invocation, return, or acknowledgment shall be ignored if the credentials parameter cannot be authenticated when, by management arrangement, credentials are required.

#### 3.2.4.5.2
If an invocation is ignored, the operation shall not be performed, and a report of the outcome shall not be returned to the invoker.

#### 3.2.4.5.3
If a return is ignored, it shall be as if no report of the outcome of the operation has been received.

### 3.2.5 INVOKE IDENTIFIER

#### 3.2.5.1
To support applications that may need to invoke several operations concurrently, the parameter **invoke-id** is specified for all operations.

**NOTES**

1. The **invoke-id** parameter allows the invoker to correlate a particular response to the invocation that prompted it.

2. Confirmed operations may be blocking or non-blocking. The choice is to be specified in the procedure definition. Unconfirmed operations are always non-blocking.

#### 3.2.5.2
The value of the **invoke-id** parameter shall be an invoker-supplied arbitrary integer value that shall be returned, unchanged, by the performer.

#### 3.2.5.3
In case the value of the **invoke-id** parameter is the same as the **invoke-id** of another operation that is still being performed within the context of the same service instance, the service provider shall issue a PEER-ABORT.

#### 3.2.5.4
To ensure that the service behaves in a predictable manner, the effects of operations shall be as though the operations were performed in the order in which they were invoked.

### 3.2.6 BLOCKING AND NON-BLOCKING OPERATIONS

#### 3.2.6.1
Invocation of an operation for the same procedure instance when a blocking operation response is outstanding constitutes a protocol error and shall lead to the service provider issuing a PEER-ABORT with the **diagnostic** parameter set to ‘protocol error’.
NOTE – After invoking a blocking operation, the invoker may invoke a PEER-ABORT with the diagnostic parameter set to ‘response timeout’ if the response to the previously invoked blocking operation is not received in good time (see 3.2.1.1).

3.2.6.2 After invoking a non-blocking operation, invocation of another operation for the same procedure instance without waiting for the response from the first invocation is allowed.

3.2.6.3 Compliance with this Recommended Standard does not require the performer to process invocations concurrently; however, the performer must accept invocations from a non-blocking invoker and buffer and serialize them by local means not visible externally.

3.2.7 TIME

The time reference for all parameters containing a time value shall be based on Coordinated Universal Time (UTC).

NOTE – The type of all time parameters is specified in annex F.

3.3 STANDARD OPERATION HEADER

3.3.1 BEHAVIOR

3.3.1.1 All operation invocations, except the PEER-ABORT invocation, shall be defined with a common header containing the parameters specified in 3.3.2.

3.3.1.2 All operation responses shall be defined with a common header containing the parameters specified in 3.3.2.

3.3.1.3 A confirmed operation may be defined with a return only or with an acknowledgement and a return.

NOTE – While the acknowledgement and return PDUs may use the same syntax, the invoker of the operation can differentiate the acknowledgement and return PDUs by reading the tag at the beginning of the PDU (see annex F).

3.3.2 INVOCATION, ACKNOWLEDGEMENT AND RETURN PARAMETERS

3.3.2.1 General

Table 3-1 identifies the parameters that appear in the invocation, acknowledgement, and return of the Standard Confirmed Operation Header. Table 3-2 identifies the parameters that appear in the invocation of the Standard Unconfirmed Operation Header. The following subsections specify each of these parameters.
Table 3-1: Standard Confirmed Operation Header Parameters

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Invocation</th>
<th>Acknowledgement</th>
<th>Return</th>
</tr>
</thead>
<tbody>
<tr>
<td>invoker-credentials</td>
<td>M</td>
<td></td>
<td></td>
</tr>
<tr>
<td>performer-credentials</td>
<td></td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>invoke-id</td>
<td></td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>procedure-instance-identifier</td>
<td>M</td>
<td></td>
<td></td>
</tr>
<tr>
<td>result</td>
<td></td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>diagnostic</td>
<td></td>
<td></td>
<td>C</td>
</tr>
</tbody>
</table>

Table 3-2: Standard Unconfirmed Operation Header Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Invocation</th>
</tr>
</thead>
<tbody>
<tr>
<td>invoker-credentials</td>
<td>M</td>
</tr>
<tr>
<td>invoke-id</td>
<td>M</td>
</tr>
<tr>
<td>procedure-instance-identifier</td>
<td>M</td>
</tr>
</tbody>
</table>

3.3.2.2 invoker-credentials

The invoker-credentials parameter shall provide information that enables the performer to authenticate the invocation (see 3.2.4). If authentication is not required, the invoker-credentials parameter shall be set to ‘unused’.

3.3.2.3 performer-credentials

The performer-credentials parameter shall provide information that enables the invoker to authenticate the response from the performance of the invoked operation (see 3.2.4). If authentication is not required, the performer-credentials parameter shall be set to ‘unused’.

3.3.2.4 invoke-id

3.3.2.4.1 The value of the invoke-id parameter shall be an invoker-supplied arbitrary integer value (see 3.2.5).

NOTE – The presence of the invoke-id in the standard unconfirmed operation header is required to maintain commonality with the confirmed operation.
3.3.2.4.2 The performer shall insert unchanged the invoker-supplied value of the invoke-id parameter in each corresponding operation response.

3.3.2.5 procedure-instance-identifier

3.3.2.5.1 The procedure-instance-identifier shall consist of:

a) the procedure-type (e.g., Buffered Data Delivery);

b) the procedure role:

1) the role of the Association Control procedure is always association control; as there is only one instance of the Association Control procedure, the procedure role parameter is set to the ‘associationControl’ value;

2) the role of any other procedure is either prime procedure instance or secondary procedure instance;

c) there is only a single instance of any prime procedure; consequently, the procedure instance number parameter in this case is set to the ‘primeProcedure’ value;

d) for secondary procedures, the procedure instance number parameter is present.

3.3.2.5.2 The procedure-type shall uniquely identify the type of the procedure.

3.3.2.5.3 The value of the procedure-instance-identifier shall be the same for all operations used in the context of that procedure instance.

3.3.2.5.4 The procedure instance number in the procedure-instance-identifier of secondary procedures shall be set to an incrementing number starting with 1. The value of procedure-instance-identifier shall represent the count of the instances of the given secondary procedure type within one service instance.

NOTE – If there is more than one instance of the prime procedure type, only one instance is considered the prime procedure, the other instances are considered secondary procedures.

EXAMPLE – A service has three instances of the procedure type ‘x’ and three instances of the procedure type ‘y’. One of the three procedure instances of ‘x’ is prime:

a) prime procedure ‘x’ instance number: not applicable;

b) secondary procedure ‘x’ instance numbers: 1 and 2;

c) secondary procedure ‘y’ instance numbers: 1, 2, and 3.
3.3.2.6 result

3.3.2.6.1 Definition

3.3.2.6.1.1 The result parameter of an operation acknowledgment shall specify the result of the related invocation and shall contain one of the following values:

a) ‘positive’—the invocation has been accepted by the performer;

b) ‘negative’—the invocation has not been accepted by the performer.

3.3.2.6.1.2 The result parameter of an operation return shall specify the result of an invocation and shall contain one of the following values:

a) ‘positive’—the operation has been performed by the performer;

b) ‘negative’—the operation has not been performed by the performer.

3.3.2.6.2 ‘positive’

All procedures shall have the possibility to extend positive responses with additional parameters, the names, types, and values of which shall depend on the procedure using that operation.

3.3.2.6.3 ‘negative’

If result is ‘negative’, a diagnostic parameter shall be present in the response.

3.3.2.7 diagnostic

3.3.2.7.1 If present (see 3.3.2.6.3), the diagnostic parameter value shall be one of the following:

a) ‘invalid parameter value’—the value of one of the parameters provided is invalid (i.e., is not within the specified range); the diagnostic shall be complemented with the name of the invalid parameter (see 3.2.3.2);

b) ‘conflicting values’—the value of one of the parameters is in conflict with the value of another parameter in the invocation (see 3.2.3.3);

c) ‘unsupported option’—one or more of the options required by the invocation are not supported, e.g., an optional procedure of a CSTS is not part of the given CSTS provider implementation;

d) ‘other reason’—the reason for rejection of the operation will have to be found by other means.
3.3.2.7.2 An implementation using the diagnostic value ‘other reason’ in a negative acknowledgement or negative return shall document under which conditions this diagnostic value is used.

3.3.2.7.3 All procedures shall have the possibility to extend ‘negative’ with additional parameters, the names, types, and values of which shall depend on the procedure using that operation; in particular, additional values of the diagnostic parameter may be defined.

3.4 BIND (CONFIRMED)

3.4.1 BEHAVIOR

NOTE – Establishment of an association between service user and service provider can only be initiated by the service user by means of invoking the BIND operation.

3.4.1.1 The service provider shall return a report of the outcome of the performance of the BIND operation to the service user, unless the BIND invocation is ignored because of invalid credentials (see 3.2.4).

3.4.1.2 The report sent by the service provider shall be a negative return if any of the conditions specified in 3.4.2.3.1 is met; otherwise a positive return shall be sent.

3.4.2 INVOCATION AND RETURN PARAMETERS

3.4.2.1 General

The parameters of the BIND operation shall be present in the invocation and return as specified in table 3-3.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Invocation</th>
<th>Return</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Operation Header (confirmed)</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>initiator-identifier</td>
<td>M</td>
<td></td>
</tr>
<tr>
<td>responder-identifier</td>
<td></td>
<td>M</td>
</tr>
<tr>
<td>responder-port-identifier</td>
<td>M</td>
<td></td>
</tr>
<tr>
<td>service-type</td>
<td>M</td>
<td></td>
</tr>
<tr>
<td>version-number</td>
<td>M</td>
<td></td>
</tr>
<tr>
<td>service-instance-identifier</td>
<td>M</td>
<td></td>
</tr>
</tbody>
</table>
3.4.2.2 Operation Parameters Definitions

3.4.2.2.1 Standard Confirmed Operation Header

This operation shall use the Standard Confirmed Operation Header (see 3.3).

3.4.2.2.2 initiator-identifier

3.4.2.2.2.1 The initiator-identifier parameter shall identify the authority on whose behalf the application entity is initiating an association.

3.4.2.2.2.2 The initiator-identifier parameter shall be a service management parameter.

3.4.2.2.3 responder-identifier

3.4.2.2.3.1 The responder-identifier parameter shall identify the authority on whose behalf the responding application is acting.

3.4.2.2.3.2 The responder-identifier parameter shall be a service management parameter.

3.4.2.2.4 responder-port-identifier

3.4.2.2.4.1 The responder-port-identifier parameter shall specify the port identifier of the responding application entity with which the initiator seeks to establish an association.

NOTE – The responder-port-identifier parameter also permits the use of particular kinds of gateways where because of different communications technologies at the peer entities establishing a direct end-to-end communications channel is not possible or where such direct end-to-end channel is not desired for security reasons. The responder-port-identifier parameter is used by such gateways to complete the association with the responding application entity, but it is not intended to be used by the responding application entity itself. Beyond this statement, the behavior of such gateways is outside the scope of this Recommended Standard.

3.4.2.2.4.2 The responding application entity shall ignore the value of the responder-port-identifier parameter for purposes of determining the validity of the invocation.

3.4.2.2.4.3 The responder-port-identifier parameter shall be a service management parameter.
NOTES

1. The value of the responder-port-identifier parameter is a logical name that can be translated into the technology-specific addressing information required to establish a connection with the responder using the agreed-upon communications service. The CSTS application entity on the service user side needs to know this parameter so that it is properly populated for use by the port-designation mechanism of the underlying communications service. On the service provider side, the application entity completely ignores this parameter. However, it needs to be known on the provider side for the configuration of the underlying communications service.

2. PM and UM of the CSSSes must have previously agreed on the responder-port-identifier and its translation to the required communications-technology specific information that is applicable to a particular instance of service. The parameter value can conveniently be used beyond the port-designation mechanism as a pointer to a set of configuration parameters of the underlying communications service such as the size of transmit and receive buffers.

3. The responder-port-identifier parameter is included in the BIND invocation select the communications port on the responder side or to support its possible use by particular kinds of gateways. The responding application entity ignores its value.

4. In case the association between service user and service provider is established via a gateway and the value of the responder-port-identifier parameter is incorrectly set, the gateway will not be able to relay the BIND invocation to the target responding application entity. Likewise, if because of an incorrectly set responder-port-identifier parameter the target application entity is not listening on the correct communications port for an incoming BIND invocation, the BIND invocation will not be noticed and the application entity will not issue a BIND return. The lack of a return for the BIND operation will trigger the 'return timeout' event on the user side. As stated in 3.6.2.2, the user is expected to abort the association by invoking the PEER-ABORT operation with the diagnostic parameter set to 'return timeout'.

3.4.2.2.5 service-type

The service-type parameter shall uniquely identify the type of service that will be provided if the BIND operation succeeds.

3.4.2.2.6 version-number

The version-number parameter shall identify the version number of the service specification that is to govern this association if the BIND operation succeeds.
3.4.2.2.7 service-instance-identifier

3.4.2.2.7.1 The service-instance-identifier parameter shall uniquely identify this service instance within the scope of the service-providing Complex.

3.4.2.2.7.2 The service-instance-identifier shall consist of the following sequence:

a) an identifier of the spacecraft being supported by the given CSTS instance;

b) an identifier of the facility where the CSTS provider is located;

c) an identifier of the CSTS type;

d) the service instance number.

3.4.2.2.7.3 The ordering of the elements constituting the service-instance-identifier shall be significant. The order shall be: spacecraft identifier first, followed by the facility identifier, followed by the transfer service type and ending with the service instance number.

3.4.2.2.7.4 The elements of the service-instance-identifier being identifiers (spacecraft, facility, CSTS type) shall be defined as Object Identifiers while the service instance number shall be a positive integer.

3.4.2.2.7.5 The spacecraft supported by the given CSTS instance shall be specified by means of the spacecraft Object Identifier assigned in the CCSDS Spacecraft Registry (see H2.5).

3.4.2.2.7.6 The ‘facility’ where the CSTS provider is located shall be specified by means of an Object Identifier assigned in the CCSDS Service Site and Aperture Registry (see H2.5).

3.4.2.2.7.7 The CSTS type shall be identified by means of the Object Identifier assigned to the service type as specified in D5.

3.4.2.2.7.8 The service-instance-identifier parameter shall be a service management parameter.

NOTES

1 For all Object Identifiers being elements of the service-instance-identifier parameter, SANA maintains registries where these Object Identifiers can be looked up.

2 For the convenience of human users, these registries may specify names in the form of strings associated with the various Object Identifiers. However, these strings are not part of the BIND invocation PDU. They are used in the following example only to illustrate the elements of the service-instance-identifier parameter.
EXAMPLE:
- Spacecraft Identifier: ‘XenoSat’
- Facility Identifier: ‘DSNDSS5’
- CSTS type: ‘monitoredData’
- Service Instance Number: 1

3.4.2.7.9 The service instance number shall be identical to the Functional Resource Instance Number of the Functional Resource Name assigned to the service instance.

3.4.2.8 BIND Invocation Syntax

The type BindInvocation, as defined in F4.5, shall define the syntax of the BIND invocation PDU and its parameters.

3.4.2.9 BIND Return Syntax

The type BindReturn, as defined in F4.5, shall define the syntax of the BIND return PDU and its parameters.

3.4.2.3 diagnostic Parameter Extension Value Definitions and Syntax

3.4.2.3.1 If a negative BIND return is sent, one of the diagnostic values specified in 3.3.2.7 or one of the following diagnostic values shall be used:

a) ‘access denied’—the value of the initiator-identifier parameter is not recognized by the service provider (the value does not identify an authorized service user of any service instance known to the service provider);

b) ‘service type not supported’—the value of the service-type parameter of the BIND invocation does not identify a service type supported by the service provider;

c) ‘version not supported’—the service type version is not supported;

d) ‘no such service instance’—the requested service instance is unknown to the service provider;

e) ‘already bound’—the service instance is already bound via a different association;

f) ‘service instance not accessible to this initiator’—the service user identified by the initiator-identifier parameter of the BIND invocation does not match the authorized initiator for the service instance identified by the service-instance-identifier parameter;

g) ‘inconsistent service type’—the value of the service-type parameter of the BIND invocation is not a valid one, or the value of the service-type parameter does not
match the service type of the service instance identified by the service-
instance-identifier parameter;

h) ‘out of service’—production-status is ‘halted’ (see annex B).

3.4.2.3.2 The type AssocBindDiagnosticExt, as defined in F4.5, shall specify the
syntax of the diagnostic parameter of the BIND return extended as listed in 3.4.2.3.1.

3.5 UNBIND (CONFIRMED)

3.5.1 BEHAVIOR

NOTE – Release of a previously established association between service user and service
provider can only be initiated by the service user by means of invoking the
UNBIND operation.

3.5.1.1 In case the service provider cannot accept the UNBIND invocation (i.e., ‘duplicate
invoke ID’), it shall abort the association by invoking PEER-ABORT.

3.5.1.2 Otherwise, the service provider shall return a positive report of the outcome of the
performance of the UNBIND operation to the service user.

3.5.2 INVOCATION AND RETURN PARAMETERS

3.5.2.1 General

The parameters of the UNBIND operation shall be present in the invocation and return as
specified in table 3-4.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Invocation</th>
<th>Return</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Operation Header (confirmed)</td>
<td>M</td>
<td>M</td>
</tr>
</tbody>
</table>

3.5.2.2 Operation Parameters Definitions

3.5.2.2.1 Standard Confirmed Operation Header

This operation shall use the Standard Confirmed Operation Header (see 3.3) without
extension.
3.5.2.2 UNBIND Invocation Syntax

The type UnbindInvocation, as defined in F4.5, shall specify the syntax of the UNBIND invocation PDU and its parameters.

3.5.2.2.3 UNBIND Return Syntax

The type UnbindReturn, as defined in F4.5, shall specify the syntax of the UNBIND return PDU and its parameters.

3.6 PEER-ABORT (UNCONFIRMED)

3.6.1 BEHAVIOR

NOTE – The service user can abort the association between service user and service provider by invoking the PEER-ABORT operation. The conditions under which this can happen are listed in 3.6.2.2.1.3.

3.6.1.1 The service provider shall invoke the PEER-ABORT operation to terminate unconditionally an association between a service user and a service provider if any of the conditions listed in 3.6.2.2.1.2 is met.

3.6.1.2 The PEER-ABORT operation shall not be extended.

3.6.1.3 On reception of a PEER-ABORT invocation, the service provider shall flush all queued data.

3.6.2 INVOCATION PARAMETERS

3.6.2.1 The parameters of the PEER-ABORT operation shall be present in the invocation as specified in table 3-5.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Invocation</th>
</tr>
</thead>
<tbody>
<tr>
<td>diagnostic</td>
<td>M</td>
</tr>
</tbody>
</table>
3.6.2.2 Operation Parameters Definitions

3.6.2.2.1 diagnostic

3.6.2.2.1.1 The diagnostic parameter shall specify why the PEER-ABORT is being invoked.

3.6.2.2.1.2 The value of the diagnostic parameter in a PEER-ABORT invocation sent by the service provider shall be one of the following:

a) ‘operational requirement’—the local system had to terminate the association to accommodate some other operational need;

b) ‘protocol error’—the local application detected an error in the sequencing of service operations;

c) ‘communications failure’—the communications service on the other side of a gateway was disrupted;

NOTE – The ‘communications failure’ diagnostic is included in the PEER-ABORT invocation to support its possible use by particular kinds of gateways. It is used by such gateways to report on a communications failure with the peer application entity. It is not intended to be used by the peer application entity itself. Beyond this statement, the behavior of such gateways is outside the scope of this Recommended Standard.

d) ‘encoding error’—the local application detected an error in the encoding of one or more operation parameters or did not recognize the operation or the data is badly formatted (e.g., one of the service instance identifier fields is missing);

e) ‘end of service instance provision period’—the service provider detected that the service instance provision period has ended and the service user has not invoked the UNBIND operation;

f) ‘duplicate invoke ID’—the value of the invoke-id parameter is the same as the invoke-id value of another operation still being performed;

g) ‘invalid procedure instance identifier’—the procedure-instance-identifier of the received operation contains an unknown procedure type or the procedure role does not match the expected one or the procedure-instance-identifier contains an unknown procedure instance;

NOTE – If a CSTS does not implement an optional procedure, invocation of operations of such unimplemented procedure will not result in the invocation of PEER-ABORT (refer to 3.3.2.7.1 c)).
h) ‘unrecognized operation or parameter type’—the operation type of the received operation does not match any of the defined types or one of the parameter types does not match any of the defined types;

i) ‘other reason’—the local application detected an unspecified error during the processing of one or more operations.

3.6.2.2.1.3 The service provider shall handle PEER-ABORT invocations sent by the service user containing one of the following diagnostic values:

NOTE – The Recommended Standard does not specify how the service provider shall handle a PEER-ABORT diagnostic value. It may e.g. be displayed to a local operator and/or written to a local log file.

a) ‘access denied’—a service provider with an identity as presented in the responder-identifier parameter of the BIND return is not known to the service user;

b) ‘unexpected responder ID’—the value of the responder-identifier parameter in the BIND return does not match the identity of the authorized service provider for this service instance as specified by service management;

c) ‘operational requirement’—the user system had to terminate the association to accommodate some other operational need;

d) ‘protocol error’—the user application detected an error in the sequencing of service operations;

e) ‘communications failure’—the communications service on the other side of a gateway was disrupted;

NOTE – The ‘communications failure’ diagnostic is included in the PEER-ABORT invocation to support its possible use by particular kinds of gateways. It is used by such gateways to report on a communications failure with the peer application entity. It is not intended to be used by the peer application entity itself. Beyond this statement, the behavior of such gateways is outside the scope of this Recommended Standard.

f) ‘encoding error’—the user application detected an error in the encoding of one or more operation parameters or did not recognize the operation or the data is badly formatted (e.g., one of the service-instance-identifier fields is missing);

g) ‘response timeout’—the user application detected that the acknowledgement from a three-phase operation or the return from a two-phase operation was not received within a specified time limit;

h) ‘unsolicited invoke-id’—the user application received a response with an invoke-id that does not match the invoke-id of any of the operations for which a response is pending;
i) ‘invalid procedure instance identifier’—the procedure-instance-identifier of the received operation contains an unknown procedure type or the procedure role does not match the expected one or the procedure-instance-identifier contains an unknown procedure instance;

j) ‘unrecognized operation or parameter type’—the operation type of the received operation does not match any of the defined types or one of the parameter types does not match any of the defined types;

k) ‘other reason’—the user application detected an unspecified error during the processing of one or more operations.

NOTE – An implementation using the PEER-ABORT diagnostic value ‘other reason’ shall document under which conditions this diagnostic value is used (see 3.3.2.7.2).

3.6.2.2.1.4 A service-type specific derived or service-original procedure shall have the capability to specify further diagnostic values within the constraints specified in F4.5. These values need to be documented in the specification of that service type.

3.6.2.2.2 PEER-ABORT Invocation Syntax

The type PeerAbortInvocation, as defined in F4.5, shall specify the syntax of the PEER-ABORT invocation PDU and its parameters.

3.7 START (CONFIRMED)

3.7.1 BEHAVIOR

NOTE – The service user can start the activities of a stateful procedure by invoking the START operation of that procedure.

3.7.1.1 The activity to be started shall be defined by the procedure using the START operation.

3.7.1.2 The service provider shall return a report of the outcome of the performance of the START operation to the service user.

3.7.1.3 After a successful START, the service provider shall:
   a) transition the procedure to the state ‘active’;
   b) perform the activities associated with the procedure using the operation.

3.7.1.4 After an unsuccessful START, the service provider shall remain in procedure state ‘inactive’.
3.7.2 INVOCATION AND RETURN PARAMETERS

3.7.2.1 General

The parameters of the START operation shall be present in the invocation and return as specified in table 3-6.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Invocation</th>
<th>Return</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Operation Header (confirmed)</td>
<td>M</td>
<td>M</td>
</tr>
</tbody>
</table>

Table 3-6: START Operation Parameters

3.7.2.2 Operation Parameters Definitions

3.7.2.2.1 Standard Confirmed Operation Header

This operation shall use the Standard Confirmed Operation Header (see 3.3).

3.7.2.2.2 START Invocation Syntax

The type StartInvocation, as defined in F4.4, shall specify the syntax of the START invocation PDU and its parameters.

3.7.2.2.3 START Return Syntax

The type StartReturn, as defined in F4.4, shall specify the syntax of the START return PDU and its parameters.

3.7.2.3 diagnostic Parameter Extension Value Definitions and Syntax

3.7.2.3.1 If a negative START return is sent, one of the diagnostic values specified in 3.3.2.7, or one of the following diagnostic values shall be used:

   a) ‘unable to comply’—the service provider is unable to activate the procedure at this time because of a fault affecting the service;

   b) ‘out of service’—the service provider has been taken out of service for an indefinite period by management action; i.e., production-status is ‘halted’.

3.7.2.3.2 The type StartDiagnosticExt, as defined in F4.4 shall specify the syntax of the diagnostic parameter of the START return extended as listed in 3.7.2.3.1.
3.8 STOP (CONFIRMED)

3.8.1 BEHAVIOR

NOTE – The service user can stop the activities of a stateful procedure by invoking the STOP operation of that procedure.

3.8.1.1 The activity to be stopped shall be defined by the procedure using the STOP operation.

NOTE – Within the constraints of the service instance provision period, the service user may re-enable the activity by again invoking the START operation.

3.8.1.2 The service provider shall provide a report of the outcome of the performance of the STOP operation to the service user.

3.8.1.3 After a successful STOP, the service provider shall:
   a) stop performing its activities;
   b) transition the procedure to the state ‘inactive’.

3.8.1.4 After an unsuccessful STOP, the service provider shall:
   a) continue performing its activities;
   b) remain in procedure state ‘active’.

3.8.2 INVOCATION, RETURN, AND PARAMETERS

3.8.2.1 General

The parameters of the STOP operation shall be present in the invocation and return as specified in table 3-7.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Invocation</th>
<th>Return</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Operation Header (confirmed)</td>
<td>M</td>
<td>M</td>
</tr>
</tbody>
</table>
3.8.2.2 Operation Parameters Definitions

3.8.2.2.1 Standard Confirmed Operation Header
This operation shall use the Standard Confirmed Operation Header (see 3.3) without extension.

3.8.2.2.2 STOP Invocation Syntax
The type StopInvocation, as defined in F4.4, shall specify the syntax of the STOP invocation PDU and its parameters.

3.8.2.2.3 STOP Return Syntax
The type StopReturn, as defined in F4.4, shall specify the syntax of the STOP return PDU and its parameters.

3.9 TRANSFER-DATA (UNCONFIRMED)

3.9.1 BEHAVIOR
The service provider shall invoke the TRANSFER-DATA operation to deliver data units to the service user.

3.9.2 INVOCATION AND PARAMETERS

3.9.2.1 General
The parameters of the TRANSFER-DATA operation shall be present in the invocation as specified in table 3-8.

Table 3-8: TRANSFER-DATA Operation Parameters

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Invocation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Operation Header (unconfirmed)</td>
<td>M</td>
</tr>
<tr>
<td>generation-time</td>
<td>M</td>
</tr>
<tr>
<td>sequence-counter</td>
<td>M</td>
</tr>
<tr>
<td>data</td>
<td>M</td>
</tr>
</tbody>
</table>
3.9.2.2 Operation Parameters Definitions

3.9.2.2.1 Standard Confirmed Operation Header

This operation shall use the Standard Unconfirmed Operation Header (see 3.3) without extension.

3.9.2.2.2 generation-time

The generation-time parameter shall contain the UTC time at which the data unit was generated.

NOTE – The meaning of data generation can be understood only in the context of the service defining the data to be transferred.

3.9.2.2.3 sequence-counter

3.9.2.2.3.1 For each instance of a procedure that uses the TRANSFER-DATA operation, the service provider shall set the sequence-counter parameter of the first data unit due for transmission to 0 after acceptance of the START operation for that procedure instance.

3.9.2.2.3.2 For each instance of a procedure that uses the TRANSFER-DATA operation, the sequence-counter parameter shall be incremented with each data unit after the first one that the service provider transmits to the service user using that procedure instance.

NOTE – The purpose of the sequence-counter is to give the service user a mechanism for checking the continuity of the data transmitted by the service provider.

3.9.2.2.3.3 When the maximum value of the counter is reached the sequence-counter parameter shall be reset to 0.

3.9.2.2.4 data

3.9.2.2.4.1 The value of the data parameter is the data unit generated.

3.9.2.2.4.2 The data parameter shall be either of the type OCTET STRING or the type shall be specified as an extension.

3.9.2.2.4.3 A procedure using this operation shall:

a) refine (i.e., specify) the format and the semantics of the octet string in the data parameter; or
b) extend the operation by defining the structure and the semantics of the extension field in the data parameter.

3.9.2.2.5 TRANSFER-DATA Invocation Syntax

The type TransferDataInvocation, as defined in F4.4, shall specify the syntax of the TRANSFER-DATA invocation PDU and its parameters.

3.10 PROCESS-DATA (UNCONFIRMED / CONFIRMED)

3.10.1 BEHAVIOR

NOTE – The service user can transfer data to the service provider for further processing by invoking the PROCESS-DATA operation.

3.10.2 INVOCATION, RETURN, AND PARAMETERS

3.10.2.1 General

The parameters of the PROCESS-DATA operation shall be present in the invocation as specified in table 3-9, where a procedure using this operation shall specify if the unconfirmed variant or the confirmed variant is applied.

Table 3-9: PROCESS-DATA Operation Parameters

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Invocation</th>
<th>Return (optional)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Operation Header (unconfirmed or confirmed)</td>
<td>$M$</td>
<td>$M$</td>
</tr>
<tr>
<td>data-unit-id</td>
<td>$M$</td>
<td></td>
</tr>
<tr>
<td>data</td>
<td>$M$</td>
<td></td>
</tr>
</tbody>
</table>

3.10.2.2 Operation Parameters Definitions

3.10.2.2.1 Standard Unconfirmed Operation Header

If the procedure using this operation opts for the unconfirmed variant of the PROCESS-DATA operation, the operation shall use the Standard Unconfirmed Operation Header (see 3.3).
3.10.2.2.2 Standard Confirmed Operation Header

If the procedure using this operation opts for the confirmed variant of the PROCESS-DATA operation, the operation shall use the Standard Confirmed Operation Header (see 3.3).

3.10.2.2.3 data-unit-id

The data-unit-id parameter value, defined to be of the type IntUnsigned, can be freely chosen by the service user. The service provider shall copy this parameter into the respective notifications reporting on the outcome of the processing of the data unit.

NOTE – Notifications can only be unambiguously associated with a specific data unit if the service user ensures that the data-unit-id parameter values of all data units already sent to the service provider, but of which processing did not yet complete or abort, are unique. One simple way for achieving uniqueness of the data-unit-id values is using a counter that is incremented by one for each data unit sent to the service provider.

3.10.2.2.4 data

3.10.2.2.4.1 The data parameter shall contain the data to be transferred from the service user to the service provider and to be subsequently processed by the service provider.

3.10.2.2.4.2 The data parameter shall be either of the type OCTET STRING or the type shall be specified as an extension.

3.10.2.2.4.3 A procedure using this operation shall:

a) refine (i.e., specify) the format and the semantics of the octet string in the data parameter; or

b) extend the operation by defining the structure and the semantics of the extension field in the data parameter.

3.10.2.2.5 PROCESS-DATA Invocation Syntax

The type ProcessDataInvocation, as defined in F4.4, shall specify the syntax of the TRANSFER-DATA invocation PDU and its parameters.

3.10.2.2.6 PROCESS-DATA Return Syntax

The type ProcessDataReturn, as defined in F4.4, shall specify the syntax of the TRANSFER-DATA return PDU and its parameters. It only applies if the procedure using the PROCESS-DATA operation has opted for the confirmed variant of this operation.
3.11 NOTIFY (UNCONFIRMED)

3.11.1 BEHAVIOR

The service provider shall invoke the NOTIFY operation to notify the service user of the occurrence of an event of interest to the service user.

NOTE – Notification of events may be of value to the service user in understanding specific service provider behavior, such as an interruption in data delivery.

3.11.2 INVOCATION AND PARAMETERS

3.11.2.1 General

The parameters of the NOTIFY operation shall be present in the invocation as specified in table 3-10.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Invocation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Operation Header (unconfirmed)</td>
<td>M</td>
</tr>
<tr>
<td>event-time</td>
<td>M</td>
</tr>
<tr>
<td>event-name</td>
<td>M</td>
</tr>
<tr>
<td>event-value</td>
<td>M</td>
</tr>
</tbody>
</table>

3.11.2.2 Operation Parameters Definitions

3.11.2.2.1 Standard Confirmed Operation Header

This operation shall use the Standard Unconfirmed Operation Header (see 3.3) without extension.

3.11.2.2.2 event-time

The event-time parameter shall contain the UTC time at which the event occurred.

3.11.2.2.3 event-name

3.11.2.2.3.1 The event-name is in the form of an Event Name as defined in E5; it consists of the Event Identifier defined for the event being notified and either the Functional Resource
Name of the Functional Resource Instance triggering the event or the procedure instance identifier of the procedure that issues the notification.

3.11.2.2.3.2 For service production related events, this operation shall define the following published events:

a) ‘production status change’ (event-name)—the status of service production has changed (see annex B). The associated event-value shall report the svcProductionStatus given since the ‘production status change’ event triggered.

b) ‘production configuration change’ (event-name)—at least one parameter controlling the configuration of service production has been changed. Unless otherwise specified by the procedure using the operation, the associated event-value shall be set to ‘empty’.

NOTE – Each CSTS specification defines how the Functional Resource Instances directly associated with the service production of an instance of that CSTS type are determined and which set of parameters of those Functional Resource Instances form the production configuration and therefore also the production configuration change event.

3.11.2.2.3.3 The Published Identifiers for the Event Names of the above listed events are specified in F4.17 as svcProductionStatusChange, and svcProductionConfigurationChange, respectively.

3.11.2.2.3.4 The events defined in 3.11.2.2.3.2 shall be transferred with the Functional Resource Name of the Functional Resource Instance triggering the events, i.e., the Functional Resource Instance representing the CSTS instance of which the production status or production configuration changed.

3.11.2.2.3.5 Procedures may require that the occurrence of events related to the procedure be notified; such procedure shall specify the Published Identifier for each of these events as well as the event-value associated with the given event.

3.11.2.2.3.6 Events of the kind addressed in 3.11.2.2.3.5 shall be transferred with the procedure instance identifier of the procedure triggering the events.

3.11.2.2.3.7 A derived procedure that inherits one or more procedure related events from a parent procedure shall notify the event by using the Published Identifier defined for this event by the parent procedure.
3.11.2.2.4 event-value

3.11.2.2.4.1 The event-value allows the notification to optionally carry additional information in the form of the type SequenceOfQualifiedValue as defined in F4.3 or in the form of an extension.

3.11.2.2.4.2 In case a derived procedure inherits one or more procedure related events, the derived procedure shall specify for each of these events the associated event-value parameter regardless of the event-value specification given in the parent procedure.

3.11.2.2.4.3 The event-value of the ‘production status change’ event shall report the svcProductionStatus value of the service instance that notifies the ‘production status change’ event. The first part of the path specifying the type to be used is ‘NotifyInvocation’: ‘eventValue’: ‘EventValue’: ‘qualifiedValues’: ‘SequenceOfQualifiedValue’ where this sequence has the length 1. The second part of the path is ‘QualifiedValue’: ‘valid’: ‘TypeAndValueComplexQualified’: ‘typeAndValue’: ‘enumerated’: ‘SEQUENCE OF INTEGER where this sequence has the length 1. This enumerated type may have one of the values defined in table Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 8,Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll.-1.

NOTE – For the rationale why an enumerated type is encoded as as an integer value refer to F3.

3.11.2.2.5 NOTIFY Invocation Syntax

The type NotifyInvocation, as defined in F4.4, shall specify the syntax of the NOTIFY invocation PDU and its parameters.

3.12 GET (CONFIRMED)

3.12.1 BEHAVIOR

NOTE – The service user can retrieve the values of specific parameters by invoking the GET operation.

3.12.1.1 The service provider shall have the capability to deliver to the service user individual parameters or a set of parameters represented by a list of Parameter Labels (see annex E).

NOTE – The list of Parameter Labels to be retrieved may be a list explicitly named in the invocation or a default list to be specified by the procedures or services using this operation.

3.12.1.2 The GET invocation is valid if it meets any one of the following conditions:
a) if the list-of-parameters parameter is ‘empty’, signifying the selection of the default list of Parameter Labels and if such default list has been established;

b) if the list-of-parameters parameter contains one parameter list name for a list of Parameter Labels that is contained in the set of label lists that has been established for the service for use by the GET operation;

c) if the list-of-parameters parameter contains one Functional Resource Type that is associated with the service instance that executes the procedure that contains the GET operation;

d) if the list-of-parameters parameter contains one name of a Functional Resource Instance that is associated with the service instance that executes the procedure containing the GET operation;

e) if the list-of-parameters parameter contains one procedure type that is associated with the service instance that executes the procedure containing the GET operation;

f) if the list-of-parameters parameter contains one procedure instance identifier of a procedure that is associated with the service instance that executes the procedure containing the GET operation;

g) if (1) the list-of-parameters parameter contains one or more Functional Resource Parameter Names or Functional Resource Parameter Labels and (2) every one of these names or labels is the name or label of a parameter of a Functional Resource that is associated with the service instance that executes the procedure that contains the GET operation;

h) if (1) the list-of-parameters parameter contains one or more procedure configuration Parameter Labels or Parameter Names and (2) every one of these labels or name is the label or name of a configuration parameter of a procedure that is associated with the service instance that executes the procedure that contains the GET operation.

3.12.1.3 If the GET invocation is valid, the service provider shall return the qualified parameters (Parameter Name, the value, the type, and the qualifier of the parameter—see C2.1) using the qualified-parameters parameter. More specifically, if list-of-parameters:

a) is left empty, then:

1) for each Functional Resource Parameter Label represented by the default list (see annex E), the service provider shall return the qualified parameter (see C2.1) for that label for the Functional Resource Instances of the given type that are directly associated with the service instance that executes the procedure containing the GET operation;
2) for each procedure configuration Parameter Label in the default list, the service provider shall return the qualified parameter for that label for every configured instance of the procedure that is associated with the service instance that executes the procedure containing the GET operation;

b) contains the name of a list of Parameter Labels, then:

1) for each Functional Resource Parameter Label in the named list (see E), the service provider shall return the qualified parameter for that label for each Functional Resource Instance of the given type that is directly associated with the service instance that executes the procedure containing the GET operation;

2) for each procedure configuration Parameter Label in the named list, the service provider shall return the qualified parameter for that label for every configured instance of the procedure that is associated with the service instance that executes the procedure containing the GET operation;

c) contains one Functional Resource Type, then the service provider shall return the qualified parameters for all parameters of all Functional Resource Instances of the given type that are directly associated with the service instance invoking the GET operation;

d) contains one Functional Resource Name, then the service provider shall return the qualified parameters for all parameters of the named Functional Resource Instance;

e) contains one procedure type, then the service provider shall return the qualified parameter for all parameters of every configured instance of that procedure type that is directly associated with the service instance invoking the GET operation;

f) contains one procedure instance identifier, then the service provider shall return the qualified parameters for all configuration parameters for that procedure instance;

g) contains any Functional Resource Parameter Labels, then for each Functional Resource Parameter Label the service provider shall return the qualified parameter for that label for each of the Functional Resource Instances of the given type that is directly associated with the service instance that executes the procedure containing the GET operation;

h) contains any labels for procedure configuration parameters, then for each procedure configuration Parameter Label the service provider shall return the qualified parameter for every configured instance of the procedure that is associated with the service instance that executes the procedure containing the GET operation;

i) contains one or more Parameter Names, then the service provider shall return the qualified parameter for each of the listed parameters.

3.12.1.4 If the GET invocation is invalid, the service provider shall issue a negative return using one of the diagnostic values specified in 3.12.2.4.
3.12.1.5 Procedures using this operation shall define
   a) the names of the lists of Parameter Labels;
   b) the Parameter Labels contained in the named lists;
   c) which of the named lists shall serve as default list, if any.

3.12.2 INVOCATION, RETURN, AND PARAMETERS

3.12.2.1 General

The parameters of the GET operation shall be present in the invocation and return as specified in table 3-11.

Table 3-11: GET Operation Parameters

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Invocation</th>
<th>Return</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Operation Header (confirmed)</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>list-of-parameters</td>
<td>M</td>
<td></td>
</tr>
<tr>
<td>qualified-parameters</td>
<td></td>
<td>C</td>
</tr>
</tbody>
</table>

3.12.2.2 Operation Parameters Definitions

3.12.2.2.1 Standard Confirmed Operation Header

This operation shall use the Standard Confirmed Operation Header (see 3.3).

3.12.2.2.2 list-of-parameters

3.12.2.2.2.1 The list-of-parameters parameter shall contain one of the following:
   (a) ‘empty’ (signifying default list), (b) the name of a list, (c) one Functional Resource Type,
   (d) one Functional Resource Name, (e) one procedure type, (f) one procedure instance identifier,
   (g) a set of individual Parameter Labels, or (h) a set of individual Parameter Names.

3.12.2.2.2.2 If the list-of-parameters parameter is set to ‘empty’, the service provider shall transmit the values of the parameters represented by the default list of Parameter Labels provided such list is known to the service provider.

NOTE – The definition of what is represented by the list of Parameter Labels can be found in annex E.
3.12.2.2.3 A name of a list of Parameter Labels shall be defined as a string.

NOTE – The composition of Parameter Names is discussed in annex E.

3.12.2.2.3 qualified-parameters

If the result is ‘positive’ (i.e., positive GET return), the parameter values requested via list-of-parameters shall be returned in the qualified-parameters parameter as specified in annex C2.1.

3.12.2.4 GET Invocation Syntax

The type GetInvocation, as defined in F4.4, shall specify the syntax of the GET invocation PDU and its parameters.

3.12.2.5 GET Return Syntax

The type GetReturn, as defined in F4.4, shall specify the syntax of the GET return PDU and its parameters.

3.12.2.3 positive Parameter Extension Value Definitions

The type GetPosReturnExt, as defined in F4.4, shall specify the syntax of the positive return extension of the GET operation.

3.12.2.4 diagnostic Parameter Extension Value Definitions and Syntax

3.12.2.4.1 If a negative GET return is sent, one of the diagnostic values specified in 3.3.2.7, or one of the following diagnostic values shall be used:

   a) ‘default not defined’—the default list (list-of-parameters set to ‘empty’) is unknown to the service provider.

   b) ‘unknown list name’—the list name contained in the list-of-parameters is unknown to the service provider. The unknown list name shall be returned with the diagnostic.

   c) ‘unknown Functional Resource Type’—the Functional Resource Type contained in the list-of-parameters is unknown to the service provider (see 3.12.2.2.2) or the Functional Resource Type is not associated with the service instance that executes the procedure containing the GET operation. The unknown Functional Resource Type shall be returned with the diagnostic.
d) ‘unknown Functional Resource Name’—while the Functional Resource Type is known, the Functional Resource Name contained in the list-of-parameters is unknown to the service provider (see 3.12.2.2.2) or the selected Functional Resource Instance is not associated with the service instance that executes the procedure containing the GET operation. The unknown Functional Resource Name shall be returned with the diagnostic.

e) ‘unknown procedure type’—the procedure type contained in the list-of-parameters is unknown to the service provider (see 3.12.2.2.2). The unknown procedure type shall be returned with the diagnostic.

f) ‘unknown procedure instance identifier’—while the procedure type is known, the procedure instance identifier contained in the list-of-parameters is unknown to the service provider (see 3.12.2.2.2). The unknown procedure instance identifier shall be returned with the diagnostic.

g) ‘unknown parameter identifier’—one or more Parameter Identifiers contained in the list-of-parameters parameter are unknown to the service provider (see 3.12.2.2.2) for one of the following reasons:

1) the Functional Resource or procedure type specified as part of the Parameter Label is not associated with the service instance executing the procedure containing the GET operation;

2) the Functional Resource or procedure instance specified as part of the Parameter Name is not associated with the service instance executing the procedure containing the GET operation;

3) a parameter with the given Published Identifier does not exist for the specified Functional Resource or procedure type.

The list of unknown Parameter Names or Parameter Labels shall be returned with the diagnostic. For each unknown Parameter Identifier that is contained in a Parameter Name in the list-of-parameters, the Parameter Name shall be returned. For each unknown Parameter Identifier that is contained in a Parameter Label in the list-of-parameters, the Parameter Label shall be returned.

3.12.2.4.2 The type GetDiagnosticExt, as defined in F4.4, shall specify the syntax of the diagnostic parameter of the GET return extended as listed in 3.12.2.4.1.

3.13 EXECUTE-DIRECTIVE (ACKNOWLEDGED)

3.13.1 BEHAVIOR

NOTES
The service user can invoke the EXECUTE-DIRECTIVE operation to cause the EM of the ESLT to perform a specified action.

The EXECUTE-DIRECTIVE is an acknowledged operation, which provides intermediate feedback to the service user to acknowledge that the invocation has been received and is valid, as well as a final feedback regarding the outcome of the operation which is returned some time after the acknowledgement.

3.13.1.1 The specified action to be performed when invoked by means of the EXECUTE-DIRECTIVE operation shall be defined by one of the following:

a) a directive-identifier registered for the procedure containing the invoked EXECUTE-DIRECTIVE operation;

b) a directive-identifier registered for a procedure type, if that type is associated with the service instance executing the procedure containing the invoked EXECUTE-DIRECTIVE;

c) a directive-identifier registered for a Functional Resource Type, if that type is associated with the service instance executing the procedure containing the invoked EXECUTE-DIRECTIVE.

3.13.1.2 The service provider shall provide a report (acknowledgement) on the acceptance of the EXECUTE-DIRECTIVE invocation to the service user.

3.13.1.3 If the EXECUTE-DIRECTIVE invocation is valid, the service provider shall execute the action and then provide a report (return) on the outcome of the overall performance of the EXECUTE-DIRECTIVE operation.

3.13.2 INVOCATION, RESPONSES AND PARAMETERS

3.13.2.1 General

The parameters of the EXECUTE-DIRECTIVE operation shall be present in the invocation, acknowledgement and return as specified in table "EXECUTE-DIRECTIVE Operation Parameters".

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Invocation</th>
<th>Acknowledgement</th>
<th>Return</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Operation Header (confirmed)</td>
<td>M</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>directive-identifier</td>
<td>M</td>
<td></td>
<td></td>
</tr>
<tr>
<td>directive-qualifier</td>
<td>M</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table "EXECUTE-DIRECTIVE Operation Parameters"
3.13.2.2 Operation Parameters Definitions

3.13.2.2.1 Standard Confirmed Operation Header

This operation shall use the Standard Confirmed Operation Header (see 3.3).

3.13.2.2.2 directive-identifier

3.13.2.2.2.1 The directive-identifier shall identify the action that is to be performed by the Complex.

3.13.2.2.2.2 The directive-identifier parameter shall be of the type PublishedIdentifier and may be registered either for a procedure type or for a Functional Resource Type (see E6.1).

3.13.2.2.3 directive-qualifier

3.13.2.2.3.1 The directive-qualifier shall contain complementary data necessary to perform the action specified by the directive-identifier parameter.

3.13.2.2.3.2 Depending on the scope of the directive-identifier (see 3.13.1.1) the directive-qualifier parameter shall be comprised of one of the following:

a) the directive qualifier values;

b) the type and instance number of the procedure the directive shall act on and the directive qualifier values;

c) the type and instance number of the Functional Resource the directive shall act on and the directive qualifier values.

3.13.2.2.3.3 The directive qualifier values shall be one of the following:

a) ‘noQualifierValues’ to indicate that the for the given directive-identifier the directive-qualifier parameter does not carry complementary information;

b) a possibly complex structure of values not associated with formally defined parameters identified by means of Published Identifiers; the data structure shall be of the type TypeAndValueComplexQualified defined in F4.3;

c) a sequence of parameter identifiers and the associated parameter values where the parameter identifier is the Published Identifier assigned to this parameter and the parameter value is of the type TypeAndValueComplexQualified defined in F4.3.
3.13.2.2.3.4 A procedure using this operation may extend the operation by defining the structure and the semantics of the extension field in the directive-qualifier parameter.

3.13.2.2.4 EXECUTE-DIRECTIVE Invocation Syntax

The type ExecuteDirectiveInvocation, as defined in F4.4, shall specify the syntax of the EXECUTE-DIRECTIVE invocation PDU and its parameters.

3.13.2.2.5 EXECUTE-DIRECTIVE Acknowledgement Syntax

The type ExecuteDirectiveAcknowledge, as defined in F4.4, shall specify the syntax of the EXECUTE-DIRECTIVE acknowledgement PDU and its parameters.

3.13.2.2.6 EXECUTE-DIRECTIVE Return Syntax

The type ExecuteDirectiveReturn, as defined in F4.4, shall specify the syntax of the EXECUTE-DIRECTIVE return PDU and its parameters.

3.13.2.3 diagnostic Parameter Extension Value Definitions and Syntax

3.13.2.3.1 If an EXECUTE-DIRECTIVE negative acknowledgement is sent, one of the diagnostic values specified in 3.3.2.7, or one of the following diagnostic values shall be used:

a) ‘unknown directive’—the directive-identifier specified in the invocation is not valid, i.e., the directive-identifier is not registered for the procedure or for the Functional Resource Type specified in the directive-qualifier parameter;

b) ‘unknown qualifier’—the directive-qualifier specified in the invocation is not valid for the given directive-identifier;

c) ‘invalid procedure instance’—the specified instance of the procedure type that the directive shall act on does not exist;

d) ‘invalid functional resource instance’—the specified instance of the given Functional Resource Type that the directive shall act on does not exist;

e) ‘invalid Functional Resource parameter’—either (1) one or more of the Parameter Identifiers in the sequence of Parameter Identifiers in the directive-qualifier is not a published Parameter Identifier of the Functional Resource the directive shall act on, or (2) the associated parameter value is not of the type specified for that parameter of the Functional Resource. This diagnostic value shall include a list of
all Parameter Names contained in the directive-qualifier which are invalid for the given Functional Resource Type or for which the type of the parameter value is invalid;

f) ‘invalid procedure parameter’—either (1) one or more of the Parameter Identifiers in the sequence of Parameter Identifiers in the directive-qualifier is not a published Parameter Identifier of a configuration parameter of the procedure the directive shall act on, or (2) the associated parameter value is not of the type specified for that configuration parameter of the procedure. This diagnostic value shall include a list of all Parameter Names contained in the directive-qualifier which are invalid for the given procedure or for which the type of the parameter value is invalid;

g) ‘parameter value out of range’—one or more of the parameters in the parameter sequence of the directive-qualifier has a value that is outside the range that is defined for that parameter. This diagnostic value shall include a list of all Parameter Names contained in the directive-qualifier for which the parameter value falls outside the valid range.

3.13.2.3.2 The type ExecDirNegAckDiagnosticExt, as defined in F4.4 shall specify the syntax of the diagnostic parameter of the EXECUTE-DIRECTIVE acknowledgement extended as listed in 3.13.2.3.1.

3.13.2.3.3 If an EXECUTE-DIRECTIVE negative return is sent, one of the diagnostic values specified in 3.3.2.7, or the following diagnostic value shall be used:

‘action not completed’—the requested action was not completed, e.g., because the guard condition of some of the parameters to be updated evaluated to FALSE. This diagnostic value shall include a list of all Parameter Names contained in the directive-qualifier for which setting of the parameter value was successful. If the given directive is not intended to change parameter values, the list of Parameter Names shall be empty.

NOTE – The only diagnostic value of those defined in 3.3.2.7 that might be applicable in this case is ‘other reason’. An implementation using this diagnostic value needs to document the conditions under which this diagnostic value applies (see 3.3.2.7.2). In case any of the other diagnostic values defined in 3.3.2.7 applies, the EXECUTE-DIRECTIVE operation will fail with a negative acknowledgement and therefore a negative return will not be sent.

3.13.2.3.4 The type ExecDirNegReturnDiagnosticExt, as defined in F4.4 shall specify the syntax of the diagnostic parameter of the EXECUTE-DIRECTIVE return extended as listed in 3.13.2.3.3.
4 PROCEEDURES

4.1 OVERVIEW

This section specifies the procedures defined in this Recommended Standard. Subsection 4.2 specifies behaviors that are generally applicable to all procedures. Subsections 4.3 through 0 specify common procedures defined in this Recommended Standard.

NOTE – Unless otherwise specified all statements made in this section shall be understood to refer to a single procedure instance only.

4.2 COMMON PROCEDURES BEHAVIOR

4.2.1 PROCEDURE INSTANCES CREATION

4.2.1.1 The Association Control procedure shall be instantiated at service instance creation and shall exist for the lifetime of the service instance.

4.2.1.2 All procedures other than the Association Control procedure shall be instantiated as soon as a positive BIND return is issued by the service provider.

4.2.1.3 The service provider shall not accept and process any operations except BIND until it returns a positive BIND return. Exception to that statement is the reception of a PEER-ABORT following the reception of a BIND invocation and preceding the issue of the BIND return.

4.2.2 TERMINATION OF THE ASSOCIATION

4.2.2.1 On reception of an UNBIND invocation, the Association Control procedure shall issue a ‘terminate procedure’ event to all procedure instances of the service instance.

4.2.2.2 On ‘protocol abort’ (see 1.6.1.7.39) or reception of a PEER-ABORT invocation (see 3.6), the Association Control procedure shall communicate a ‘terminate procedure’ event to all procedure instances of the service instance.

4.2.2.3 If any procedure other than the Association Control procedure initiates an abort, it shall issue a ‘procedure to association abort ‘xxx’’ event to the Association Control procedure, where ‘xxx’ represents the diagnostic value for the abort event (see 4.2.2.5).

4.2.2.4 One of the conditions under which a procedure shall issue a ‘procedure to association abort “xxx”’ event to the Association Control procedure is that the ‘invalid PDU’ incoming event triggers. This shall be the case whenever one of the conditions specified in 3.2.3.6 a), b), c) or e) is given.
NOTE – The condition specified in 3.2.3.6 d) is covered by the individual procedure state tables.

4.2.2.5 The diagnostic parameter value (see 3.6.2.2.1.2) to be used in the ‘procedure to association abort ‘xxx’’ action is:

   a) ‘encoding error’ in case the condition specified in 3.2.3.6 b) applies;
   b) ‘duplicate invoke id’ in case the condition specified in 3.2.3.6 e) applies;
   c) ‘invalid procedure instance identifier’ in case the condition specified in 3.2.3.6 c) applies;
   d) ‘unrecognized operation or parameter type’ in case the condition specified in 3.2.3.6 a) applies.

NOTE – If an implementation chooses to use the diagnostic value ‘other reason’ (see 3.6.2.2.1.2 i)), the exact condition under which this is done needs to be specified (see 3.3.2.7.2).

4.2.2.6 On reception of the ‘procedure to association abort ‘xxx’’ event from any other procedure, the Association Control procedure shall abort the association.

4.2.2.7 In aborting the association the Association Control procedure shall invoke the PEER-ABORT operation with the appropriate diagnostic value.

4.2.2.8 When invoking the PEER-ABORT, the Association Control procedure of the service provider shall communicate a ‘terminate procedure’ event to all procedure instances of the service instance.

4.2.3 TERMINATING

4.2.3.1 The Association Control procedure is responsible for sending the ‘terminate procedure’ event to all procedures of the service instance.

4.2.3.2 On reception of a ‘terminate procedure’ event from the Association Control procedure all procedures shall terminate all their activities, shall release their resources and shall cease to exist, unless otherwise specified by the procedures.

NOTE – If a procedure is terminated prior to action completion, the service provider will not report on the result of the on-going operations after re-establishing the association.

4.2.4 PROCEDURE STATES

4.2.4.1 Once the association is established all stateful procedures shall be in state ‘inactive’.
4.2.4.2 For stateful procedures that have a START and a STOP operation:

a) the transition from ‘inactive’ to ‘active’ occurs after the procedure accepts the START invocation (i.e., when the procedure has sent a positive START return);

b) the transition from ‘active’ to ‘inactive’ occurs after the procedure accepts the STOP invocation (i.e., when the procedure has sent a positive STOP return).

4.2.4.3 For stateful procedures that do not have a START and a STOP operation, the state transition shall be specified by the procedure.

NOTE – Annex G should also be consulted for a description of the service state tables.

4.2.5 DERIVED PROCEDURES

4.2.5.1 The specification of a derived procedure shall identify the parent procedure type from which it is derived.

4.2.5.2 If a procedure is designated as a derived procedure, it inherits the complete behavior of the parent procedure except where the specification of the derived procedure explicitly modifies the parent procedure’s behavior.

4.2.5.3 The state table and the associated tables of a derived procedure shall be self-contained, however, elements being inherited from the parent procedure without any modification shall be presented in italic font.

NOTE – The procedures specified in 4.7, 4.8, and 4.10 are examples of derived procedures.
4.3 ASSOCIATION CONTROL

4.3.1 VERSION NUMBER

The version number of this procedure is 1.

4.3.2 DISCUSSION

4.3.2.1 Purpose

The Association Control procedure establishes and releases an association between a service user and a service provider for a given service instance.

4.3.2.2 Concept

The service user initiates the association by sending a BIND invocation. On reception of the BIND invocation, the service provider reports to the service user whether the association is established or not.

To orderly terminate the association the service user sends an UNBIND invocation. On reception of the UNBIND invocation the service provider reports to the service user whether the association release is accepted or aborted. The Association Control procedure forwards the ‘terminate procedure’ event to all procedure instances of the service instance.

The association can be aborted by either the service user or the service provider to inform the peer system that the local system detected an error that requires the association be terminated. In case of abort, the Association Control procedure forwards the ‘terminate procedure’ event to all procedure instances of the service instance.

The values of the version-number and service-type parameters are selected as part of the service definition.

4.3.3 BEHAVIOR

4.3.3.1 Activities

4.3.3.1.1 At the beginning of the service instance provision period, as specified by Service Management, the Association Control procedure of the service instance shall be placed in the ‘unbound’ state and made available for binding by the service user.

4.3.3.1.2 After having received a valid BIND invocation, the service provider shall establish the association for the given service instance with the service user having invoked the BIND operation, transitioning from service instance state 1 (‘unbound’) to service instance state 2 (‘bound’).
4.3.3.1.3 After having received a valid UNBIND invocation, the service provider shall release the association transitioning from service instance state 2 (‘bound’) to service instance state 1 (‘unbound’).

4.3.3.1.4 The service provider may abort the association by invoking the PEER-ABORT operation.

4.3.3.1.5 The service provider shall abort the association when receiving the PEER-ABORT invocation from the service user.

4.3.3.1.6 An association also may be aborted because of certain failures of the underlying communications service; such failures are signaled to the local application by a ‘protocol abort’ event (see 1.6.1.7.39).

4.3.3.1.7 The deletion of a service instance shall result in the release of all resources associated with that service instance.

4.3.3.1.8 Binding

4.3.3.1.8.1 Should the service user after having invoked the BIND operation invoke any further operations for this service instance before the service provider has sent the BIND return, such invocation shall be treated as an invalid PDU (see 3.2.3.6 d)).

4.3.3.1.8.2 If a BIND invocation is received from a service user for a service instance that is already bound to another service user, it shall be rejected with a BIND return with the result parameter set to ‘negative’ and the diagnostic parameter set to ‘already bound’.

NOTE – If the return from the BIND invocation is not received after a sufficiently long time, the service user may attempt to recover by invoking the PEER-ABORT operation followed by another BIND invocation. The length of the duration that constitutes ‘a sufficiently long time’ will be defined by the service using this procedure or by a derived procedure (service-user-responding-timer—see table 4-2).

4.3.3.1.8.3 On reception of the BIND invocation, if the invocation is accepted, the service provider shall allocate all resources needed for the service instance.

4.3.3.1.8.4 Once the association is established, the Association Control procedure shall transition to state 2 (‘bound’).

NOTE – Following receipt of the return from an UNBIND invocation or following the invocation of PEER-ABORT, the service user may issue another BIND invocation if permissible at that point (e.g., if the end of the service instance provision period has not yet been reached).
4.3.3.1.9 Unbinding

4.3.3.1.9.1 On reception of a valid UNBIND invocation the service provider shall send a positive UNBIND return and release the association previously established by a BIND operation.

4.3.3.1.9.2 Should the service user after having invoked the UNBIND operation invoke any further operations for this service instance before the service provider has sent the UNBIND return, such invocation shall be treated as an invalid PDU (see 3.2.3.6 d)).

NOTE – If the return from the UNBIND operation is not received after a sufficiently long time, the service user may attempt to recover by invoking the PEER-ABORT operation to abort the association. The length of the duration that constitutes ‘a sufficiently long time’ will be defined by the service using this procedure or by a derived procedure (service-user-responding-timer—see table 4-2).

4.3.3.1.9.3 The service provider shall accept the UNBIND invocation only in service instance state 2.1 (‘bound.ready’).

4.3.3.1.9.4 If the UNBIND invocation is accepted, then the Association Control procedure shall confirm the release of the association by issuing a positive UNBIND return.

4.3.3.1.10 Releasing

Releasing the association has the following effect: The service provider shall transition to state 1 (‘unbound’).

NOTE – The act of releasing the association for a particular service instance does not necessarily terminate the associated service production.

4.3.3.1.11 Aborting

4.3.3.1.11.1 The association may be aborted in one of three ways:

a) service provider initiated PEER-ABORT;

b) protocol abort signaled by the underlying communication layer;

c) service user initiated PEER-ABORT.

4.3.3.1.11.2 Regardless of the way the association is aborted, the service provider shall transition to the state ‘unbound’.

4.3.3.1.11.3 If the event ‘end of service instance provision period’ occurs, then the Association Control procedure of the service provider shall abort the association using the PEER-ABORT operation, delete the service instance and release its resources.
4.3.3.11.4 The Association Control procedure shall abort the association upon receipt of a ‘procedure to association abort “xxx”’ event from any of the other procedures that constitute the service.

4.3.3.11.5 If the occurrence of an underlying communication problem is flagged by means of the ‘protocol abort’ event, then the Association Control procedure shall act as if it had invoked the PEER-ABORT operation.

4.3.3.11.6 In case the prime procedure is stateful, any attempt to release the association while the prime procedure is ‘active’ shall result in a PEER-ABORT invoked by the service provider.

4.3.3.12 Access Control

4.3.3.12.1 The Association Control procedure shall implement access control based on the identity of the initiator and responder. Access control is performed at two levels:

a) the initiator must be registered at the responder and the responder must be registered at the initiator;

b) the initiator and responder must be authorized for the given service instance.

4.3.3.12.2 The initiator shall have access to a registry of authorized responders and the responder shall have access to a registry of authorized initiators. These registries shall be maintained by the UM and the PM of the CSSSes, respectively.

4.3.3.12.3 The initiator and responder shall indicate their identity by setting the parameters initiator_identifier and responder_identifier in the BIND operation to the values assigned by service management.

4.3.3.13 Extensibility

4.3.3.13.1 The Association Control procedure may be extended with additional parameters.

NOTE – Extending the parameters is not recommended as use of this feature may impact the generality of the Association Control procedure.

4.3.3.13.2 The Association Control procedure may be extended with additional diagnostic values.

NOTE – Extending the diagnostic with additional values is not recommended as use of this feature may impact the generality of the Association Control procedure.

4.3.3.13.3 A CSTS shall not derive or refine the Association Procedure through inclusion of operations other than the BIND, UNBIND, and PEER-ABORT operations.
4.3.4 REQUIRED OPERATIONS

Table 4-1: Association Control Procedure Required Operations

<table>
<thead>
<tr>
<th>Operations</th>
<th>Source</th>
<th>Extended</th>
<th>Refined</th>
<th>Procedure Blocking/Non-Blocking</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIND</td>
<td>Common</td>
<td>N</td>
<td>N</td>
<td>Blocking</td>
</tr>
<tr>
<td>UNBIND</td>
<td>Common</td>
<td>N</td>
<td>N</td>
<td>Blocking</td>
</tr>
<tr>
<td>PEER-ABORT</td>
<td>Common</td>
<td>N</td>
<td>N</td>
<td>Non-Blocking</td>
</tr>
</tbody>
</table>

4.3.5 CONFIGURATION PARAMETERS

The Association Control procedure configuration parameters that need to be configured in the context of the procedure shall be as defined in table 4-2.

NOTE – For each configuration parameter, the table provides the engineering unit (if applicable), a cross reference to the use of the parameter in the specification of the procedure, identifies whether the parameter may be read, and also identifies the Parameter Identifier and type to be used in reporting the value of the parameter. None of the configuration parameters of this procedure can be dynamically changed while the service instance executing the procedure is bound.

Table 4-2: Association Control Procedure Configuration Parameters

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Cross-Reference</th>
<th>Readable</th>
<th>Configuration Parameter Identifier and Type (F4.16)</th>
</tr>
</thead>
<tbody>
<tr>
<td>service-user-responding-timer (in seconds)</td>
<td>NOTE in 4.3.3.1.8.2, NOTE in 4.3.3.1.9.2</td>
<td>Yes</td>
<td>pACserviceUserRespTimer pACserviceUserRespTimerType</td>
</tr>
<tr>
<td>initiator-identifier</td>
<td>3.4.2.2.2, 4.3.3.1.12.3</td>
<td>Yes</td>
<td>pACinitiatorId pACinitiatorIdType</td>
</tr>
<tr>
<td>responder-identifier</td>
<td>3.4.2.2.3, 4.3.3.1.12.3</td>
<td>Yes</td>
<td>pACresponderId pACresponderIdType</td>
</tr>
<tr>
<td>service-instance-identifier</td>
<td>3.4.2.2.7</td>
<td>Yes</td>
<td>pACserviceInstanceId pACserviceInstanceIdType</td>
</tr>
</tbody>
</table>
4.3.6 PROCEDURE STATE TABLE

NOTE – The state transition matrix specified in table 4-3 represents one instance of the Association Control procedure. Since there is one and only one instance of the Association Control procedure for each instance of a CSTS, the state table thus represents the single association for that CSTS.

Table 4-3: Association Control Procedure State Table

<table>
<thead>
<tr>
<th>No.</th>
<th>Incoming Event</th>
<th>State 1 ('unbound')</th>
<th>State 2 ('bound')</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>(BindInvocation)</td>
<td>IF &quot;positive result&quot; THEN (+BindReturn) → 2 ELSE (-BindReturn) → 1 ENDIF</td>
<td>{peer abort 'protocol error'} → 1</td>
</tr>
<tr>
<td>2</td>
<td>'end of service instance provision period'</td>
<td>'delete service instance'</td>
<td>{peer abort 'end-of-service-instance-provision-period'} 'delete service instance' → 1</td>
</tr>
<tr>
<td>3</td>
<td>(UnbindInvocation)</td>
<td>[ignore]</td>
<td>IF 'prime procedure is stateful and active' THEN (peer abort 'protocol error') ELSE (+UnbindReturn) 'terminate procedure' ENDIF → 1</td>
</tr>
<tr>
<td>4</td>
<td>(PeerAbortInvocation)</td>
<td>[ignore]</td>
<td>'terminate procedure' → 1</td>
</tr>
<tr>
<td>5</td>
<td>'procedure to association abort 'xxx'</td>
<td>[ignore]</td>
<td>(peer abort 'xxx') → 1</td>
</tr>
<tr>
<td>6</td>
<td>'invalid PDU' 'xxx'</td>
<td>[ignore]</td>
<td>(peer abort 'xxx') → 1</td>
</tr>
<tr>
<td>7</td>
<td>'protocol abort'</td>
<td>[ignore]</td>
<td>'terminate procedure' → 1</td>
</tr>
</tbody>
</table>
### Table 4-4: Procedure State Table Incoming Event Description References

<table>
<thead>
<tr>
<th>Event</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>'end of service instance provision period'</td>
<td>3.6.2.2, 4.3.3.1.11.3</td>
</tr>
<tr>
<td>'invalid PDU `xxx''</td>
<td>3.2.3.6, 4.2.2.4. <code>xxx</code> is one of the diagnostic values specified in 4.2.2.5.</td>
</tr>
<tr>
<td>'procedure to association abort `xxx''</td>
<td>4.2.2.3, 4.2.2.5, 4.3.3.1.11.4</td>
</tr>
<tr>
<td>'protocol abort'</td>
<td>4.3.3.1.11.5</td>
</tr>
<tr>
<td>(PeerAbortInvocation)</td>
<td>4.3.3.1.11.1</td>
</tr>
<tr>
<td>(UnbindInvocation)</td>
<td>4.3.3.1.9.4</td>
</tr>
<tr>
<td>(BindInvocation)</td>
<td>4.3.3.1.8.2, 4.3.3.1.8.3</td>
</tr>
</tbody>
</table>

### Table 4-5: Procedure State Table Predicate Descriptions

<table>
<thead>
<tr>
<th>Predicate</th>
<th>Evaluates to TRUE if</th>
</tr>
</thead>
<tbody>
<tr>
<td>“positive result”</td>
<td>No reason for sending a negative BIND return has been detected, i.e., none of the conditions in 3.4.2.3.1 applies.</td>
</tr>
<tr>
<td>“prime procedure is stateful and active”</td>
<td>The prime procedure of the given CSTS instance is stateful and currently in the state ‘active’.</td>
</tr>
</tbody>
</table>

### Table 4-6: Procedure State Table Simple Action References

<table>
<thead>
<tr>
<th>Name</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>'delete service instance'</td>
<td>4.3.3.1.7</td>
</tr>
<tr>
<td>'abort `xxx''</td>
<td>4.2.2.7, 4.2.2.5. <code>xxx</code> indicates the diagnostic value that is reported by the PEER-ABORT operation</td>
</tr>
<tr>
<td>'terminate procedure'</td>
<td>4.2.3, internal event from the Association Control procedure to all other procedures of the service instance in response to a ‘protocol abort’ event, a PEER-ABORT, or an UNBIND</td>
</tr>
</tbody>
</table>

### Table 4-7: Procedure State Table Compound Action Definitions

<table>
<thead>
<tr>
<th>Name</th>
<th>Actions Performed</th>
</tr>
</thead>
<tbody>
<tr>
<td>(peer abort `xxx' )</td>
<td>‘terminate procedure’</td>
</tr>
<tr>
<td></td>
<td>‘abort `xxx''</td>
</tr>
</tbody>
</table>
4.4 UNBUFFERED DATA DELIVERY

4.4.1 VERSION NUMBER

The version number of this procedure is 1.

4.4.2 DISCUSSION

4.4.2.1 Purpose

This Unbuffered Data Delivery procedure can be used to accomplish the transfer of data from the service provider to the service user in a ‘best effort’ manner; i.e., data are delivered as soon as generated if possible and are discarded individually in case of communication link congestion or backpressure from the peer entity.

4.4.2.2 Concept

The Unbuffered Data Delivery procedure supports transfer of data units from the service provider to the service user. The behavior of this process is the following:

As each data unit is generated, it is either immediately transferred or immediately discarded in case the underlying communication service does not accept the data unit for transfer. Each data unit contains a sequence counter allowing the service user to detect the loss of data.

Production of data units might refer to extraction of these data units from the space link or to any other process generating data.

The operations defined in this procedure allow a service user to interact with a service provider to:

a) request start of the data transfer specifying the selection criteria of the data to be transferred;

b) receive the specified data units;

c) stop and optionally later re-start the delivery of data units applying the same or a different selection.

The service user starts the data transfer by invoking the START operation and specifying the selection criteria of the data to be transferred.

The service user can stop the data transfer at any time by invoking the STOP operation.
4.4.3 BEHAVIOR

4.4.3.1 Starting

The service provider shall send a positive START return and perform the START operation invoked by the service user except if

a) the production-status is ‘halted’ in which case the START operation shall be rejected by sending a negative START return with the diagnostic ‘out of service’;

b) the procedure is in State 2 (‘active’) in which case the procedure shall request the Association Control procedure to abort the association with setting the diagnostic value to ‘protocol error’.

NOTE – The service user will initiate the transfer of data by this procedure by invoking the START operation.

4.4.3.2 Transferring Data

4.4.3.2.1 After a successful START operation, the service provider shall transfer the data by means of invoking the TRANSFER-DATA operation as the data become available from the production and pass the TRANSFER-DATA PDU to the underlying communications service.

4.4.3.2.2 The transfer shall end when one of the following occurs:

a) no more data are to be expected;

b) STOP is invoked by the service user;

c) the service instance is aborted.

4.4.3.2.3 TRANSFER-DATA is valid only in procedure state ‘active’ and shall be invoked only by the service provider.

4.4.3.2.4 The transfer shall start with the most recently generated data, where the availability of new data generated by the production engine constitutes the ‘data available’ event (see table 4-10).

4.4.3.2.5 Data units shall be transmitted in the sequence in which they are generated.

4.4.3.2.6 While the underlying communications service does not accept data units for transfer because of to backpressure, the affected data units shall be discarded.

NOTE – Backpressure may be caused by a congested communication link or by a user application that does not accept the data units at the rate at which they are generated.
4.4.3.3 Stopping

4.4.3.3.1 The service provider shall perform the STOP operation when receiving a valid STOP invocation from the service user.

4.4.3.3.2 If the service provider accepts the STOP invocation:
   a) it shall stop sending TRANSFER-DATA invocations;
   b) it shall send the STOP return.

4.4.3.4 Terminating

Upon receipt of a ‘terminate procedure’ event from the Association Control procedure, the procedure shall terminate by:
   a) stopping transmitting TRANSFER-DATA invocations;
   b) releasing the resources.

4.4.4 REQUIRED OPERATIONS

Table 4-8: Unbuffered Data Delivery Procedure Required Operations

<table>
<thead>
<tr>
<th>Operations</th>
<th>Source</th>
<th>Extended</th>
<th>Refined</th>
<th>Procedure Blocking/Non-Blocking</th>
</tr>
</thead>
<tbody>
<tr>
<td>START</td>
<td>Common</td>
<td>N</td>
<td>N</td>
<td>Blocking</td>
</tr>
<tr>
<td>STOP</td>
<td>Common</td>
<td>N</td>
<td>N</td>
<td>Blocking</td>
</tr>
<tr>
<td>TRANSFER-DATA</td>
<td>Common</td>
<td>N</td>
<td>N</td>
<td>Non-Blocking</td>
</tr>
</tbody>
</table>

NOTE – Subsection 3.9.2.2.4.3 stipulates that a procedure using the TRANSFER-DATA operation refines or extends the data parameter of that operation. The Unbuffered Data Delivery procedure does not do that. The data syntax definition is left to a derived procedure or the service using this procedure.

4.4.5 CONFIGURATION PARAMETERS

The Unbuffered Data Delivery procedure does not have any configuration parameters.

NOTE – Consequently the Unbuffered Data Delivery procedure has neither any configuration parameter that can be read by a service using this procedure nor any parameter that can be changed dynamically while the service instance executing the Unbuffered Data Delivery procedure instance is bound.
### 4.4.6  PROCEDURE STATE TABLE

#### Table 4-9: Unbuffered Data Delivery Procedure State Table

<table>
<thead>
<tr>
<th>No.</th>
<th>Incoming Event</th>
<th>State 1 ('inactive')</th>
<th>State 2 ('active')</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>(StartInvocation)</td>
<td>IF &quot;positive result&quot; THEN (+StartReturn) → 2 ELSE (-StartReturn) ENDIF</td>
<td>'procedure to association abort 'protocol error'' → 1</td>
</tr>
<tr>
<td>2</td>
<td>(StopInvocation)</td>
<td>'procedure to association abort 'protocol error''</td>
<td>IF &quot;positive result&quot; THEN (+StopReturn) → 1 ELSE (-StopReturn) ENDIF</td>
</tr>
<tr>
<td>3</td>
<td>'data available'</td>
<td>Not applicable</td>
<td>IF (NOT &quot;backpressure&quot;) THEN 'send data to underlying communications service' ELSE 'discard data' ENDIF</td>
</tr>
<tr>
<td>4</td>
<td>'invalid PDU 'xxx'</td>
<td>'procedure to association abort 'xxx''</td>
<td>'procedure to association abort 'xxx'' → 1</td>
</tr>
<tr>
<td>5</td>
<td>'terminate procedure'</td>
<td>'terminate itself'</td>
<td>'terminate itself'</td>
</tr>
</tbody>
</table>

#### Table 4-10: Procedure State Table Incoming Event Description References

<table>
<thead>
<tr>
<th>Event</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>'data available'</td>
<td>4.4.3.2.4</td>
</tr>
<tr>
<td>'invalid PDU 'xxx'</td>
<td>3.2.3.6, 4.2.2.4. 'xxx' is one of the diagnostic values specified in 4.2.2.5.</td>
</tr>
<tr>
<td>'terminate procedure'</td>
<td>4.2.3, internal event from the Association Control procedure to all other procedures of the service instance in response to a protocol abort, a PEER-ABORT, or an UNBIND</td>
</tr>
</tbody>
</table>

#### Table 4-11: Procedure State Table Predicate Descriptions

<table>
<thead>
<tr>
<th>Predicate</th>
<th>Evaluates to TRUE if</th>
</tr>
</thead>
</table>

Predicate | Evaluates to TRUE if
--- | ---
"positive result" | No reason for sending a negative return has been detected, i.e., for the START invocation none of the condition in 3.7.2.3.1 applies, and for the STOP invocation none of the conditions in 3.3.2.7.1 applies.

Table 4-12: Procedure State Table Boolean Flags

<table>
<thead>
<tr>
<th>Flag</th>
<th>Set to TRUE if</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;backpressure&quot;</td>
<td>The underlying communications service does not accept the data unit to be transferred because of backpressure.</td>
</tr>
</tbody>
</table>

Table 4-13: Procedure State Table Simple Action References

<table>
<thead>
<tr>
<th>Name</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘send data to underlying communications service’</td>
<td>4.4.3.2.1</td>
</tr>
<tr>
<td>‘discard data’</td>
<td>4.4.3.2.6</td>
</tr>
<tr>
<td>‘procedure to association abort ‘xxx’’</td>
<td>4.2.2.3, 4.2.2.5, raise ‘procedure to association abort ‘xxx’’ event with diagnostic set to ‘xxx’ to the Association Control procedure</td>
</tr>
<tr>
<td>‘terminate itself’</td>
<td>4.4.3.4</td>
</tr>
</tbody>
</table>
4.5 BUFFERED DATA DELIVERY

4.5.1 VERSION NUMBER

The version number of this procedure is 1.

4.5.2 DISCUSSION

4.5.2.1 Purpose

The Buffered Data Delivery procedure is intended to be used for the development of services that transfer bulk data from a service provider to a service user. The data to be delivered is structured into delimited data units by a service production process. These data units are either:

a) service production data units, which contain data obtained from a service production process; or

b) service production event notifications, which contain information related to changes in the status of the production process.

The Buffered Data Delivery procedure is suitable for transfer of data under either of the following conditions, which are typical of space mission operations:

a) The service user requires delivery of the most-recent data available. Some data may be discarded and thus not sent to the service user, if necessary to maintain timeliness when communication backpressure occurs.

b) The service user requires delivery of all data requested. Delayed delivery is acceptable, if necessary to provide complete delivery of data when communication backpressure occurs.

For this purpose, the procedure allows the service instance to be configured to operate in one of the following delivery modes:

a) real-time;

b) complete.

NOTE – Strictly speaking, the delivery mode is a characteristic of the Buffered Data Delivery procedure rather than a characteristic of a service instance using this procedure. However, given that delivery-mode is a service management parameter that cannot be dynamically modified and given further that Service Management configures the service management parameters of all instances of a procedure type equally (see 2.3), all Buffered Data Delivery procedure instances associated with a given service instance will operate in the same delivery mode. Therefore one can also associate the service instance with that delivery mode.
4.5.2.2 Concept

4.5.2.2.1 Overview

The Buffered Data Delivery (BDD) procedure supports either of the following delivery modes:

a) **real-time**—the service provider ensures that blocks containing the desired minimum number of the most recent consecutive data units are transferred with a specified maximum latency; if that latency were exceeded, such blocks of data units are discarded and the service user is notified.

b) **complete**—the service provider transfers previously recorded data accepting potentially high latency in case backpressure on the ground link does not allow transferring the data in a timely manner or the service user requested the delivery after the data generation had happened. The service provider ensures that no data is discarded.

The complete delivery mode has the following objectives:

a) data retrieved from the recording buffer are delivered to the service user;

b) data units and event notifications are always delivered in sequence without discarding data.

The BDD procedure reacts to changes of the service production status. Service production status always refers to the production status of the service at the time the service instance using for instance the BDD procedure is bound. If the procedure is used in real-time delivery mode, this also reflects the status of the production process generating the data to be delivered to the service user. In complete mode, the production process generating the data may take place at a time when the service instance using the BDD procedure does not even exist. Nonetheless problems during the production may arise resulting for instance in missing data. Depending on the local implementation of the Functional Resources involved in the production process, they may report events regarding changes of the resource status and these events may be stored together with the to be delivered data in the recording buffer. During the data delivery to the user, the service may evaluate the previously recorded resource status change events and derive from them some aggregate status which may then be notified to the user and explain for instance why certain data are missing. Such status derived from previously stored events is different from the service production status.

The service user can stop the data transfer at any time by invoking the **STOP** operation.

The formal specification of the delivery modes is provided in 4.5.3.

NOTES

1 Transfer of data in real-time delivery mode implies that data units are transmitted as soon as possible after their generation by an ongoing service production session.
2 Transfer of previously recorded data in complete delivery mode implies that data units are retrieved from a storage filled by an ongoing service production session or by service production sessions terminated in the meantime.

3 The delivery mode to be applied to a given service instance needs to be defined by the service using this procedure or by a derived procedure or may be delegated to Service Management.

The operations used by this procedure allow a service user to interact with a service provider to:

a) request the start of the data transfer, specifying the selection criteria of the data to be transferred;

   NOTE – Apart from the start and stop generation times that are included in the START invocation, the specification of the selection criteria of the data depends on the specific service or the derived procedure and is not defined by this procedure.

b) receive the data units that meet the service user’s selection criteria;

c) receive, synchronized with the transfer of data units, notifications on events that have a direct impact on the production and/or delivery of data units;

d) stop and optionally later re-start the delivery of data units applying the same or a different selection.

An event that may result in an event notification is:

a) discardable: in case of backpressure affecting the communications service, notifications reporting such event will be discarded; or

b) non-discardable: the notifications reporting such events are not discarded and delivery to the service user is ensured.

NOTES

1 If a derived procedure introduces events in addition to those specified in 4.5.4.2.1.1, then this derived procedure will have to classify those events as discardable or non-discardable.

2 In complete delivery mode, all data units and event notifications are delivered to the service user, and therefore the distinction of discardable and non-discardable events is not relevant.
4.5.2.2 Buffering

4.5.2.2.1 General

As to achieve the characteristics of the real-time and complete delivery modes, the Buffered Data Delivery procedure uses two buffering mechanisms, the return buffer and the recording buffer. A return buffer, as shown in figure 4-1, is used by any instance of the Buffered Data Delivery procedure or a procedure derived from it to prepare data for the transfer to the service user, regardless of the delivery mode.

Sequence of Service Production Items from the production process

• • • SPDU SPDU SPDU SPDU SPDU SPDU SPDU SPEN SPDU

Buffered Data Delivery Derived Procedure Instance

• Add Standard Header (H) and instance-specific annotation (A).
• Insert instance-specific notifications (N)

[H+A+SPDU] [SPEN] [N] [H+A+SPDU]

[TD-Invoc][N-Invoc] [N-Invoc] [TD-Invoc]

Legend
SPDU: Service Production Data Unit
SPEN: Service Production Event Notification
H: CSTS Standard Header
A: Instance-specific annotation
N: Instance-specific notification
[TD-Invoc]: Transfer Data Invocation
[N-Invoc]: Notify Invocation (from production)
[N-Invoc]: Notify Invocation (instance-specific)

Figure 4-1: Services Using a Buffered Data Delivery Procedure

The recording buffer is used to store service production items for subsequent delivery by instances of services operating in complete delivery mode. Figure 4-2 shows both real-time and complete delivery mode service instances, and the use of the recording buffer for providing data to service instances in complete delivery mode.
Figure 4-2: Real-Time and Complete Buffered Data Delivery Service Instances and Supporting Buffering Mechanisms

NOTE – For convenience, the following subsections are written as if:

a) the contents of the recording buffer consisted of a list of data units which are either service production data units or service production event notifications; and

b) the contents of the return buffer consisted of an ordered list of data units which are either service production data units or service production event notifications.

However, this is not intended to constrain how the recording and return buffers are implemented in a real system. It is sufficient that a real system provides the externally visible behaviors that are specified herein.
4.5.2.2.2 Return Buffer

Each instance of a Buffered Data Delivery procedure or a procedure derived from it has a dedicated return buffer, which is used to accumulate data prior to the transfer to the service user. For each service production data unit, such procedure adds the Standard Operation Header and other parameters as applicable to create a TRANSFER-DATA invocation (see 3.9). For each service production event notification, such procedure adds the Standard Operation Header and other parameters as applicable to create a NOTIFY invocation. These invocations are inserted into the return buffer in the sequence in which they were generated.

The Buffered Data Delivery procedure or a procedure derived from it may also generate instance-specific notifications in the form of NOTIFY invocations to inform the service user of events or conditions that pertain only to the given instance of this procedure. A service using a Buffered Data Delivery procedure or a derived procedure and requiring such notifications needs to specify the events that trigger the generation of such procedure type specific notifications. It may also specify that multiple notifications of persistent conditions or recurring events are not to be sent in the absence of a to-be-transferred TRANSFER-DATA invocation and/or NOTIFY invocation.

The details of how the return buffer is used by a given instance of the Buffered Data Delivery procedure are specified in 4.5.3.2, 4.5.3.3 and 4.5.3.4.

4.5.2.2.3 Recording Buffer

Since the complete delivery mode is intended to deliver all data, even in the case of extended communications service outages or backpressure, or even several days after the service production session, extensive buffering is required. The recording buffer is intended to hold all service production data units and service production event notifications for significant periods of time.

A single instance of a recording buffer type may be shared by multiple instances of the service that share the service production resources that generate the type of data stored by that recording buffer type.

The recording buffer specification in terms of normative behavior, queriable parameters and notifiable events common to all recording buffer types is provided in 4.5.7. Procedures derived from the BDD procedure may extend this recording buffer specification as required by the service using such procedure.

4.5.3 BEHAVIOR

4.5.3.1 Starting

The service provider shall send a positive START return and perform the START operation invoked by the service user except if
a) the production-status is ‘halted’ in which case the START operation shall be rejected by sending a negative START return with the diagnostic ‘out of service’;

b) the procedure is in State 2 (‘active’) in which case the procedure shall request the Association Control procedure to abort the association with setting the diagnostic value to ‘protocol error’.

NOTE – The service user will initiate the transfer of data by this procedure using the START operation including the selection criteria. The only selection criteria specified for this procedure are the start and end generation times (see 4.5.4.1.2).

4.5.3.2 Transferring Data and Notifications

4.5.3.2.1 Upon successful completion of the START operation the service provider shall initialize the return buffer and insert the data that conform to the selection criteria in the form of TRANSFER-DATA and/or NOTIFY invocations into the return buffer as the data become available from the service production process or from the data retrieval from the recording buffer.

4.5.3.2.2 The service provider shall set the value of the sequence-counter parameter of the first TRANSFER-DATA invocation to be inserted into the return buffer to 0 as per 3.9.2.2.3.1.

4.5.3.2.3 The service provider shall handle the value of the sequence-counter as per 3.9.2.2.3.

4.5.3.2.4 Upon successful completion of the START operation, the service provider shall inform the service user about events affecting the production or the transfer of the data by means of the NOTIFY operation.

4.5.3.2.5 All data and events shall be delivered in the order in which they were generated.

4.5.3.2.6 The service provider shall act in accordance with the applicable delivery mode.

4.5.3.2.7 The TRANSFER-DATA and NOTIFY invocations shall be inserted into the associated return buffer of the Buffered Data Delivery procedure only while the procedure state is ‘active’.

4.5.3.2.7.1 At the time of insertion of a TRANSFER-DATA or NOTIFY invocation into an empty return buffer, the service provider shall start a timer called the release timer.

4.5.3.2.7.2 The duration from the time that the release timer is started until it expires is given by the delivery-latency-limit parameter, the value of which is configured by the service using this procedure or by a derived procedure.

4.5.3.2.7.3 For a given instance of the service, the return buffer shall accommodate a set number of TRANSFER-DATA and/or NOTIFY invocations. That number, given by the
ReturnBufferSize parameter, is initially configured by the service using this procedure or by a derived procedure based on the procedure’s return-buffer-size parameter.

4.5.3.2.7.4 The contents of the return buffer shall be passed to the communications service (in the form of one ReturnBuffer PDU) as soon as one of the following conditions is met:

a) the buffer becomes full, i.e., the number of TRANSFER-DATA and/or NOTIFY invocation contained in the buffer is equal to the value of the ReturnBufferSize parameter;

b) the release timer expires;

c) one of the notifications ‘end of data’, ‘production status change’, ‘production configuration change’, or ‘buffered data delivery configuration change’ is inserted into the return buffer; or

d) the service user invokes the STOP operation.

4.5.3.2.7.5 The ReturnBuffer PDU shall contain the TRANSFER-DATA and NOTIFY invocations in the same sequence as they were inserted into the return buffer.

4.5.3.2.8 The insertion of invocations into the return buffer shall end when one of the following occurs:

a) no further data or notification meeting the selection criteria specified in the START invocation are available;

b) data and/or notifications provided by service production have a generation time that is later than the stop-generation-time in the START invocation; however, in this case the ‘end of data’ notification is still to be inserted into the return buffer (see 4.5.3.2.9);

c) STOP is invoked by the service user;

d) the association is aborted.

4.5.3.2.9 In case the generated data contains a generation time that is later than the stop-generation-time in the START invocation, an ‘end of data’ notification shall be generated and inserted into the return buffer.

4.5.3.2.10 Further conditions triggering the ‘end of data’ notification may be defined by derived procedures.

NOTE – The definition of such conditions is in particular needed when the real-time delivery mode is used and the stop-generation-time may be ‘undefined’.
4.5.3.3 Transferring Data and Notifications (Real-Time Delivery Mode)

4.5.3.3.1 Having built a TRANSFER-DATA invocation from the data received from service production ready for insertion into the return buffer constitutes the ‘data available’ event (see 4.5.6).

4.5.3.3.2 A NOTIFY invocation shall be built and inserted into the return buffer whenever one of the events ‘end of data’, ‘production status change’, ‘production configuration change’ or ‘buffered data delivery configuration change’ triggers.

4.5.3.3.3 Insertion of invocations into the return buffer shall begin with:

   a) the most recent data or notification with a generation time equal to or later than the time specified in the start-generation-time parameter in the START invocation; or

   b) if the start-generation-time parameter in the START invocation is not set, with the most recent data or notification with a generation time equal to or later than the time at which the positive START return has been sent by the service provider.

4.5.3.3.4 The service provider shall insert notifications into the return buffer after the last data generated before the event occurrence and before the first data generated after the event.

NOTE – Such synchronous insertion of notifications is performed upon production status changes and according to further events being part of the procedure and/or service definition.

4.5.3.3.5 If the underlying communications service generates backpressure, i.e., if the communications service does not accept the ReturnBuffer PDU and the ReturnBuffer PDU does not contain an ‘end of data’ notification, the service provider shall:

   a) discard this ReturnBuffer PDU;

   b) clear the return buffer with the exception of notifications associated with non-discardable events;

   c) insert a ‘data discarded due to excessive backlog’ notification at the top of the return buffer;

   d) increase the size of the return buffer (ReturnBufferSize) by one plus the number of notifications of non-discardable events; that new size shall remain in effect until the contents of the return buffer are passed to the communications service, after which ReturnBufferSize shall be reverted to the original size as configured via the return-buffer-size parameter.
NOTE – The temporary increase of the ReturnBufferSize ensures a minimum of data flow in case of backpressure. Otherwise, only ‘data discarded due to excessive backlog’ and non-discardable event notifications might be sent.

4.5.3.4 Transferring Data and Notifications (Complete Delivery Mode)

4.5.3.4.1 Having built a TRANSFER-DATA or NOTIFY invocation from the data retrieved from the recording buffer ready for insertion into the return buffer constitutes the ‘data read from recording buffer’ event (see 4.5.6).

4.5.3.4.2 A NOTIFY invocation shall be built and inserted into the return buffer whenever one of the events ‘end of data’, ‘production status change’, ‘production configuration change’, or ‘buffered data delivery configuration change’ triggers.

4.5.3.4.3 Insertion of invocations into the return buffer shall begin with the first data or notification generated at or after the time specified by the start-generation-time parameter in the START invocation and stored in the recording buffer.

4.5.3.4.4 Subsequent data units and notification records shall be retrieved from the recording buffer and inserted into the return buffer in the same order in which they were originally generated or received.

NOTE – Recording itself is outside the scope of the Buffered Data Delivery procedure. However, the key characteristics of a recording buffer suitable for this procedure are outlined in 4.5.2.2.2.3 and formally specified in 4.5.7.

4.5.3.4.5 When the underlying communications service has accepted the ReturnBuffer PDU, the service provider shall clear the return buffer and resume retrieving data and notifications from the recording buffer as described above.

4.5.3.5 Stopping

4.5.3.5.1 The service provider shall perform the STOP operation when receiving a valid STOP invocation from the service user.

4.5.3.5.2 If the service provider accepts the STOP invocation:

   a) it shall stop inserting TRANSFER-DATA and NOTIFY invocations into the return buffer;

   b) it shall immediately build from the return buffer contents a ReturnBuffer PDU and shall keep attempting to pass that ReturnBuffer PDU to the underlying communications service until it is accepted;

   c) it shall send the STOP return.
NOTE – In case the return buffer cannot be transmitted within a reasonable time, the return buffer may be discarded as the service user is expected to invoke a PEER-ABORT as soon as the return timer expires.

4.5.3.6 Terminating

Upon receipt of a ‘terminate procedure’ event from the Association Control procedure, the Buffered Data Delivery procedure shall terminate by:

a) stopping the insertion of invocations into the return buffer;

b) stopping the extraction of data and events from the recording buffer in case of complete delivery mode;

c) clearing the return buffer, stopping the release timer, stopping all return timers and releasing associated resources.

4.5.4 REQUIRED OPERATIONS

Table 4-14: Buffered Data Delivery Procedure Required Operations

<table>
<thead>
<tr>
<th>Operations</th>
<th>Source</th>
<th>Extended</th>
<th>Refined</th>
<th>Procedure Blocking/Non-Blocking</th>
</tr>
</thead>
<tbody>
<tr>
<td>START</td>
<td>Common</td>
<td>Y</td>
<td>N</td>
<td>Blocking</td>
</tr>
<tr>
<td>STOP</td>
<td>Common</td>
<td>N</td>
<td>N</td>
<td>Blocking</td>
</tr>
<tr>
<td>TRANSFER-DATA</td>
<td>Common</td>
<td>N</td>
<td>N</td>
<td>Non-Blocking</td>
</tr>
<tr>
<td>NOTIFY</td>
<td>Common</td>
<td>Y</td>
<td>N</td>
<td>Non-Blocking</td>
</tr>
</tbody>
</table>

NOTE – Subsection 3.9.2.2.4.3 stipulates that a procedure using the TRANSFER-DATA operation refines or extends the data parameter of that operation. The Buffered Data Delivery procedure does not do that. The data syntax definition is left to a derived procedure or the service using this procedure.

4.5.4.1 START (Confirmed)

4.5.4.1.1 General

The Buffered Data Delivery procedure shall extend the START operation defined in 3.7.2 by adding two parameters to the invocation and by adding values to the diagnostic parameter of the return.
4.5.4.1.2 Operation Parameters Definitions

NOTE – Table 4-15 shows the extension parameters of the START operation defined by this procedure.

Table 4-15: START Extension Parameters

<table>
<thead>
<tr>
<th>Extension Parameters</th>
<th>Invocation</th>
<th>Return</th>
</tr>
</thead>
<tbody>
<tr>
<td>start-generation-time</td>
<td>M</td>
<td></td>
</tr>
<tr>
<td>stop-generation-time</td>
<td>M</td>
<td></td>
</tr>
</tbody>
</table>

4.5.4.1.2.1 Extension Parameters Syntax

The type BuffDataDelStartInvocExt, as defined in F4.7, shall specify the syntax of the extension parameters of the START invocation.

4.5.4.1.2.2 start-generation-time

4.5.4.1.2.2.1 For the real-time delivery mode, if start-generation-time is ‘undefined’, the data transfer shall begin with the next data unit that is acquired from the data acquisition process.

4.5.4.1.2.2.2 For the real-time delivery mode, start-generation-time when not ‘undefined’ must satisfy the following criteria:

   a) start-generation-time must be equal to or later than the start time of the service instance provision period for this service instance;

   b) start-generation-time must be earlier than the end time of the service instance provision period for this service instance;

   c) if stop-generation-time and start-generation-time are not ‘undefined’, start-generation-time must be earlier than stop-generation-time (see 4.5.4.1.2.3).

4.5.4.1.2.2.3 For the complete delivery mode, the service provider shall deliver all available data that meet the delivery criteria regardless of the service production session in which they were acquired.

4.5.4.1.2.2.4 For the complete delivery mode, start-generation-time must not be set to ‘undefined’.
4.5.4.1.2.2.5 For the complete delivery mode, start-generation-time must be earlier than stop-generation-time (see 4.5.4.1.2.3).

4.5.4.1.2.3 \textit{stop-generation-time}

4.5.4.1.2.3.1 For the real-time delivery mode, if stop-generation-time is ‘undefined’, the service provider shall continue to transfer all data that are acquired from the service production session and satisfy the delivery criteria until either the service user invokes a STOP operation, the production terminates, or the association is released or aborted.

4.5.4.1.2.3.2 For the real-time delivery mode, stop-generation-time must satisfy the following criteria:

a) stop-generation-time, if not ‘undefined’, must be later than start-generation-time;

b) stop-generation-time, if not ‘undefined’, must be earlier than or equal to the end time of the service instance provision period for this service instance.

4.5.4.1.2.3.3 For the complete delivery mode, stop-generation-time must satisfy the following criteria:

a) it must not be ‘undefined’;

b) it must be later than start-generation-time;

c) it must be earlier than or equal to the end time of the service instance provision period for this service instance.

4.5.4.1.3 \textit{diagnostic Parameter Extension Value Definitions and Syntax}

4.5.4.1.3.1 If a negative START return is sent, the diagnostic parameter shall use one of the diagnostic values specified in 3.7.2.3, or one of the following values:

a) ‘missing time value’—for the complete delivery mode, the value of start-generation-time or stop-generation-time is ‘undefined’;

b) ‘invalid start generation time’—the value of start-generation-time provided in the invocation is not valid;

c) ‘invalid stop generation time’—the value of stop-generation-time provided in the invocation is not valid;

d) ‘inconsistent time’—the value of start-generation-time is later than the value of stop-generation-time.
4.5.4.1.3.2 The type BuffDataDelStartDiagnosticExt, as defined in F4.7, shall specify the syntax of the diagnostic parameter of the START return extended as listed in 4.5.4.1.3.1.

4.5.4.2 NOTIFY (Unconfirmed)

4.5.4.2.1 General

The Buffered Data Delivery procedure shall extend the NOTIFY operation defined in 3.11 by adding four permissible Event Identifiers to the event-name parameter.

4.5.4.2.2 Invocation and Parameters

4.5.4.2.2.1 event-name Extension

4.5.4.2.2.1.1 The value of the event-name shall be one of the following:

   a) one of the values specified for the common NOTIFY operation in 3.11.2.2.3;

   NOTE – The notifications specified in the common NOTIFY are discardable for the Buffered Data Delivery procedure.

   b) ‘data discarded due to excessive backlog’ (event-name)—some data was discarded by the service provider because of timeliness considerations (real-time delivery mode);

      1) the event-name of this event shall contain the Functional Resource Name of the service triggering the event;

      2) unless otherwise specified by the service using that procedure or by a derived procedure, the associated event-value shall be empty;

      3) this notification is discardable;

   c) ‘bdd recording buffer overflow’ (event-name)—some data may have been lost because during the service production session a recording buffer overflow occurred and therefore recording of service production data stopped; this event applies only to complete delivery mode (see 4.5.7.5);

      1) the event-name of this event shall contain the Functional Resource Name of the Functional Resource modeling the recording buffer;

      2) unless otherwise specified by the service using that procedure or by a derived procedure, the associated event-value shall be empty;

   NOTES
Each recording buffer generates a ‘bdd recording buffer overflow’ event notification when the overflow event occurs and stores it for subsequent retrieval by BDD-using CSTSes operating in complete delivery mode. When a BDD procedure instance reads the overflow event notification from the recording buffer that procedure creates a NOTIFY invocation that reports to the user of a service containing such procedure that a recording buffer overflow had occurred during the production process.

In addition to storing a ‘bdd recording buffer overflow’ event notification for subsequent retrieval by a BDD-using CSTS, the recording buffer Functional Resource also emits an ‘fr recording buffer overflow’ notifiable event that triggers when the recording buffer overflow occurs. Services containing procedures with NOTIFY operations capable of subscribing to real-time events (e.g., the Notification procedure) may subscribe to the ‘fr recording buffer overflow’ event and will then be notified of the occurrence in real time (see 4.5.7.5).

d) ‘end of data’ (event-name)—the service provider has no more data to send;

1) as stated in 4.5.3.2.10 the conditions triggering the ‘end of data’ insertion in addition to the condition specified in 4.5.3.2.9 shall be defined by the service using that procedure or by the derived procedure;

2) the event-name of this event shall contain the Functional Resource Name of the service triggering the event;

3) the associated event-value shall be empty;

4) this notification is non-discardable;

e) ‘buffered data delivery configuration change’ (event-name)—a dynamic modification of the return-buffer-size parameter or the delivery-latency-limit parameter has occurred:

1) the event-name of this event shall contain the procedure instance identifier of the procedure instance in which the event occurs;

2) the associated event-value shall contain the current values of the return-buffer-size and delivery-latency-limit parameters;

i) the first part of the path specifying the type to be used is ‘NotifyInvocation’: ‘eventName’: ‘EventValue’: ‘qualifiedValues’: ‘SequenceOfQualifiedValue’: ‘SEQUENCE OF QualifiedValue’ where this sequence has the length 2;

ii) the first element of this sequence shall report the return-buffer-size and the second element the delivery-latency-limit; for each of the two parameters the following shall apply: if the qualifier of the to-be-reported value is not ‘valid’, then the second part of the path is one of the following:
(a) ‘QualifiedValue’: ‘ unavailable’: ‘NULL’; 
(b) ‘QualifiedValue’: ‘undefined’: ‘NULL’; or 
(c) ‘QualifiedValue’: ‘error’: ‘NULL’;

iii) If the qualifier of the to-be-reported value is ‘valid’, then the second part of the path is ‘QualifiedValue’: ‘valid’: ‘TypeAndValueComplexQualified’: ‘typeAndValue’: ‘integerPositive’: ‘SEQUENCE OF IntPos’, where this sequence shall have the length 1;  

NOTE – All relevant types are defined in F4.3.

3) This notification is discardable.

NOTE – A change of the configuration of a procedure can only be accomplished by invoking the associated directive by means of the EXECUTE-DIRECTIVE operation. Although the notification reporting the procedure configuration change may be discarded, the service user is nonetheless informed of the configuration change by the EXECUTE-DIRECTIVE return.

4.5.4.2.2.1.2 The Published Identifiers for the above defined new Event Identifier values are specified in F4.16 as pBDDdataDiscardedExcessBacklog, pBDDrecordingBufferOverflow, pBDDendOfData, and pBDDconfigurationChange, respectively.

NOTE – The end of data to be transferred is notified to the service user (see 4.5.4.2), but does not stop the procedure. The service user is expected to terminate the procedure by invoking the STOP operation when receiving this notification.

4.5.4.2.2 notification-invocation-extension Extension

The NOTIFY invocation is not further extended and therefore notification-invocation-extension shall be set to ‘notUsed’.

4.5.5 CONFIGURATION PARAMETERS

The Buffered Data Delivery procedure configuration parameters that need to be configured in the context of the procedure shall be as defined in table 4-16.

NOTE – For each configuration parameter, the table provides the engineering unit (if applicable), a cross reference to the use of the parameter in the specification of the procedure, identifies whether the parameter may be read and/or dynamically modified, and also identifies the Parameter Identifier and type to be used in reporting the value of the parameter.
<table>
<thead>
<tr>
<th>Parameters</th>
<th>Cross-Reference</th>
<th>Readable</th>
<th>Dynamically modify-able</th>
<th>Configuration Parameter Identifier and Type (F4.16)</th>
</tr>
</thead>
<tbody>
<tr>
<td>return-buffer-size (in number of TRANSFER-DATA and/or NOTIFY invocations the buffer will accommodate)</td>
<td>4.5.3.2.7.3</td>
<td>Yes</td>
<td>Yes</td>
<td>pBDDreturnBufferSize PBDDreturnBufferSizeType</td>
</tr>
<tr>
<td>delivery-lateness-limit (in seconds)</td>
<td>4.5.3.2.7.2</td>
<td>Yes</td>
<td>Yes</td>
<td>pBDDdeliveryLatencyLimit PBDDdeliveryLatencyLimitType</td>
</tr>
<tr>
<td>delivery-mode</td>
<td>4.5.2.2.2.1, 4.5.3.2.6</td>
<td>Yes</td>
<td>No</td>
<td>pBDDdeliveryMode PBDDdeliveryModeType</td>
</tr>
</tbody>
</table>

NOTE – A notification of the occurrence of the pBDDconfigurationChange when the BDD procedure is operating in real time delivery mode will be inserted into the return buffer by that procedure. A delay in reporting of this event is kept to a minimum in that the return buffer is released to the underlying communications service as soon as such notification is inserted into the return buffer. However, that notification may be discarded in case of backpressure on the link to the CSTS user. If the service using the Buffered Data Delivery procedure shall ensure that this event is notified to the service user rather than possibly being discarded, the service must also use a procedure that contains a NOTIFY operation and will regardless of potential backpressure never discard a notification. For example, the service could use the Notification procedure, through which the user could subscribe to the pBDDconfigurationChange event.
## 4.5.6  PROCEDURE STATE TABLE

Table 4-17: Buffered Data Delivery Procedure State Table

<table>
<thead>
<tr>
<th>No.</th>
<th>Incoming Event</th>
<th>State 1 ('inactive')</th>
<th>State 2 ('active')</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>(StartInvocation)</td>
<td>IF “positive result” THEN (StartReturn) → 2 ‘initialize return buffer’ set “data ended” to FALSE ELSE (StartReturn) ENDIF</td>
<td>‘procedure to association abort ‘protocol error’’ → 1</td>
</tr>
<tr>
<td>2</td>
<td>(StopInvocation)</td>
<td>‘procedure to association abort ‘protocol error’’</td>
<td>IF “positive result” THEN IF (NOT “buffer empty”) THEN {pass buffer contents} ENDIF set “data ended” to FALSE ‘stop all return timers’ (StopReturn) → 1 ELSE (StopReturn) ENDIF</td>
</tr>
<tr>
<td>3</td>
<td>‘data available’</td>
<td>Not applicable</td>
<td>IF “return buffer full” THEN (pass buffer contents) IF “backpressure” THEN ‘increment buffer size’ ‘notify ‘data discarded’’ / ‘empty’” ‘copy non-discardable notifications’ ENDIF ‘insert data in return buffer’ (init and start release timer) ELSE IF “buffer empty” THEN (init and start release timer) ENDIF ‘insert data in return buffer’ IF “return buffer full” THEN (attempt pass buffer contents) ENDIF ENDIF</td>
</tr>
<tr>
<td>No.</td>
<td>Incoming Event</td>
<td>State 1 (‘inactive’)</td>
<td>State 2 (‘active’)</td>
</tr>
<tr>
<td>-----</td>
<td>-----------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>4</td>
<td>‘data read from recording buffer’</td>
<td>Not applicable</td>
<td>IF &quot;buffer empty&quot; THEN {init and start release timer}</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>'insert data in return buffer' IF &quot;return buffer full&quot; THEN {transmit buffer} ENDIF</td>
</tr>
<tr>
<td>5</td>
<td>‘real-time, release timer expired’</td>
<td>Not applicable</td>
<td>{pass buffer contents} IF &quot;backpressure&quot; THEN 'increment buffer size'</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>'notify ‘data discarded’ / ‘empty’ 'copy non-discardable notifications' (init and start release timer) ENDIF</td>
</tr>
<tr>
<td>6</td>
<td>‘complete, release timer expired’</td>
<td>Not applicable</td>
<td>{transmit buffer}</td>
</tr>
<tr>
<td>7</td>
<td>‘end of data’</td>
<td>Not applicable</td>
<td>IF (NOT “data ended”) THEN {transmit buffer}</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>set “data ended” to TRUE</td>
</tr>
<tr>
<td>8</td>
<td>‘production status change’ [when Buffered Data Delivery procedure is in real-time delivery mode]</td>
<td>Not applicable</td>
<td>IF &quot;return buffer full&quot; THEN {pass buffer contents} IF &quot;backpressure&quot; THEN 'increment buffer size'</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>'notify ‘data discarded’ / ‘empty’ 'copy non-discardable notifications’ ENDIF ENDIF</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>'notify ‘production status change’ / ‘empty’ in return buffer {attempt pass buffer contents}</td>
</tr>
<tr>
<td>9</td>
<td>‘production status change’ [when Buffered Data Delivery procedure is in complete delivery mode]</td>
<td>Not applicable</td>
<td>{notify ‘production status change’ / ‘empty’ in return buffer}</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(transmit buffer)</td>
</tr>
<tr>
<td>10</td>
<td>‘production configuration change’ [when Buffered Data Delivery procedure is in real-time delivery mode]</td>
<td>Not applicable</td>
<td>IF &quot;return buffer full&quot; THEN {pass buffer contents} IF &quot;backpressure&quot; THEN 'increment buffer size'</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>'notify ‘data discarded’ / ‘empty’ 'copy non-discardable notifications’ ENDIF ENDIF</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>'notify ‘production configuration change’ / ‘empty’ in return buffer {attempt pass buffer contents}</td>
</tr>
<tr>
<td>No.</td>
<td>Incoming Event</td>
<td>State 1 ('inactive')</td>
<td>State 2 ('active')</td>
</tr>
<tr>
<td>-----</td>
<td>--------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>11</td>
<td>‘production configuration change’ [when Buffered Data Delivery procedure is in complete-time delivery mode]</td>
<td>Not applicable</td>
<td>‘notify ‘production configuration change’ / ‘empty’ in return buffer (transmit buffer)</td>
</tr>
<tr>
<td>12</td>
<td>‘buffered data delivery configuration change’ [when Buffered Data Delivery procedure is in real-time delivery mode]</td>
<td>Not applicable</td>
<td>IF “return buffer full” THEN (pass buffer contents) IF “backpressure” THEN ‘increment buffer size’ ‘notify ‘data discarded’ / ‘empty’ ‘copy non-discardable notifications’ ENDIF ENDIF ‘notify ‘buffered data delivery configuration change’ / ‘empty’ in return buffer (attempt pass buffer contents)</td>
</tr>
<tr>
<td>13</td>
<td>‘buffered data delivery configuration change’ [when Buffered Data Delivery procedure is in complete delivery mode]</td>
<td>Not applicable</td>
<td>‘notify ‘buffered data delivery configuration change’ / ‘empty’ in return buffer (transmit buffer)</td>
</tr>
<tr>
<td>14</td>
<td>‘invalid PDU ‘xxx’’</td>
<td>‘procedure to association abort ‘xxx’’</td>
<td>‘procedure to association abort ‘xxx’’ → 1</td>
</tr>
<tr>
<td>15</td>
<td>‘terminate procedure’</td>
<td>‘terminate itself’</td>
<td>‘terminate itself’</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Event</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘data available’</td>
<td>4.5.3.3.1</td>
</tr>
<tr>
<td>‘data read from recording buffer’</td>
<td>4.5.3.4.1</td>
</tr>
<tr>
<td>‘end of data’</td>
<td>4.5.3.2.7.4, 4.5.3.2.8, 4.5.3.2.9, 4.5.3.2.10, 4.5.4.2.2.1.1</td>
</tr>
<tr>
<td>‘production status change’</td>
<td>B2.5</td>
</tr>
<tr>
<td>‘production configuration change’</td>
<td>3.11.2.2.3.2 b)</td>
</tr>
<tr>
<td>‘buffered data delivery configuration change’</td>
<td>4.5.4.2.2.1.1</td>
</tr>
<tr>
<td>‘real-time, release timer expired’</td>
<td>4.5.3.2.7.2</td>
</tr>
<tr>
<td>‘complete, release timer expired’</td>
<td>4.5.3.2.7.2</td>
</tr>
<tr>
<td>‘invalid PDU ‘xxx’’</td>
<td>3.2.3.6, 4.2.2.4. ‘xxx’ is one of the diagnostic values specified in 4.2.2.5.</td>
</tr>
<tr>
<td>‘terminate procedure’</td>
<td>4.2.3. internal event from the Association Control procedure to all other procedures of the service instance in response to a protocol abort, a PEER-ABORT, or an UNBIND</td>
</tr>
</tbody>
</table>
Table 4-19: Procedure State Table Predicate Descriptions

<table>
<thead>
<tr>
<th>Predicate</th>
<th>Evaluates to TRUE if</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;return buffer full&quot;</td>
<td>The return buffer cannot accommodate the currently available data or notification.</td>
</tr>
<tr>
<td>&quot;buffer empty&quot;</td>
<td>The return buffer does not contain any data or notification.</td>
</tr>
<tr>
<td>&quot;complete&quot;</td>
<td>Delivery mode is complete.</td>
</tr>
<tr>
<td>&quot;real-time&quot;</td>
<td>Delivery mode is real-time.</td>
</tr>
<tr>
<td>&quot;positive result&quot;</td>
<td>No reason for sending a negative return has been detected, i.e., for the START invocation none of the conditions in 4.5.4.1.3.1 applies, and for the STOP invocation none of the conditions in 3.3.2.7.1 applies.</td>
</tr>
</tbody>
</table>

Table 4-20: Procedure State Table Boolean Flags

<table>
<thead>
<tr>
<th>Flag</th>
<th>Set to TRUE if</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;backpressure&quot;</td>
<td>The underlying communications service does not accept the contents of the return buffer because of backpressure.</td>
</tr>
<tr>
<td>&quot;data ended&quot;</td>
<td>The service provider has sent the 'end of data' notification.</td>
</tr>
<tr>
<td>Name</td>
<td>References</td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>------------------------------------------------------</td>
</tr>
<tr>
<td>'increment buffer size'</td>
<td>4.5.3.3.5</td>
</tr>
<tr>
<td>'set release timer to delivery latency limit'</td>
<td>4.5.3.2.7.2</td>
</tr>
<tr>
<td>'start release timer'</td>
<td>4.5.3.2.7.4</td>
</tr>
<tr>
<td>'stop release timer'</td>
<td>4.5.3.6 c)</td>
</tr>
<tr>
<td>'stop all return timers'</td>
<td>4.5.3.6 c)</td>
</tr>
<tr>
<td>'initialize return buffer'</td>
<td>4.5.3.2.1</td>
</tr>
<tr>
<td>'copy non-discardable notifications'</td>
<td>4.5.3.3.5</td>
</tr>
<tr>
<td>'notify 'xxx' / 'yyy''</td>
<td>4.5.3.2.4, (NotifyInvocation) with event-name set to 'xxx' and event-value set to 'yyy'. In case a notification does not use an event-value, 'yyy' shall be set to 'empty'</td>
</tr>
<tr>
<td>'submit content of return buffer to underlying communications service'</td>
<td>4.5.3.2.7.4</td>
</tr>
<tr>
<td>'procedure to association abort 'xxx''</td>
<td>4.2.2.3, 4.2.2.5, raise 'procedure to association abort 'xxx'' event with diagnostic set to 'xxx' to the Association Control procedure</td>
</tr>
<tr>
<td>'insert data in return buffer'</td>
<td>4.5.3.2.7</td>
</tr>
<tr>
<td>'reinitialize return buffer using the nominal size'</td>
<td>4.5.3.3.5</td>
</tr>
<tr>
<td>'terminate itself'</td>
<td>4.5.3.6</td>
</tr>
</tbody>
</table>
Table 4-22: Procedure State Table Compound Action Definitions

<table>
<thead>
<tr>
<th>Name</th>
<th>Actions Performed</th>
</tr>
</thead>
<tbody>
<tr>
<td>{attempt pass buffer contents}</td>
<td>‘submit contents of return buffer to underlying communications service’</td>
</tr>
<tr>
<td></td>
<td>IF</td>
</tr>
<tr>
<td></td>
<td>‘stop release timer’</td>
</tr>
<tr>
<td></td>
<td>‘reinitialize return buffer using the normal size’</td>
</tr>
<tr>
<td></td>
<td>ENDIF</td>
</tr>
<tr>
<td>{pass buffer contents}</td>
<td>‘stop release timer’</td>
</tr>
<tr>
<td></td>
<td>‘submit contents of return buffer to underlying communications service’</td>
</tr>
<tr>
<td></td>
<td>IF</td>
</tr>
<tr>
<td></td>
<td>successful</td>
</tr>
<tr>
<td></td>
<td>THEN</td>
</tr>
<tr>
<td></td>
<td>‘stop release timer’</td>
</tr>
<tr>
<td></td>
<td>‘reinitialize return buffer using the normal size’</td>
</tr>
<tr>
<td></td>
<td>IF</td>
</tr>
<tr>
<td></td>
<td>set “backpressure” to FALSE</td>
</tr>
<tr>
<td></td>
<td>ELSE</td>
</tr>
<tr>
<td></td>
<td>set “backpressure” to TRUE</td>
</tr>
<tr>
<td></td>
<td>ENDIF</td>
</tr>
<tr>
<td>(init and start release timer)</td>
<td>‘set release timer to delivery latency limit’</td>
</tr>
<tr>
<td></td>
<td>‘start release timer’</td>
</tr>
<tr>
<td>(transmit buffer)</td>
<td>‘stop release timer’</td>
</tr>
<tr>
<td></td>
<td>‘submit the contents of return buffer to underlying communications service’</td>
</tr>
<tr>
<td></td>
<td>until accepted by that service</td>
</tr>
<tr>
<td></td>
<td>‘reinitialize return buffer using the nominal size’</td>
</tr>
</tbody>
</table>

4.5.7 REQUIREMENTS FOR RECORDING BUFFERS FOR USE BY THE BUFFERED DATA DELIVERY PROCEDURE

4.5.7.1 Each recording buffer type shall be represented by an associated Functional Resource Type. A CSTS type using the BDD procedure or a procedure derived from it shall specify the associated recording buffer type and the associated Functional Resource Type and its Object Identifier.

NOTE – The Functional Resource Type shall be registered on the crossSupportFunctionalities subbranch of the OID tree structure (see figure Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 8,Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll.-6). More information regarding the registration of derived recording buffer Functional Resources and the associated events and parameters can be found in reference [Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 8,Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll.3].
4.5.7.2 The time between data being inserted into the recording buffer by the production process and availability of this data for retrieval from this buffer for transfer to a service user shall be kept to a minimum.

4.5.7.3 Multiple service instances requiring access to data generated by the same production process shall be able to share the same recording buffer.

4.5.7.4 The production process shall continue inserting acquired service production data units and service production related events as emitted by the Functional Resources taking part in the production process in the form of ‘resource status change’ notifications into the recording buffer. This recording shall be performed as specified for the given recording buffer type (see 4.5.7.1) and as determined by the controlling service agreement and service package, regardless of the state of any service instance and regardless of whether an association with any service user is established.

NOTE – The events recorded in the recording buffer relate only to the recording buffer itself and to the production process that needs to be active as to produce the data that shall be stored in the recording buffer. Such events do not have any impact on the production status reported by the CSTS that at some point in time will retrieve the data of interest from the recording buffer. The CSTS production status always refers to the current status of the CSTS service instance. Typically the CSTSes that will transfer the data stored earlier in the recording buffer will not be bound or not even exist at the time the service production related events to be stored in the recording buffer occur. However, when a CSTS includes the BDD procedure or a procedure derived from it and the recording buffer type is specified to record events that may be notified by the Functional Resources modeling the production process filling the recording buffer, such CSTS may specify that the procedure used to read from the recording buffer shall extract such events from that buffer and report them or some aggregate events derived from them synchronously with the data. The derivation of aggregate events is never done by the recording buffer, but always by the CSTS instance. However, a CSTS regardless of its specification will only be able to provide such notifications if the local implementation of the Functional Resources modeling the production process emit the required event notifications.

4.5.7.5 If the recording buffer overflows, the recording buffer shall

   a) store a ‘bdd recording buffer overflow’ event notification in the recording buffer (see 4.5.4.2.2.1.1 c));

      1) the latest data unit previously stored on the recording buffer shall be deleted if that is necessary to have sufficient storage space for storing the ‘bdd recording buffer overflow’ event;

      2) following this event, no further service production data units shall be stored on the recording buffer;
NOTE – It is normally expected that the recording buffer is sufficiently large to hold all data that might be accumulated during several service production sessions. The time span over which data is retained in the recording buffer, the policy for deleting data from the recording buffer, and the conditions under which the recording buffer begins to accept data following an overflow condition are outside the scope of this Recommended Standard. In general, this may be specified by the CSTS using a specific recording buffer type or the service provider and service user will agree on a data custody transfer protocol.

b) emit an ‘fr recording buffer overflow’ event.

NOTE – Given that the ‘fr recording buffer overflow’ event is notifiable, a service including the Notify procedure could subscribe to it. However, the production process and therefore filling of the recording buffer may take place well before a service instance that might subscribe to the event is bound. Such service instance might not even exist at the time the overflow occurs. In general it is therefore not useful if services using a recording buffer implement the capability to be notified of the recording buffer overflow in real-time.

4.5.7.6 The ‘fr recording buffer overflow’ event for each derived recording buffer Functional Resource Type shall be registered under the eventsId branch of the functionalResourceType Published Identifier for that derived recording buffer Functional Resource Type (see D6.2.3).

4.5.7.7 The Functional Resources that are relevant for the production process generating the data to be captured in a given recording buffer type should emit ‘resource status change’ and ‘resource configuration change’ event notifications which then will be stored in the recording buffer.

4.5.7.8 The CSTS specification shall specify the recording buffer type to be used for that service type and the Functional Resources of which the ‘resource status change’ and ‘resource configuration change’ event notifications shall be captured in the recording buffer. Such events shall be inserted into the recording buffer after the last data acquired before the occurrence of the event and before the first data acquired following the event.

NOTE – The kind of notifications addressed in 4.5.7.7 will not be defined as events of the Functional Resource representing the recording buffer, but as events notified by the individual Functional Resources being part of the production process.

4.5.7.9 If a BDD derived procedure extends the recording buffer Functional Resource to have buffer-operation-related events beyond the recording buffer overflow that are to be emitted in real-time, then those events shall be specified as notifiable events of the derived recording buffer Functional Resource and registered under the eventsId branch of the
4.5.7.10 A Functional Resource Type representing a recording buffer shall have a queriable recording-buffer-size parameter that specifies the storage capacity of the recording buffer. The recording-buffer-size parameter for each derived recording buffer Functional Resource shall be registered under the parametersId branch of the functionalResourceType Published Identifier for that derived recording buffer Functional Resource Type (see D6.2.3).

NOTE – Given that the recording-buffer-size parameter is queriable, it is accessible to the GET operation as, e.g., contained in the Information Query procedure. In particular, monitoring of this parameter by the service including the Buffered Data Delivery procedure or a procedure derived from it is possible if that service includes a procedure containing the GET operation as does, e.g., the Information Query procedure.

4.6 DATA PROCESSING

4.6.1 VERSION NUMBER

The version number of this procedure is 1.

4.6.2 DISCUSSION

4.6.2.1 Purpose

The purpose of the Data Processing procedure is to provide transfer of data units from the service user to the service provider for processing of the data units by the service provider. This procedure does neither define the data units being transferred, nor the processing to be performed by the service provider. It is assumed, however, that processing is part of service production and will be specified by the service using this procedure.

The Data Processing procedure is abstract and cannot be implemented directly because the specification is incomplete. To be implementable, derived procedures must provide the missing specifications.

4.6.2.2 Concept

The Data Processing procedure supports transfer of data units from the service user to the service provider by means of PROCESS-DATA operations. When the service provider receives a PROCESS-DATA invocation it stores the invocation on an Input Queue and processes the contained data unit as soon as possible. The service provider processes the data sequentially in the order transmitted by the service user, processing only one unit at any point in time. This means that a CSTS will normally comprise a single instance of this procedure. Derived procedures may specify more complex data processing behaviors. The specification of
this procedure offers the means needed in case a CSTS will comprise more than one instance of a procedure derived from the Data Processing Procedure. Such service specification will then need to define in particular how concurrently executing procedure instances shall interact with the shared underlying service production in a conflict-free manner (see 4.6.7).

The ability of the service provider to process the data depends on the production status described in more detail in annex B. If production-status is ‘operational’, the service provider is able to perform data processing; otherwise, the service provider is unable to perform data processing. As long as production-status is ‘operational’, the service provider removes PROCESS-DATA invocations from the Input Queue and processes the enclosed data unit; otherwise, PROCESS-DATA invocations already queued remain on the queue until production-status becomes ‘operational’, until the service user stops the procedure, or until the associated service instance is aborted or unbound.

The service provider will inform the service user by means of a NOTIFY operation if the production status changes and the procedure instance is in the ‘active’ state. However, change of production-status to ‘interrupted’ per se does not mean that the user needs to take action to recover from this situation. If production-status changes to ‘interrupted’ while no PROCESS-DATA invocations are queued for processing, then there is a chance that production-status reverts back to ‘operational’ in time before the service user is actually affected by production-status presently being ‘interrupted’. The notification that production-status is ‘interrupted’ has the purpose to make the service user aware that the processing of the data unit will be delayed until production-status becomes ‘operational’ and that the input queue might fill up if further PROCESS-DATA operations are invoked.

Successful completion of processing is reported to the service user by means of a NOTIFY operation only if a report has been explicitly requested for that data unit by the service user. As to enable requesting such report, this procedure has extended the PROCESS-DATA operation (see 4.6.4.1.4). Failure of processing is always notified to the service user.

In order to enable the identification of the data unit for which a report is issued, the PROCESS-DATA invocation that transfers the data unit also includes the data-unit-id parameter the value of which is used to refer to that data unit in notifications sent to the service user. The service user can freely choose the data-unit-id parameter value and the service provider does not check if the identification of the related data unit is unique. If such uniqueness is required, it has to be ensured by the service user.

The method by which the size of the Input Queue for incoming PROCESS-DATA operations is configured is defined by a derived procedure or by the service using this procedure, possibly delegating the definition to service management. Handling of a queue overflow condition is left undefined by this procedure and because such a condition cannot be excluded this procedure specification remains abstract and cannot be directly implemented. In order to be implementable, derived procedures must provide the missing specification.
As this procedure neither specifies the content of the data units transferred for processing nor the type of processing to be performed, it does not specify what processing failures can occur and shall be notified to the service user, with the exception of production status changes that affect processing of data units. If the occurrence of a failure causes more than one data unit to be discarded, then the service provider sends only a single notification. All NOTIFY operations issued include information from which the service user can derive the state of processing.

The service user can terminate processing of data units at any time by invocation of the STOP operation. When PROCESS-DATA invocations are still queued for processing at the time the STOP invocation is received, the service provider discards all PROCESS-DATA invocations stored in the queue, i.e., all invocations for which processing has not yet started, but the service provider completes processing of the data unit for which processing has already started if that is possible. The user can avoid inadvertent discarding of data units by requesting a processing report for the last data unit in the sequence and not invoking the STOP operation before that processing report has been received.

4.6.3 BEHAVIOR

4.6.3.1 Starting

The service provider shall send a positive START return and perform the START operation invoked by the service user except if:

a) the production-status is ‘halted’ in which case the START operation shall be rejected by sending a negative START return with the diagnostic ‘out of service’;

b) the procedure is in State 2 (‘active’) in which case the procedure shall request the Association Control procedure to abort the association with setting the diagnostic value to ‘protocol error’.

NOTE – By invoking the START operation, the service user requests that the service provider prepares to receive PROCESS-DATA invocations for processing.

4.6.3.2 Transfer and Queuing of PROCESS-DATA Invocations

4.6.3.2.1 If the service provider receives a PROCESS-DATA invocation, then the invocation shall be queued until either processing of the enclosed data unit begins or the invocation is discarded.

NOTE – The service user will invoke the PROCESS-DATA operation for each data unit to be transferred to the service provider for processing.

4.6.3.2.2 The provider shall accept any value of the data-unit-id parameter received with a PROCESS DATA invocation and store it for later use in notifications related to the processing of the given data unit.
4.6.3.2.3 The size of the Input Queue for incoming PROCESS-DATA operations expressed as the number of PROCESS-DATA invocations the Input Queue can hold shall be defined using the input-queue-size procedure configuration parameter (see 4.6.5).

NOTE – The Input Queue decouples the timing of the processing of the PROCESS-DATA invocations from the transfer of those invocations.

4.6.3.2.4 The service provider shall queue received PROCESS-DATA invocations regardless of the value of production-status.

NOTE – If the production-status is not ‘operational’ PROCESS-DATA invocations will not be processed (see 4.6.3.3) and the queue may fill up.

4.6.3.2.5 If the queue is full at the time the service provider receives a PROCESS-DATA invocation the behavior of the provider is not defined by this procedure. Because of this missing specification this procedure is abstract and cannot be directly implemented. To be implementable, derived procedures shall provide the missing specification.

4.6.3.3 Processing of Data Units

4.6.3.3.1 The service provider shall remove PROCESS-DATA invocations from the Input Queue and process the data units included as soon as possible as long as production-status is ‘operational’.

4.6.3.3.2 When the procedure has performed its processing (if any) of the data unit, the (processed) data unit shall be submitted to the associated service production functions (see 4.6.7) functions. The data unit as submitted to service production shall consist of:

   a) the contents of the data and data-unit-id parameters of the PROCESS-DATA invocation;
   
   b) the procedure-instance-identifier of the Data Processing procedure; and
   
   c) the service-instance-identifier of the service instance using the Data Processing procedure.

4.6.3.3.3 If production-status changes to a value other than ‘operational’ then the service provider shall suspend processing of data units until production-status changes to ‘operational’ again.

NOTES

1 Processing of data units for which processing has already started at the time production-status changes to ‘interrupted’ or ‘halted’ will fail and processing of such data units will not be resumed (see 4.6.3.3.6).
2 PROCESS-DATA invocations for which processing has not started remain queued and will be processed when production-status changes to ‘operational’.

4.6.3.3.4 The service provider shall process the data units sequentially in the order in which they were received.

NOTES

1 The term sequential processing as used here excludes all concurrency and in particular means that at most one data unit is being processed by the procedure at any point in time. However, there may be more than one data unit being processed by the underlying service production.

2 It is assumed that a CSTS type using the Data Processing procedure comprises only a single instance of a derived procedure. Should that service type need to permit several instances of a derived procedure executing concurrently, it will need to specify how those procedure instances shall interact with the underlying shared service production in a conflict-free manner.

4.6.3.3.5 The data-unit-id parameter value of the PROCESS-DATA invocation shall be used as a reference to data units in any NOTIFY invocations sent by the service provider to the service user.

4.6.3.3.6 If any data unit has started but has not completed processing at the time production-status changes from ‘operational’ to ‘interrupted’ or ‘halted’ the service provider shall discard any data unit being processed by the procedure and direct the underlying service production to discard any in-process data units that are associated with the service instance that is executing the procedure.

NOTES

1 The requirement stated in 4.6.3.3.6 is valid only if a CSTS type comprising a procedure derived from the Data Processing procedure uses only a single instance of that derived procedure. If the CSTS type permits more than one instance of the derived procedure executing concurrently, it needs to specify the effect that the request to service production to discard data units emitted by an individual procedure instance shall have.

2 How service production can be requested to discard data units for which processing has started depends on the specific implementation and is therefore outside the scope of this Recommended Standard. The only assumption is that requesting the underlying service production to discard data units although there are currently no data units being processed by service production is not regarded an error condition.
4.6.3.4 Positive Feedback

The ‘data unit processing completed’ event may be notified by service production or may may determined by a procedure derived from the Data Processing procedure itself if such procedure processes the data unit without involving service production. Every CSTS therefore has to specify under which condition(s) the ‘data unit processing completed’ shall trigger in the context of the service.

Upon the ‘data unit processing completed’ event and if the value of the process-completion-report parameter (see 4.6.4.1.4) in the associated PROCESS-DATA invocation was ‘produce report’, the service provider shall notify the service user with Event Identifier ‘data unit processing completed’.

NOTE – This procedure defines only one report to be issued upon occurrence of the ‘data unit processing completed’ event. Derived procedures might define additional processing steps, the completion of which should be reported.

4.6.3.5 Notifications

4.6.3.5.1 Notification of Production Status Changes

4.6.3.5.1.1 The service provider shall notify the service user whenever production-status changes independent of the effect this change has on the processing of data units. To that end the service provider shall invoke the NOTIFY operation with the event-name set to ‘production status change’ and the event-value set to the value of production-status after the change has occurred.

NOTES

1 When production-status changes to ‘interrupted’ or ‘halted’ this may imply that processing of a data unit fails; whether this is the case or not can be derived from the information provided in the notification.

2 Whether a data unit has started but not completed processing and will therefore be discarded can be derived from the information provided in the notification.

3 The notification of production-status having changed to ‘interrupted’ makes the service user aware that the processing of any data unit on the Input Queue will be delayed until production-status becomes ‘operational’ and that therefore the Input Queue might fill up if further PROCESS-DATA operations are invoked.

4.6.3.5.2 Notification of Production Configuration Changes

The service provider shall notify the service user when the production configuration is changed (see 3.11.2.2.3.2 b) while the service is bound.
4.6.3.5.3 Notification of Procedure Configuration Changes

The service provider shall notify the service user when the value of a dynamically modifiable configuration parameter is changed while the service is bound.

4.6.3.6 Stopping

NOTE – The service user will invoke the STOP operation to inform the service provider that the service user is stopping the sending of PROCESS-DATA invocations.

4.6.3.6.1 When an incoming STOP invocation is accepted, the service provider shall send a positive STOP return and the procedure state shall change to State 1 (‘inactive’).

4.6.3.6.2 When receiving a STOP invocation while there are PROCESS-DATA invocations in the service provider’s Input Queue, the service provider shall:
   a) discard any PROCESS-DATA invocations for which processing has not yet started; notifications shall not be issued for the data units enclosed in those PROCESS-DATA invocations;
   b) complete processing of the data units, if any, for which processing has already started.

NOTE – The procedure being stopped, the service provider cannot notify the service user when the remaining data unit completes processing.

4.6.3.7 Terminating

Upon receipt of a ‘terminate procedure’ event from the Association Control procedure, the procedure shall terminate by:
   a) completing processing of any data unit for which processing has already started;
   b) discarding all PROCESS-DATA invocations for which processing has not yet started;
   c) discarding pending notifications;
   d) releasing the resources.

4.6.3.8 Aborting

4.6.3.8.1 When detecting a condition that requires the procedure to request the Association Control procedure to abort the association, the procedure shall:
   a) complete processing of any data units for which processing has already started;
   b) discard all PROCESS-DATA invocations for which processing has not yet started, i.e., flush the service provider’s Input Queue;
c) discard any pending notifications;

d) request the Association Control procedure to abort the association providing the relevant diagnostic value as specified in 3.6.2.1.2; and

e) release the resources.

### 4.6.4 REQUIRED OPERATIONS

**Table 4-23: Data Processing Procedure Required Operations**

<table>
<thead>
<tr>
<th>Operations</th>
<th>Source</th>
<th>Extended</th>
<th>Refined</th>
<th>Procedure Block/Non-Blocking</th>
</tr>
</thead>
<tbody>
<tr>
<td>START</td>
<td>Common</td>
<td>N</td>
<td>N</td>
<td>Blocking</td>
</tr>
<tr>
<td>STOP</td>
<td>Common</td>
<td>N</td>
<td>N</td>
<td>Blocking</td>
</tr>
<tr>
<td>PROCESS-DATA</td>
<td>Common</td>
<td>Y</td>
<td>N</td>
<td>Non-Blocking</td>
</tr>
<tr>
<td>NOTIFY</td>
<td>Common</td>
<td>Y</td>
<td>N</td>
<td>Non-Blocking</td>
</tr>
</tbody>
</table>

**NOTE** – Although there are no extensions or refinements to the START operation, this procedure defines an additional reason for returning a negative result with the diagnostic ‘out of service’, as specified in 4.6.3.1 a).

#### 4.6.4.1 PROCESS-DATA (Unconfirmed)

##### 4.6.4.1.1 General

**NOTE** – Subsection 3.10.2.2.4 stipulates that a procedure using the PROCESS-DATA operation refines or extends the data parameter of that operation. The Data Processing procedure does not do that. The data syntax definition is left to a derived procedure or the service using this procedure.

The Data Processing procedure shall extend the PROCESS-DATA operation defined in 3.10 by adding one parameter to the invocation. The Data Processing procedure uses the unconfirmed variant of the PROCESS-DATA operation.

##### 4.6.4.1.2 Operation Parameters Definitions

**NOTE** – Table 4-24 shows the extension parameters of the PROCESS-DATA operation defined by this procedure.
### Table 4-24: PROCESS-DATA Extension Parameter

<table>
<thead>
<tr>
<th>Extension Parameters</th>
<th>Invocation</th>
</tr>
</thead>
<tbody>
<tr>
<td>process-completion-report</td>
<td>M</td>
</tr>
</tbody>
</table>

#### 4.6.4.1.3 Extension Parameter Syntax

The type DataProcProcDataInvocExt, as defined in F4.8, shall specify the syntax of the extension parameter of the PROCESS-DATA invocation.

#### 4.6.4.1.4 process-completion-report

The process-completion-report parameter shall specify whether the service provider shall invoke a NOTIFY operation to inform the service user that processing of the data unit enclosed in the PROCESS-DATA invocation has been completed successfully.

#### 4.6.4.2 NOTIFY (Unconfirmed)

##### 4.6.4.2.1 General

The Data Processing procedure shall extend the NOTIFY operation defined in 3.11 through the addition of six parameters to the invocation and through adding two permissible Event Identifier values to the event-name parameter.

##### 4.6.4.2.2 Operation Parameters Definitions

**NOTE** – The most precise and meaningful reporting will only be obtained if the service user applies sequential numbers with a fixed increment for identifying the data units.

##### 4.6.4.2.2.1 Overview

Table 4-25 shows the extension parameters of the NOTIFY operation defined by this procedure.

#### Table 4-25: NOTIFY Extension Parameters

<table>
<thead>
<tr>
<th>Extension Parameters</th>
<th>Invocation</th>
</tr>
</thead>
<tbody>
<tr>
<td>data-unit-id-last-processed</td>
<td>M</td>
</tr>
<tr>
<td>data-processing-status</td>
<td>C</td>
</tr>
<tr>
<td>data-processing-start-time</td>
<td>C</td>
</tr>
</tbody>
</table>
4.6.4.2.2.2  Extension Parameter Syntax

The type DataProcNotifyInvocExt, as defined in F4.8, shall specify the syntax of the extension parameters of the NOTIFY invocation.

4.6.4.2.2.3  data-unit-id-last-processed

For all notifications, the data-unit-id-last-processed parameter shall be present. Its value shall be set as follows:

a) if the service provider has not yet processed or attempted to process any data from the service user during the given association established by the service instance using this instance of the Data Processing procedure, the value of the data-unit-id-last-processed parameter shall be set to ‘noDataProcessed’, i.e., ‘null’;

b) otherwise, the data-unit-id-last-processed parameter shall specify the identifier of the data unit, i.e., the value of the data-unit-id parameter of that data unit that the service provider most recently processed or attempted to process, regardless of whether the data was successfully processed or an exception occurred.

4.6.4.2.2.4  data-processing-status

4.6.4.2.2.4.1 For all notifications, if the value of the data-unit-id-last-processed parameter is ‘noDataProcessed’, the data-processing-status parameter shall not be present.

4.6.4.2.2.4.2 Whenever the value of the data-unit-id-last-processed parameter is not ‘noDataProcessed’, the data-processing-status parameter shall be present and shall contain one of the following values representing the processing state of the data identified by data-unit-id-last-processed:

a) ‘successfully processed’—the processing of the data completed; i.e., the data is guaranteed to have been processed nominally;

b) ‘processing interrupted’—the processing of the data started but did not complete because production-status became ‘interrupted’ or ‘halted’;

c) ‘processing started’ —the processing of the data started but did not yet complete.
4.6.4.2.4.3 Additional values of the data-processing-status can be introduced by using dataProcessingStatusExtension (see F4.8) if needed in procedures derived from the Data Processing procedure.

4.6.4.2.4.4 The Data Processing procedure does not extend the data-processing-status parameter, and therefore the CHOICE dataProcessingStatusExtension must not be selected (see F4.8).

4.6.4.2.5 data-processing-start-time

4.6.4.2.5.1 For all notifications, if the data-unit-id-last-processed is 'noDataProcessed', the data-processing-start-time parameter shall not be present.

4.6.4.2.5.2 Whenever data-unit-id-last-processed is not 'noDataProcessed', the data-processing-start-time parameter shall be present and shall contain the time at which the service provider started to process the data identified by the data-unit-last-processed parameter.

4.6.4.2.6 data-unit-id-last-OK

For all notifications, the data-unit-id-last-OK parameter shall be present. Its value shall be set as follows:

a) if no data have been successfully processed during the given association established by the service instance using this instance of the Data Processing procedure the value of the data-unit-id-last-OK parameter shall be set to 'noSuccessfulProcessing';

b) otherwise, the data-unit-id-last-OK parameter shall specify the sequence number, i.e., the value of the data-unit-id parameter of the most recent data unit that was successfully processed.

4.6.4.2.7 data-processing-stop-time

4.6.4.2.7.1 For all notifications, if the data-unit-id-last-OK is 'noSuccessfulProcessing', the data-processing-stop-time parameter shall not be present.

4.6.4.2.7.2 Whenever data-unit-id-last-OK is not 'noSuccessfulProcessing', the data-processing-stop-time parameter shall be present and shall contain the time at which processing of the data, identified by data-unit-id-last-OK, successfully completed.
4.6.4.2.8 production-status

4.6.4.2.8.1 For all notifications except ‘production status change’ the production-status parameter shall be present and shall contain the value of the production status at the time of the event notification (see annex B).

4.6.4.2.8.2 If the notified event is ‘production status change’, the production-status parameter shall be absent.

NOTE – The ‘production status change’ notification reports the post event production status value by means of the event-value parameter (see 3.11.2.2.4.3).

4.6.4.2.3 event-name Extension

The value of the event-name shall be one of the following:

a) one of the values specified for the common NOTIFY operation in 3.11.2.2.3.2;

b) ‘data processing completed’ (event-name)—processing of the data unit identified in the parameter data-unit-id-last-OK completed successfully; or

1) the event-name of this event shall contain the procedure instance identifier of the procedure instance triggering the event;

2) unless otherwise specified by the service using this procedure or by a derived procedure, the associated event-value shall be ‘empty’;

c) ‘data processing configuration change’ (event-name)—at least one of the dynamically modifiable configuration parameters defined in 4.6.5 has been changed;

NOTE – The input-queue-size parameter defined in 4.6.5 is the only dynamically modifiable parameter of the Data Processing procedure.

1) the event-name of this event shall contain the procedure instance identifier of the procedure instance in which the event occurs;

2) the notification of the data processing configuration change event shall report the input-queue-size value by means of the event-value parameter:

i) the first part of the path specifying the type to be used is ‘NotifyInvocation’: ‘eventValue’: ‘EventValue’: ‘qualifiedValues’: ‘SequenceOfQualifiedValue’: ‘SEQUENCE OF QualifiedValue’ where this sequence has the length 1;

ii) if the qualifier of the to-be-reported value is not ‘valid’, then the second part of the path is one of the following: (a) ‘QualifiedValue’: ‘unavailable’: ‘NULL’; or (b) ‘QualifiedValue’: ‘undefined’: ‘NULL’; or (c) ‘QualifiedValue’: ‘error’: ‘NULL’;
iii) if the qualifier of the to-be-reported value is ‘valid’, then the second part of the path is ‘QualifiedValue’: ‘valid’: ‘TypeAndValueComplex’: ‘typeAndValue’: ‘integerPositive’: ‘SEQUENCE OF IntPos’, where this sequence shall have the length 1.

NOTE – All relevant types are defined in F4.3.

4.6.4.2.4 The Published Identifier, i.e., the Event Identifier, for the event-name of the ‘data processing complete’ event is specified in F4.16 as pDPdataProcessingCompleted.

4.6.4.2.5 The Published Identifier i.e., the Event Identifier, for the event-name of the ‘data processing configuration change’ event is specified in F4.16 as pDPconfigurationChange.

4.6.5 CONFIGURATION PARAMETERS

The Data Processing procedure configuration parameter that needs to be configured in the context of the procedure shall be as defined in table 4-26.

NOTE – For the configuration parameter, the table provides the engineering unit, a cross reference to the use of the parameter in the specification of the procedure, identifies whether the parameter may be read and/or dynamically modified, and also identifies the Parameter Identifier and type to be used in reporting the value of the parameter.

Table 4-26: Data Processing Procedure Configuration Parameters

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Cross-Reference</th>
<th>Readable</th>
<th>Dynamically modifiable</th>
<th>Configuration Parameter Identifier and Type (F4.16)</th>
</tr>
</thead>
<tbody>
<tr>
<td>input-queue-size (in number of PROCESS-DATA invocations the queue will store)</td>
<td>4.6.3.2.3</td>
<td>Yes</td>
<td>Yes</td>
<td>pDPinputQueueSize</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PDPinputQueueSizeType</td>
</tr>
</tbody>
</table>
## 4.6.6 PROCEDURE STATE TABLE

**Table 4-27: Data Processing Procedure State Table**

<table>
<thead>
<tr>
<th>No.</th>
<th>Incoming Event</th>
<th>State 1 ('inactive')</th>
<th>State 2 ('active')</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>(StartInvocation)</td>
<td>IF &quot;positive result&quot; THEN (+StartReturn) → 2 ELSE (-StartReturn) ENDIF</td>
<td>(procedure to association abort 'protocol error') → 1</td>
</tr>
<tr>
<td>2</td>
<td>(StopInvocation)</td>
<td>(procedure to association abort 'protocol error')</td>
<td>IF &quot;positive result&quot; THEN (initiate stop) → 1 ELSE (-StopReturn) ENDIF</td>
</tr>
<tr>
<td>3</td>
<td>(ProcessDataInvocation)</td>
<td>(procedure to association abort 'protocol error')</td>
<td>‘queue data unit’</td>
</tr>
<tr>
<td>4</td>
<td>'data unit ready'</td>
<td>Not applicable</td>
<td>'process data unit'</td>
</tr>
<tr>
<td>5</td>
<td>'data unit processing completed'</td>
<td>[ignore]</td>
<td>IF &quot;report&quot; THEN ‘notify 'data processing completed' / 'empty' ENDIF</td>
</tr>
<tr>
<td>6</td>
<td>'production status change to 'interrupted'</td>
<td>[ignore]</td>
<td>'discard data units in processing' ‘notify 'production status change' / 'interrupted'</td>
</tr>
<tr>
<td>7</td>
<td>'production status change to 'halted'</td>
<td>[ignore]</td>
<td>'discard data units in processing' ‘notify 'production status change' / 'halted'</td>
</tr>
<tr>
<td>8</td>
<td>'production status change to 'operational'</td>
<td>[ignore]</td>
<td>‘notify 'production status change' / 'operational'</td>
</tr>
<tr>
<td>9</td>
<td>'production status change to 'configured'</td>
<td>[ignore]</td>
<td>‘notify 'production status change' / 'configured'</td>
</tr>
<tr>
<td>10</td>
<td>'production configuration change'</td>
<td>[ignore]</td>
<td>‘notify 'production configuration change' / 'empty'</td>
</tr>
<tr>
<td>11</td>
<td>'data processing configuration change'</td>
<td>[ignore]</td>
<td>‘notify 'data processing configuration change' / 'procedure configuration parameter values' (see 4.6.4.2.3 c) 2))</td>
</tr>
<tr>
<td>12</td>
<td>'invalid PDU' 'xxx'</td>
<td>(procedure to association abort 'xxx')</td>
<td>(procedure to association abort 'xxx') → 1</td>
</tr>
<tr>
<td>13</td>
<td>'terminate procedure'</td>
<td>'terminate itself'</td>
<td>'terminate itself'</td>
</tr>
</tbody>
</table>

**Table 4-28: Procedure State Table Incoming Event Description References**

<table>
<thead>
<tr>
<th>Event</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 4-29: Procedure State Table Predicate Descriptions

<table>
<thead>
<tr>
<th>Predicate</th>
<th>Evaluates to TRUE if</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;positive result&quot;</td>
<td>No reason for sending a negative return has been detected, i.e., for the START invocation none of the conditions in 3.7.2.3.1 or 4.6.3.1 a) (see NOTE below) applies, and for the STOP invocation none of the conditions in 3.3.2.7.1 applies.</td>
</tr>
<tr>
<td>&quot;report&quot;</td>
<td>The process-completion-report parameter value in the associated (ProcessDataInvocation) is ‘produce report’.</td>
</tr>
</tbody>
</table>

Table 4-30: Procedure State Table Simple Action References

<table>
<thead>
<tr>
<th>Name</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>'queue data unit'</td>
<td>Fehler! Verweisquelle konnte nicht gefunden werden.</td>
</tr>
<tr>
<td>'process data unit'</td>
<td>4.6.3.3</td>
</tr>
<tr>
<td>'complete data processing'</td>
<td>4.6.3.6.2 b)</td>
</tr>
<tr>
<td>'discard data units in processing'</td>
<td>4.6.3.3.6</td>
</tr>
<tr>
<td>'notify ‘xxx’ / ‘yyy’'</td>
<td>4.6.3.5.1.1, 4.6.3.5.2, 4.6.3.5.3, 4.6.4.2.3 a), 4.6.4.2.3 b), 4.6.4.2.3 c), (NotifyInvocation) with event-name set to ‘xxx’ and event-value set to ‘yyy’. In case a notification does not use an event-value, ‘yyy’ shall be set to ‘empty’</td>
</tr>
</tbody>
</table>
4.6.7 REQUIREMENTS FOR PRODUCTION PROCESSING IN SUPPORT OF THE DATA PROCESSING PROCEDURE

4.6.7.1 General

Because the Data Processing procedure can be used in a CSTS to process almost any kind of data, the nature of the production processing that supports such a CSTS is highly dependent on the nature of the data itself and the kind of processing that is to be performed.

While the essential functions performed by production processing are specific to the nature of the individual CSTS, the Data Processing procedure levies certain data management and data accounting requirements on all production processes, regardless of the nature of the data processing being performed. Specifically, production processing must (a) carry the identification of each data unit being processed, (b) discard in-process data units at the request of the Data Processing procedure, and (c) report back to the Data Processing procedure upon the completion of processing of each data unit.

4.6.7.2 Data unit identification

Production processing shall tag each data unit being processed with the data-unit-id of the source PROCESS-DATA invocation, the procedure-instance-identifier of the source Data Processing procedure instance, and the service-instance-identifier of the source CSTS instance.
NOTE – The identification information for each data unit is supplied by the Data Processing procedure, as defined in 4.6.3.2.

4.6.7.3 Discarding of data units

Upon receipt of a 'discard data units' request from an instance of the Data Processing procedure executing on a CSTS instance (see 4.6.3.3.6), production processing shall discard all data units tagged with the service-instance-identifier specified in that request.

NOTES

1. The extent into the production processing to which the discarding of data units applies is dependent on the specific nature of the CSTS and the ability of production processing to identify each data unit and extract it. For example, if the data processing associated with a given CSTS type at some stage transforms data units from multiple CSTS instances into a product from which the contributions of individual data units cannot be removed, then the discarding of data units must be limited to a processing step before the generation of that product. Each CSTS should specify the extent into production processing that discarding of data units is meaningful.

2. As described in 4.6.3.3.6, Note 1, nominally a CSTS will use only a single instance of the Data Processing procedure. It is possible for a CSTS to use multiple instances of the Data Processing procedure concurrently, but the behavior and the interactions among those multiple instances is undefined in this Recommended Standard and must be addresses by the CSTS specification. However, if the nature of the CSTS is such that discarding of data units on the basis of the source Data Processing procedure instance is appropriate to the service, the procedure-instance-identifier component of the data unit tag can be used to further identify the data units to be discarded.

4.6.7.4 Reporting completion of data processing

Production processing shall notify the source Data Processing procedure instance upon completion of processing of each data unit submitted by that procedure instance, using the data-unit-id of that data unit.

NOTES

1. As described in 4.6.3.4, the Data Processing procedure uses the data unit processing completed information to confirm processing completion to the CSTS user.

2. The meaning of completion of processing of a data unit is specific to each CSTS type. For example, for a given service it could defined as the estimated time for the beginning of radiation of the data unit. Each CSTS specification should specify how data unit processing completion is defined in the context of that service and specify the
basis upon which completion is determined (e.g., some combination of measured and estimated times).
4.7 BUFFERED DATA PROCESSING

4.7.1 VERSION NUMBER

The version number of this procedure is 1.

4.7.2 DISCUSSION

4.7.2.1 Purpose

The purpose of the Buffered Data Processing procedure is to support transfer of large volumes of data at high data rates from the service user to the service provider for processing by the service provider where the maximum latency of data units may have to be limited. For this purpose the procedure allows a service to select one of the following transfer modes:

a) complete transfer mode, in which data are transmitted to the service provider completely based on the flow control capabilities of the underlying data communications service and any latency that might be implied is accepted;

b) timely transfer mode, in which the service provider ensures that data units will not be queued longer than a configurable latency limit and will discard the oldest unprocessed data units if the capacity of the configurable Input Queue is exceeded.

The Buffered Data Processing procedure is abstract and cannot be implemented directly because the specification is incomplete. To be implementable, derived procedures must provide the missing specifications. The missing information is explicitly identified in the applicable subsection(s) of this section.

4.7.2.2 Concept

The Buffered Data Processing procedure extends the Data Processing procedure (see 4.6) and in particular provides specifications for the handling of Input Queue overflow conditions that are left unspecified by the Data Processing procedure. The specification of this behavior makes the Buffered Data Processing procedure implementable.

In order to support transfer of large data volumes at high data rates, the service user blocks PROCESS-DATA invocations into a data unit called forward buffer. The forward buffer is used exclusively for the purpose of transferring the PROCESS-DATA invocations from the service user to the service provider. When the service provider receives a forward buffer it extracts the PROCESS-DATA invocations and places them on the Input Queue in the order they have been inserted into the forward buffer by the service user. The maximum size of the forward buffer is expressed as the number of PROCESS-DATA invocations that may be stored in the buffer. It is a configuration parameter that is specified by the service using the procedure or by a derived procedure.
The service user may also send individual PROCESS-DATA invocations that as specified for the parent procedure are not enclosed in a forward buffer. The service provider will handle such unbuffered PROCESS-DATA invocations in the same manner as a forward buffer enclosing a single PROCESS-DATA invocation.

The Buffered Data Processing procedure defines two modes for the transfer of PROCESS-DATA invocations from the service user to the service provider; these modes differ in the method of handling or preventing overflow of the Input Queue:

a) In complete transfer mode, the service provider stops reading data from the underlying data communications service when the available space on the Input Queue drops below the maximum size of a forward buffer and resumes reading data when there is sufficient room on the Input Queue to store all PROCESS-DATA invocations that might be included in a maximum sized forward buffer. This approach has the effect that backpressure is built up on the transport layer, eventually preventing the service user from transmitting further data. In effect, data will always be transferred completely accepting any delay that might be implied.

b) In timely transfer mode, when there is insufficient room on the Input Queue to store all PROCESS-DATA invocations received within a forward buffer, the service provider discards as many of the oldest PROCESS-DATA invocations, for which processing has not started, as needed to store all PROCESS-DATA invocations contained in the most recently received forward buffer. The objective of this approach is to minimize the overall processing latency at the expense of dropping data with the highest accumulated latency.

The service specification may fix the transfer mode to be used as part of the service specification or may require the selection of the transfer mode by means of a service management parameter.

When adding a PROCESS-DATA invocation to the Input Queue in timely transfer mode, the service provider starts a latency timer for that PROCESS-DATA invocation and sets its initial value to the value defined by the parameter processing-latency-limit. The service provider discards the PROCESS-DATA invocation if the latency timer expires before processing of the data unit enclosed in the PROCESS-DATA invocation starts.

When data are discarded in timely transfer mode because of queue overflow or because of expiry of the processing latency timer (see 4.7.3.2.2.5), the service user is not notified. This procedure assumes that detection and handling of data loss is performed by higher processing layers. Where this assumption does not apply, notification of the service user will have to be added by derived procedures.

4.7.2.3 Derivation

The Buffered Data Processing procedure extends the Data Processing procedure specified in 4.6 by the following features:
a) buffering of PROCESS-DATA invocations for the purpose of transfer from the service user to the service provider;

b) support for timely and complete transfer modes for PROCESS-DATA invocations including specifications how Input Queue overflow shall be prevented or handled;

c) support of a processing latency limit in the timely transfer mode to constrain the time a PROCESS-DATA invocation may be queued by the service provider before processing of the enclosed data unit starts.

4.7.3 BEHAVIOR

4.7.3.1 Starting

The Buffered Data Processing procedure shall be started as defined in the parent procedure in 4.6.3.1.

4.7.3.2 Transfer and Queuing of PROCESS-DATA Invocations

NOTE – The following behavior is specified in addition to the specifications for the parent procedure in 4.6.3.2.

4.7.3.2.1 Forward Buffer

4.7.3.2.1.1 PROCESS-DATA invocations may be grouped into a forward buffer, which shall be handled by the service provider in its entirety.

NOTES

1 The forward buffer is used exclusively for the purpose of transferring the PROCESS-DATA invocations from the service user to the service provider and is not an operation invocation or response.

2 The service user may also send individual PROCESS-DATA invocations as specified for the parent procedure in 4.6.3.2.

4.7.3.2.1.2 The maximum forward buffer size, expressed as the maximum number of PROCESS-DATA invocations that can be stored in a forward buffer, shall be specified by the service using this procedure or by a derived procedure, where setting of this parameter may be delegated to Service Management.

NOTES

1 The number of PROCESS-DATA invocations included in a forward buffer is at the discretion of the service user as long as it is less than or equal to the specified maximum forward buffer size.
Even if for a given service type the forward buffer will not be used, as only individual PROCESS-­DATA invocations will be sent, the size of the forward buffer needs to be specified. In case only individual PROCESS-­DATA invocations shall be handled, the size will be limited to a single invocation.

4.7.3.2.1.3 The maximum forward buffer size shall be less than the configured Input Queue size.

4.7.3.2.1.4 Upon receipt of a forward buffer containing more PROCESS-­DATA invocations than the specified maximum, this forward buffer shall be considered an invalid PDU as per 3.2.3.6 f). The procedure shall issue the 'procedure to association abort' event (refer to 4.2.2.3) setting the diagnostic to 'forward buffer too large'.

4.7.3.2.1.5 When receiving a forward buffer, the service provider shall extract the PROCESS-­DATA invocations and place them on the Input Queue in the same order as they have been inserted into the forward buffer by the service user.

4.7.3.2.1.6 When receiving an individual unbuffered PROCESS-­DATA invocation as specified in the parent procedure (see 4.6), the service provider shall handle it in the same way as a forward buffer containing a single PROCESS-­DATA invocation.

4.7.3.2.2 Data Transfer Modes

4.7.3.2.2.1 The service provider shall support the following transfer modes for the reception of forward buffers:

a) complete transfer mode;

b) timely transfer mode.

NOTES

1 The complete transfer mode ensures that all data transmitted by the service user are received, queued, and processed by the service provider accepting any delay that might be implied.

2 In the timely transfer mode, the service provider will discard PROCESS-­DATA invocations that are queued longer than given by the value of the processing-­latency-­limit parameter (see 4.7.2.2). In addition, the service provider will discard PROCESS-­DATA invocations with the highest accumulated latency when the Input Queue overflows.

4.7.3.2.2.2 The transfer mode to be applied shall be defined by the service using the procedure or by a derived procedure or may be delegated to Service Management.

4.7.3.2.2.3 In complete transfer mode the service provider shall stop reading data from the data communications service when the available space on the Input Queue drops below the maximum
forward buffer size and shall resume reading data from the data communications service when the available space on the Input Queue enables accommodating at least the number of PROCESS-DATA invocations that can be included in a maximum sized forward buffer.

NOTES

1 When reading from the data communications service is suspended, backpressure will build up that may eventually prevent the service user from sending further PROCESS-DATA invocations.

2 In this situation the service user will not be able to terminate the procedure nominally by invocation of the STOP operation until all transmitted data have been read and queued by the service provider. The only way to terminate the procedure earlier is by invocation of PEER-ABORT.

3 This specification assumes that a service will only use a single instance of the Buffered Data Processing procedure if that is operated in complete transfer mode. If more than one instance is used then all instances of the Buffered Data Processing procedure as well as any other procedures communicating via the same connection may be blocked if one of the instances stops reading data from the communications service.

4 Most of the points addressed in the notes above will apply regardless of the specifics of the underlying communications technology as long as such technology has the characteristics as specified in 1.3.1. The behavior as described in the notes above applies fully in case the underlying communication is as specified in reference [2].

4.7.3.2.2.4 In timely transfer mode, when the available space on the Input Queue does not allow storing all PROCESS-DATA invocations extracted from a forward buffer, the service provider shall discard as many of the oldest PROCESS-DATA invocations for which processing has not started as needed to queue all PROCESS-DATA invocations received.

NOTE – The service user is not notified that PROCESS-DATA invocations have been discarded.

4.7.3.2.2.5 The parameter processing-latency-limit shall specify the maximum time that a PROCESS-DATA invocation may be queued in timely transfer mode before processing of the enclosed data unit has to start.

4.7.3.2.2.6 A value of zero for the processing-latency-limit parameter shall specify that the processing latency shall not be controlled by the service provider; i.e., the ‘processing latency timer expired’ event (see table 4-35) shall not occur.

NOTE – As in complete data transfer mode the service provider does not control the processing latency; i.e., except as provided in 4.7.3.2.2.5, data units will be discarded only in case the Input Queue overflows. The processing-latency-limit parameter is set to zero as long as complete transfer mode applies.
4.7.3.2.2.7 The value of the parameter processing-latency-limit shall be specified by the service using the procedure or by a derived procedure or may be delegated to Service Management.

4.7.3.2.2.8 When placing a PROCESS-DATA invocation on the Input Queue the service provider shall start a specific latency timer for that PROCESS-DATA invocation if the value of the processing-latency-limit parameter is not zero.

4.7.3.2.2.9 The initial value of latency timer shall be set to the value specified by the parameter processing-latency-limit.

4.7.3.2.2.10 When processing of the data unit enclosed in the PROCESS-DATA invocation starts or the PROCESS-DATA invocation is discarded the associated latency timer shall be canceled.

4.7.3.2.2.11 If the latency timer expires before processing of the enclosed data unit starts, the PROCESS-DATA invocation shall be discarded.

NOTE – The service user is not notified that a PROCESS-DATA invocation has been discarded because of expiry of the latency timer.

4.7.3.3 Processing of Data Units

Data units shall be processed as specified for the parent procedure in 4.6.3.3.

4.7.3.4 Positive Feedback

Positive feedback shall be provided as specified for the parent procedure in 4.6.3.4.

4.7.3.5 Notifications

Events shall be notified as specified for the parent procedure in 4.6.3.5 with the exception specified in 4.7.4.2.

4.7.3.6 Stopping

The procedure shall be stopped as specified for the parent procedure in 4.6.3.6.

4.7.3.7 Terminating

The procedure shall terminate as specified for the parent procedure in 4.6.3.7.
4.7.3.8 Aborting

The procedure shall handle the need to request the Association Control procedure to abort the association as specified for the parent procedure in 4.6.3.8.

4.7.4 REQUIRED OPERATIONS

Table 4-32: Buffered Data Processing Procedure Required Operations

<table>
<thead>
<tr>
<th>Operations</th>
<th>Source</th>
<th>Extended</th>
<th>Refined</th>
<th>Procedure Blocking/Non-Blocking</th>
</tr>
</thead>
<tbody>
<tr>
<td>START</td>
<td>Data Processing</td>
<td>N</td>
<td>N</td>
<td>Blocking</td>
</tr>
<tr>
<td>STOP</td>
<td>Data Processing</td>
<td>N</td>
<td>N</td>
<td>Blocking</td>
</tr>
<tr>
<td>PROCESS-DATA</td>
<td>Data Processing</td>
<td>N</td>
<td>N</td>
<td>Non-Blocking</td>
</tr>
<tr>
<td>NOTIFY</td>
<td>Data Processing</td>
<td>Y</td>
<td>N</td>
<td>Non-Blocking</td>
</tr>
</tbody>
</table>

4.7.4.1 PROCESS-DATA (Unconfirmed)

4.7.4.1.1 The Buffered Data Processing procedure uses the unconfirmed variant of the PROCESS-DATA operation.

4.7.4.1.2 The data syntax definition is left to the service using this procedure.

NOTE – Subsection 3.10.2.2.4 stipulates that a procedure using the PROCESS-DATA operation refines or extends the data parameter of that operation. The Buffered Data Processing procedure does not do that.

4.7.4.2 NOTIFY (Unconfirmed)

4.7.4.2.1 General

The Buffered Data Processing procedure shall inherit the notifications defined for the parent procedure in 4.6.4.2.3.

Notification shall be performed as defined in the parent procedure in 4.6.3.5.

4.7.4.2.2 event-value

4.7.4.2.2.1 Except for the ‘data processing configuration change’ (event-name) event the event-value specifications of the parent procedure shall apply.
4.7.4.2.2 For the ‘data processing configuration change’ (event-name) event the event-value shall report the values of the dynamically modifiable parameters maximum-forward-buffer-size, input-queue-size and processing-latency-limit defined in 4.7.5. The first part of the path specifying the type to be used is ‘NotifyInvocation’: ‘eventValue’: ‘EventValue’: ‘qualifiedValues’: ‘SequenceOfQualifiedValues’: ‘SEQUENCE OF QualifiedValue’ where this sequence has the length 3. The first element of this sequence shall report the maximum-forward-buffer-size, the second the input-queue-size, and the third the processing-latency-limit parameter value. For each of the three parameters the following shall apply: If the qualifier of the to-be-reported value is not ‘valid’, then the second part of the path is one of the following: (a) ‘QualifiedValue’: ‘unavailable’: ‘NULL’; or (b) ‘QualifiedValue’: ‘undefined’: ‘NULL’; or (c) ‘QualifiedValue’: ‘error’: ‘NULL’. If the qualifier of the to-be-reported value is ‘valid’, then the second part of the path is ‘QualifiedValue’: ‘valid’: ‘TypeAndValueComplex’: ‘typeAndValue’: ‘integerPositive’: ‘SEQUENCE OF IntPos’, where this sequence shall have the length 1. All relevant types are defined in F4.3.

4.7.5 CONFIGURATION PARAMETERS

4.7.5.1 The Buffered Data Processing procedure configuration parameters that need to be configured in the context of the procedure shall be as defined in table 4-33.

NOTE – For each configuration parameter, the table provides the engineering unit (if applicable), a cross reference to the use of the parameter in the specification of the procedure, identifies whether the parameter may be read and/or dynamically modified, and also identifies the Parameter Identifier and type to be used in reporting the value of the parameter.

Table 4-33: Buffered Data Processing Procedure Configuration Parameters

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Cross-Reference</th>
<th>Readable</th>
<th>Dynamically modifiable</th>
<th>Configuration Parameter Identifier and Type (F4.16)</th>
</tr>
</thead>
<tbody>
<tr>
<td>data-transfer-mode</td>
<td>4.7.3.2.2</td>
<td>Yes</td>
<td>No</td>
<td>pBDPdataTransferMode pBDPdataTransferModeType</td>
</tr>
<tr>
<td>maximum-forward-buffer-size (in number of PROCESS-DATA invocations the buffer will store)</td>
<td>4.7.3.2.1.2</td>
<td>Yes</td>
<td>Yes</td>
<td>pBDPmaxForwardBufferSize pBDPmaxForwardBufferSizeType</td>
</tr>
<tr>
<td>Parameters</td>
<td>Cross-Reference</td>
<td>Readable</td>
<td>Dynamically modifiable</td>
<td>Configuration Parameter Identifier and Type (F4.16)</td>
</tr>
<tr>
<td>---------------------------------------------------------------------------</td>
<td>-----------------</td>
<td>----------</td>
<td>------------------------</td>
<td>------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>input-queue-size (in number of PROCESS-DATA invocations the queue will store)</td>
<td>4.6.3.2.3</td>
<td>Yes</td>
<td>Yes</td>
<td>pDInputQueueSize&lt;br&gt;PDInputQueueSizeType (inherited from the parent Data Processing procedure)</td>
</tr>
<tr>
<td>processing-latency-limit (in milliseconds)</td>
<td>4.7.3.2.2.5</td>
<td>Yes</td>
<td>Yes</td>
<td>pBDPprocessingLatencyLimit&lt;br&gt;PBDPprocessingLatencyLimitType</td>
</tr>
</tbody>
</table>
### 4.7.6 PROCEDURE STATE TABLE

#### Table 4-34: Buffered Data Processing Procedure State Table

<table>
<thead>
<tr>
<th>No.</th>
<th>Incoming Event</th>
<th>State 1 ('inactive')</th>
<th>State 2 ('active')</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>(StartInvocation)</td>
<td>IF &quot;positive result&quot; THEN set &quot;reading suspended&quot; to FALSE (+StartReturn) → 2 ELSE (-StartReturn) ENDIF</td>
<td>[procedure to association abort 'protocol error'] → 1</td>
</tr>
<tr>
<td>2</td>
<td>(StopInvocation)</td>
<td>(procedure to association abort 'protocol error')</td>
<td>IF &quot;positive result&quot; THEN (initiate stop) → 1 ELSE (-StopReturn) ENDIF</td>
</tr>
<tr>
<td>3</td>
<td>(ProcessDataInvocation)¹</td>
<td>(procedure to association abort 'protocol error')</td>
<td>IF &quot;timely mode&quot; THEN IF &quot;queue overflow&quot; THEN 'discard oldest data units' ENDIF IF &quot;complete mode&quot; THEN IF &quot;queue full&quot; THEN 'suspend reading' set &quot;reading suspended&quot; to TRUE ENDIF ENDIF</td>
</tr>
</tbody>
</table>

¹ In terms of Service Provider behavior, handling of an incoming PROCESS-DATA invocation and handling of an incoming forward buffer containing only one PROCESS-DATA invocation are identical.
<table>
<thead>
<tr>
<th>No.</th>
<th>Incoming Event</th>
<th>State 1 ('inactive')</th>
<th>State 2 ('active')</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>(ForwardBuffer)</td>
<td>(procedure to association abort 'protocol error')</td>
<td>FOR_EACH (ProcessDataInvocation) IN (ForwardBuffer) IF &quot;timely mode&quot; THEN IF &quot;queue overflow&quot; THEN 'discard oldest data units' ENDIF ENDIF 'queue data unit' IF &quot;complete mode&quot; THEN IF &quot;queue full&quot; THEN 'suspend reading' set 'reading suspended' to TRUE ENDIF ENDIF ENDFOR_EACH</td>
</tr>
<tr>
<td>5</td>
<td>'data unit ready'</td>
<td>Not applicable</td>
<td>'process data unit'</td>
</tr>
<tr>
<td>6</td>
<td>'data unit processing completed'</td>
<td>[Ignore]</td>
<td>IF &quot;report&quot; THEN 'notify 'data processing completed' / 'empty'&quot; ENDIF IF &quot;reading suspended&quot; THEN IF (NOT &quot;queue full&quot;) THEN 'resume reading' set 'reading suspended' to FALSE ENDIF ENDIF</td>
</tr>
<tr>
<td>7</td>
<td>'processing latency timer expired'</td>
<td>Not applicable</td>
<td>'discard data unit'</td>
</tr>
<tr>
<td>8</td>
<td>'production status change to 'interrupted'</td>
<td>[Ignore]</td>
<td>'discard data units in processing' 'notify 'production status change' / 'interrupted'&quot;</td>
</tr>
<tr>
<td>9</td>
<td>'production status change to 'halted'</td>
<td>[Ignore]</td>
<td>'discard data units in processing' 'notify 'production status change' / 'halted&quot;</td>
</tr>
<tr>
<td>10</td>
<td>'production status change to 'operational&quot;</td>
<td>[Ignore]</td>
<td>'notify 'production status change' / 'operational&quot;</td>
</tr>
<tr>
<td>11</td>
<td>'production status change to 'configured'</td>
<td>[Ignore]</td>
<td>'notify 'production status change' / 'configured&quot;</td>
</tr>
<tr>
<td>12</td>
<td>'production configuration change'</td>
<td>[Ignore]</td>
<td>'notify 'production configuration change' / 'empty&quot;</td>
</tr>
<tr>
<td>13</td>
<td>'data processing configuration change'</td>
<td>[Ignore]</td>
<td>'notify 'data processing configuration change' / 'procedure configuration parameter values&quot; (see 4.7.4.2.2.2)</td>
</tr>
<tr>
<td>14</td>
<td>'invalid PDU ( \text{xxx} )'</td>
<td>(procedure to association abort 'xxx')</td>
<td>(procedure to association abort 'xxx') ( \rightarrow ) 1</td>
</tr>
</tbody>
</table>
Table 4-35: Procedure State Table Incoming Event Description References

<table>
<thead>
<tr>
<th>Event</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘data unit processing completed’</td>
<td>4.6.3.4</td>
</tr>
<tr>
<td>‘data unit ready’</td>
<td>4.6.3.1</td>
</tr>
<tr>
<td>‘processing latency timer expired’</td>
<td>4.7.3.2.11</td>
</tr>
<tr>
<td>‘terminate procedure’</td>
<td>4.2.3</td>
</tr>
<tr>
<td>‘production status change to ‘xxx”</td>
<td>B2.5</td>
</tr>
<tr>
<td>‘production configuration change’</td>
<td>3.11.2.2.2</td>
</tr>
<tr>
<td>‘data processing configuration change’</td>
<td>4.7.4.2.2</td>
</tr>
<tr>
<td>‘invalid PDU ‘xxx’”</td>
<td>3.2.3.6, 4.2.2.4, 4.7.3.2.1.4. ‘xxx’ is one of the diagnostic values specified in 4.2.2.5 or 4.7.3.2.1.4</td>
</tr>
</tbody>
</table>

Table 4-36: Procedure State Table Predicate Descriptions

<table>
<thead>
<tr>
<th>Predicate</th>
<th>Evaluates to TRUE if</th>
</tr>
</thead>
<tbody>
<tr>
<td>“queue overflow”</td>
<td>There is not sufficient space on the Input Queue to store the PROCESS-DATA invocations received (see 4.7.3.2.2.4). The transfer mode is ‘timely’.</td>
</tr>
<tr>
<td>“queue full”</td>
<td>There is not enough space on the Input Queue to store all PROCESS-DATA invocations that might be contained in a maximum sized forward buffer (see 4.7.3.2.2.3). The transfer mode is ‘complete’.</td>
</tr>
<tr>
<td>“complete mode”</td>
<td>Complete transfer mode is in effect (see 4.7.3.2.2).</td>
</tr>
<tr>
<td>“timely mode”</td>
<td>Timely transfer mode is in effect (see 4.7.3.2.2).</td>
</tr>
<tr>
<td>“positive result”</td>
<td>No reason for sending a negative return has been detected, i.e., for the START invocation none of the conditions in 3.7.2.3.1 or 4.6.3.1 a) applies, and for the STOP invocation none of the conditions in 3.3.3.7.1 applies.</td>
</tr>
<tr>
<td>“report”</td>
<td>The process-completion-report parameter value in the associated (ProcessDataInvocation) is ‘produce report’ (see 4.6.4.1.4).</td>
</tr>
</tbody>
</table>

Table 4-37: Procedure State Table Boolean Flags

<table>
<thead>
<tr>
<th>Predicate Flag</th>
<th>Set to TRUE if</th>
</tr>
</thead>
<tbody>
<tr>
<td>“reading suspended”</td>
<td>in complete transfer mode reading data from the data communications service has been suspended.</td>
</tr>
</tbody>
</table>
**Table 4-38: Procedure State Table Simple Action References**

<table>
<thead>
<tr>
<th>Name</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘queue data unit’</td>
<td>4.7.3.2</td>
</tr>
<tr>
<td>‘suspend reading’</td>
<td>4.7.3.2</td>
</tr>
<tr>
<td>‘resume reading’</td>
<td>4.7.3.2</td>
</tr>
<tr>
<td>‘discard oldest data units’</td>
<td>4.7.3.2</td>
</tr>
<tr>
<td>‘discard data unit’</td>
<td>4.7.3.2.2.11</td>
</tr>
<tr>
<td>‘discard data units in processing’</td>
<td>4.6.3.3.6</td>
</tr>
<tr>
<td>‘clear the Input Queue’</td>
<td>4.6.3.6.2 a)</td>
</tr>
<tr>
<td>‘complete data processing’</td>
<td>4.6.3.6.2 b)</td>
</tr>
<tr>
<td>‘notify ‘xxx’ / ‘yyy’’</td>
<td>4.6.3.5.1.1, 4.6.3.5.2, 4.6.3.5.3, 4.6.4.2.3 a), 4.6.4.2.3 b), 4.6.4.2.3 c), 4.7.4.2.2, (NotifyInvocation) with event-name set to ‘xxx’ and event-value set to ‘yyy’. In case a notification does not use an event-value, ‘yyy’ shall be set to ‘empty’</td>
</tr>
<tr>
<td>‘procedure to association abort ‘xxx’’</td>
<td>4.2.2.3, 4.2.2.5, raise ‘procedure to association abort ‘xxx’’ event with diagnostic set to ‘xxx’ to the Association Control procedure, where the diagnostic value may be one of those specified in 3.6.2.2.1.2 or the value specified in 4.7.3.2.1.4</td>
</tr>
<tr>
<td>‘terminate itself’</td>
<td>4.6.3.7</td>
</tr>
</tbody>
</table>

**Table 4-39: Procedure State Table Compound Action Definitions**

<table>
<thead>
<tr>
<th>Name</th>
<th>Actions Performed</th>
</tr>
</thead>
<tbody>
<tr>
<td>(initiate stop)</td>
<td>‘clear the input queue’ ‘complete data processing’ (+StopReturn)</td>
</tr>
<tr>
<td>(procedure to association abort ‘xxx’)</td>
<td>‘clear the input queue’ ‘discard data units in processing’ ‘procedure to association abort ‘xxx’”</td>
</tr>
</tbody>
</table>
4.8 SEQUENCE-CONTROLLED DATA PROCESSING

4.8.1 VERSION NUMBER

The version number of this procedure is 1.

4.8.2 DISCUSSION

4.8.2.1 Purpose

The purpose of the Sequence-Controlled Data Processing procedure is:

a) to provide strict sequential transfer and processing of data units in the sequence defined by the service user;

b) to enable the service user to resynchronize transfer and processing of data units in case a problem is detected during processing of a data unit.

The procedure is intended for use in Cross Support Transfer Services that involve sequence-controlled data transfer and processing and that need confirmation of data transfer and status reports on the ongoing production process.

The Sequence-Controlled Data Processing procedure is abstract and cannot be implemented directly because the specification is incomplete. To be implementable, derived procedures must provide the missing specifications. The missing information is explicitly identified in the applicable subsection(s) of this section.

4.8.2.2 Concept

The Sequence-Controlled Data Processing procedure extends the Data Processing procedure (see 4.6). Before data units can be transferred for processing, the service user invokes a START operation, which contains the data-unit-id value the service provider shall accept in the first PROCESS-DATA invocation after the successful completion of the START operation.

When the service provider receives the first PROCESS-DATA invocation, it verifies that the contained data-unit-id value is equal to the one defined in the START operation, otherwise the service provider rejects the PROCESS-DATA invocation.

NOTE – The Sequence-Controlled Data Processing procedure uses the confirmed variant of the PROCESS-DATA operation.

For all following PROCESS-DATA invocations, the service provider verifies that the data–unit-id is one greater than the one received in the previous accepted PROCESS-DATA invocation; if that is not the case, the PROCESS-DATA invocation is rejected.
Before a PROCESS-DATA invocation can finally be accepted, the service provider checks:

a) whether production-status is not ‘halted’;

b) whether the included earliest and latest production times are consistent;

c) whether the Input Queue is not full; and

d) whether the service provider is in the ‘active.processing’ state (see table 4-44).

If any of these checks fails, the PROCESS-DATA invocation is rejected.

NOTE – Further details on production status changes are defined in annex B.

After acceptance of the PROCESS-DATA invocation, the service provider sends a positive return to the service user and buffers the PROCESS-DATA invocation on the Input Queue. The service provider starts processing not earlier than the earliest-data-process-start-time and not later than the latest-data-process-start-time included in the PROCESS-DATA invocation. In case no earliest-data-process-start-time is given for the data unit, processing starts as soon as possible regardless if the latest-data-process-start-time is given or not; otherwise the service provider starts data unit processing within the time frame defined by the earliest and latest processing times.

NOTE – Regardless of the service user having defined earliest-data-process-start-time and latest-data-process-start-time, the service provider processes the data units in the sequence defined by the data-unit-id in the PROCESS-DATA operation, which in this procedure serves as a sequence counter. This means that the PROCESS-DATA operations are always processed in the order they have been received and buffered.

Reporting of the completion of processing steps is performed as defined by the parent Data Processing procedure in 4.6.3.4.

If processing of a data unit fails, the service provider enters a ‘locked’ state and notifies the service user of the problem. While in the ‘locked’ state, the service provider does not perform any data processing, nor does it accept any new PROCESS-DATA invocations from the service user. To recover from the ‘locked’ state, the service user may issue a STOP invocation; the service provider then clears the Input Queue, exits the ‘locked’ state and terminates the procedure. After the completion of the STOP operation, the service user issues a START invocation (as soon as production-status becomes ‘operational’ again—see NOTE) with the next data-unit-id the service provider shall accept.

NOTE – Because the STOP operation puts the procedure in the ‘inactive’ state, the service user in this case must use other means to obtain the production status if provided by the service.
Alternatively to invoking a STOP operation followed by a START operation, the service user may invoke an EXECUTE-DIRECTIVE operation with the directive-identifier ‘reset’ to clear the Input Queue and exit the ‘locked’ state, where the directive-qualifier parameter defines the next data-unit-id the service provider shall accept.

NOTE – The ‘locked’ state is a substate of the ‘active’ state that does not affect the state of the service instance.

4.8.2.3 Derivation

The Sequence-Controlled Data Processing procedure extends the parent Data Processing procedure specified in 4.6 by the following features:

a) use of the confirmed variant of the PROCESS-DATA operation;

b) start of processing of the data units not earlier than an earliest and not later than a latest processing start time defined by the service user;

c) transition to a ‘locked’ state and notification of the service user in case processing of a data unit fails;

NOTE – In such a case the service provider is blocked, and does not accept any further PROCESS-DATA invocations, as the strict sequential processing cannot be guaranteed anymore.

d) resynchronization of data unit processing by the service user in case of a problem detected during data unit processing.

4.8.3 BEHAVIOR

4.8.3.1 Starting

4.8.3.1.1 The behavior of the Sequence-Controlled Data Processing procedure regarding starting shall be as specified for the Data Processing procedure in 4.6.3.1, with the additional requirements specified in the following subsection.

NOTE – The service user will invoke the START operation with the first-data-unit-id parameter to request that the service provider prepare to receive data units for processing and to specify the permissible data-unit-id value in the first PROCESS-DATA invocation that will be sent.

4.8.3.1.2 The service provider shall record the first-data-unit-id parameter value that shall be accepted with the first PROCESS-DATA invocation.

4.8.3.1.3 If production-status is ‘interrupted’ at the time the START invocation is received, the service provider shall issue a negative return with the diagnostic ‘unable to comply’.
4.8.3.2 Transfer and Queuing of PROCESS-DATA invocations

4.8.3.2.1 The behavior of the Sequence-Controlled Data Processing procedure regarding the transfer and queuing of PROCESS-DATA invocations shall be as specified for the parent Data Processing procedure in 4.6.3.2, with the additional requirements specified in this subsection.

4.8.3.2.2 The service provider shall accept the first PROCESS-DATA invocation after a successful START operation only if the value of the data-unit-id parameter is that of the first-data-unit-id parameter of the previously accepted START invocation.

4.8.3.2.3 The service provider shall accept subsequent PROCESS-DATA invocations only if the data-unit-id parameter value of all PROCESS-DATA invocations following the first PROCESS-DATA invocation if the value of the data-unit-id parameter of the previous accepted PROCESS-DATA invocation is one less than the current one.

4.8.3.2.4 If the data-unit-id value has reached the maximum value given by the range of the data-unit-id parameter and has to be incremented by one, the parameter value shall wrap around to zero.

4.8.3.2.5 If the service provider detects an unexpected value of the data-unit-id parameter of the PROCESS-DATA operation, it shall issue a negative PROCESS-DATA return with the diagnostic ‘out of sequence’.

4.8.3.2.6 If the Input Queue used for buffering of incoming PROCESS-DATA operations is full at the time the service provider receives a PROCESS-DATA invocation, the service provider shall issue a negative PROCESS-DATA return with the diagnostic ‘unable to store’.

4.8.3.2.7 If production-status is ‘halted’ at the time of reception of a PROCESS-DATA invocation, the service provider shall issue a negative PROCESS-DATA return with the diagnostic ‘unable to process’.

4.8.3.2.8 If production-status is not ‘halted’ at the time of reception of a PROCESS-DATA operation invocation, but the service provider is in the ‘locked’ substate, the service provider shall issue a negative PROCESS-DATA return with the diagnostic ‘service instance locked’.

4.8.3.2.9 If the service provider does not accept a PROCESS-DATA invocation, it shall not queue the data unit by appending it to the Input Queue, but discard it.

4.8.3.3 Processing of Data Units

4.8.3.3.1 The behavior of the Sequence-Controlled Data Processing procedure regarding the processing of data units while in State 2.1 (‘active.processing’) shall be as specified for the
Data Processing procedure in 4.6.3.3, with the additional requirements specified in the following subsection.

NOTE – While the Sequence-Controlled Data Processing procedure is in State 2.2 (‘processing.locked’), no data units are processed. The conditions for entering and leaving the ‘processing.locked’ state are specified in 4.8.3.7. Table 4-44 specifies all behavioral differences of the procedure when in state 2.1 and 2.2, respectively.

### 4.8.3.3.2 Data Processing Start Time

**4.8.3.3.2.1** The service provider shall start processing of the data unit not earlier than the time defined by the earliest-data-process-start-time parameter and not later than the time defined by the latest-data-process-start-time parameter, both defined in the PROCESS-DATA operation.

**4.8.3.3.2.2** If the value of the earliest-data-process-start-time parameter is ‘undefined’ in the PROCESS-DATA invocation, the service provider shall process the data unit included as soon as possible as long as production-status is ‘operational’.

NOTE – This implies that while production-status is ‘configured’ or ‘interrupted’ the service provider waits until production-status changes to ‘operational’.

**4.8.3.3.2.3** If the value of the latest-data-process-start-time parameter is ‘undefined’ in the PROCESS-DATA operation, then the service provider shall process the included data unit as long as the production status is ‘operational’.

**4.8.3.3.2.4** If the latest-data-process-start-time parameter in the PROCESS-DATA operation is not ‘undefined’, the service provider shall defer processing of the data unit if the current production-status is ‘interrupted’. Processing shall be deferred until production-status changes to ‘operational’ before latest-data-process-start-time expires.

**4.8.3.3.2.5** If processing of a data unit has not begun at or before latest-data-process-start-time, a NOTIFY operation shall be issued with the Event Identifier ‘expired’ (event-name) and the data unit shall be discarded.

**4.8.3.3.2.6** If production-status changes to ‘interrupted’, and there is a data unit at the head of the queue, and its latest-data-process-start-time is ‘undefined’, and no other data unit is being processed, the service provider shall not start processing but wait until production-status changes back to ‘operational’.

### 4.8.3.4 Positive Feedback

Status reporting shall be performed as defined in the parent procedure in 4.6.3.4.
4.8.3.5 Notification of Production Status Changes

Production status changes shall be reported as defined in the parent procedure in 4.6.3.5.1.

4.8.3.6 Notification of Production Configuration Changes

Production configuration changes shall be reported as defined in the parent procedure in 4.6.3.5.2.

4.8.3.7 Locking

4.8.3.7.1 The state ‘active.locked’ shall be a substate of the ‘active’ state.

4.8.3.7.2 The service provider shall enter the ‘active.locked’ substate when:
   a) the data unit has already expired at the time when processing shall start; or
   b) production-status changes to ‘interrupted’ and a data unit is currently being processed; or
   c) production-status changes to ‘halted’.

4.8.3.7.3 In the ‘active.locked’ substate, the service provider shall reject PROCESS-DATA invocations from the service user with the diagnostic ‘service instance locked’; it shall not perform any processing of data units in its Input Queue.

4.8.3.7.4 The Sequence-Controlled Data Processing procedure shall return to State 2.1 (‘active.processing’) after having accepted a STOP and a subsequent START invocation or an EXECUTE-DIRECTIVE invocation with the directive-identifier equal to ‘reset’.

NOTE – Both options clear the Input Queue.

4.8.3.8 Resetting

When receiving an EXECUTE-DIRECTIVE invocation with the directive-identifier equal to ‘reset’, the service provider shall:
   a) send an EXECUTE-DIRECTIVE positive acknowledgement to the service user;
   b) clear the Input Queue;
   c) wait for processing to complete, and provide feedback as described in 4.6.3.4, if any data unit is currently being processed;
   d) if in ‘active.locked’ substate, wait for production-status to become ‘operational’ and then transition to the ‘active.processing’ substate;
e) set the first-data-unit-id to the value requested in the EXECUTE-DIRECTIVE invocation;

f) send an EXECUTE-DIRECTIVE positive return to the service user.

4.8.3.9 Stopping

The procedure shall be stopped as specified for the parent procedure in 4.6.3.6.

4.8.3.10 Terminating

The procedure shall terminate as specified for the parent procedure in 4.6.3.7. In addition any pending acknowledgements shall be deleted.

4.8.3.11 Aborting

4.8.3.11.1 When detecting a condition that requires the procedure to request the Association Control procedure to abort the association, the procedure shall:

a) complete processing of any data units for which processing has already started;

b) discard all PROCESS-DATA invocations for which processing has not yet started, i.e., flush the service provider’s Input Queue;

c) discard any pending notifications;

d) request the Association Control procedure to abort the association providing the relevant diagnostic value as specified in 3.6.2.2.1.2; and

e) release the resources.

4.8.4 REQUIRED OPERATIONS

Table 4-40: Sequence-Controlled Data Processing Procedure Required Operations

<table>
<thead>
<tr>
<th>Operations</th>
<th>Source</th>
<th>Extended</th>
<th>Refined</th>
<th>Procedure Blocking/Non-Blocking</th>
</tr>
</thead>
<tbody>
<tr>
<td>START</td>
<td>Data Processing</td>
<td>Y</td>
<td>N</td>
<td>Blocking</td>
</tr>
<tr>
<td>STOP</td>
<td>Common</td>
<td>N</td>
<td>N</td>
<td>Blocking</td>
</tr>
<tr>
<td>PROCESS-DATA</td>
<td>Data Processing</td>
<td>Y</td>
<td>N</td>
<td>Non-Blocking</td>
</tr>
<tr>
<td>NOTIFY</td>
<td>Data Processing</td>
<td>Y</td>
<td>N</td>
<td>Non-Blocking</td>
</tr>
<tr>
<td>EXECUTE-DIRECTIVE</td>
<td>Common</td>
<td>Y</td>
<td>N</td>
<td>Blocking</td>
</tr>
</tbody>
</table>
4.8.4.1 START (Confirmed)

4.8.4.1.1 General

The Sequence-Controlled Data Processing procedure shall extend the START operation defined in 3.7 through the addition of one parameter to the invocation.

4.8.4.1.2 Operation Parameters Definitions

The Sequence-Controlled Data Processing procedure shall extend the START operation defined in 3.7 through the addition of the `first-data-unit-id` parameter.

<table>
<thead>
<tr>
<th>Table 4-41: START Extension Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extension Parameters</td>
</tr>
<tr>
<td><code>first-data-unit-id</code></td>
</tr>
</tbody>
</table>

4.8.4.1.3 Extension Parameter Syntax

4.8.4.1.3.1 The type `SequContrDataProcStartInvocExt`, as defined in F4.10, shall specify the syntax of the extension parameter of the START invocation.

4.8.4.1.3.2 `first-data-unit-id`

The `first-data-unit-id` parameter shall contain the value of the `data-unit-id` parameter that will be present in the first `PROCESS-DATA` invocation after the preceding successful START operation.

NOTE – Following a data processing failure, processing of a data unit for which processing started before the failure condition occurred may still continue. Also, reports on the progress of this processing may still be generated. The service user (when restarting the data transfer) shall therefore choose the value of the `first-data-unit-id` parameter such that all data units can still be unambiguously identified.
4.8.4.2 PROCESS-DATA (Confirmed)

4.8.4.2.1 General

NOTE – Subsection 3.10.2.2.4 stipulates that a procedure using the PROCESS-DATA operation refines or extends the data parameter of that operation. The Sequence-Controlled Data Processing procedure does not do that. The data syntax definition is left to the service using this procedure.

4.8.4.2.1.1 The Sequence-Controlled Data Processing procedure shall extend the PROCESS-DATA invocation defined in 3.10 through the addition of the earliest-data-process-start-time and latest-data-process-start-time parameters, and additional diagnostic values.

4.8.4.2.1.2 The Sequence-Controlled Data Processing procedure shall use the confirmed variant of the PROCESS-DATA operation and as a consequence the confirmed variant of the Standard Operation Header.

4.8.4.2.1.3 The Sequence-Controlled Data Processing procedure shall extend the PROCESS-DATA return defined in 3.10 through the addition of the data-unit-id parameter.

Table 4-42: PROCESS-DATA Extension Parameters

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Invocation</th>
<th>Return</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Operation Header (confirmed)</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>earliest-data-process-start-time</td>
<td>M</td>
<td></td>
</tr>
<tr>
<td>latest-data-process-start-time</td>
<td>M</td>
<td></td>
</tr>
<tr>
<td>data-unit-id</td>
<td>M</td>
<td></td>
</tr>
</tbody>
</table>

4.8.4.2.2 Standard Confirmed Operation Header

This operation shall use the Standard Confirmed Operation Header (see 3.3).

4.8.4.2.3 Extension Parameters Syntax

4.8.4.2.3.1 The type SequContrDataProcProcDataInvocExt, as defined in F4.10, shall specify the syntax of the extension parameters of the invocation of the PROCESS-DATA operation.
4.8.4.2.3.2 The type SequContrDataProcProcDataPosReturnExt, as defined in F4.10, shall define the syntax of the extended positive return of the PROCESS-DATA operation.

4.8.4.2.3.3 The type SequContrDataProcProcDataNegReturnExt, as defined in F4.10, shall define the syntax of the extended negative return of the PROCESS-DATA operation.

4.8.4.2.4 data-unit-id

4.8.4.2.4.1 The service provider shall set the data-unit-id in the PROCESS-DATA return to the value expected in the next PROCESS-DATA invocation.

4.8.4.2.4.2 If the invocation is accepted, the data-unit-id in the PROCESS-DATA return contains the value of the data-unit-id in the PROCESS-DATA invocation incremented by one.

4.8.4.2.4.3 If the invocation is rejected, the data-unit-id in the PROCESS-DATA return shall contain the value expected by the service provider:

a) in case of the first PROCESS-DATA operation following a successful START operation, it is the value specified in first-data-unit-id parameter of the START invocation;

b) otherwise the value is one greater than the value of the data-unit-id of the last accepted PROCESS-DATA invocation.

4.8.4.2.4.4 If the data-unit-id value has reached the maximum value given by the range of the data-unit-id parameter and has to be incremented by one, the parameter value shall wrap around to zero.

4.8.4.2.5 earliest-data-processing-start-time

4.8.4.2.5.1 The earliest-data-processing-start-time parameter shall either be ‘undefined’ or shall contain the earliest time at which processing of the data unit may begin.

4.8.4.2.5.2 If the earliest-data-processing-start-time parameter is ‘undefined’ the service provider shall begin processing as soon as:

a) production-status becomes or is ‘operational’; and

b) no other data unit that was transferred earlier than this data unit has not yet completed processing.
4.8.4.2.6 latest-data-processing-start-time

4.8.4.2.6.1 The latest-data-process-start-time parameter shall either be ‘undefined’ or shall contain the latest time at which processing of the data unit shall begin.

4.8.4.2.6.2 If the latest-data-process-start-time is equal to the earliest-data-process-start-time, the processing of the data shall start at this time.

4.8.4.2.7 diagnostic Parameter Extension Value Definitions and Syntax

4.8.4.2.7.1 If a negative PROCESS-DATA return is sent, the diagnostic parameter shall use one of the diagnostic values specified in 3.3.2.7.1 or one of the following values:

a) ‘unable to process’—the service provider cannot process data because the service provider has been taken out of service for an indefinite period by management action, i.e., production-status is ‘halted’;

b) ‘service instance locked’—production-status is not ‘halted’, but the service provider is in the ‘active.locked’ substate and therefore cannot process the data;

**NOTE** – The service provider has reported the fault condition causing the ‘active.locked’ substate to the service user via a NOTIFY operation. (For possible reasons, see 4.8.3.7.2).

c) ‘out of sequence’—the value of the data-unit-id parameter is not equal to the value expected by the service provider; the expected value is one of the following:

1) in the case of the first PROCESS-DATA operation following a successful START, the value of the first-data-unit-id parameter of that START invocation;

2) otherwise, the value of the data-unit-id parameter of the last positive PROCESS-DATA return;

d) ‘inconsistent time range’—the time specified in the earliest-data-process-start-time parameter is later than the time specified in the latest-data-process-start-time parameter;

e) ‘invalid time’—the production time window is invalid for one of the following reasons:

1) the period from earliest-data-process-start-time to latest-data-process-start-time does not overlap with the range of times for which service production is scheduled;

2) the period from earliest-data-process-start-time to latest-data-process-start-time does not overlap with the service instance provision period;
NOTE – The production may be scheduled to terminate earlier than the service instance provision period ends. An ESLT may do so to have the production engine available for support of a different mission as soon as possible, but permitting the service users of the previous production period some extra time to retrieve for example a status report reflecting the final accounting information.

f) ‘late data’—latest-data-process-start-time is earlier than the time the PROCESS -DATA operation is received by the service provider;

g) ‘data error’—the service provider has performed error checks as provided in the service agreement and has determined that this data is in error; for example, the data exceeds the maximum size allowed for this service instance;

h) ‘unable to store’—the service provider has not enough buffer space available to store this PROCESS-DATA invocation.

4.8.4.2.7.2 The type SequContrDataProcProcDataDiagnosticExt, as defined in F4.10, shall specify the syntax of the diagnostic parameter of the PROCESS-DATA return extended as listed in 4.8.4.2.7.1.

4.8.4.3 NOTIFY (Unconfirmed)

4.8.4.3.1 General

The Sequence-Controlled Data Processing procedure shall inherit the notifications defined for the parent procedure in 4.6.4.2.3, but shall extend the NOTIFY operation by introducing additional values for the data-processing-status parameter and by adding two permissible Event Identifier values to the event-name parameter as specified in the following subsections.

4.8.4.3.2 data-processing-status Parameter Extension

4.8.4.3.2.1 The type DataProcNotifyInvocExt, as defined in F4.8, is inherited from the parent procedure, but is extended for the Sequence-Controlled Data Processing procedure by the type SequContrDataProcStatus as defined in F4.10.

4.8.4.3.2.2 By means of this extension, the data-processing-status parameter can also have one of the following values:

a) ‘expired’—at the time processing of the data unit identified by the data-unit-last-processed parameter was attempted, the latest-data-process-start-time was already in the past;
b) ‘processing not started’—processing of the data unit identified by the data-unit-last-processed parameter was attempted, but could not be started because the production-status was ‘interrupted’.

4.8.4.3.3 event-name Extension

4.8.4.3.3.1 The value of the event-name shall be one of the following:

a) one of the events specified by the Data Processing procedure NOTIFY operation in 4.6.4.2.3; or

b) ‘expired’ (event-name)—at the time when processing is being started, the latest-data-process-start-time is already in the past; the event-name of this event shall contain the procedure instance identifier of the procedure instance triggering the event; or

NOTE – When the ‘expired’ event occurs, the procedure enters the ‘active.locked’ substate (see 4.8.3.7.2) which in turn means that the ‘locked’ event is to be reported. Therefore, whenever the ‘expired’ event occurs, two notifications will be sent by this procedure.

c) ‘locked’ (event-name)—at the time when processing is supposed to be started or while a data unit is being processed, one of the conditions specified in 4.8.3.7.2 occurred: the event-name of this event shall contain the procedure instance identifier of the procedure instance triggering the event.

4.8.4.3.3.2 The Published Identifiers for the values (event-name) ‘expired’ and ‘locked’ are specified in F4.16 as pSCDPexpired and pSCPDblocked, respectively.

4.8.4.3.4 event-value

4.8.4.3.4.1 For the ‘data processing configuration change’ (event-name) event the event-value shall report the value of the dynamically modifiable parameter input-queue-size defined in 4.8.5. The first part of the path specifying the type to be used is ‘NotifyInvocation’: ‘eventValue’: ‘EventValue’: ‘qualifiedValues’: ‘SequenceOfQualifiedValue’: ‘SEQUENCE OF QualifiedValue’ where this sequence has the length 1. If the qualifier of the to-be-reported value is not ‘valid’, then the second part of the path is one of the following: (a) ‘QualifiedValue’: ‘unavailable’: ‘NULL’; or (b) ‘QualifiedValue’: ‘undefined’: ‘NULL’; or (c) ‘QualifiedValue’: ‘error’: ‘NULL’. If the qualifier of the to-be-reported value is ‘valid’, then the second part of the path is ‘QualifiedValue’: ‘valid’: ‘TypeAndValueComplex’: ‘typeAndValue’: ‘integerPositive’: ‘SEQUENCE OF IntPos’, where this sequence shall have the length 1. All relevant types are defined in F4.3.
4.8.4.3.4.2 For the ‘expired’ (event-name) event the event-value shall be ‘empty’ unless otherwise specified by the service using this procedure or by a derived procedure.

4.8.4.3.4.3 For the ‘locked’ (event-name) event the event-value shall be ‘empty’ unless otherwise specified by the service using this procedure or by a derived procedure.

4.8.4.3.4.4 Except for the ‘data processing configuration change’, the ‘expired’ and the ‘locked’ (event-name) events the event-value specifications of the parent procedure apply.

4.8.4.4 EXECUTE-DIRECTIVE (Acknowledged)

4.8.4.4.1 General

The Sequence-Controlled Data Processing procedure shall extend the EXECUTE-DIRECTIVE operation defined in 3.13 through the definition of one value possible for the directive-identifier parameter.

4.8.4.4.2 directive-identifier Extension

The Sequence-Controlled Data Processing procedure shall add ‘reset’ to the set of Directive Identifiers possible for the directive-identifier parameter (see the pSCDPdirectivesId branch of the Object Identifier tree). This Directive Identifier requests that the service provider clears the Input Queue.

4.8.4.4.3 directive-qualifier Value

4.8.4.4.3.1 The value of the directive-qualifier shall identify the next-data-unit-id parameter value, i.e., the data-unit-id parameter value the service provider shall accept in the next PROCESS-DATA invocation.

4.8.4.4.3.2 The directive-qualifier parameter is defined by ‘ExecuteDirectiveInvocation’: ‘directiveQualifier’: ‘localProcDirQualifier’: ‘DirectiveQualifierValues’: ‘TypeAndValueComplex’: ‘typeAndValue’: ‘TypeAndValue’: ‘intUnsigned’: ‘SEQUENCE OF IntUnsigned’ where this SEQUENCE has the length 1.

4.8.5 CONFIGURATION PARAMETERS

4.8.5.1 The Sequence-Controlled Data Processing procedure configuration parameters that need to be configured in the context of the procedure shall be as defined in table 4-43.
NOTE – For each configuration parameter, the table provides the engineering unit (if applicable), a cross reference to the use of the parameter in the specification of the procedure, identifies whether the parameter may be read and/or dynamically modified, and also identifies the Parameter Identifier and type to be used in reporting the value of the parameter.

Table 4-43: Sequence-Controlled Data Processing Procedure Configuration Parameters

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Cross-Reference</th>
<th>Readable</th>
<th>Dynamically modifiable</th>
<th>Configuration Parameter Identifier and Type (F4.16)</th>
</tr>
</thead>
<tbody>
<tr>
<td>input-queue-size (in number of PROCESS-DATA invocations the queue will store)</td>
<td>4.6.3.2.3</td>
<td>Yes</td>
<td>Yes</td>
<td>pDPinputQueueSize PDPinputQueueSizeType (inherited from the parent Data Processing procedure)</td>
</tr>
</tbody>
</table>
### 4.8.6 PROCEDURE STATE TABLE

**Table 4-44: Sequence-Controlled Data Processing Procedure State Table**

<table>
<thead>
<tr>
<th>No.</th>
<th>Incoming Event</th>
<th>State 1 ('inactive')</th>
<th>State 2.1 ('active.processing')</th>
<th>State 2.2 ('active.locked')</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>(StartInvocation)</td>
<td>IF &quot;positive result&quot; THEN (+StartReturn) → 2.1 ELSE (-StartReturn) ENDIF</td>
<td>procedure to association abort 'protocol error' → 1</td>
<td>procedure to association abort 'protocol error' → 1</td>
</tr>
<tr>
<td>2</td>
<td>(StopInvocation)</td>
<td>(procedure to association abort 'protocol error')</td>
<td>IF &quot;positive result&quot; THEN (initiate stop) → 1 ELSE (-StopReturn) ENDIF</td>
<td>IF &quot;positive result&quot; THEN (initiate stop) → 1 ELSE (-StopReturn) ENDIF</td>
</tr>
<tr>
<td>3</td>
<td>(ProcessDataInvocation)</td>
<td>(procedure to association abort 'protocol error')</td>
<td>IF &quot;positive result&quot; THEN 'queue data unit' (+ProcessDataReturn) ELSE (-ProcessDataReturn) ENDIF</td>
<td>(-ProcessDataReturn)</td>
</tr>
<tr>
<td>4</td>
<td>'data unit ready'</td>
<td>Not applicable</td>
<td>IF &quot;production status = 'interrupted'&quot; THEN → 2.2 ELSE 'process data unit' ENDIF</td>
<td>Not applicable</td>
</tr>
<tr>
<td>5</td>
<td>'data unit processing completed'</td>
<td>[ignore]</td>
<td>IF &quot;report&quot; THEN 'notify 'data processing completed' / 'empty' ENDIF</td>
<td>Not applicable</td>
</tr>
<tr>
<td>6</td>
<td>'expired'</td>
<td>Not applicable</td>
<td>'notify 'expired' / 'empty' 'discard data unit' → 2.2</td>
<td>Not applicable</td>
</tr>
<tr>
<td>7</td>
<td>'production status change to 'interrupted''</td>
<td>[ignore]</td>
<td>'notify 'production status change' / 'interrupted' IF 'processing data unit' THEN 'discard data units in processing' → 2.2 ENDIF</td>
<td>[ignore]</td>
</tr>
<tr>
<td>8</td>
<td>'production status change to 'halted''</td>
<td>[ignore]</td>
<td>'discard data units in processing' 'notify 'production status change' / 'halted' → 2.2</td>
<td>notify 'production status change' / 'halted'</td>
</tr>
</tbody>
</table>
Table 4-45: Procedure State Table

<table>
<thead>
<tr>
<th>No.</th>
<th>Incoming Event</th>
<th>State 1 ('inactive')</th>
<th>State 2.1 ('active.processing')</th>
<th>State 2.2 ('active.locked')</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>'production status change to 'operational'</td>
<td>[ignore]</td>
<td>Not applicable</td>
<td>'notify 'production status change' / 'operational'</td>
</tr>
<tr>
<td>10</td>
<td>'production status change to 'configured'</td>
<td>[ignore]</td>
<td>Not applicable</td>
<td>'notify 'production status change' / 'configured'</td>
</tr>
<tr>
<td>11</td>
<td>'production configuration change'</td>
<td>[ignore]</td>
<td>'notify 'production configuration change' / 'empty'</td>
<td>'notify 'production configuration change' / 'empty'</td>
</tr>
<tr>
<td>12</td>
<td>'data processing configuration change'</td>
<td>[ignore]</td>
<td>'notify 'data processing configuration change' / 'procedure configuration parameter values' (see 4.8.4.3.4.1)</td>
<td>'notify 'data processing configuration change' / 'procedure configuration parameter values' (see 4.8.4.3.4.1)</td>
</tr>
<tr>
<td>13</td>
<td>'invalid PDU 'xxx'</td>
<td>(procedure to association abort 'protocol error')</td>
<td>(procedure to association abort 'xxx') \rightarrow 1</td>
<td>(procedure to association abort 'xxx') \rightarrow 1</td>
</tr>
<tr>
<td>14</td>
<td>'terminate procedure'</td>
<td>'terminate itself'</td>
<td>'terminate itself'</td>
<td>'terminate itself'</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Event</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>'expired'</td>
<td>4.8.3.3.2.5, 4.8.4.3.2, a data unit is available at the head of the Input Queue, but its latest-data-process-start-time has expired.</td>
</tr>
<tr>
<td>'data unit processing completed'</td>
<td>4.6.3.4</td>
</tr>
<tr>
<td>'data unit ready'</td>
<td>4.8.3.3.2, a data unit is available at the head of the Input Queue, and production-status is 'operational'; neither earliest-data-process-start-time nor latest-data-process-start-time is specified, or the current time is between earliest-data-process-start-time and latest-data-process-start-time, and production-status is 'operational'.</td>
</tr>
<tr>
<td>'terminate procedure'</td>
<td>4.2.3</td>
</tr>
<tr>
<td>'production status change to 'xxx'</td>
<td>B2.5</td>
</tr>
<tr>
<td>'production configuration change'</td>
<td>3.11.2.2.3.2 b)</td>
</tr>
</tbody>
</table>
### Table 4-46: Procedure State Table Predicate Descriptions

<table>
<thead>
<tr>
<th>Predicate</th>
<th>Evaluates to TRUE if</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;positive result&quot;</td>
<td>No reason for sending a negative return has been detected, i.e., for the START invocation none of the conditions in 3.7.2.3.1 or 4.6.3.1 a) applies, for the STOP invocation none of the conditions in 3.3.2.7.1 applies, and for the PROCESS-DATA invocation none of the conditions in 4.8.4.2.7.1 applies.</td>
</tr>
<tr>
<td>&quot;report&quot;</td>
<td>The process-completion-report parameter value in the associated (ProcessDataInvocation) is ‘produce report’</td>
</tr>
<tr>
<td>&quot;processing data unit”</td>
<td>A data unit has been read from the top of the Input Queue and processing of this data unit has started but not completed</td>
</tr>
<tr>
<td>&quot;production status = 'interrupted'&quot;</td>
<td>The current value of production-status is ‘interrupted’</td>
</tr>
</tbody>
</table>

### Table 4-47: Procedure State Table Simple Action References

<table>
<thead>
<tr>
<th>Name</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>'queue data unit'</td>
<td>4.8.3.2</td>
</tr>
<tr>
<td>'process data unit'</td>
<td>4.8.3.3</td>
</tr>
<tr>
<td>'complete data processing'</td>
<td>4.6.3.6.2 b)</td>
</tr>
<tr>
<td>'clear the Input Queue’</td>
<td>4.6.3.6.2 a), 4.8.3.8 b)</td>
</tr>
<tr>
<td>'notify ‘xxx’ / ‘yyy’</td>
<td>4.6.3.5.1.1, 4.6.3.5.2, 4.6.3.5.3, 4.6.4.2.3 a), 4.6.4.2.3 b), 4.6.4.2.3 c), 4.8.4.3.3.1 (NotifyInvocation) with event-name set to ‘xxx’ and event-value set to ‘yyy’. In case a notification does not use an event-value, ‘yyy’ shall be set to ‘empty’</td>
</tr>
<tr>
<td>'discard data unit’</td>
<td>4.8.3.3.2.5</td>
</tr>
<tr>
<td>'discard data units in processing’</td>
<td>4.6.3.3.6</td>
</tr>
<tr>
<td>'procedure to association abort ‘xxx’”</td>
<td>4.2.2.3, 4.2.2.5, raise ‘procedure to association abort ‘xxx” event with diagnostic set to ‘xxx’ to the Association Control procedure</td>
</tr>
<tr>
<td>‘terminate itself’</td>
<td>4.6.3.7</td>
</tr>
<tr>
<td>'set the data-unit-id parameter’</td>
<td>4.8.3.8 e), set the data-unit-id parameter as per the directive-qualifier parameter value of the received ‘reset’ directive.</td>
</tr>
</tbody>
</table>
**Table 4-48: Procedure State Table Compound Action Definitions**

<table>
<thead>
<tr>
<th>Name</th>
<th>Actions Performed</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>{initiate stop}</code></td>
<td>‘clear the input queue’</td>
</tr>
<tr>
<td></td>
<td>‘complete data processing’</td>
</tr>
<tr>
<td></td>
<td>(+StopReturn)</td>
</tr>
<tr>
<td><code>{procedure to association abort 'xxx'}</code></td>
<td>‘clear the input queue’</td>
</tr>
<tr>
<td></td>
<td>‘discard data units in processing’</td>
</tr>
<tr>
<td></td>
<td>‘procedure to association abort ‘xxx’”</td>
</tr>
<tr>
<td><code>{reset}</code></td>
<td>‘clear the Input Queue’</td>
</tr>
<tr>
<td></td>
<td>‘wait ‘data unit processing completed”</td>
</tr>
<tr>
<td></td>
<td>‘wait ‘production status operational’</td>
</tr>
<tr>
<td></td>
<td>‘set the data-unit-id parameter’</td>
</tr>
</tbody>
</table>
4.9 INFORMATION QUERY

4.9.1 VERSION NUMBER

The version number of this procedure is 1.

4.9.2 DISCUSSION

4.9.2.1 Purpose

The Information Query procedure enables the service user to request from the service provider the provision of a standard set of parameters reflecting either the configuration of the transfer service instance using this procedure or the status of other service provider parameters.

4.9.2.2 Concept

The Information Query procedure provides the CSTS user with the capability to request the current values of registered parameters. A CSTS that incorporates the Information Query procedure is hereinafter referred to as a queriable CSTS.

The set of queriable parameters for a CSTS is identified by the Parameter Names of individual queriable parameters and/or parameter list names where such list contains a set of Parameter Labels for that service. The list-of-parameters includes one of the following: (a) ‘empty’ signifying the default list is selected, (b) a parameter list name of a list of Parameter Labels, (c) a Functional Resource Type, (d) a Functional Resource Name, (e) a procedure type, (f) a procedure instance identifier, or (g) Parameter Names or Parameter Labels of individual queriable parameters.

Each parameter list name consists of a string that represents multiple individual Parameter Labels. One special case of parameter list may also exist for each queriable CSTS: the default list. The default list is named as any other list that may exist for the CSTS, but it is automatically applied when the list-of-parameters parameter is set to ‘empty’. The default list is specified by the CSTS using the Information Query procedure or by a derived procedure or may be delegated to Service Management.

For a given queriable CSTS, the set of Parameter Labels included in the default list (if any) and/or the set of Parameter Labels represented by named label lists and the set of individual queriable Parameter Labels or Parameter Names are defined by the specification of that CSTS or a derived Information Query procedure. A CSTS using this procedure will have to:

a) select the Functional Resource Types and associated gettable parameters from the Published Identifiers used for cross support or Agencies functionalities (see D6) and
select the procedure types and the associated gettable parameters from the Published Identifiers used for the framework or services branches;

b) define the grouping of Parameter Labels into lists and allocate a list name for each list;
c) identify which of the defined lists will be the default list, if any.

While a queriable CSTS instance is bound, the service user invokes the GET operation of the Information Query procedure to query parameter values in one of the following ways:

a) by leaving the selection of parameters unspecified, thereby selecting the default list of Parameter Labels;
b) by specifying a list name, where the list represents a predefined set of Parameter Labels;
c) by specifying a Functional Resource Type thereby identifying all parameters belonging to the instances of that Functional Resource Type that are directly associated with the transfer service executing the Information Query procedure;
d) by specifying a Functional Resource Name (Functional Resource Type and Instance Number), thereby identifying all parameters belonging to that Functional Resource Instance;
e) by specifying a procedure type thereby selecting all configuration parameters of all active instances of the given procedure type that are associated with the service instance that executes the Information Query procedure;
f) by specifying a procedure instance identifier thereby selecting the configuration parameters of that procedure instance; or
g) by specifying Parameter Names or Parameter Labels of the individual queriable parameters.

The service provider sends to the service user the requested qualified parameter values using the GET operation return. As specified in annex C2.1, the qualified value for each parameter value indicates whether the value is valid, unavailable, undefined, or in error.

4.9.3 BEHAVIOR

4.9.3.1 Getting Parameters

The service provider shall respond to GET invocations sent by the service user (see 3.12).

4.9.3.2 Terminating

Upon receipt of a ‘terminate procedure’ event from the Association Control procedure, the procedure shall terminate by releasing all pending GET operations without answering them.
4.9.4 REQUIRED OPERATIONS

Table 4-49: Information Query Procedure Required Operations

<table>
<thead>
<tr>
<th>Operations</th>
<th>Source</th>
<th>Extended</th>
<th>Refined</th>
<th>Procedure Blocking/Non-Blocking</th>
</tr>
</thead>
<tbody>
<tr>
<td>GET</td>
<td>Common</td>
<td>N</td>
<td>N</td>
<td>Non-Blocking</td>
</tr>
</tbody>
</table>

4.9.5 CONFIGURATION PARAMETERS

The Information Query procedure configuration parameters that need to be configured in the context of the procedure shall be as defined in table 4-50.

NOTE – For each configuration parameter, the table provides a cross reference to the use of the parameter in the specification of the procedure, identifies whether the parameter may be read, and also identifies the Parameter Identifier and type to be used in reporting the value of the parameter. None of the configuration parameters of this procedure can be dynamically changed while the service instance executing the procedure is bound.

Table 4-50: Information Query Procedure Configuration Parameters

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Cross-Reference</th>
<th>Readable</th>
<th>Configuration Parameter Identifier and Type (F4.16)</th>
</tr>
</thead>
<tbody>
<tr>
<td>default list of parameters</td>
<td>4.9.2.2</td>
<td>No</td>
<td>N/A</td>
</tr>
<tr>
<td>named label lists</td>
<td>3.12.1.2 b)</td>
<td>Yes</td>
<td>pIQnamedLabelLists pIQnamedLabelListsType</td>
</tr>
</tbody>
</table>

NOTE – The default list of parameters is shown in table 4-50 as not readable. This is because one cannot query directly the name of the default list. However, one can retrieve the full set of list names and for each list it is stated whether this list is specified to be the default list.
4.9.6 PROCEDURE STATE TABLE

Table 4-51: Information Query Procedure State Table

<table>
<thead>
<tr>
<th>No.</th>
<th>Incoming Event</th>
<th>Stateless</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>(GetInvocation)</td>
<td>IF &quot;positive result&quot; THEN (+GetReturn) ELSE (-GetReturn) ENDIF</td>
</tr>
<tr>
<td>2</td>
<td>‘terminate procedure’</td>
<td>‘terminate itself’</td>
</tr>
</tbody>
</table>

Table 4-52: Procedure State Table Incoming Event Description References

<table>
<thead>
<tr>
<th>Event</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘terminate procedure’</td>
<td>4.2.3, internal event from the Association Control procedure to all other procedures of the service instance in response to a protocol abort, a PEER-ABORT, or an UNBIND</td>
</tr>
</tbody>
</table>

Table 4-53: Procedure State Table Predicate Descriptions

<table>
<thead>
<tr>
<th>Predicate</th>
<th>Evaluates to TRUE if</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;positive result&quot;</td>
<td>No reason for sending a negative return has been detected, i.e., for the GET invocation none of the conditions in 3.12.2.4.1 applies.</td>
</tr>
</tbody>
</table>

Table 4-54: Procedure State Table Simple Action References

<table>
<thead>
<tr>
<th>Name</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘terminate itself’</td>
<td>4.9.3.2</td>
</tr>
</tbody>
</table>
4.10 CYCLIC REPORT

4.10.1 VERSION NUMBER

The version number of this procedure is 1.

4.10.2 DISCUSSION

4.10.2.1 Purpose of the Procedure

The Cyclic Report procedure enables a service user to receive periodically parameter values from a service provider.

4.10.2.2 Concept

The Cyclic Report procedure extends the Unbuffered Data Delivery procedure with the following capabilities:

a) the procedure defines the structure of the data as a set of parameter values;

b) the selected parameter values are delivered periodically.

Each instance of a CSTS that incorporates the Cyclic Report procedure (hereinafter referred to as a reporting CSTS) cyclically (periodically) reports on the current value of a set of predefined and selected parameters.

The set of reportable parameters for a CSTS is identified by parameter list names of lists of Parameter Labels for that service and/or the Parameter Names of individual reportable parameters. The list-of-parameters parameter includes one of the following: (a) ‘empty’, i.e., the list-of-parameters parameter is unspecified, (b) a parameter list name where the list contains Parameter Labels, (c) a Functional Resource Type, (d) a Functional Resource Name, (e) a procedure type, (f) a procedure instance identifier, or the Parameter Names or Parameter Labels of individual reportable parameters.

Each parameter list name consists of a string that represents multiple individual Parameter Labels. One special case of parameter list may also exist for each reporting CSTS: the default list. The default list is named as any other list that may exist for the given CSTS, but it is automatically applied when the list-of-parameters parameter is set to ‘empty’. The definition of the default list is controlled by the specification of the CSTS using the Cyclic Report procedure or by a derived procedure or may be delegated to Service Management.

For a given reporting CSTS, the Parameter Labels included in the default list (if any) and/or the Parameter Labels represented by named Parameter Label lists, the set of Parameter Labels or the set of Parameter Names are defined by the specification of that CSTS or by a derived procedure. A CSTS using this procedure or a derived procedure will have to:
a) select the Functional Resource Types and associated reportable parameters from the Published Identifiers used for cross support or Agencies functionalities (see D6) and select the procedure types and the associated reportable parameters from the Published Identifiers used for the framework or services branches;

b) define the grouping of Parameter Labels into lists and allocate a list name for each list;

c) identify which of the defined lists will be the default list.

In starting the Cyclic Report procedure, the service user subscribes to the particular parameters that are to be reported by that procedure in one of the following ways:

a) by leaving the list-of-parameters parameter unspecified (i.e., set to ‘empty’), thus selecting the parameters represented by the default list of Parameter Labels to be reported;

b) by specifying a list name, which represents a predefined set of Parameter Labels;

c) by specifying a Functional Resource Type, thereby identifying all parameters belonging to the instances of that Functional Resource Type that are directly associated with the CSTS executing the Cyclic Report procedure;

d) by specifying a Functional Resource Name, thereby identifying all parameters belonging to that Functional Resource Instance;

e) by specifying a procedure type, thus selecting the configuration parameters of all active instances of that procedure type associated with the service instance executing the Cyclic Report procedure;

f) by specifying a procedure instance identifier, thereby selecting the configuration parameters of that procedure instance; or

g) by identifying the Parameter Names or Parameter Labels of the individual parameters that are reportable by that service instance.

The service user requests periodic reporting by invoking the START operation and specifying the following criteria:

a) the delivery cycle to be used for periodic delivery;

b) the default list of parameters to be delivered, the name of a list defining the parameters to be delivered, a Functional Resource Type, a Functional Resource Name, a procedure type, a procedure instance, or the set of individual parameters to be delivered.

The service provider delivers the qualified parameters the service user has subscribed to using the TRANSFER-DATA operation until the service user invokes a STOP operation. A qualified parameter consists of the Parameter Name, value, type, and qualifier of that parameter (see C2.1).
After stopping the procedure, the service user may optionally re-start the cyclic delivery of parameter values, applying the same or a different selection of parameters.

4.10.3 BEHAVIOR

4.10.3.1 Starting

NOTE – The service user invokes the START operation to (a) subscribe to the set of parameters that are to be cyclically reported either by selecting the default list by leaving the selection of parameters unspecified, or by selecting one of the named Parameter Label lists, or by using a Functional Resource Type, a Functional Resource Name, a procedure type, or a procedure instance identifier, or by listing the parameters individually and (b) to configure the cyclic timer by setting the value of the delivery-cycle parameter.

4.10.3.1.1 The service provider shall send a positive START return and perform the START operation invoked by the service user except if

a) the production-status is ‘halted’ in which case the START operation shall be rejected by sending a negative START return with the diagnostic ‘out of service’;

b) the delivery-cycle parameter is less than the limit set by the configuration parameter PCRminimumAllowedDeliveryCycleType (see Fehler! Verweisquelle konnte nicht gefunden werden.) in which case the START operation shall be rejected by sending a negative START return with the diagnostic ‘out of range’;

c) none of the conditions specified in 4.10.3.1.2 is met in which case the START operation shall be rejected by sending a negative START return with the diagnostic set to the applicable value as specified in 4.10.4.1.3.1; or

d) the procedure is in State 2 (‘active’) in which case the procedure shall request the Association Control procedure to abort the association with setting the diagnostic value to ‘protocol error’.

4.10.3.1.2 Upon arrival of the START operation, the service provider shall confirm that the invocation is valid. A START invocation for the Cyclic Report procedure is valid if it meets any one of the following conditions:

a) if the list-of-parameters parameter is set to ‘empty’ signifying subscription to the default list of Parameter Labels, provided a default list has been established;

b) if the list-of-parameters parameter contains one parameter list name for a list of Parameter Labels that is contained in the set of label lists that has been established for the CSTS for use for use by the Cyclic Report procedure;
c) if the list-of-parameters parameter contains one Functional Resource Type that is associated with the service instance that executes the Cyclic Report procedure;

d) if the list-of-parameters parameter contains the name of one Functional Resource Instance that is associated with the service instance that executes the Cyclic Report procedure;

e) if the list-of-parameters parameter contains one procedure type that is associated with the service instance that executes the Cyclic Report procedure;

f) if the list-of-parameters parameter contains one procedure instance identifier of a procedure instance that is associated with the service instance that executes the Cyclic Report procedure;

g) if (1) the list-of-parameters parameter contains one or more Functional Resource Parameter Names or Functional Resource Parameter Labels and (2) every one of these names or labels is the name or label of a parameter of a Functional Resource that is associated with the service instance that executes the Cyclic Report procedure; or

h) if (1) the list-of-parameters parameter contains one or more procedure configuration Parameter Names or Parameter Labels and (2) every one of these names or labels is the name or label of a parameter of a configured procedure that is associated with the service instance that executes the Cyclic Report procedure.

4.10.3.1.3 The service provider shall set the cyclic timer to the value of the delivery-cycle parameter in the START invocation and start it.

4.10.3.2 Transferring Data

4.10.3.2.1 After a successful START operation, the service provider shall transfer the qualified parameters cyclically by means of invoking the TRANSFER-DATA operation.

NOTE – The availability of a TRANSFER-DATA invocation for delivery to the communications service constitutes the ‘data available’ event.

4.10.3.2.2 Qualified parameter delivery shall be governed by the cyclic timer. The cyclic timer expiration constitutes the ‘cyclic timer expired’ event.

4.10.3.2.3 Upon expiration of the cyclic timer the service provider shall send the up-to-date qualified parameters selected by means of the START invocation parameter list-of-parameters to the service user and restart the cyclic timer.

4.10.3.2.4 The service provider shall deliver the qualified parameters (Parameter Name, the value, the type, and the qualifier of the parameters (see C2.1) using the qualified-parameters parameter. If list-of-parameters
a) is left empty, then

1) for each Functional Resource Parameter Label in the default list (see E), the service provider shall deliver the qualified parameter (see C2.1) for that label for each of the Functional Resource Instances of the given type that are directly associated with the service instance that executes the Cyclic Report procedure;

2) for each procedure configuration Parameter Label in the default list, the service provider shall deliver the qualified parameter for that label for every configured instance of the procedure that is directly associated with the service instance that executes the Cyclic Report procedure;

b) contains the name of a list of Parameter Labels, then;

1) for each Functional Resource Parameter Label in the named list, the service provider shall deliver the qualified parameter for that label for each instance of the given Functional Resource Type that is directly associated with the service instance that executes the Cyclic Report procedure;

2) for each procedure configuration Parameter Label in the named list, the service provider shall deliver the qualified parameter for that label for every configured instance of the procedure that is directly associated with the service instance that executes the Cyclic Report procedure;

c) contains a Functional Resource Type, the service provider shall deliver for each Parameter Label associated with that Functional Resource Type the qualified parameter for that label of each Functional Resource Instance of the given type that is directly associated with the service instance that executes the Cyclic Report procedure;

d) contains a Functional Resource Name, the service provider shall deliver the qualified parameters for all the parameters of the named Functional Resource Instance;

e) contains a procedure type, then the service provider shall deliver the qualified parameters for all configuration parameters of every configured instance of that procedure type that is associated with the service instance executing the Cyclic Report procedure;

f) contains a procedure instance identification, then the service provider shall deliver the qualified parameters for all configuration parameters for that procedure instance;

g) contains any Parameter Labels for Functional Resource parameters, the service provider shall deliver the qualified parameter for that label for each instance of the given Functional Resource Type that is associated with the service instance that executes the Cyclic Report procedure;

h) contains any Parameter Labels for procedure configuration parameters, the service provider shall deliver for each label the qualified parameters for every configured instance of the procedure that is associated with the service instance that executes the Cyclic Report procedure; or
i) contains one or more Parameter Names, the service provider shall deliver the qualified parameter for each of the listed parameters.

4.10.3.3 Stopping

Upon reception of a STOP invocation, the service provider shall:

a) stop the cyclic timer;

b) stop transferring the qualified parameters.

4.10.3.4 Terminating

Upon receipt of a ‘terminate procedure’ event from the Association Control procedure, the procedure shall terminate by:

a) stopping transmitting TransferDataInvocation PDUs;

b) releasing the resources.

4.10.4 REQUIRED OPERATIONS

Table 4-55: Cyclic Report Procedure Required Operations

<table>
<thead>
<tr>
<th>Operations</th>
<th>Source</th>
<th>Extended</th>
<th>Refined</th>
<th>Procedure Blocking/Non-Blocking</th>
</tr>
</thead>
<tbody>
<tr>
<td>START</td>
<td>Unbuffered Data Delivery</td>
<td>Y</td>
<td>N</td>
<td>Blocking</td>
</tr>
<tr>
<td>STOP</td>
<td>Unbuffered Data Delivery</td>
<td></td>
<td>N</td>
<td>Blocking</td>
</tr>
<tr>
<td>TRANSFER-DATA</td>
<td>Unbuffered Data Delivery</td>
<td>N</td>
<td>Y</td>
<td>Non-Blocking</td>
</tr>
</tbody>
</table>

4.10.4.1 START (Confirmed)

4.10.4.1.1 General

The Cyclic Report procedure shall extend the START operation defined by the Unbuffered Data Delivery procedure (see 4.10.3.1) through the addition of two parameters to the invocation and through the addition of one value for the diagnostic parameter of the return.
4.10.4.1.2 Operation Parameters Definitions

NOTE – Table 4-56 shows the extension parameters of the START operation defined by this procedure.

### Table 4-56: START Extension Parameters

<table>
<thead>
<tr>
<th>Extension Parameters</th>
<th>Invocation</th>
<th>Return</th>
</tr>
</thead>
<tbody>
<tr>
<td>delivery-cycle</td>
<td>M</td>
<td></td>
</tr>
<tr>
<td>list-of-parameters</td>
<td>M</td>
<td></td>
</tr>
</tbody>
</table>

4.10.4.1.2.1 Extension Parameters Syntax

The type CyclicReportStartInvocExt, as defined in F4.12, shall specify the syntax of the extension parameters of the START invocation.

4.10.4.1.2.2 delivery-cycle

The delivery-cycle parameter shall be present in the invocation and shall specify the requested interval between subsequent TRANSFER-DATA invocations.

4.10.4.1.2.3 list-of-parameters

4.10.4.1.2.3.1 The list of Parameter Names / Parameter Labels or the names of the lists that can be requested shall be defined by the service using this procedure or a procedure derived from this procedure.

4.10.4.1.2.3.2 The list-of-parameters parameter shall contain one of the following:
(a) ‘empty’ value, i.e., left unspecified,
(b) the name of a list,
(c) a Functional Resource Type,
(d) a Functional Resource Name,
(e) a procedure type,
(f) a procedure instance identifier,
(g) a list of individual Parameter Labels,
or
(h) a list of individual Parameter Names.

4.10.4.1.2.3.3 The Parameter Names and parameter list names shall comply with the definition in annex E.

4.10.4.1.3 diagnostic Parameter Extension Value Definitions and Syntax

4.10.4.1.3.1 If a negative START return is sent, the diagnostic parameter shall use one of the diagnostic values specified by the START operation in the Unbuffered Data Delivery procedure (see 4.5.4.1.3.1), or one of the following values:
a) ‘default not defined’—the default list (list-of-parameters set to ‘empty’) is unknown to the service provider.

b) ‘unknown list name’—the list name contained in the list-of-parameters is unknown to the service provider. The unknown list name shall be returned with the diagnostic.

c) ‘unknown Functional Resource Type’—the Functional Resource Type contained in the list-of-parameters parameter is unknown to the service provider (see 4.10.4.1.2.3) or the Functional Resource Type is not associated with the service instance that executes the Cyclic Report procedure. The unknown Functional Resource Type shall be returned with the diagnostic.

d) ‘unknown Functional Resource Name’—while the Functional Resource Type is known, the Functional Resource Name contained in the list-of-parameters parameter is unknown to the service provider (see 4.10.4.1.2.3) or the Functional Resource Name is not associated with the service instance that executes the Cyclic Report procedure. The unknown Functional Resource Name shall be returned with the diagnostic.

e) ‘unknown procedure type’—the procedure type contained in the list-of-parameters parameter is unknown to the service provider (see 4.10.4.1.2.3). The unknown procedure type shall be returned with the diagnostic.

f) ‘unknown procedure instance identifier’—while the procedure type is known, the procedure instance identifiers contained in the list-of-parameters parameter is unknown to the service provider (see 4.10.4.1.2.3). The unknown procedure instance identifier shall be returned with the diagnostic.

g) ‘unknown parameter identifier’—one or more Parameter Identifiers contained in the list-of-parameters parameter are unknown to the service provider (see 4.10.4.1.2.3) for one of the following reasons:

1) the Functional Resource or procedure type specified as part of the Parameter Label is not associated with the service instance executing the given Cyclic Report procedure instance;

2) a parameter with the given Published Identifier does not exist for the specified Functional Resource or procedure type or instance.

The list of unknown Parameter Names or Parameter Labels shall be returned with the diagnostic. For each unknown Parameter Identifier that is contained in a Parameter Name in the list-of-parameters, the Parameter Name shall be returned. For each unknown Parameter Identifier that is contained in a Parameter Label in the list-of-parameters, the Parameter Label shall be returned.

h) ‘out of range’—the service user requested a delivery cycle which is shorter than the limit set by the configuration parameter
4.10.4.1.3.2 The type CyclicReportStartDiagnosticExt, as defined in F4.12, shall specify the syntax of the diagnostic parameter of the START return extended as listed in 4.10.4.1.3.1.

4.10.4.2 TRANSFER-DATA (Unconfirmed)

4.10.4.2.1 General

This procedure refines the TRANSFER-DATA operation defined in 4.4.3.2 defining the syntax of one parameter of the invocation.

4.10.4.2.2 Operation Parameters Definitions

NOTE – The common parameters of the TRANSFER-DATA operation are defined in 3.9.2. This procedure refines the data parameter of the TRANSFER-DATA operation.

4.10.4.2.2.1 data Parameter Syntax

The type CyclicReportTransferDataInvocDataRef defined in F4.12 shall specify the syntax of the data parameter of the TRANSFER-DATA invocation using the qualified-parameters definition.

NOTE – The data parameter syntax is structured as a sequence of qualified parameters, each of which carries the name, the value, the type, and the qualifier of the parameter (see annex C).

4.10.4.2.2.2 qualified-parameters

The qualified-parameters parameter shall carry the name, the value, the type, and the qualifier of the parameters (see annex C).

4.10.5 CONFIGURATION PARAMETERS

The Cyclic Report procedure configuration parameters that need to be configured in the context of the procedure shall be as defined in table 4-57.
NOTE – For each configuration parameter, the table provides the engineering unit (if applicable), a cross reference to the use of the parameter in the specification of the procedure, identifies whether the parameter may be read, and also identifies the Parameter Identifier and type to be used in reporting the value of the parameter. None of the configuration parameters of this procedure can be dynamically changed while the service instance executing the procedure is bound.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Cross-Reference</th>
<th>Readable</th>
<th>Configuration Parameter Identifier and Type (F4.16)</th>
</tr>
</thead>
</table>
| named-label-lists                 | 4.10.3.1.2 b)   | Yes      | pCRnamedLabellLists
                                          |                 |          | PCRnamedLabellListsType                   |
| minimum-allowed-delivery-cycle (in milliseconds) | 4.10.4.1.2.2  | Yes      | pCRminimumAllowedDeliveryCycle
                                          |                 |          | PCRminimumAllowedDeliveryCycleType       |
| default list of parameters        | 4.10.3.1.2 a)   | No       | N/A                                               |

NOTE – The default list of parameters is shown in table 4-57 as not readable. This is because one cannot query directly the name of the default list. However, one can retrieve the full set of list names and for each list it is stated whether this list is specified to be the default list (see LabelList in F4.16).
### 4.10.6 PROCEDURE STATE TABLE

Table 4-58: Cyclic Report Procedure State Table

<table>
<thead>
<tr>
<th>No.</th>
<th>Incoming Event</th>
<th>State 1 ('inactive')</th>
<th>State 2 ('active')</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>(StartInvocation)</td>
<td>IF &quot;positive result&quot; THEN (+StartReturn) 'start cyclic timer' ⇒ 2 ELSE (-StartReturn) ENDIF</td>
<td>'procedure to association abort 'protocol error' ⇒ 1</td>
</tr>
<tr>
<td>2</td>
<td>(StopInvocation)</td>
<td>'procedure to association abort protocol error'</td>
<td>IF &quot;positive result&quot; THEN (+StopReturn) 'stop cyclic timer' ⇒ 1 ELSE (-StopReturn) ENDIF</td>
</tr>
<tr>
<td>3</td>
<td>'cyclic timer expired'</td>
<td>Not applicable</td>
<td>(periodic delivery)</td>
</tr>
<tr>
<td>4</td>
<td>'data available'</td>
<td>Not applicable</td>
<td>IF (NOT &quot;backpressure&quot;) THEN 'send data to underlying communications service' ELSE 'discard data' ENDIF</td>
</tr>
<tr>
<td>5</td>
<td>'invalid PDU 'xxx'</td>
<td>'procedure to association abort 'xxx'</td>
<td>'procedure to association abort 'xxx' ⇒ 1</td>
</tr>
<tr>
<td>6</td>
<td>'terminate procedure'</td>
<td>'terminate itself'</td>
<td>'terminate itself'</td>
</tr>
</tbody>
</table>

Table 4-59: Procedure State Table Incoming Event Description References

<table>
<thead>
<tr>
<th>Event</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>'cyclic timer expired'</td>
<td>4.10.3.2.1</td>
</tr>
<tr>
<td>'invalid PDU 'xxx'</td>
<td>3.2.3.6, 4.2.2.4. 'xxx' is one of the diagnostic values specified in 4.2.2.5</td>
</tr>
<tr>
<td>'terminate procedure'</td>
<td>4.2.3; internal event from the Association Control procedure to all other procedures of the service instance in response to a protocol abort, a PEER-ABORT, or an UNBIND</td>
</tr>
</tbody>
</table>
Table 4-60: Procedure State Table Predicate Descriptions

<table>
<thead>
<tr>
<th>Predicate</th>
<th>Evaluates to TRUE if</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;positive result&quot;</td>
<td>No reason for sending a negative return has been detected, i.e., for the START invocation none of the conditions in 4.10.4.1.3.1 applies, and for the STOP invocation none of the conditions in 3.3.2.7.1 applies.</td>
</tr>
</tbody>
</table>

Table 4-61: Procedure State Table Simple Action References

<table>
<thead>
<tr>
<th>Name</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>'set cyclic timer to delivery-cycle value'</td>
<td>4.10.3.1.3</td>
</tr>
<tr>
<td>'start cyclic timer'</td>
<td>4.10.3.1.3</td>
</tr>
<tr>
<td>'data available'</td>
<td>4.10.3.2.1</td>
</tr>
<tr>
<td>'restart cyclic timer'</td>
<td>4.10.3.2.3</td>
</tr>
<tr>
<td>'stop cyclic timer'</td>
<td>4.10.3.3</td>
</tr>
<tr>
<td>'terminate itself'</td>
<td>4.10.3.4</td>
</tr>
</tbody>
</table>

Table 4-62: Procedure State Table Compound Action Definitions

<table>
<thead>
<tr>
<th>Name</th>
<th>Actions Performed</th>
</tr>
</thead>
<tbody>
<tr>
<td>{periodic delivery}</td>
<td>IF data is available THEN trigger the 'data available' incoming event ENDIF 'restart cyclic timer'</td>
</tr>
<tr>
<td>{start cyclic timer}</td>
<td>'set cyclic timer to delivery-cycle value' 'start cyclic timer'</td>
</tr>
</tbody>
</table>
4.11 **NOTIFICATION**

4.11.1 **VERSION NUMBER**

The version number of this procedure is 1.

4.11.2 **DISCUSSION**

4.11.2.1 **Purpose**

The Notification procedure provides a means by which a service user is able to select from a set of pre-identified events and subsequently receive notification of the occurrence of those selected events while the Notification procedure is active.

**NOTE** – A CSTS can issue notifications without using the Notification procedure by using a procedure that directly includes the NOTIFY operation. For each such NOTIFY-extended procedure, the definition of the events that are to be reported via the NOTIFY operation is specified for that procedure and/or for the service that incorporates the procedure.

4.11.2.2 **Concept**

Each instance of a CSTS that incorporates the Notification procedure (hereinafter referred to as a *notification-enabled CSTS*) reports on each occurrence of any event belonging to a set of predefined and selected events.

The set of notifiable events for a CSTS is identified by named event lists, i.e., named lists of Event Labels for that service or the Event Labels or Event Names of individual notifiable events. The list-of-events parameter includes one of the following: (a) ‘empty’ signifying that the default list shall be applied, (b) a named list of Event Labels, (c) a Functional Resource Type, (d) a Functional Resource Name, (e) a procedure type, (f) a procedure instance identifier, or (g) the Event Labels or Names of individual notifiable events.

Each named event list has a string naming that list that represents multiple individual Event Labels. One special case of a notifiable named event list exists for each notification-enabled CSTS: the default list. The default list is named as any other list that may exist for the given CSTS, but it is automatically subscribed to when the list-of-events parameter is left empty. The definition of the default list is controlled by the specification of the CSTS using the Notification procedure or by a derived procedure or may be delegated to Service Management.

For a given notification-enabled CSTS, the event list names, the Event Labels represented by the list names and the Event Labels included in the default list (if any) and the set of Event Labels or Event Names are defined by the specification of that CSTS. A CSTS using this procedure will have to:
a) select the Functional Resource Types and procedure types as well as the associated events from the Published Identifiers (maintained by SANA);

b) define the grouping of Event Labels into lists and allocate a list name for each list;

c) identify which of the defined lists will be the default list.

In starting the Notification procedure as part of a CSTS, the service user subscribes to the particular events that are to be reported by that procedure in one of the following ways:

a) by leaving the list-of-events unspecified (i.e., set to ‘empty’); then for each Event Label represented by the default list of Event Labels the reporting of the associated events is enabled;

b) by specifying the name of a list of Event Labels which represents a predefined set of Event Labels;

c) by selecting a Functional Resource Type, thereby enabling the reporting of all events belonging to the instances of that Functional Resource Type that is directly associated with the CSTS executing the Notification procedure;

d) by selecting a Functional Resource Name, thereby enabling the reporting of all events belonging to that Functional Resource Instance;

e) selecting a procedure type, thereby enabling the reporting of all configuration change events of all procedure instances of the given procedure type associated with the service instance executing the Notification procedure;

f) selecting a procedure instance identification, thereby enabling the reporting of all configuration change events belonging to that procedure instance; or

g) by listing the Event Labels or Event Names of the individual events that are reportable by that service instance.

The operations defined in this procedure allow a service user to interact with a service provider to:

a) request the start of reporting the occurrence of any of the set of pre-identified notifiable events;

b) receive notification of the occurrence of the specified events;

c) stop and optionally later re-start the delivery of event notifications, applying the same or a different selection of notifiable events.
4.11.3 BEHAVIOR

4.11.3.1 Starting

NOTE – The service user selects the subset of notifiable events to which he wishes to subscribe by means of the START invocation. The selected events will be notified on their occurrence.

4.11.3.1.1 The service provider shall send a positive START return and perform the START operation invoked by the service user except if

a) the production-status is ‘halted’ in which case the START operation shall be rejected by sending a negative START return with the diagnostic ‘out of service’;

b) none of the conditions specified in 4.11.3.1.2 is met in which case the START operation shall be rejected by sending a negative START return with the diagnostic set to the applicable value as specified in 4.11.4.1.3.1; or

c) the procedure is in State 2 (‘active’) in which case the procedure shall request the Association Control procedure to abort the association with setting the diagnostic value to ‘protocol error’.

4.11.3.1.2 A START invocation for the Notification procedure is valid if it meets any one of the following conditions:

a) if the list-of-events parameter is ‘empty’, signifying subscription to the default list of Event Labels provided such default list has been established;

b) if the list-of-events parameter contains one event list name for a list of Event Labels that is contained in the set of label lists that has been established for the CSTS for use by the Notification procedure;

c) if the list-of-events parameter contains one Functional Resource Type that is associated with the service instance that executes the Notification procedure;

d) if the list-of-events parameter contains one name of a Functional Resource Instance that is associated with the service instance that executes the Notification procedure;

e) if the list-of-events parameter contains one procedure type that is associated with the service instance that executes the Notification procedure;

f) if the list-of-events parameter contains one procedure instance identifier of a procedure instance that is associated with the service instance that executes the Notification procedure;

g) if (1) the list-of-events parameter contains one or more Functional Resource Event Names or Event Labels, and (2) every one of those labels or names is the label
or name of an event of a Functional Resource that is associated with the service instance that executes the Notification procedure;

h) if (1) the list-of-events parameter contains one or more procedure configuration change Event Labels or Event Names, and (2) every one of these labels or names is the label or name of an event of a configured procedure that is associated with the service instance that executes the Notification procedure.

4.11.3.1.3 Upon success of the START operation, the Notification procedure instance shall be subscribed to the published events identified in the START invocation.

4.11.3.2 Notifying Occurrences of Events

4.11.3.2.1 The NOTIFY invocation is valid only in the procedure state ‘active’ and shall be invoked only by the service provider.

4.11.3.2.2 Upon the occurrence of any of the notifiable events to which the procedure instance has been subscribed (see 4.11.3.1), the service provider shall invoke the NOTIFY operation to inform the service user of the occurrence of the event. If the list-of-events parameter:

a) is left empty, then

1) for each Functional Resource Event Label in the default list (see annex E), the service provider shall notify the occurrence of the event (see C2.1) for that label for each Functional Resource Instance of the given type that is directly associated with the service instance that executes the Notification procedure;

2) for each procedure configuration change Event Label in the default list, the service provider shall notify the occurrence of the event for that label for every configured instance of the procedure that is associated with the service instance that executes the Notification procedure;

b) contains the name of a list of Event Labels, then

1) for each Functional Resource Event Label in the named list, the service provider shall notify the occurrence of the event for that label for the Functional Resource Instances of the given type that are directly associated with the service instance that executes the Notification procedure;

2) for each procedure configuration change Event Label in the named list, the service provider shall notify the occurrence of the event for that label for every configured instance of the procedure that is associated with the service instance that executes the Notification procedure;

c) contains a Functional Resource Type, then the service provider shall notify the occurrence of all events for all instances of that Functional Resource Type that are directly associated with the service instance that executes the Notification procedure;
d) contains a Functional Resource Name, then the service provider shall notify the occurrence of all events of the named Functional Resource Instance;

e) contains a procedure type, then the service provider shall notify the occurrence of any configuration parameter change event for all configured instances of the procedure type that are associated with the service instance executing the Notification procedure;

f) contains a procedure instance identification, then the service provider shall notify any occurrence of a configuration parameter change event for that procedure instance;

g) contains any Functional Resource Event Labels, then for each label the service provider shall notify the occurrence of the event for that label for each Functional Resource Instance of the given type that is directly associated with the service instance that executes the Notification procedure;

h) contains any procedure configuration change Event Labels, then for each label the service provider shall notify the occurrence of the event for that label for every configured instance of the procedure that is associated with the service instance that executes the Notification procedure;

i) contains one or more Event Names, then the service provider shall notify the occurrence of any of the listed events.

4.11.3.2.3 If an event is subscribed in terms of an individual Event Name, the corresponding event-name parameter (see 3.11.2.2.3.1) shall contain that Event Name.

4.11.3.2.4 The service specification or derived procedure shall specify the conditions under which it is permissible or required to use the Event Label or Event Name in an event-name parameter that corresponds to an event that is subscribed in terms of an Event Label.

4.11.3.3 Stopping

When receiving a valid STOP invocation, the procedure shall disable the generation of notifications of the occurrence of previously subscribed events.

4.11.3.4 Terminating

Upon receipt of a ‘terminate procedure’ event from the Association Control procedure, the procedure shall terminate by:

a) discarding pending notification;

b) releasing the resources.
4.11.4 REQUIRED OPERATIONS

Table 4-63: Notification Procedure Required Operations

<table>
<thead>
<tr>
<th>Operations</th>
<th>Source</th>
<th>Extended</th>
<th>Refined</th>
<th>Blocking/Non-Blocking</th>
</tr>
</thead>
<tbody>
<tr>
<td>START</td>
<td>Common</td>
<td>Y</td>
<td>N</td>
<td>Blocking</td>
</tr>
<tr>
<td>STOP</td>
<td>Common</td>
<td>N</td>
<td>N</td>
<td>Blocking</td>
</tr>
<tr>
<td>NOTIFY</td>
<td>Common</td>
<td>N</td>
<td>N</td>
<td>Non-Blocking</td>
</tr>
</tbody>
</table>

4.11.4.1 START (Confirmed)

4.11.4.1.1 General

The Notification procedure shall extend the START operation defined in 3.7.2 through the addition of one parameter to the invocation and through the addition of values for the diagnostic parameter of the return.

4.11.4.1.2 Operation Parameters Definitions

NOTE – Table 4-64 shows the extension parameters of the START operation defined by this procedure.

Table 4-64: START Extension Parameters

<table>
<thead>
<tr>
<th>Extension Parameters</th>
<th>Invocation</th>
<th>Return</th>
</tr>
</thead>
<tbody>
<tr>
<td>list-of-events</td>
<td>M</td>
<td></td>
</tr>
</tbody>
</table>

4.11.4.1.2.1 Extension Parameters Syntax

The type NotificationStartInvocExt, as defined in F4.13, shall specify the syntax of the extension parameter of the START invocation.

4.11.4.1.2.2 list-of-events

4.11.4.1.2.2.1 The list of events or the named event lists that can be requested shall be defined by the service using this procedure or by a procedure derived from this procedure or may be delegated to Service Management.
4.11.4.1.2.2.2 The list-of-events parameter shall contain one of the following:

a) ‘empty’ which signifies that the service provider shall notify the events defined in the default list of events;

b) one named event list that defines a predefined set of Event Labels that represent the notifiable events that are to be reported to the service user upon their occurrence;

c) one Functional Resource Type, in which case the occurrence of events related to any of the instances of the Functional Resource Type associated with the service instance in which the Notification procedure executes shall be notified to the service user;

d) one Functional Resource Name, for which all associated events shall be notified to the service user upon their occurrence;

e) one procedure type, in which case the occurrence of any change of the configuration parameters of all configured procedure instances of that procedure type associated with the service instance in which the Notification procedure executes shall be notified to the service user;

f) one procedure instance identifier, in which case the occurrence of any change of the configuration parameters of that procedure instance shall be notified to the service user; or

g) one or more individual Event Labels or Event Names of the notifiable events that are to be reported to the service user upon their occurrence.

4.11.4.1.2.2.3 The procedure shall notify one or more of the published events defined by this Recommended Standard, if the list-of-events parameter in the START invocation contains one or more of the Event Names corresponding to the following definitions:

a) svcProductionStatusChange: subscription to the ‘production status change’ event;

b) svcProductionConfigurationChange: subscription to the ‘production configuration change’ event.

NOTE – The published events listed in a) and b) above are defined as Published Identifiers (see F4.17).

4.11.4.1.2.2.4 A service using this procedure or a procedure derived from this procedure may define additional individual notifiable events. For each additional individual notifiable event, an Event Label and (optionally) an event value (along with its type and range) shall be defined.

4.11.4.1.2.2.5 The procedure shall notify the occurrence of any of those additional individual notifiable events, if the list-of-events parameter in the START invocation contains the Event Label or Event Name of each notifiable event to be reported.
NOTE – Notifiable Event Labels that are added by services using this procedure or by procedures derived from this procedure may also be included in the list of Event Labels represented by a named event list.

4.11.4.1.2.2.6 A service using this procedure or a procedure derived from this procedure may define one or more lists of Event Labels. Each list shall have an event list name defined for it.

4.11.4.1.2.2.7 If the list-of-events parameter in the START invocation contains the name of a notifiable named event list, the procedure shall notify the occurrence of the events identified by that named event list.

4.11.4.1.2.2.8 A service using this procedure or a procedure derived from this procedure may define a single list of notifiable events as the default list.

NOTE – The default list is a named event list; i.e., a name is assigned also to the default list. However, it is also flagged to serve as the default list and can therefore be selected by setting the list-of-events parameter to ‘empty’. (See ListOfParametersEvents in F4.3.)

4.11.4.1.2.2.9 Each named event list shall contain the Event Identifiers and associated Functional Resource Types of individually published events (see annex E).

4.11.4.1.2.2.10 The Event Identifiers shall be defined using Published Identifiers.

4.11.4.1.2.2.11 The named event list name shall be defined using a string.

4.11.4.1.3 diagnostic Parameter Extension Value Definitions and Syntax

4.11.4.1.3.1 If a negative START return is sent, the diagnostic parameter shall use one of the diagnostic values specified in 3.7.2.3, or one of the following values:

a) ‘default not defined’—the default list (list-of-events set to ‘empty’) is unknown to the service provider.

b) ‘unknown list name’—the list name contained in the list-of-parameters is unknown to the service provider. The unknown list name shall be returned with the diagnostic.

c) ‘unknown Functional Resource Type’—the Functional Resource Type contained in the list-of-events parameter is unknown to the service provider (see 4.11.4.1.2.2) or the Functional Resource Type is not associated with the service instance that executes the Notification procedure. The unknown Functional Resource Type shall be returned with the diagnostic.

d) ‘unknown Functional Resource Name’—while the Functional Resource Type is known, the Functional Resource Name contained in the list-of-events parameter is unknown to the service provider (see 4.11.4.1.2.2) or the Functional
Resource Name is not associated with the service instance that executes the Notification procedure. The unknown Functional Resource Name shall be returned with the diagnostic.

e) ‘unknown procedure type’—the procedure type contained in the list-of-events parameter is unknown to the service provider (see 4.11.4.1.2.2). The unknown procedure type shall be returned with the diagnostic.

f) ‘unknown procedure instance identifier’—while the procedure type is known, the procedure instance identifier contained in the list-of-events parameter is unknown to the service provider (see 4.11.4.1.2.2). The unknown procedure instance identifier shall be returned with the diagnostic.

g) ‘unknown event identifier’—one or more Event Identifiers contained in the list-of-events parameter are unknown to the service provider (see 4.11.4.1.2.2) for one of the following reasons:

1) the Functional Resource specified as part of the Event Name is not associated with the service instance executing the given Notification procedure instance;

2) the Functional Resource Type or procedure type specified as part of the Event Label is not associated with the service instance executing the given Notification procedure instance;

3) an event with the given Published Identifier does not exist for the specified Functional Resource Type;

4) an event with the given Published Identifier does not exist for the specified procedure type.

The list of unknown Event Names or Event Labels shall be returned with the diagnostic. For each unknown Event Identifier that is contained in an Event Name in the list-of-events, the Event Name shall be returned. For each unknown Event Identifier that is contained in an Event Label in the list-of-events, the Event Label shall be returned.

4.11.4.1.3.2 The type NotificationStartDiagnosticExt, as defined in F4.13, shall specify the syntax of the diagnostic parameter of the START return extended as listed in 4.11.4.1.3.1.
4.11.5 CONFIGURATION PARAMETERS

The Notification procedure configuration parameters that need to be configured in the context of the procedure shall be as defined in table 4-65.

NOTE — For each configuration parameter, the table provides a cross reference to the use of the parameter in the specification of the procedure, identifies whether the parameter may be read, and also identifies the Parameter Identifier and type to be used in reporting the value of the parameter. None of the configuration parameters of this procedure can be dynamically changed while the service instance executing the procedure is bound.

Table 4-65: Notification Procedure Configuration Parameters

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Cross-Reference</th>
<th>Readable</th>
<th>Configuration Parameter Identifier and Type (F4.16)</th>
</tr>
</thead>
<tbody>
<tr>
<td>named label lists</td>
<td>4.11.3.2.2 b)</td>
<td>Yes</td>
<td>pNnamedLabellLists                    pNnamedLabellListsType</td>
</tr>
<tr>
<td>default list of events</td>
<td>4.11.4.1.2.2.8</td>
<td>No</td>
<td>N/A</td>
</tr>
</tbody>
</table>

NOTE — The default list of events is shown in table 4-65 as not readable. This is because one cannot query directly the name of the default list. However, one can retrieve the full set of list names and for each named event list it is stated whether this list is specified to be the default list.
4.11.6 PROCEDURE STATE TABLE

Table 4-66: Notification Procedure State Table

<table>
<thead>
<tr>
<th>No.</th>
<th>Incoming Event</th>
<th>State 1 ('inactive')</th>
<th>State 2 ('active')</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>(StartInvocation)</td>
<td>IF &quot;positive result&quot; THEN (+StartReturn) enable event notification for selected events ⇒ 2 ELSE (-StartReturn) ENDIF</td>
<td>&quot;procedure to association abort 'protocol error' ⇒ 1&quot;</td>
</tr>
<tr>
<td>2</td>
<td>(StopInvocation)</td>
<td>'procedure to association abort 'protocol error'</td>
<td>IF &quot;positive result&quot; THEN (+StopReturn) ELSE (-StopReturn) ENDIF</td>
</tr>
<tr>
<td>3</td>
<td>'notifiable event occurred'</td>
<td>Not applicable</td>
<td>'notify 'notifiable event' / 'event value''</td>
</tr>
<tr>
<td>4</td>
<td>'invalid PDU 'xxx''</td>
<td>'procedure to association abort 'xxx''</td>
<td>'procedure to association abort &quot;xxx&quot; ⇒ 1'</td>
</tr>
<tr>
<td>5</td>
<td>'terminate procedure'</td>
<td>'terminate itself'</td>
<td>'terminate itself'</td>
</tr>
</tbody>
</table>

Table 4-67: Procedure State Table Event Description References

<table>
<thead>
<tr>
<th>Event</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>'notifiable event occurred'</td>
<td>4.11.3.2</td>
</tr>
<tr>
<td>'invalid PDU 'xxx''</td>
<td>3.2.3.6, 4.2.2.4. 'xxx' is one of the diagnostic values specified in 4.2.2.5.</td>
</tr>
<tr>
<td>'terminate procedure'</td>
<td>4.2.3, internal event from the Association Control procedure to all other procedures of the service instance in response to a protocol abort, a PEER-ABORT, or an UNBIND.</td>
</tr>
</tbody>
</table>
Table 4-68: Procedure State Table Predicate Descriptions

<table>
<thead>
<tr>
<th>Predicate</th>
<th>Evaluates to TRUE if</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;positive result&quot;</td>
<td>No reason for sending a negative return has been detected, i.e., for the START invocation none of the conditions in 4.11.4.1.3.1 applies, and for the STOP invocation none of the conditions in 3.3.2.7.1 applies.</td>
</tr>
</tbody>
</table>

Table 4-69: Procedure State Table Simple Action References

<table>
<thead>
<tr>
<th>Name</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>'create a notification'</td>
<td>4.11.3.2.2</td>
</tr>
<tr>
<td>'notify 'xxx' / 'yyy''</td>
<td>4.11.3.2.2, (NotifyInvocation) with event-name set to 'xxx' and event-value set to 'yyy'. In case a notification does not use an event-value, 'yyy' shall be set to 'empty'</td>
</tr>
<tr>
<td>'procedure to association abort 'xxx''</td>
<td>4.2.2.3, 4.2.2.5, raise 'procedure to association abort 'xxx'' event with diagnostic set to 'xxx' to the Association Control procedure</td>
</tr>
<tr>
<td>'terminate itself'</td>
<td>4.11.3.4</td>
</tr>
</tbody>
</table>
4.12 THROW EVENT

4.12.1 VERSION NUMBER

The version number of this procedure is 1.

4.12.2 DISCUSSION

4.12.2.1 Purpose

The Throw Event procedure provides the capability for a service user to request the service provider to initiate predefined actions to be performed by the Complex, to receive acknowledgements of successful receipt of the requests, and to receive reports of the final outcomes of the actions from the service provider.

The service provider executes the actions and checks the guard conditions applicable to the actions. The guard conditions are the conditions under which the service provider can properly and safely execute the actions. The guard conditions are defined by the service using this procedure or by the Functional Resources and their parameters the procedure shall act on.

4.12.2.2 Concept

The Throw Event procedure is intended for use in Cross Support Transfer Services that involve the modification of operating parameters of a Provider CSSS during the execution of a service package. The procedure may be incorporated into a CSTS to provide a capability to modify:

a) dynamically modifiable configuration parameters of the procedures of a given CSTS instance (refer to 3.13.1.1 b));

b) production parameters associated with the data being transferred by that transfer service (e.g., a service whose primary purpose is to deliver commands to the space element, which uses the Throw Event procedure to modify the link parameters used to deliver those commands); or

c) production parameters of the Provider CSSS independent of any data transfer via that transfer service (e.g., a service whose purpose is to control parameters of production functions that support multiple Cross Support Service instances, and for which no single service instance has the authority to modify those parameters on behalf of the service user).
NOTE – If the directed action cannot be completed by the CSTS service provider itself (e.g., it must be performed by the EM of the ESLT), then the service provider must forward the directive to the appropriate EM of the ESLT for completion of the action.

No specific directives and the actions that these directives would trigger are defined as part of the Throw Event procedure. Each service that uses this procedure defines the directives and the associated actions. Also Functional Resources may specify such directives that are intended to modify the Functional Resource configuration.

NOTE – The service itself may defer the definition of the actions to a bilateral agreement between the service providing and service using organizations.

This procedure uses only one operation: the EXECUTE-DIRECTIVE. It allows the service user to transmit a directive to the service provider.

The service user may invoke the EXECUTE-DIRECTIVE operations at any time that the service instance is in the state ‘bound’.

4.12.3 BEHAVIOR

4.12.3.1 Activities

NOTE – The service user can request the performance of a predefined action by the EM of an ESLT by invoking the EXECUTE-DIRECTIVE operation.

4.12.3.1.1 The service provider shall acknowledge the receipt of a valid request and deny any invalid request contained in an incoming EXECUTE-DIRECTIVE invocation.

4.12.3.1.2 If the request is valid, the service provider shall subsequently report on the success or failure of the requested action.

4.12.3.1.3 The service using this procedure or the Functional Resources this procedure is acting on shall define the guard conditions required to execute the predefined actions properly and safely.

4.12.3.2 Acknowledging Directives

4.12.3.2.1 If the invocation is a valid directive, the service provider shall:
    a) send a positive acknowledgement; and
    b) begin performing the requested action (see 4.12.3.3).

4.12.3.2.2 If the invocation is not a valid directive, the service provider shall:
    a) send a negative acknowledgement; and
b) shall not perform the requested action.

4.12.3.3 Performing Directed Actions

4.12.3.3.1 The EM of the ESLT shall attempt to perform the directed action. There are no time constraints imposed by the Throw Event procedure on the completion of the action.

NOTE – Procedures derived from the Throw Event procedure may impose time constraints on the completion of the directed action.

4.12.3.3.2 A single action may involve setting of a sequence of parameters.

4.12.3.3.2.1 In this case the individual parameters shall be set in the same sequence as specified in the directive-qualifier parameter.

4.12.3.3.2.2 Parameter-specific parameter guard conditions shall be evaluated only after setting of the previous parameter in the sequence has completed.

NOTE – This approach ensures that each guard condition is checked only once preceding configuration have taken effect and therefore the check is performed based on the up-to-date status.

4.12.3.3.3 When the action is successfully completed, the service provider shall send a positive return.

4.12.3.3.4 If the action cannot be successfully completed, the service provider shall send a negative return.

4.12.3.3.5 After having sent the return of the EXECUTE-DIRECTIVE operation, the service provider shall cease performing the operation.

4.12.3.4 Terminating

Upon receipt of a ‘terminate procedure’ event from the Association Control procedure, the procedure shall terminate by:

a) ceasing the performing of any ongoing EXECUTE-DIRECTIVE operations;

b) releasing the resources.

NOTE – If the execution of directed actions is not yet completed at the time the Throw Event procedure is terminated, completion of these actions will not be reported by this procedure and will have to be determined by other means.
4.12.4 REQUIRED OPERATIONS

Table 70: Throw Event Procedure Required Operations

<table>
<thead>
<tr>
<th>Operations</th>
<th>Source</th>
<th>Extended</th>
<th>Refined</th>
<th>Procedure Blocking/Non-Blocking</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXECUTE-DIRECTIVE</td>
<td>Common</td>
<td>Y</td>
<td>N</td>
<td>Non-Blocking</td>
</tr>
</tbody>
</table>

4.12.4.1 EXECUTE-DIRECTIVE (Acknowledged)

4.12.4.1.1 General

The Throw Event procedure shall extend the EXECUTE-DIRECTIVE operation defined in 3.13 through the addition of one value for the diagnostic parameter of the acknowledgement and return.

4.12.4.1.2 Invocation, Acknowledgement, Return, and Parameters

The common parameters of the EXECUTE-DIRECTIVE (acknowledged) operation are defined in 3.13.2.

4.12.4.1.3 diagnostic Parameter Extension Value Definition and Syntax

NOTE – Whenever a negative acknowledgement has been sent by the service provider, the action identified by the directive-identifier parameter has not been performed. Whenever a negative return has been sent by the service provider, the action identified by the directive-identifier parameter has either been performed only partially or not at all. The negative return provides the detailed information regarding the extent to which a requested action has been performed, e.g., for which Functional Resource parameters the update has failed.

4.12.4.1.3.1 If an EXECUTE-DIRECTIVE negative acknowledgement is sent, the diagnostic parameter shall use one of the diagnostic values specified in 3.13.2.3.1n.

4.12.4.1.3.2 If an EXECUTE-DIRECTIVE negative return is sent, the diagnostic parameter shall use one of the following values:

a) one of the diagnostic values specified in 3.13.2.3.3; or

b) the value ‘guard condition evaluated to false’—a required condition was found not to be met.
4.12.4.1.3.3 The type TeExecDirNegReturnDiagnosticExt, as defined in F4.14, shall specify the syntax of the diagnostic parameter of the EXECUTE-DIRECTIVE return extended as listed in 4.12.4.1.3.2.

4.12.5 CONFIGURATION PARAMETERS

An instance of the Throw Event procedure requires no configuration. Any information related to the capabilities accessible through the Throw Event procedure will be governed by the directives that are supported by the ESLT that hosts the CSTS provider and/or the Service Agreement that establishes the capabilities that are provided to the individual user mission.

4.12.6 PROCEDURE STATE TABLE

Table Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll.-71: Throw Event Procedure State Table

<table>
<thead>
<tr>
<th>No.</th>
<th>Incoming Event</th>
<th>State 1 (‘inactive’)</th>
<th>State 2 (‘active’)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>‘action completed [N]’</td>
<td>(+ExecuteDirectiveReturn) [N] IF ‘no other operation invocation is awaiting return’ THEN 1 ENDIF</td>
<td>(+ExecuteDirectiveReturn) [N] IF ‘no other operation invocation is awaiting return’ THEN 1 ENDIF</td>
</tr>
<tr>
<td>3</td>
<td>‘action not successfully completed [N]’</td>
<td>(-ExecuteDirectiveReturn) [N] IF ‘no other operation invocation is awaiting return’ THEN 1 ENDIF</td>
<td>(-ExecuteDirectiveReturn) [N] IF ‘no other operation invocation is awaiting return’ THEN 1 ENDIF</td>
</tr>
<tr>
<td>4</td>
<td>‘invalid PDU ’xxx’’</td>
<td>‘procedure to association abort ‘xxx’’</td>
<td>‘procedure to association abort ‘xxx’’</td>
</tr>
<tr>
<td>5</td>
<td>‘terminate procedure’</td>
<td>‘terminate itself’</td>
<td>‘terminate itself’</td>
</tr>
</tbody>
</table>
### Table: Procedure State Table Incoming Event Description References

<table>
<thead>
<tr>
<th>Event</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>'action completed'</td>
<td>4.12.3.3.3</td>
</tr>
<tr>
<td>'action not successfully completed'</td>
<td>4.12.3.3.4</td>
</tr>
<tr>
<td>'invalid PDU ‘xxx’'</td>
<td>3.2.3.6, 4.2.2.4, 'xxx' is one of the diagnostic values specified in 4.2.2.5.</td>
</tr>
<tr>
<td>'terminate procedure'</td>
<td>4.2.3, internal event from the Association Control procedure to all other procedures of the service instance in response to a protocol abort, a PEER-ABORT, or an UNBIND</td>
</tr>
</tbody>
</table>

### Table: Procedure State Table Predicate Definitions

<table>
<thead>
<tr>
<th>Predicate</th>
<th>Evaluates to TRUE if</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;valid directive&quot;</td>
<td>none of the error conditions identified in 4.12.4.1.3.1 is true for the EXECUTE-DIRECTIVE invocation</td>
</tr>
</tbody>
</table>

### Table: Procedure State Table Simple Action References

<table>
<thead>
<tr>
<th>Name</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>'initiate action'</td>
<td>4.12.3.3.1</td>
</tr>
<tr>
<td>'procedure to association abort ‘xxx’&quot;</td>
<td>4.2.2.3, 4.2.2.5, raise 'procedure to association abort ‘xxx”' event with diagnostic set to ‘xxx’ to the Association Control procedure</td>
</tr>
<tr>
<td>‘terminate itself’</td>
<td>4.12.3.4</td>
</tr>
</tbody>
</table>
ANNEX A

IMPLEMENTATION CONFORMANCE STATEMENT PROFORMA

(NORMATIVE)

A1 INTRODUCTION

A1.1 OVERVIEW

Although it might be possible to implement a software library on the basis of this specification, the prime intent of this document is to provide a framework for the specification of Cross Support Transfer Services. Such service specification will provide a specification for all elements that are left abstract in this document and can thus be implemented.

As the baseline for the specification of Cross Support Transfer Services, implementation conformance in this Recommended Standard is expressed with regard to the protocol on the interface between the user and the provider of CSTSes. Therefore the ICS is a Protocol ICS (PICS).

As an aide to the creation of the PICS proforma for transfer services developed on the basis of this document, this annex provides the PICS Requirements List (RL) for the elements specified herein. Service specifications are expected to import this Requirements List and to create a service-specific profile on this basis.

The RL support column in this annex is blank. An implementation’s completed RL is called the PICS. The PICS states which capabilities and options have been implemented. The following can use the PICS:

a) the implementer, as a checklist to reduce the risk of failure to conform to the standard through oversight;
b) a supplier or potential acquirer of the implementation, as a detailed indication of the capabilities of the implementation, stated relative to the common basis for understanding provided by the standard PICS proforma;
c) a user or potential user of the implementation, as a basis for initially checking the possibility of interworking with another implementation (it should be noted that, while interworking can never be guaranteed, failure to interwork can often be predicted from incompatible PICSes);
d) a tester, as the basis for selecting appropriate tests against which to assess the claim for conformance of the implementation.
A1.2 ABBREVIATIONS AND CONVENTIONS

The RL consists of information in tabular form. The status of features is indicated using the abbreviations and conventions described below.

Item Column

The item column contains a prefix identifying the element the given table is referring to and sequential numbers for items in the table.

Feature Column

The feature column contains a brief descriptive name for a feature. It implicitly means ‘Is this feature supported by the implementation?’

Status Column

The status column uses the following notations:

a) M mandatory;
b) O optional;
c) O<n> optional, but support of at least one of the group of options labeled by the same numeral <n> is required;
d) C<n> conditional as defined in corresponding expression below the table;
e) X prohibited;
f) N/A not applicable.

Support Column Symbols

The support column is to be used by the implementer to state whether a feature is supported by entering Y, N, or N/A, indicating:

a) Y Yes, supported by the implementation;
b) N No, not supported by the implementation;
c) N/A Not applicable.

The support column should also be used, when appropriate, to enter values supported for a given capability.

Allowed Values Column

All PDU parameter types are specified in annex F using ASN.1. The ASN.1 data type specifications constrain among others the permissible value range, and therefore such
constraints are not repeated in the Allowed Values column in the tables contained in this annex. However, if a parameter is constrained for all instances of the given PDU to a subset of the range or set specified for that parameter in annex F, then the subset is identified in the tables that contain the PDU parameters.

Allowed Values Column Symbols

If the specification of allowed values is too large to fit in the Allowed Values cell, the Allowed Values column uses the notation ‘AV<n>’ as an indication that the allowed values are specified below the table.

Supported Values Column

The Supported Values column is to be used by the implementer to state whether the specified range or set of values for the parameter is supported by entering Y or SV<n>, indicating:

a) Y Yes, the range/set defined in the Recommended Specification is fully supported by the implementation;
b) SV<n> The range/set defined in the Recommended Standard is not fully supported by the implementation. The supported subset is documented below the table.

A1.3 INSTRUCTIONS FOR COMPLETING THE RL

An implementer shows the extent of compliance to the Recommended Standard by completing the RL; that is, the state of compliance with all mandatory requirements and the options supported are shown. The resulting completed RL is called PICS. The implementer shall complete the RL by entering appropriate responses in the support or values supported column, using the notation described in A1.2. If a conditional requirement is inapplicable, N/A should be used. If a mandatory requirement is not satisfied, exception information must be supplied by entering a reference Xi, where i is a unique identifier to an accompanying rationale for the noncompliance.

A2 PICS PROFORMA FOR XYZ CSTS PROTOCOL (CCSDS 9NM.1-B-K)

A2.1 GENERAL INFORMATION

The PICS for a CSTS implementation shall encompass the filled in tables.
Table: Identification of PICS

<table>
<thead>
<tr>
<th>Date of Statement (DD/MM/YYYY)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>PICS serial number</td>
<td></td>
</tr>
<tr>
<td>System Conformance statement cross-reference</td>
<td></td>
</tr>
</tbody>
</table>

Table: Identification of Implementation under Test

<table>
<thead>
<tr>
<th>Implementation name</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Implementation version</td>
<td></td>
</tr>
<tr>
<td>Special Configuration</td>
<td></td>
</tr>
<tr>
<td>Other Information</td>
<td></td>
</tr>
</tbody>
</table>

Table: Identification of Supplier

<table>
<thead>
<tr>
<th>Supplier</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Contact Point for Queries</td>
<td></td>
</tr>
<tr>
<td>Implementation Name(s) and Versions</td>
<td></td>
</tr>
<tr>
<td>Other information necessary for full identification, e.g., name(s) and version(s) for machines and/or operating systems;</td>
<td></td>
</tr>
<tr>
<td>System Name(s)</td>
<td></td>
</tr>
</tbody>
</table>
Table: Identification of Specification

<table>
<thead>
<tr>
<th>CCSDS 9NM.I-B-K</th>
</tr>
</thead>
<tbody>
<tr>
<td>Have any exceptions been required?</td>
</tr>
<tr>
<td>NOTE – A YES answer means that the implementation does not conform to the Recommended Standard. Non-supported mandatory capabilities are to be identified in the PICS, with an explanation of why the implementation is nonconforming.</td>
</tr>
</tbody>
</table>

A2.2 REQUIREMENTS LIST

This subsection provides the Requirement Lists for the elements specified in this Recommended Standard. Depending on which procedures and associated PDUs are actually used in a Cross Support Transfer Service specification, the relevant subset of the tables will become part of the service-specific PICS proforma.

Table: Required Procedures

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Reference</th>
<th>Status</th>
<th>Support</th>
</tr>
</thead>
<tbody>
<tr>
<td>proc-1</td>
<td>Association Control</td>
<td>4.3</td>
<td>M</td>
<td></td>
</tr>
<tr>
<td>proc-2</td>
<td>Unbuffered Data Delivery</td>
<td>4.4</td>
<td>O</td>
<td></td>
</tr>
<tr>
<td>proc-3</td>
<td>Buffered Data Delivery</td>
<td>4.5</td>
<td>O</td>
<td></td>
</tr>
<tr>
<td>proc-4</td>
<td>Data Processing</td>
<td>4.6</td>
<td>O</td>
<td></td>
</tr>
<tr>
<td>proc-5</td>
<td>Buffered Data Processing</td>
<td>4.7</td>
<td>O</td>
<td></td>
</tr>
<tr>
<td>proc-6</td>
<td>Sequence-Controlled Data Processing</td>
<td>4.8</td>
<td>O</td>
<td></td>
</tr>
<tr>
<td>proc-7</td>
<td>Information Query</td>
<td>4.9</td>
<td>O</td>
<td></td>
</tr>
<tr>
<td>proc-8</td>
<td>Cyclic Report</td>
<td>4.10</td>
<td>O</td>
<td></td>
</tr>
<tr>
<td>proc-9</td>
<td>Notification</td>
<td>4.11</td>
<td>O</td>
<td></td>
</tr>
<tr>
<td>proc-10</td>
<td>Throw Event</td>
<td>0</td>
<td>O</td>
<td></td>
</tr>
</tbody>
</table>
### Table 6: Required PDUs

<table>
<thead>
<tr>
<th>Item</th>
<th>PDU</th>
<th>Ref.</th>
<th>Service Provider System</th>
<th>Service User System</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Status</td>
<td>Support</td>
</tr>
<tr>
<td>pdu-1</td>
<td>BindInvocation</td>
<td>F4.5</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>pdu-2</td>
<td>BindReturn</td>
<td>F4.5</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>pdu-3</td>
<td>PeerAbortInvocation</td>
<td>F4.5</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>pdu-4</td>
<td>UnbindInvocation</td>
<td>F4.5</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>pdu-5</td>
<td>UnbindReturn</td>
<td>F4.5</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>pdu-6</td>
<td>ExecuteDirectiveAcknowledge</td>
<td>F4.4</td>
<td>C1</td>
<td>C1</td>
</tr>
<tr>
<td>pdu-7</td>
<td>ExecuteDirectiveInvocation</td>
<td>F4.4</td>
<td>C1</td>
<td>C1</td>
</tr>
<tr>
<td>pdu-8</td>
<td>ExecuteDirectiveReturn</td>
<td>F4.4</td>
<td>C1</td>
<td>C1</td>
</tr>
<tr>
<td>pdu-9</td>
<td>GetInvocation</td>
<td>F4.4</td>
<td>C2</td>
<td>C2</td>
</tr>
<tr>
<td>pdu-10</td>
<td>GetReturn</td>
<td>F4.4</td>
<td>C2</td>
<td>C2</td>
</tr>
<tr>
<td>pdu-11</td>
<td>NotifyInvocation</td>
<td>F4.4</td>
<td>C3</td>
<td>C3</td>
</tr>
<tr>
<td>pdu-12</td>
<td>ProcessDataInvocation</td>
<td>F4.4</td>
<td>C4</td>
<td>C4</td>
</tr>
<tr>
<td>pdu-13</td>
<td>ProcessDataReturn</td>
<td>F4.4</td>
<td>C5</td>
<td>C5</td>
</tr>
<tr>
<td>pdu-14</td>
<td>StartInvocation</td>
<td>F4.4</td>
<td>C6</td>
<td>C6</td>
</tr>
<tr>
<td>pdu-15</td>
<td>StartReturn</td>
<td>F4.4</td>
<td>C6</td>
<td>C6</td>
</tr>
<tr>
<td>pdu-16</td>
<td>StopInvocation</td>
<td>F4.4</td>
<td>C6</td>
<td>C6</td>
</tr>
<tr>
<td>pdu-17</td>
<td>StopReturn</td>
<td>F4.4</td>
<td>C6</td>
<td>C6</td>
</tr>
<tr>
<td>pdu-18</td>
<td>TransferDataInvocation</td>
<td>F4.4</td>
<td>C7</td>
<td>C7</td>
</tr>
<tr>
<td>pdu-19</td>
<td>ReturnBuffer</td>
<td>F4.7</td>
<td>C8</td>
<td>C8</td>
</tr>
<tr>
<td>pdu-20</td>
<td>ForwardBuffer</td>
<td>F4.9</td>
<td>C9</td>
<td>C9</td>
</tr>
</tbody>
</table>

C1 IF proc-6 OR proc-10 THEN M ELSE N/A
C2 IF proc-7 THEN M ELSE N/A
C3 IF proc-3 OR proc-4 OR proc-5 OR proc-6 OR proc-9 THEN M ELSE N/A
C4 IF proc-4 OR proc-5 OR proc-6 THEN M ELSE N/A
C5 IF proc-6 THEN M ELSE N/A
C6 IF proc-2 OR proc-3 OR proc-4 OR proc-5 OR proc-6 OR proc-8 OR proc-9 THEN M ELSE N/A
CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

C7 IF proc-2 OR proc-3 OR proc-8 THEN M ELSE N/A
C8 IF proc-3 THEN M ELSE N/A
C9 IF proc-5 THEN M ELSE N/A

Table Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 8,Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll.-7: BIND Invocation Parameters

<table>
<thead>
<tr>
<th>Item</th>
<th>Parameter</th>
<th>Ref.</th>
<th>Status</th>
<th>Support</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>bindInv-1</td>
<td>invokerCredentials</td>
<td>F4.3</td>
<td>M</td>
<td></td>
<td></td>
</tr>
<tr>
<td>bindInv-2</td>
<td>invokeld</td>
<td>F4.3</td>
<td>M</td>
<td></td>
<td></td>
</tr>
<tr>
<td>bindInv-3</td>
<td>procedureInstanceId</td>
<td>F4.3</td>
<td>M</td>
<td></td>
<td>AV1</td>
</tr>
<tr>
<td>bindInv-4</td>
<td>initiatorIdentifier</td>
<td>F4.5</td>
<td>M</td>
<td></td>
<td></td>
</tr>
<tr>
<td>bindInv-5</td>
<td>responderPortIdentifier</td>
<td>F4.5</td>
<td>M</td>
<td></td>
<td></td>
</tr>
<tr>
<td>bindInv-6</td>
<td>serviceType</td>
<td>F4.5</td>
<td>M</td>
<td></td>
<td></td>
</tr>
<tr>
<td>bindInv-7</td>
<td>versionNumber</td>
<td>F4.5</td>
<td>M</td>
<td></td>
<td></td>
</tr>
<tr>
<td>bindInv-8</td>
<td>serviceInstanceId</td>
<td>F4.5</td>
<td>M</td>
<td></td>
<td></td>
</tr>
<tr>
<td>bindInv-9</td>
<td>bindInvocationExtension</td>
<td>F4.5</td>
<td>M</td>
<td></td>
<td>AV2</td>
</tr>
</tbody>
</table>

AV1 For the BIND invocation the procedureRole element of the parameter bindInv-3 must be set to ‘associationControl’.

AV2 If parameters need to be added to the BIND invocation PDU, the parameter bindInv-9 can be used to do so, but no such extension is defined in this Recommended Standard and extension of the BIND invocation PDU, although permissible, is discouraged (see 4.3.3.1.13). Except if a procedure derived from the parent Association Control procedure that is using this PDU specifies such extension, the value of this parameter shall be set to ‘notUsed’.

The parameters bindInv-1, bindInv-2 and bindInv-3 are contained in the complex parameter standardInvocationHeader in the BindInvocation type shown in F4.5. This parameter is of the type StandardInvocationHeader that is specified in F4.3.
**Table** 8: BIND Return Parameters

<table>
<thead>
<tr>
<th>Item</th>
<th>Parameter</th>
<th>Ref.</th>
<th>Status</th>
<th>Support</th>
<th>Allowed</th>
<th>Supported</th>
</tr>
</thead>
<tbody>
<tr>
<td>bindRet-1</td>
<td>performerCredentials</td>
<td>F4.3</td>
<td>M</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>bindRet-2</td>
<td>invokeId</td>
<td>F4.3</td>
<td>M</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>bindRet-3</td>
<td>result</td>
<td>F4.3</td>
<td>M</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>bindRet-4</td>
<td>positive</td>
<td>F4.3</td>
<td>C10</td>
<td>AV3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>bindRet-5</td>
<td>diagnostic</td>
<td>F4.3</td>
<td>C11</td>
<td>AV4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>bindRet-6</td>
<td>negExtension</td>
<td>F4.3</td>
<td>C11</td>
<td>AV5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>bindRet-7</td>
<td>responderIdentifier</td>
<td>F4.5</td>
<td>M</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

C10 IF bindRet-3 = ‘positive’ THEN M ELSE X
C11 IF bindRet-3 = ‘negative’ THEN M ELSE X

AV3 If parameters need to be added to the positive BIND return PDU, the parameter bindRet-4 can be used to do so, but no such extension is defined in this Recommended Standard and extension of the BIND return PDU, although permissible, is discouraged (see 4.3.3.1.13). Except if a procedure derived from the parent Association Control procedure and using this PDU specifies such extension, the value of this parameter shall be set to ‘notUsed’.

AV4 For the negative BIND return the parameter bindRet-5 is extended by the type AssocBindDiagnosticExt defined in F4.5. Therefore the parameter bindRet-5 may have (a) any value defined for the Diagnostic type in F4.3 except ‘diagnosticExtension’; or (b) any value defined by ‘diagnosticExtension’: ‘acBindDiagExt’; ‘AssocBindDiagnosticExt’ defined in F4.5 except ‘assocBindDiagnosticExtExtension’. Additional values can be introduced by the further extension ‘diagnosticExtension’: ‘acBindDiagExt’; ‘AssocBindDiagnosticExt’; ‘assocBindDiagnosticExtExtension’, but such extension is discouraged (see 4.3.3.1.13) and not specified in this Recommended Standard.
AV5 If parameters need to be added to the negative BIND return PDU, the parameter bindRet-6 can be used to do so, but no such extension is defined in this Recommended Standard and extension of the BIND return PDU, although permissible, is discouraged (see 4.3.3.1.13). Except if a procedure derived from the parent Association Control procedure and using this PDU specifies such extension, the value of this parameter shall be set to ‘notUsed’.

All parameters of the BIND return PDU except bindRet-7 are contained the complex parameter of the type StandardReturnHeader that is specified in F4.3. Specific extensions are, however, specified in F4.5.

Table PEER-ABORT Invocation Parameters

<table>
<thead>
<tr>
<th>Item</th>
<th>Parameter</th>
<th>Ref.</th>
<th>Status</th>
<th>Support</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>peerAbortInv-1</td>
<td>diagnostic</td>
<td>F4.5</td>
<td>M</td>
<td></td>
<td>Allowed</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Supported</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>40..126</td>
</tr>
</tbody>
</table>

If an implementation uses the PEER-ABORT diagnostic value 'other reason' (126), the conditions under which this is done shall be specified (see 3.3.2.7.2).

Table UNBIND Invocation Parameters

<table>
<thead>
<tr>
<th>Item</th>
<th>Parameter</th>
<th>Ref.</th>
<th>Status</th>
<th>Support</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>unbindInv-1</td>
<td>invokerCredentials</td>
<td>F4.3</td>
<td>M</td>
<td></td>
<td>Allowed</td>
</tr>
<tr>
<td>unbindInv-2</td>
<td>invokeld</td>
<td>F4.3</td>
<td>M</td>
<td></td>
<td>Supported</td>
</tr>
<tr>
<td>unbindInv-3</td>
<td>procedureInstanceld</td>
<td>F4.3</td>
<td>M</td>
<td></td>
<td>AV6</td>
</tr>
</tbody>
</table>
### Parameters of the UnbindInvocation PDU

<table>
<thead>
<tr>
<th>Item</th>
<th>Parameter</th>
<th>Ref.</th>
<th>Status</th>
<th>Support</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>unbindInv-4</td>
<td>unbindInvocationExtension</td>
<td>F4.5</td>
<td>M</td>
<td></td>
<td>AV7</td>
</tr>
</tbody>
</table>

AV6  For the UNBIND invocation the procedureRole element of the parameter unbindInv-3 must be set to ‘associationControl’.

AV7  If parameters need to be added to the UNBIND invocation PDU, the parameter unbindInv-4 can be used to do so, but no such extension is defined in this Recommended Standard and extension of the UNBIND invocation PDU, although permissible, is discouraged (see 4.3.3.1.13). Except if a procedure derived from the parent Association Control procedure and using this PDU specifies such extension, the value of this parameter shall be set to ‘notUsed’.

The parameters unbindInv-1, unbindInv-2 and unbindInv-3 are contained in the complex parameter standardInvocationHeader in the UnbindInvocation type shown in F4.5. This parameter is of the type StandardInvocationHeader that is specified in F4.3.

### Table: UNBIND Return Parameters

<table>
<thead>
<tr>
<th>Item</th>
<th>Parameter</th>
<th>Ref.</th>
<th>Status</th>
<th>Support</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>unbindRet-1</td>
<td>performerCredentials</td>
<td>F4.3</td>
<td>M</td>
<td></td>
<td></td>
</tr>
<tr>
<td>unbindRet-2</td>
<td>invokeId</td>
<td>F4.3</td>
<td>M</td>
<td></td>
<td></td>
</tr>
<tr>
<td>unbindRet-3</td>
<td>result</td>
<td>F4.3</td>
<td>M</td>
<td></td>
<td>AV8</td>
</tr>
</tbody>
</table>
AV8 The value of the parameter unbindRet-3 of the UNBIND return PDU shall always be set to the value ‘positive’: ‘notUsed’; i.e., the result is always positive and not extended.

All parameters of the UNBIND return PDU are contained the complex parameter of the type StandardReturnHeader that is specified in F4.3.

### Table: EXECUTE-DIRECTIVE Invocation Parameters

<table>
<thead>
<tr>
<th>Item</th>
<th>Parameter</th>
<th>Ref.</th>
<th>Status</th>
<th>Support</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>execDirInv-1</td>
<td>invokerCredentials</td>
<td>F4.3</td>
<td>M</td>
<td></td>
<td></td>
</tr>
<tr>
<td>execDirInv-2</td>
<td>invokeld</td>
<td>F4.3</td>
<td>M</td>
<td></td>
<td></td>
</tr>
<tr>
<td>execDirInv-3</td>
<td>procedureInstanceId</td>
<td>F4.3</td>
<td>M</td>
<td></td>
<td>AV9</td>
</tr>
<tr>
<td>execDirInv-4</td>
<td>directiveIdentifier</td>
<td>F4.4</td>
<td>M</td>
<td></td>
<td>AV10</td>
</tr>
<tr>
<td>execDirInv-5</td>
<td>localProcDirQualifier</td>
<td>F4.4</td>
<td>C12</td>
<td></td>
<td>AV11</td>
</tr>
<tr>
<td>execDirInv-6</td>
<td>targetprocedureInstanceId</td>
<td>F4.4</td>
<td>C13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>execDirInv-7</td>
<td>serviceProcDirQualifierValues</td>
<td>F4.4</td>
<td>C13</td>
<td></td>
<td>AV12</td>
</tr>
<tr>
<td>execDirInv-8</td>
<td>functionalResourceInstanceNumber</td>
<td>F4.4</td>
<td>C14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>execDirInv-9</td>
<td>functionalResourceQualifiers</td>
<td>F4.4</td>
<td>C14</td>
<td></td>
<td>AV13</td>
</tr>
<tr>
<td>execDirInv-10</td>
<td>directiveQualifierExtension</td>
<td>F4.4</td>
<td>C15</td>
<td></td>
<td>AV14</td>
</tr>
<tr>
<td>execDirInv-11</td>
<td>executeDirectiveInvocationExtension</td>
<td>F4.4</td>
<td>M</td>
<td></td>
<td>AV15</td>
</tr>
</tbody>
</table>

C12 IF execDirInv-4 is set to the Published Identifier of a directive that is registered under the procedure type that shall perform the EXECUTE-DIRECTIVE operation THEN M ELSE X

C13 IF execDirInv-4 is set to the Published Identifier of a directive that is registered under a procedure type that is associated with the type of service invoking the EXECUTE-DIRECTIVE operation, but different from the procedure type that shall perform the EXECUTE-DIRECTIVE operation THEN M ELSE X
IF execDirInv-4 is set to the Published Identifier of a directive that is registered under a Functional Resource Type THEN M ELSE X

IF NOT (C12 OR C13 OR C14) THEN M ELSE X

The value of the procedureRole element of the parameter execDirInv-3 is constrained to one of the two values ‘prime procedure’ or ‘secondary procedure’.

The Published Identifier specified in the execDirInv-4 parameter must identify a registered directive.

The parameter execDirInv-5 will be one of the following: (a) ‘directiveQualifier’: ‘localProcDirQualifier’: ‘DirectiveQualifierValues’: ‘sequenceOfParamIdsAndValues’, (b) ‘directiveQualifier’: ‘localProcDirQualifier’: ‘DirectiveQualifierValues’: ‘parameterlessValues’, or (c) ‘directiveQualifier’: ‘localProcDirQualifier’: ‘DirectiveQualifierValues’: ‘noQualifierValues’.

The parameter execDirInv-7 will be one of the following: (a) ‘directiveQualifier’: ‘serviceProcDirQualifier’: ‘serviceProcDirQualifierValues’: ‘DirectiveQualifierValues’: ‘sequenceOfParamIdsAndValues’, (b) ‘directiveQualifier’: ‘serviceProcDirQualifier’: ‘serviceProcDirQualifierValues’: ‘parameterlessValues’, or (c) ‘directiveQualifier’: ‘serviceProcDirQualifier’: ‘serviceProcDirQualifierValues’: ‘noQualifierValues’.


The directive qualifier can be defined by the extension ‘directiveQualifier’: ‘directiveQualifierExtension’, but no such extension is specified in this Recommended Standard. Except if a procedure using this PDU defines such extension, this parameter must be absent.

If parameters need to be added to the EXECUTE-DIRECTIVE invocation PDU, the parameter execDirInv-11 can be used to do so, but no such extension is defined in this Recommended Standard. Except if the procedure using this PDU specifies such extension, the value of this parameter shall be set to ‘notUsed’.

The parameters execDirInv-1, execDirInv-2 and execDirInv-3 are contained in the complex parameter standardInvocationHeader in the ExecuteDirectiveInvocation type shown in F4.4. This parameter is of the type StandardInvocationHeader that is specified in F4.3.
Table: Parameters of the ExecuteDirectiveAcknowledge PDU

<table>
<thead>
<tr>
<th>Item</th>
<th>Parameter</th>
<th>Ref.</th>
<th>Status</th>
<th>Support</th>
<th>Values</th>
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<td>performerCredentials</td>
<td>F4.3</td>
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<tr>
<td>execDirAck-2</td>
<td>invoked</td>
<td>F4.3</td>
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<tr>
<td>execDirAck-3</td>
<td>result</td>
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<td>M</td>
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</tr>
<tr>
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<td>C16</td>
<td>AV16</td>
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<td>AV17</td>
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<tr>
<td>execDirAck-6</td>
<td>negExtension</td>
<td>F4.3</td>
<td>C17</td>
<td>AV18</td>
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</tr>
</tbody>
</table>

C16 IF execDirAck-3 = ‘positive’ THEN M ELSE X
C17 IF execDirAck-3 = ‘negative’ THEN M ELSE X

AV16 If parameters need to be added to the positive EXECUTE-DIRECTIVE acknowledgement PDU, the parameter execDirAck-4 can be used to do so, but no such extension is defined in this Recommended Standard. Except if the procedure using this PDU specifies such extension, the value of this parameter shall be set to ‘notUsed’.

AV17 For the EXECUTE-DIRECTIVE acknowledgement the parameter execDirAck-5 is extended by the type ExecDirNegAckDiagnosticExt defined in F4.4. Therefore the parameter execDirAck-5 may have (a) any value defined for the Diagnostic type in F4.3 except ‘diagnosticExtension’; or (b) any value defined by the extension ‘diagnosticExtension’: ‘execDirAckDiagExt’: ‘ExecDirNegAckDiagnosticExt’ in F4.4 except ‘execDirNegAckDiagnosticExtExtension’. Additional values can be introduced by the further extension ‘diagnosticExtension’: ‘execDirAckDiagExt’: ‘ExecDirNegAckDiagnosticExt’: ‘execDirNegAckDiagnosticExtExtension’, but no such extension is defined in this Recommended Standard.
AV18 If parameters need to be added to the negative EXECUTE-DIRECTIVE acknowledgement PDU, the parameter execDirAck-6 can be used to do so, but no such extension is defined in this Recommended Standard. Except if a procedure using this PDU specifies such extension, the value of this parameter shall be set to ‘notUsed’.

All parameters of the EXECUTE-DIRECTIVE acknowledgement PDU are contained the complex parameter of the type StandardReturnHeader that is specified in F4.3. Specific extensions are, however, specified in F4.4.

Table: Parameters of the ExecuteDirectiveReturn PDU

<table>
<thead>
<tr>
<th>Item</th>
<th>Parameter</th>
<th>Ref.</th>
<th>Status</th>
<th>Support</th>
<th>Values</th>
</tr>
</thead>
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<td>performerCredentials</td>
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<td>M</td>
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<td></td>
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<tr>
<td>execDirRet-2</td>
<td>invokeId</td>
<td>F4.3</td>
<td>M</td>
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<td></td>
</tr>
<tr>
<td>execDirRet-3</td>
<td>result</td>
<td>F4.3</td>
<td>M</td>
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<td></td>
</tr>
<tr>
<td>execDirRet-4</td>
<td>positive</td>
<td>F4.3</td>
<td>C18</td>
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</tr>
<tr>
<td>execDirRet-5</td>
<td>diagnostic</td>
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<td>C19</td>
<td>AV20</td>
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<tr>
<td>execDirRet-6</td>
<td>negExtension</td>
<td>F4.3</td>
<td>C19</td>
<td>AV21</td>
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</tr>
</tbody>
</table>

C18 IF execDirRet-3 = ‘positive’ THEN M ELSE X
C19 IF execDirRet-3 = ‘negative’ THEN M ELSE X

AV19 If parameters need to be added to the positive EXECUTE-DIRECTIVE return PDU, the parameter execDirRet-4 can be used to do so, but no such extension is defined in this Recommended Standard. Except if the procedure using this PDU specifies such extension, the value of this parameter shall be set to ‘notUsed’.

AV20 For the negative EXECUTE-DIRECTIVE return PDU the parameter execDirRet-5 is extended by the type ExecDirNegReturnDiagnosticExt defined in F4.4. Therefore the parameter execDirRet-5 may have (a) any standard value defined for the Diagnostic type in F4.3 except ‘diagnosticExtension’; or (b) any value
defined by the extension ‘diagnosticExtension’: ‘execDirNegReturnDiagnosticExt’: ‘ExecDirNegReturnDiagnosticExt’ defined in F4.4 except ‘execDirNegReturnDiagnosticExtExtension’. Additional values can be introduced by the further extension ‘diagnosticExtension’: ‘execDirNegReturnDiagnosticExt’: ‘ExecDirNegReturnDiagnosticExt’: ‘execDirNegReturnDiagnosticExtExtension’. If the EXECUTE-DIRECTIVE return PDU is used by the Throw Event procedure, i.e., the procedureType element of the parameter execDirInv-3 of the associated EXECUTE-DIRECTIVE invocation has the value ‘throwEvent’, additional values are introduced by the further extension ‘diagnosticExtension’: ‘execDirNegReturnDiagnosticExt’: ‘ExecDirNegReturnDiagnosticExt’: ‘execDirNegReturnDiagnosticExtExtension’: ‘teExecDirDiagExt’: ‘TeExecDirNegReturnDiagnosticExt’, where the type TeExecDirNegReturnDiagnosticExt is specified in F4.14. Therefore the parameter execDirRet-5 may have in this case (a) any standard value defined for the Diagnostic type in F4.3 except ‘diagnosticExtension’; or (b) any value defined by the extension ‘diagnosticExtension’: ‘execDirNegReturnDiagnosticExt’: ‘ExecDirNegReturnDiagnosticExt’ defined in F4.4 except ‘execDirNegReturnDiagnosticExtExtension’; or (c) any value defined by the extension ‘diagnosticExtension’: ‘execDirNegReturnDiagnosticExt’: ‘ExecDirNegReturnDiagnosticExt’: ‘execDirNegReturnDiagnosticExtExtension’: ‘teExecDirDiagExt’: ‘TeExecDirNegReturnDiagnosticExt’ defined in F4.14 except ‘teExecDirNegReturnDiagnosticExtExtension’. Additional values can be introduced by the further extension ‘diagnosticExtension’ ‘execDirNegReturnDiagnosticExt’: ‘execDirNegReturnDiagnosticExtExtension’: ‘teExecDirDiagExt’: ‘TeExecDirNegReturnDiagnosticExtExtension’: ‘teExecDirNegReturnDiagnosticExtExtension’, but no such extension is defined in this Recommended Standard.

AV21 If parameters need to be added to the negative EXECUTE-DIRECTIVE return PDU, the parameter execDirRet-6 can be used to do so, but no such extension is defined in this Recommended Standard. Except if the procedure using this PDU specifies such extension, the value of this parameter shall be set to ‘notUsed’.

All parameters of the EXECUTE-DIRECTIVE return PDU are contained the complex parameter of the type StandardReturnHeader that is specified in F4.3. Specific extensions are, however, specified in F4.4 and F4.14.
### Table: GET Invocation Parameters

<table>
<thead>
<tr>
<th>Item</th>
<th>Parameter</th>
<th>Ref.</th>
<th>Status</th>
<th>Support</th>
<th>Values</th>
<th>Allowed</th>
<th>Supported</th>
</tr>
</thead>
<tbody>
<tr>
<td>getInv-1</td>
<td>invokerCredentials</td>
<td>F4.3</td>
<td>M</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>getInv-2</td>
<td>invokeId</td>
<td>F4.3</td>
<td>M</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>getInv-3</td>
<td>procedureInstanceId</td>
<td>F4.3</td>
<td>M</td>
<td>AV22</td>
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<td></td>
<td></td>
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<tr>
<td>getInv-4</td>
<td>listOfParameters</td>
<td>F4.4</td>
<td>M</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>getInv-5</td>
<td>getInvocationExtension</td>
<td>F4.4</td>
<td>M</td>
<td>AV23</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

AV22  The value of the procedureRole element of the parameter getInv-3 is constrained to one of the two values ‘prime procedure’ or ‘secondary procedure’.

AV23  If parameters need to be added to the GET invocation PDU, the parameter getInv-5 can be used to do so, but no such extension is defined in this Recommended Standard. Except if the procedure using this PDU specifies such extension, the value of this parameter shall be set to ‘notUsed’.

The parameters getInv-1, getInv-2, and getInv-3 are contained in the complex parameter standardInvocationHeader in the GetInvocation type shown in F4.4. This parameter is of the type StandardInvocationHeader that is specified in F4.3.
Table: GET Return Parameters

<table>
<thead>
<tr>
<th>Item</th>
<th>Parameter</th>
<th>Ref.</th>
<th>Status</th>
<th>Support</th>
<th>Allowed</th>
<th>Supported</th>
</tr>
</thead>
<tbody>
<tr>
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<td>performerCredentials</td>
<td>F4.3</td>
<td>M</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>getRet-2</td>
<td>invokeld</td>
<td>F4.3</td>
<td>M</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>getRet-3</td>
<td>result</td>
<td>F4.3</td>
<td>M</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>getRet-4</td>
<td>positive</td>
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<td>C20</td>
<td>AV24</td>
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<tr>
<td>getRet-5</td>
<td>qualifiedParameters</td>
<td>F4.4</td>
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<td>AV25</td>
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<tr>
<td>getRet-6</td>
<td>getPosReturnExtExtension</td>
<td>F4.4</td>
<td>C20</td>
<td>AV26</td>
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<tr>
<td>getRet-7</td>
<td>diagnostic</td>
<td>F4.3</td>
<td>C21</td>
<td>AV27</td>
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<td></td>
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<tr>
<td>getRet-8</td>
<td>negExtension</td>
<td>F4.3</td>
<td>C21</td>
<td>AV28</td>
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<td></td>
</tr>
</tbody>
</table>

C20  IF getRet-3 = ‘positive’ THEN M ELSE X
C21  IF getRet-3 = ‘negative’ THEN M ELSE X

AV24  For the positive GET return the parameter getRet-4 is set to ‘getPosReturnExt’: ‘GetPosReturnExt’ defined in F4.4.

AV25  For the positive GET return the parameter getRet-5 is specified by ‘qualifiedparameters’: ‘QualifiedParametersSequence’. The type QualifiedParametersSequence is defined in F4.4.

AV26  If further parameters need to be added to the positive GET return PDU, the parameter getRet-6 can be used to do so, but no such extension is defined in this Recommended Standard. Except if the procedure using this PDU specifies such extension, the value of this parameter shall be set to ‘notUsed’.
AV27 For the negative GET return the parameter getRet-7 is extended by the type GetDiagnosticExt defined in F4.4. Therefore the parameter getRet-7 may have (a) any standard value defined for the Diagnostic type in F4.3 except ‘diagnosticExtension’; or (b) any value defined by the extension ‘diagnosticExtension’: ‘getDiagnosticExt’: ‘GetDiagnosticExt’ defined in F4.4 except ‘getDiagnosticExtExtension’. Additional values can be introduced by the further extension ‘diagnosticExtension’: ‘getDiagnosticExt’: ‘GetDiagnosticExt’: ‘getDiagnosticExtExtension’.

AV28 If parameters need to be added to the negative GET return PDU, the parameter getRet-8 can be used to do so, but no such extension is defined in this Recommended Standard. Except if the procedure using this PDU specifies such extension, the value of this parameter shall be set to ‘notUsed’.

All parameters of the GET return PDU are contained the complex parameter of the type StandardReturnHeader that is specified in F4.3. Specific extensions are, however, specified in F4.4.

### Table Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 8, Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll.-17: PROCESS-DATA Invocation Parameters

<table>
<thead>
<tr>
<th>Item</th>
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<th>Ref.</th>
<th>Status</th>
<th>Support</th>
<th>Values</th>
</tr>
</thead>
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<td>M</td>
<td></td>
<td></td>
</tr>
<tr>
<td>procDataInv-2</td>
<td>invokeId</td>
<td>F4.3</td>
<td>M</td>
<td></td>
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</tr>
<tr>
<td>procDataInv-3</td>
<td>procedureInstanceId</td>
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<td>M</td>
<td>AV29</td>
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<tr>
<td>procDataInv-4</td>
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</tr>
<tr>
<td>procDataInv-5</td>
<td>data</td>
<td>F4.4</td>
<td>M</td>
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</tr>
<tr>
<td>procDataInv-6</td>
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<td>procDataInv-7</td>
<td>processCompletionReport</td>
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<td>C22</td>
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<tr>
<td>procDataInv-8</td>
<td>dataProcProcDataInvocExtExtension</td>
<td>F4.8</td>
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<td>AV31</td>
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<tr>
<td>procDataInv-9</td>
<td>earliestDataProcessingTime</td>
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Parameters of the ProcessDataInvocation PDU

<table>
<thead>
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<th>Item</th>
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</thead>
<tbody>
<tr>
<td>procDataInv-10</td>
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<tr>
<td>procDataInv-11</td>
<td>sequContrDataProcProcDataInvocationExtension</td>
<td>F4.10</td>
<td>C23</td>
<td></td>
<td></td>
<td>AV32</td>
</tr>
</tbody>
</table>

C22 IF procDataInv-6 = (‘dpProcDataInvocationExt’: ‘DataProcProcDataInvocationExt’) THEN M ELSE X

C23 IF procDataInv-8 = (‘scdpProcDataInvocationExt’: ‘SequContrDataProcProcDataInvocationExt’) THEN M ELSE X

AV29 The value of the procedureRole element of the parameter procDataInv-3 is constrained to one of the two values ‘prime procedure’ or ‘secondary procedure’.

AV30 If the procedureType element of the parameter procDataInv-3 has the value ‘dataProcessing’ or ‘bufferedDataProcessing’ or ‘sequenceControlledDataProcessing’ or if the procedure using this PDU is derived from one of these three procedure types, then the parameter procDataInv-6 shall be set to the value ‘dpProcDataInvocationExt’: ‘DataProcProcDataInvocationExt’. Otherwise, no such extension is specified in this Recommended Standard and the value of procDataInv-6 shall be set to ‘notUsed’ except if the procedure using this PDU is mentioned above. In case of other procedure types, this parameter shall be set to ‘notUsed’ except if the procedure using this PDU specifies such extension.

AV31 If further parameters need to be added to the PROCESS-DATA invocation PDU, the parameter procDataInv-8 can be used to do so. Such extension is defined for the Sequence-Controlled Data Processing procedure. Except if such extension is defined by the procedure derived from the Data Processing procedure or the Buffered Data Processing procedure and using this PDU, the value of this parameter shall be set to ‘notUsed’. If the PDU is used by the Sequence-Controlled Data Processing procedure, i.e., the procedureType element of the parameter procDataInv-3 has the value ‘sequenceControlledDataProcessing’, then the parameter procDataInv-8 shall be set to ‘scdpProcDataInvocationExt’: ‘SequContrDataProcProcDataInvocationExt’.
AV32 If parameters need to be added to the PROCESS-DATA invocation PDU used by the Sequence-Controlled Data Processing procedure, i.e., the procedureType element of the parameter procDataInv-3 has the value ‘sequenceControlledDataProcessing’, the parameter procDataInv-11 can be used to do so, but no such extension is defined in this Recommended Standard. Except if the procedure derived from the parent Sequence-Controlled Data Processing procedure and using this PDU specifies such extension, this parameter shall be set to ‘notUsed’.

The parameters procDataInv-1, procDataInv-2 and procDataInv-3 are contained in the complex parameter standardInvocationHeader in the ProcessDataInvoke type shown in F4.4. This parameter is of the type StandardInvocationHeader that is specified in F4.3.

Table Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 8,Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll.-18: PROCESS-DATA Return Parameters

<table>
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<tr>
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</tr>
<tr>
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<td>result</td>
<td>F4.3</td>
<td>M</td>
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</tr>
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<td>C24</td>
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</tr>
<tr>
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<td>F4.10</td>
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<td>C25</td>
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</tr>
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<td>AV36</td>
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<td>sequContrDataProcDataNegReturnExtExtension</td>
<td>F4.10</td>
<td></td>
<td>C27</td>
<td>AV37</td>
</tr>
</tbody>
</table>

C24 IF procDataRet-3 = ‘positive’ THEN M ELSE X
C25 IF procDataRet-3 = ‘positive’ AND procDataRet-4 = ‘scdpProcDataPosReturnExt’:
  ‘SequContrDataProcProcDataPosReturnExt’ THEN M ELSE X
C26 IF procDataRet-3 = ‘negative’ THEN M ELSE X
C27 IF procDataRet-3 = ‘negative’ AND procDataRet-8 = ‘scdpProcDataNegReturnExt’:
  ‘SequContrDataProcProcDataNegReturnExt’ THEN M ELSE X

AV33 If parameters need to be added to the positive PROCESS-DATA return PDU, the parameter procDataRet-4 can be used to do so. Such extension is defined for the Sequence-Controlled Data Processing procedure. If this PDU is used by the Sequence-Controlled Data Processing procedure, i.e., the procedureType element of parameter procDataInv-3 in the associated invocation has the value ‘sequenceControlledDataProcessing’, then the parameter procDataRet-4 shall be set to ‘scdpProcDataPosReturnExt’: ‘SequContrDataProcProcDataPosReturnExt’. If the procedure using this PDU does not specify such extension, the value of the parameter procDataRet-4 shall be set to ‘notUsed’.

AV34 If further parameters need to be added to the positive PROCESS-DATA return PDU, the parameter procDataRet-6 can be used to do so, but this Recommended Standard does not specify such extension. Except if a procedure derived from the parent Sequence-Controlled Data Processing procedure and using this PDU specifies such extension, the value of this parameter shall be set to ‘notUsed’.

AV35 For the PROCESS-DATA return the parameter procDataRet-7 is extended by the type ‘SequContrDataProcProcDataDiagnosticExt’ defined in F4.10. Therefore the parameter procDataRet-7 may have (a) any standard value defined for the Diagnostic type in F4.3 except ‘diagnosticExtension’; or (b) any value defined by the extension ‘diagnosticExtension’: ‘scdpProcDataDiagExt’: ‘SequContrDataProcProcDataDiagnosticExt’ defined in F4.10 except ‘sequContrDataProcProcDataDiagnosticExtExtension’. Additional values can be introduced by the further extension ‘diagnosticExtension’: ‘scdpProcDataDiagExt’:
  ‘SequContrDataProcProcDataDiagnosticExt’:
  ‘sequContrDataProcProcDataDiagnosticExtExtension’, but no such extension is specified in this Recommended Standard.

AV36 If parameters need to be added to the negative PROCESS-DATA return PDU, the parameter procDataRet-8 can be used to do so. Such extension is defined for the Sequence-Controlled Data Processing procedure. If this PDU is used by the Sequence-Controlled Data Processing procedure, i.e., the procedureType element of the parameter procDataInv-3 in the associated invocation has the value ‘sequenceControlledDataProcessing’, then the parameter procDataRet-8 shall be set to ‘scdpProcDataNegReturnExt’: ‘SequContrDataProcProcDataNegReturnExt’. The type ‘SequContrDataProcProcDataNegReturnExt’ is defined in F4.10. Except if such extension is defined by a procedure using this PDU, the value of this parameter shall be set to ‘notUsed’.
AV37 If further parameters need to be added to the negative PROCESS-DATA return PDU, the parameter procDataRet-10 can be used to do so, but this Recommended Standard does not specify such extension. Except if a procedure derived from the parent Sequence-Controlled Data Processing procedure and using this PDU specifies such extension, the value of this parameter shall be set to ‘notUsed’.

This PDU is valid only in case the PROCESS-DATA operation is used by the Sequence-Controlled Data Processing procedure, i.e., the procedureType element of the parameter procDataInv-3 of the associated PROCESS-DATA invocation has the value ‘sequenceControlledDataProcessing’. The Data Processing procedure and the Buffered Data Processing procedure use the unconfirmed variant of the PROCESS-DATA operation.

All parameters of the PROCESS-DATA return PDU are contained the complex parameter of the type StandardReturnHeader that is specified in F4.3. Specific extensions are, however, specified in F4.10.

**Table** Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 8,Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll.-19: **START Invocation Parameters**

<table>
<thead>
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<th>Ref.</th>
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<th>Support</th>
<th>Values</th>
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<tr>
<td>startInv-1</td>
<td>invokerCredentials</td>
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<td>M</td>
<td>AV39</td>
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<td>startInv-5</td>
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<td>C28</td>
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<td>startInv-8</td>
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<td>startInv-9</td>
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<td>startInv-10</td>
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<td>startInv-11</td>
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<td>C30</td>
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Parameters of the StartInvocation PDU

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<td>startInv-12</td>
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<tr>
<td>startInv-14</td>
<td>notificationStartInvocExtExtension</td>
<td>F4.13</td>
<td>C31</td>
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<td>AV43</td>
</tr>
</tbody>
</table>

C28 IF startInv-4 = ‘bddStartInvocExt’: ‘BuffDataDelStartInvocExt’ THEN M ELSE X
C29 IF startInv-4 = ‘scdpStartInvocExt’: ‘SequContrDataProcStartInvocExt’ THEN M ELSE X
C30 IF startInv-4 = ‘crStartInvocExt’: ‘CyclicReportStartInvocExt’ THEN M ELSE X
C31 IF startInv-4 = ‘nStartInvocExt’: ‘NotificationStartInvocExt’ THEN M ELSE X

AV38 The value of the procedureRole element of the parameter startInv-3 is constrained to one of the two values ‘prime procedure’ or ‘secondary procedure’.

AV39 If the procedureType element of the parameter startInv-3 has the value ‘bufferedDataDelivery’, then the parameter startInv-4 shall be set to the value ‘bddStartInvocExt’: ‘BuffDataDelStartInvocExt’.

If the procedureType element of the parameter startInv-3 has the value ‘sequenceControlledDataProcessing’, then the parameter startInv-4 shall be set to the value ‘scdpStartInvocExt’: ‘SequContrDataProcStartInvocExt’.

If the procedureType element of the parameter startInv-3 has the value ‘cyclicReport’, then the parameter startInv-4 shall be set to the value ‘crStartInvocExt’: ‘CyclicReportStartInvocExt’.

If the procedureType element of the parameter startInv-3 has the value ‘notification’, then the parameter startInv-4 shall be set to the value ‘nStartInvocExt’: ‘NotificationStartInvocExt’.

Also in all other cases where parameters need to be added to the START invocation PDU, the parameter startInv-4 can be used to do so, but no such extension is defined in this Recommended Standard. Therefore this parameter shall be set to the value ‘notUsed’ except if the procedure using this PDU specifies such extension.
AV40 If parameters need to be added to the START invocation PDU used by a procedure derived from the parent Buffered Data Delivery procedure, the parameter startInv-7 can be used to do so, but no such extension is defined in this Recommended Standard. Except if a procedure derived from the parent Buffered Data Delivery procedure specifies such extension, this parameter shall be set to ‘notUsed’.

AV41 If parameters need to be added to the START invocation PDU used by a procedure derived from the parent Sequence-Controlled Data Processing procedure, the parameter startInv-9 can be used to do so, but no such extension is defined in this Recommended Standard. Except if a procedure derived from the parent Sequence-Controlled Data Processing procedure specifies such extension, this parameter shall be set to ‘notUsed’.

AV42 If parameters need to be added to the START invocation PDU used by a procedure derived from the parent Cyclic Report procedure, the parameter startInv-12 can be used to do so, but no such extension is defined in this Recommended Standard. Except if a procedure derived from the parent Cyclic Report procedure specifies such extension, this parameter shall be set to ‘notUsed’.

AV43 If parameters need to be added to the START invocation PDU used by a procedure derived from the parent Notification procedure, the parameter startInv-14 can be used to do so, but no such extension is defined in this Recommended Standard. Except if the procedure derived from the parent Notification procedure specifies such extension, this parameter shall be set to ‘notUsed’.

The parameters startInv-1, startInv-2 and startInv-3 are contained in the complex parameter standardInvocationHeader in the StartInvocation type shown in F4.4. This parameter is of the type StandardInvocationHeader that is specified in F4.3.

---

Table: If parameters need to be added to the START invocation PDU used by a procedure derived from one of the parent procedures, the parameter startInv-... can be used to do so, but no such extension is defined in this Recommended Standard. Except if a procedure derived from the parent procedure specifies such extension, this parameter shall be set to ‘notUsed’.

<table>
<thead>
<tr>
<th>Item</th>
<th>Parameter</th>
<th>Ref.</th>
<th>Status</th>
<th>Support</th>
<th>Allowed</th>
<th>Supported</th>
</tr>
</thead>
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<tr>
<td>startRet-1</td>
<td>performerCredentials</td>
<td>F4.3</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>startRet-2</td>
<td>invokeId</td>
<td>F4.3</td>
<td>M</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>startRet-3</td>
<td>result</td>
<td>F4.3</td>
<td>M</td>
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<tr>
<td>startRet-4</td>
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<td>F4.3</td>
<td>C32</td>
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### Parameters of the StartReturn PDU

<table>
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<tr>
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<td>diagnostic</td>
<td>F4.3</td>
<td>C33</td>
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<td>AV45</td>
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<tr>
<td>startRet-6</td>
<td>negExtension</td>
<td>F4.3</td>
<td>C33</td>
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<td>AV46</td>
</tr>
</tbody>
</table>

C32  IF startRet-3 = ‘positive’ THEN M ELSE X
C33  IF startRet-3 = ‘negative’ THEN M ELSE X

AV44  If parameters need to be added to the positive START return PDU, the parameter startRet-4 can be used to do so, but no such extension is defined in this Recommended Standard. Except if the procedure using this PDU specifies such extension, the value of this parameter shall be set to ‘notUsed’.

AV45  For the START return PDU the parameter startRet-5 is extended by the type StartDiagnosticExt defined in F4.4. Therefore the parameter startRet-5 may have (a) any standard value defined for the Diagnostic type in F4.3 except ‘diagnosticExtension’; or (b) any value defined by the extension ‘diagnosticExtension’: ‘startDiagnosticExt’: ‘StartDiagnosticExt’ in F4.4 except ‘startDiagnosticExtExtension’.

If the procedureType element of the parameter startInv-3 of the associated START invocation has the value ‘bufferedDataDelivery’, then parameter startRet-5 is further extended by the type BuffDataDelStartDiagnosticExt defined in F4.7. Therefore the parameter startRet-5 may have in this case (a) any standard value defined for the Diagnostic type in F4.3 except ‘diagnosticExtension’; or (b) any value defined by the extension ‘diagnosticExtension’: ‘startDiagnosticExt’: ‘StartDiagnosticExt’ in F4.4 except ‘startDiagnosticExtExtension’; or (c) any value defined by the extension ‘diagnosticExtension’: ‘startDiagnosticExt’: ‘startDiagnosticExtExtension’: ‘bddStartDiagExt’: ‘BuffDataDelStartDiagnosticExt’ except ‘buffDataDelStartDiagnosticExtExtension’.

Additional values can be introduced by the further extension ‘diagnosticExtension’: ‘startDiagnosticExt’: ‘StartDiagnosticExt’: ‘startDiagnosticExtExtension’: ‘bddStartDiagExt’: ‘BuffDataDelStartDiagnosticExt’; ‘buffDataDelStartDiagnosticExtExtension’, but no such extension is specified in this Recommended Standard.

If the procedureType element of the parameter startInv-3 of the associated START invocation has the value ‘cyclicReport’, then parameter startRet-5 is extended by the
type CyclicReportStartDiagnosticExt defined in F4.12. Therefore the parameter startRet-5 may have in this case (a) any standard value defined for the Diagnostic type in F4.3 except ‘diagnosticExtension’; or (b) any value defined by the extension ‘startDiagnosticExt’ ‘startDiagnosticExt’ in F4.4 except ‘startDiagnosticExtExtension’; or (c) any value defined by the extension ‘diagnosticExtension’ ‘startDiagnosticExt’ ‘startDiagnosticExtExtension’ crStartDiagExt: ‘CyclicReportStartDiagnosticExt’ defined in F4.12 except ‘cyclicReportStartDiagnosticExtExtension’. Additional values can be introduced by the further extension ‘diagnosticExtension’ ‘startDiagnosticExt’ ‘startDiagnosticExtExtension’ ‘nStartDiagExt’ ‘CyclicReportStartDiagnosticExt’ ‘cyclicReportStartDiagnosticExtExtension’, but no such extension is specified in this Recommended Standard.

If the procedureType element of the parameter startInv-3 of the associated START invocation has the value ‘notification’, then parameter startRet-5 is extended by the type NotificationStartDiagnosticExt defined in F4.13. Therefore the parameter startRet-5 may have in this case (a) any standard value defined for the Diagnostic type in F4.3 except ‘diagnosticExtension’; or (b) any value defined by the extension ‘diagnosticExtension’ ‘startDiagnosticExt’ ‘startDiagnosticExtExtension’ ‘startDiagnosticExtExtension’ ‘nStartDiagExt’ ‘NotificationStartDiagnosticExt’ defined in F4.13 except ‘notificationStartDiagnosticExtExtension’. Additional values can be introduced by the further extension ‘diagnosticExtension’ ‘startDiagnosticExt’ ‘startDiagnosticExtExtension’ ‘nStartDiagExt’ ‘NotificationStartDiagnosticExt’ ‘notificationStartDiagnosticExtExtension’, but no such extension is specified in this Recommended Standard.

AV46 If parameters need to be added to the negative START return PDU, the parameter startRet-6 can be used to do so, but no such extension is defined in this Recommended Standard. Except if the procedure using this PDU specifies such extension, the value of this parameter shall be set to ‘notUsed’.

The parameters startRet-1, startRet-2 and startRet-3 of the START return PDU are contained the complex parameter of the type StandardReturnHeader that is specified in F4.3. Specific extensions are, however, specified in F4.4, F4.7, F4.12 and F4.13.
### Parameters of the StopInvocation PDU

<table>
<thead>
<tr>
<th>Item</th>
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<th>Values</th>
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<td>stopInvocationExtension</td>
<td>F4.4</td>
<td>M</td>
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<td>AV48</td>
</tr>
</tbody>
</table>

**AV47** The value of the procedureRole element of the parameter stopInv-3 is constrained to one of the two values ‘prime procedure’ or ‘secondary procedure’.

**AV48** If parameters need to be added to the STOP invocation PDU, the parameter stopInv-4 can be used to do so, but no such extension is defined in this Recommended Standard. Except if the procedure using this PDU specifies such extension, the value of this parameter shall be set to ‘notUsed’.

The parameters stopInv-1, stopInv-2 and stopInv-3 are contained in the complex parameter standardInvocationHeader in the StopInvocation type shown in F4.4. This parameter is of the type StandardInvocationHeader that is specified in F4.3.

### Parameters of the StopReturn PDU

<table>
<thead>
<tr>
<th>Item</th>
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<th>Ref.</th>
<th>Status</th>
<th>Support</th>
<th>Values</th>
</tr>
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<tr>
<td>stopRet-2</td>
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</table>
### Parameters of the StopReturn PDU

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<th>Values</th>
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<tr>
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<tr>
<td>stopRet-4</td>
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<td>F4.3</td>
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<tr>
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<td>stopRet-6</td>
<td>negExtension</td>
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<td>C35</td>
<td>AV51</td>
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</tbody>
</table>

C34 IF stopRet-3 = ‘positive’ THEN M ELSE X
C35 IF startRet-3 = ‘negative’ THEN M ELSE X

AV49 If parameters need to be added to the positive STOP return PDU, the parameter stopRet-4 can be used to do so, but no such extension is defined in this Recommended Standard. Except if the procedure using this PDU specifies such extension, the value of this parameter shall be set to ‘notUsed’.

AV50 The parameter stopRet-5 may have any standard value defined for the Diagnostic type in F4.3 except ‘diagnosticExtension’. Additional values can be introduced by the extension ‘diagnosticExtension’, but no such extension is specified in this Recommended Standard.

AV51 If parameters need to be added to the negative STOP return PDU, the parameter stopRet-6 can be used to do so, but no such extension is defined in this Recommended Standard. Except if the procedure using this PDU specifies such extension, the value of this parameter shall be set to ‘notUsed’.

All parameters of the STOP return PDU are contained the complex parameter of the type StandardReturnHeader that is specified in F4.3.
Table Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 8, Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll. - 23: NOTIFY Invocation Parameters

<table>
<thead>
<tr>
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<td></td>
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<tr>
<td>notifyInv-2</td>
<td>invokedId</td>
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<td>M</td>
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<td>notifyInv-4</td>
<td>eventTime</td>
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<td>eventValue</td>
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<td>notifyInv-7</td>
<td>notifyInvocationExtension</td>
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<td>notifyInv-8</td>
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<tr>
<td>notifyInv-9</td>
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<td>AV55</td>
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<td>notifyInv-11</td>
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<td>AV56</td>
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<tr>
<td>notifyInv-14</td>
<td>dataProcNotifyInvocExtExtension</td>
<td>F4.8</td>
<td>C36</td>
<td>AV57</td>
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</tr>
</tbody>
</table>

C36 IF notifyInv-7 = ‘dpNotifyInvocExt’: ‘DataProcNotifyInvocExt’ THEN M ELSE X

C37 IF (notifyInv-7 = ‘dpNotifyInvocExt’: ‘DataProcNotifyInvocExt’) AND (notifyInv-8 is NOT ‘noDataProcessed’) THEN M ELSE X

C38 IF (notifyInv-7 = ‘dpNotifyInvocExt’: ‘DataProcNotifyInvocExt’) AND (notifyInv-11 is NOT ‘noSuccessfulProcessing’) THEN M ELSE X

AV52 The value of the procedureRole element of the notifyInv-3 parameter is constrained to one of the two values ‘prime procedure’ or ‘secondary procedure’.

AV53 The value of the notifyInv-6 parameter can be any value that can be expressed using the type SequenceOfQualifiedValue defined in F4.3 or ‘empty’ or any value that can be defined by means of the extension ‘eventValueExtension’ (see EventValue defined in F4.3), but no such extension is specified in this Recommended Standard. Except if a procedure using this PDU specifies such
extension, the value of 'eventValue’ must not be set to ‘eventValueExtension’.

AV54 If the procedureType element of the parameter notifyInv-3 has the value ‘dataProcessing’, ‘bufferedDataProcessing’ or ‘sequenceControlledDataProcessing’ or a value associated with a procedure derived from the Data Processing procedure, the Buffered Data Processing procedure, or the Sequence-Controlled Data Processing procedure, then the parameter notifyInv-7 shall be set to the value ‘dpNotifyInvocExt’: ‘DataProcNotifyInvocExt’.

Also in all other cases, if parameters need to be added to the NOTIFY invocation PDU, the parameter notifyInv-7 can be used to do so, but no such extension is defined in this Recommended Standard. Except if the procedure using this PDU specifies such extension, this parameter shall be set to ‘notUsed’.

AV55 If the procedureType element of the parameter notifyInv-3 has the value ‘sequenceControlledFrameDataProcessing’, the parameter notifyInv-9 can take on (a) any value specified for the dataProcessingStatus element of the DataProcNotifyInvocExt type defined in F4.8 except ‘dataProcessingStatusExtension’, or (b) any value specified by the SequContrDataProcStatus type defined in F4.8 except ‘sequContrDataProcStatusExtension’.

If the procedureType element of the parameter notifyInv-3 has the value ‘bufferedFrameDataProcessing’, the parameter notifyInv-9 can take on any value specified for the dataProcessingStatus element of the DataProcNotifyInvocExt type defined in F4.8 except ‘dataProcessingStatusExtension’.

AV56 If the parameter notifyInv-5 has the value ‘productionStatusChange’, the parameter notifyInv-13 shall be set to ‘productionStatusChange’: ‘NULL’; i.e., it is absent. For all other values of the parameter notifyInv-5, it shall be set to ‘anyOtherEvent’: ‘ProductionStatus’.

AV57 If parameters need to be added to the NOTIFY invocation PDU used by a procedure derived from the Data Processing procedure, the Buffered Data Processing procedure, or the Sequence-Controlled Data Processing procedure, then the parameter notifyInv-14 can be used to do so, but no such extension is defined in this Recommended Standard. Except if the procedure using this PDU specifies such extension, the value of this parameter shall be set to ‘notUsed’.

The parameters notifyInv-1, notifyInv-2 and notifyInv-3 are contained in the complex parameter standardInvocationHeader in the NotifyInvocation type shown in F4.4. This parameter is of the type StandardInvocationHeader that is specified in F4.3.
Table Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 8, Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll.-24: TRANSFER-DATA Invocation Parameters

<table>
<thead>
<tr>
<th>Item</th>
<th>Parameter</th>
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<th>Status</th>
<th>Support</th>
<th>Values</th>
</tr>
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<tbody>
<tr>
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<td>invokerCredentials</td>
<td>F4.3</td>
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<td></td>
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<tr>
<td>transferDataInv-2</td>
<td>invokeId</td>
<td>F4.3</td>
<td>M</td>
<td></td>
<td></td>
</tr>
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<td>procedureInstanceId</td>
<td>F4.3</td>
<td>M</td>
<td>AV58</td>
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<td>C39</td>
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<tr>
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<td>cyclicReportTransferDataInvocationExtension</td>
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<td>C39</td>
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</tr>
</tbody>
</table>

C39 IF transferDataInv-6 = ‘extendedData’: `crTransferDataInvocationDataRef`: ‘CyclicReportTransferDataInvocationDataRef’ THEN M ELSE X

AV58 The value of the procedureRole element of the parameter transferDataInv-3 is constrained to one of the two values ‘prime procedure’ or ‘secondary procedure’.

AV59 If the procedureType element of the parameter transferDataInv-3 is ‘cyclicReport’, then the parameter transferDataInv-6 shall be set to the value ‘extendedData’: ‘crTransferDataInvocationDataRef’: ‘CyclicReportTransferDataInvocationDataRef’. The type CyclicReportTransferDataInvocationDataRef is defined in F4.12.

Also in all other cases where a type different from OCTET STRING is needed for the data to be transferred by means of the TRANSFER-DATA invocation PDU, the parameter transferDataInv-6 can be used to specify such type by means of the extension ‘extendedData’, but except for the Cyclic Report procedure no such extension is defined in this Recommended Standard. Except if the procedure using this PDU specifies such extension, this parameter shall be set to ‘opaqueString’: ‘OCTET STRING’. 
AV60 If parameters need to be added to the TRANSFER-DATA invocation PDU used by a procedure derived from the parent Cyclic Report procedure, then the parameter transferDataInv-8 can be used to do so, but no such extension is defined in this Recommended Standard. Except if a procedure derived from the parent Cyclic Report procedure and using this PDU specifies such extension, the value of this parameter shall be set to ‘notUsed’.

AV61 If parameters need to be added to the TRANSFER-DATA invocation PDU, the parameter transferDataInv-9 can be used to do so, but no such extension is defined in this Recommended Standard. Except if the procedure using this PDU specifies such extension, the value of this parameter shall be set to ‘notUsed’.

The parameters transferDataInv-1, transferDataInv-2 and transferDataInv-3 are contained in the complex parameter standardInvocationHeader in the TransferDataInvocation type shown in F4.4. This parameter is of the type StandardInvocationHeader that is specified in F4.3.
ANNEX B

PRODUCTION STATUS

(NORMATIVE)

B1 OVERVIEW

This annex defines the states and transitions of the production status and presents in tabular form the effect of the production status on the processing of data and operations. The transitions that may occur are illustrated in figure Figure Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 8,Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll.-1.

Figure Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 8,Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll.-1: Production Status Diagram

B2 PRODUCTION STATUS SPECIFICATIONS

B2.1 The production status values shall be set in accordance with the high-level semantic definition listed in table Figure Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 8,Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll.-1.
B2.2 The integer values used to indicate the production-status values shall be those specified by the type ProductionStatus in F4.3.

B2.3 The Published Identifier for the production status parameter for a CSTS svcProductionStatus as specified in F4.17.

B2.4 The parameter reporting the value of the production status shall be named using the Functional Resource Instance representing the CSTS instance reporting the production status.

B2.5 A CSTS instance shall change the production status value in accordance with the conditions specified in table Production Status Semantic. Such change of the production status shall constitute the procedure state table incoming events ‘production status change’, and, depending on the actual transition, ‘production status change to ‘operational’’, ‘production status change to ‘interrupted’’, ‘production status change to ‘halted’’, and ‘production status change to ‘configured’’, respectively.

Table Production Status Semantic

<table>
<thead>
<tr>
<th>Production Status Value</th>
<th>Semantic Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘configured’</td>
<td>The configuration of the service production process has been completed.</td>
</tr>
<tr>
<td>‘operational’</td>
<td>The service production process is ready to process data.</td>
</tr>
<tr>
<td>‘interrupted’</td>
<td>The service production process has stopped because of an error condition that may be temporary.</td>
</tr>
<tr>
<td>‘halted’</td>
<td>The service production process has been stopped by management action.</td>
</tr>
</tbody>
</table>

B2.6 The event reporting the change of the production status shall be named using the Functional Resource Instance representing the CSTS instance reporting the event (see 3.11.2.2.3).

NOTES

1. The production status is always a property of the CSTS itself and not of the associated production process. The CSTS may specify how the aggregate production status shall be derived for instance from the resource status and resource configuration change event reported by the Functional Resources representing the production process.

2. The production status always refers to the current status of the CSTS. Therefore, in case a CSTS is used to retrieve data that have been collected using a production process that completed before the CSTS was instantiated, any issues related to the
production process that collected the data now being retrieved by the CSTS are not visible from the CSTS production status. However, the CSTS may specify means different from the production status for reporting events that affected the data collection.

Table 2: Production Status Transitions

<table>
<thead>
<tr>
<th>Start Status</th>
<th>End Status</th>
<th>Cause of Status Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>'configured'</td>
<td>'operational'</td>
<td>Management action to make the production status 'operational'; this typically includes ensuring the availability of the service provider services.</td>
</tr>
<tr>
<td>'operational'</td>
<td>'interrupted'</td>
<td>Occurrence of a production fault detected by the service provider.</td>
</tr>
<tr>
<td>'interrupted'</td>
<td>'operational'</td>
<td>Maintenance action typically is required to correct the production fault (e.g., re-configuration to use a backup service production). The production status changes to 'operational' when the service provider detects that the fault is corrected.</td>
</tr>
<tr>
<td>[any]</td>
<td>'halted'</td>
<td>Direct management action is required such as an operator directive causing the service provider to halt production.</td>
</tr>
<tr>
<td>'halted'</td>
<td>'configured'</td>
<td>Direct management action is required such as an operator directive restoring the required configuration and declaring the production status to be 'configured'.</td>
</tr>
</tbody>
</table>

B2.7 The transition to the production status ‘operational’ shall only be notified by a CSTS instance, if a different production status value has been notified before and the transition to production status ‘operational’ has not yet been notified since the most recent successful BIND operation.

B2.8 The transition to the production status ‘interrupted’ shall only be notified by a CSTS instance if it is presently affected by the possibly transient production fault.

NOTE – When the production status is ‘halted’ the BIND operation shall be rejected (see 3.4.2.3.1). The effects of the production status parameter value on the operations other than the BIND are addressed by the procedures using the operation whenever needed.
ANNEX C

QUALIFIED PARAMETERS

(NORMATIVE)

C1 OVERVIEW

This annex defines the requirements applicable to named parameters used by the GET operation (see 3.12), the Information Query procedure (see 4.9), and the Cyclic Report procedure (see 4.10).

C2 REQUIREMENTS

C2.1 The qualified-parameters parameter shall contain for each parameter identified in the list-of-parameters the following information:

a) the Parameter Name defined with its Functional Resource Name (see 1.6.1.7.23) and its Parameter Identifier (see 1.6.1.7.31);

b) the parameter type (see C2.3);

c) the parameter value(s): a parameter may be expressed as a single or as multiple values;

d) the parameter qualifier reporting the validity of the parameter value (see C2.5).

C2.2 The Functional Resource Name (see 1.6.1.7.23) shall be defined by its Functional Resource Type (see 1.6.1.7.24) and its Functional Resource Instance Number (see 1.6.1.7.22).

C2.3 The supported parameter types shall be:

a) integer;

b) unsigned integer;

c) positive integer;

d) duration;

e) character string;

f) Boolean;

g) octet string;

h) real;
i) time;
j) enumerated;
k) Published Identifier;
l) Object Identifier.

C2.4 All procedures shall have the possibility to extend the types with additional type definitions.

C2.5 The qualifier of a value shall be one of the following:

   a) ‘valid’—the value is valid;
   b) ‘unavailable’—the service provider cannot provide the value;
   c) ‘undefined’—in the current service provider context, the value is undefined;
   d) ‘error’—the processing of the service provider resulted in an error.

C2.6 If the value qualifier of a given parameter is ‘unavailable’, ‘undefined’, or ‘error’, type and value of that parameter shall not be returned.
ANNEX D

OBJECT IDENTIFIERS DEFINITION

(NORMATIVE)

D1 OVERVIEW

This annex defines

a) the Object Identifier tree structure that is used (a) by the procedures defined in this
   Recommended Standard and (b) for registering Functional Resource Types and their
   associated parameters, events, and directives;

   NOTE – It is not intended to constrain how the data types of, e.g., parameters, are
   implemented or encoded. These definitions are suitable for inclusion in any type of ASN.1
   based protocol that implements Cross Support Services.

b) the procedures to be applied for the management of the Object Identifiers defined in
   this annex and for the creation of new Object Identifiers that need to be defined when
   new services are specified;

c) the top-level Object Identifiers themselves.

   NOTE – The complete set of Object Identifiers defined by this Recommended
   Standard is specified in F4.1, F4.16 and F4.17. An informative description
   of the registries relevant to this Recommended Standard and their
   management is provided in H2. An informative presentation of the overall
   OID tree structure is provided in annex K.

D2 OBJECT IDENTIFIERS REGISTRATION

D2.1 This document requests the creation of or uses registries that will be managed by the
   Space Assigned Numbers Authority (SANA) applying the registration rules outlined in H2.
   New assignments in these registries will be shown at the SANA registry Web site: http://sanaregistry.org. Therefore, the reader shall look at the SANA Web site for all the
   assignments contained in these registries.

D2.2 Already registered Object Identifiers shall be affected neither by any extension of
   registries as requested by this Recommended Standard nor by the definition of new CSTSes.

D2.3 Requests to add assignments to the subtrees of the OID Registry that are owned by
   the CSS Area beyond those initiated by the CSS Area shall be submitted to SANA and come
   from a Member Agency, or an Observer Agency, or a CCSDS Associate, or an industry
partner supported by a Member Agency. The request shall be related to a cross support activity. After evaluation of the request and approval by the CSS Area Director (AD) or CSS Area Deputy Area Directory (DAD) or a person duly authorized by the AD or DAD, a new Object Identifier will be allocated and added to the relevant subtree owned by the CSS Area and added in this way to the existing OID Registry.

D3 TREE STRUCTURE

NOTE – The overall tree structure can be found in annex K.

![Tree Structure Diagram]

**Figure** Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 8, Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll.-1: CSTS and Cross Support Resources Root Object Identifier Tree

D3.1 Under the css (Cross Support Services) node one Object Identifier branch with the top-level node csts shall be allocated for all Cross Support Transfer Service information objects.
D3.2 Under the css (Cross Support Services) node one Object Identifier branch with the top-level node crossSupportResources shall be allocated for all Cross Support Resources information objects (see D6).

D3.3 The csts Object Identifier branch shall be subdivided into the following subbranches:

a) ‘framework’ which lists all Object Identifiers that are reserved for the CSTS Specification Framework definition;

b) ‘services’ which lists all Object Identifiers that are relevant for CSTSes, each new service having its own subbranch;

c) ‘externallyDefinedTypeAndValueExtension’ which contains the Object Identifiers of the data types defined as extension, i.e., the data types that cannot be defined using the existing ASN.1 (valueExtension of the TypeAndValue definition in F4.3). Each data type extension shall be defined in the specification of the service that uses the new data type.

D3.4 The ‘framework’ branch (see D4) shall be divided as follows:

a) The ‘modules’ branch lists the Object Identifiers of the ASN.1 modules defined in this Recommended Standard.

b) The ‘operations’ branch lists the Object Identifiers applicable to each operation defined in this Recommended Standard and specifies for each operation the Object Identifiers of the extended types defined in this Recommended Standard.

c) The ‘procedures’ branch lists the Object Identifiers to be used for each procedure. Each CSTS Specification Framework procedure may be further detailed with derived procedures and with parameter extensions of the procedure.

d) The ‘fwProceduresFunctionalities’ branch lists for each procedure defined in this Recommended Standard in a procedure-specific subbranch the Parameter Identifiers, the Event Identifiers and the Directive Identifiers. Under each of the procedure-specific subbranches of the ‘fwProceduresFunctionalities’ branch, there shall be three separate subbranches, one for Parameters, one for Events, and one for Directives, as defined in F4.16.

NOTE – The Parameter Identifiers, Event Identifiers and Directive Identifiers are used to construct the Parameter, Event, and Directive Names that are transferred via various CSTS operations. Annex E specifies the rules for the construction of names using these identifiers.

e) The ‘serviceGenericIdentifiers’ branch lists those identifiers that are generic and accessible by all services using the CSTS Specification Framework. Parameters, Events, and Directives shall be accessed with the OID in this branch but shall be associated with the Functional Resource of the service using them. There shall be three separate subbranches under the ‘serviceGenericIdentifiers’ branch, one for Parameters,
one for Events, and one for Directives, as defined in F4.17. For consistency with parameters, events and directives of Functional Resources (see D6.2), also the OIDs of parameters, events and directives registered on the ‘serviceGenericIdentifiers’ subbranch are extended by one digit which identifies the version of the given parameter, event, or directive (see F4.17).

NOTE – Although the ‘serviceGenericIdentifiers’ branch has a ‘directives’ subbranch, no service-generic directives have been defined as of this issue of this Recommended Standard. The ‘directives’ subbranch exists for possible use in future issues of this Recommended Standard.

D3.5 The ‘services’ branch (see D5) shall contain the service-type Object Identifiers and for each of them it may contain the extended parameters, the derived services, newly defined procedures and service type specific ASN.1 modules.

D4 CSTS SPECIFICATION FRAMEWORK OBJECT IDENTIFIERS REGISTRATION

NOTES

1 This section specifies some rules regarding the construction of the strings that are used to name Object Identifiers. While within this Recommended Standard these rules have been adhered to, this is not meant to impose the same rules on related documents such as CSTS specifications. If deemed more convenient, different rules for the construction of strings naming OIDs may be applied in those documents.

2 To better illustrate how strings used to name Object Identifiers are built, all figures in sections D4 to D6 contain such strings, but these strings are examples only; i.e., they do not name actually specified Object Identifiers of service types, procedures, parameters, events, directives, etc. As such, the figures in these sections are informative only.

D4.1 New Object Identifiers in the ‘framework’ branch shall be allocated only in the context of an update of this Recommended Standard.

D4.2 New Object Identifiers in the ‘modules’ branch shall be allocated only if new ASN.1 modules are created in this Recommended Standard.

D4.3 New Object Identifiers in the ‘operations’ branch shall be allocated only in the context of a definition of new operations and additional extensions in the definitions of the operations in this Recommended Standard.

NOTE – Strictly speaking, not the operations as such but the PDUs associated with a given operation are registered in the ‘operations’ branch. For example, different Object Identifiers are assigned to the START invocation and to the START return PDU, respectively. Likewise, extensions are registered separately for each PDU.
D4.4 New Object Identifiers in the ‘procedures’ branch (see figure Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 8, Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll.) shall be allocated only in the context of:

a) definition of new procedures: in case a new procedure is created in this Recommended Standard, the newly allocated Object Identifier shall be complemented with two subbranches:
   1) ‘(procedure classifier)DerivedProcedures’ to register any derivation of a procedure from this newly registered procedure,
   2) ‘(procedure classifier)ExtProcedureParam’ to register operations parameters extensions;

b) procedure derived from an existing procedure: the created Object Identifier shall be complemented with two subbranches:
   1) ‘(derived procedure classifier)DerivedProcedures’ to register the derivation of a procedure from the given parent procedure,
   2) ‘(derived procedure classifier)ExtProcedureParam’ to register the operations parameters extension.
Figure Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 8, Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll. 2: ‘procedures’ Subtree
D4.5 New Object Identifiers in the ‘proceduresFunctionalities’ branch shall be allocated only in the context of the definition of a new procedure in this Recommended Standard. The newly allocated Object Identifier node name shall be of the form ‘proc(Procedure Long Name)’. Each such Object Identifier shall be complemented with three subbranches (see figure Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 8, Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll.-3):

a) ‘p(PROCEDURE SHORT NAME)parametersId’ to register the procedure’s parameters;

b) ‘p(PROCEDURE SHORT NAME)eventsId’ to register the procedure’s events;

c) ‘p(PROCEDURE SHORT NAME)directivesId’ to register the procedure’s directives.
Figure Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 8, Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll.

3: ‘fwProceduresFunctionalities’ Subtree

NOTES

1. The <Procedure Short Name> strings used for the procedures contained in this Recommended Standard are specified in F4.16.

2. Figure Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 8, Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll. 4 illustrates the
above specified OID tree structure for all procedures specified within this Recommended Standard.

D5 SERVICE OBJECT IDENTIFIERS REGISTRATION

D5.1 Whenever a new non-derived service is specified, a new Object Identifier shall be allocated directly under the ‘services’ node. The allocated Object Identifier shall be complemented with five subbranches (see figure Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 8,Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll.-4):

a) ‘(service classifier)DerivedServices’ to register services derived from the specified service;

b) ‘(service classifier)ExtendedServiceParameters’ to register service type specific parameters;

c) ‘(service classifier)ServiceProcedures’ to register procedures derived for this service;

d) ‘(service classifier)ServiceModules’ to register service type specific ASN.1 modules;

e) ‘(service classifier)ServiceFrRef’ to register the reference to the Functional Resource Type that models the given service type.
Figure 4: ‘services’ Subtree

D5.2 For each procedure defined for a given service, four subbranches shall be created directly under that procedure node as follows (see figure Figure Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 8,Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll.-4: ‘services’ Subtree):

a) ‘(service classifier)SP(service procedure classifier)ExtendedOpsParam’ to register extensions of operation parameters used by this procedure;

b) ‘(service classifier)SP(service procedure classifier)ExtendedProcParam’ to register extensions of procedure specific parameters;

c) ‘(service classifier)SP(service procedure classifier)EventsId’ to register procedure type specific events;

d) ‘(service classifier)SP(service procedure classifier)DirectivesId’ to register procedure type specific directives.
D5.3 Whenever a new service derived from an existing service is specified, a new Object Identifier shall be allocated directly under the service it is derived from (see figure *Figure Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 8, Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll.*). The allocated Object Identifier shall be complemented with five subbranches:

a) ‘(derived service classifier)DerivedServices’ to register services derived from the specified service;

b) ‘(derived service classifier)ExtendedServiceParameters’ to register parameters syntax;

c) ‘(derived service classifier)ServiceProcedures’ to register derived procedures and extended parameters for this service;

d) ‘(derived service classifier)ServiceModules’ to register ASN.1 modules for this service;
e) ‘(derived service classifier)ServiceFrRef’ to register the reference to the Functional Resource Type that models the given service type.

D6 CROSS SUPPORT RESOURCES OBJECT IDENTIFIERS REGISTRATION

D6.1 GENERAL

The Cross Support Resources branch shall be divided into two branches: ‘crossSupportFunctionalities’ and ‘agenciesFunctionalities’.

D6.2 CROSS SUPPORT FUNCTIONALITIES BRANCH

D6.2.1 Published Identifiers in this branch shall be allocated independently of this Recommended Standard.

D6.2.2 Published Identifier registration shall ensure registration of parameters, events, and directives grouped per Functional Resource Type.

D6.2.3 Functional Resources Types, Parameter Identifiers, Event Identifiers and Directive Identifiers shall be registered as Published Identifiers (see figure Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 8,Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll.-6).
Whenever a new Functional Resource Type is defined:

a) a ‘functionalResourceType’ Published Identifier shall be allocated for that Functional Resource Type with three subbranches: ‘parametersId’, ‘eventsId’ and ‘directivesId’ as required in D6.2.3;

b) Functional Resource Type specific parameters (in the ‘parametersId’ branch) shall be allocated reporting the specific parameters that may be defined for that Functional Resource Type;

c) Functional Resource Type specific events (in the ‘eventsId’ branch) shall be allocated corresponding to the specific events that may be defined for that Functional Resource Type;

d) Functional Resource Type specific directives (in the ‘directivesId’ branch) shall be allocated corresponding to the specific directives that may be defined for that Functional Resource Type.
NOTE – The Parameter Identifiers, Event Identifiers and Directive Identifiers are used to construct the Parameter, Event, and Directive Names that are transferred via various CSTS operations. Annex E specifies the rules for the construction of names using these identifiers.

D6.2.5 Whenever a new CSTS is defined, a ‘functionalResourceType’ Published Identifier shall be allocated for that CSTS with three branches: ‘parametersId’, ‘eventsId’ and ‘directivesId’ as required in D6.2.3 and populated as specified in D6.2.4.

NOTE – The provision of any CSTS is modeled by means of a service type specific Functional Resource. Therefore the definition of a new CSTS requires also the specification of the related Functional Resource and consequently the allocation of an Object Identifier to that Functional Resource Type.

D6.2.6 Whenever a new version of a Functional Resource is required, it shall be assigned a new Object Identifier. The old Functional Resource shall remain untouched, but may be deprecated.

D6.2.7 Whenever a new version of a parameter, event, or directive is required, the following steps shall be performed:

a) the existing parameter/event/directive shall be left untouched;

b) a new parameter/event/directive shall be created the Object Identifier of which shall be the same as the original parameter except that the appended version number shall be incremented by one;

c) at any point in time the original parameter may be deprecated.

D6.3 AGENCIES FUNCTIONALITIES

D6.3.1 An Agency may support agency specific Functional Resources that are not covered under the ‘crossSupportFunctionalities’ branch.

D6.3.2 That Agency may request from SANA a dedicated Object Identifier that is allocated to that Agency and is to be registered under the ‘agenciesFunctionalities’ branch.

D6.3.3 The Agency may then request SANA to register new Functional Resources, parameters, events, and directives in line with the structure adopted under the ‘crossSupportFunctionalities’ branch (see figure Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 8,Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll.-7).

NOTES

1 It is the responsibility of the Agency to allocate and maintain the required Published Identifiers (Functional Resource Types, parameters, events, and directives).
It is the responsibility of the Agency not to duplicate already existing ‘crossSupportFunctionalities’ definitions.

The registration rules applying to the ‘agenciesFunctionalities’ subbranch and to the related registration of Agency-specific Functional Resources are documented in H2.4.

Figure Fehler! Verwendten Sie die Registerkarte 'Start', um Heading 8, Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll.-7: ‘agenciesFunctionalities’ Subtree
ANNEX E

COMPOSITION OF PARAMETER, EVENT, AND DIRECTIVE NAMES AND PARAMETER AND EVENT LISTS

(NORMATIVE)

E1 OVERVIEW

Naming Functional Resources and the observable parameters, notifiable events, and directives associated with those Functional Resources is achieved by means of Published Identifiers. Published Identifiers are Object Identifiers that are registered with the Space Assigned Numbers Authority (SANA). Use of Published Identifiers allows for the specification of CSTSes that can use parameters or events that have not been identified at the time of the writing of those CSTS specifications.

Those Published Identifiers are used in a variety of ways in the operations and procedures of the CSTS Specification Framework:

a) to form the Parameter Names used (1) in the list-of-parameters parameter of the GET operation (3.12.2.2.2) and the Cyclic Report procedure START operation (4.10.4.1.2.3), and (2) in the qualified-parameters parameter of the GET operation (3.12.2.2.3) and the Cyclic Report procedure TRANSFER-DATA operation (4.10.4.2.2.2);

b) to form the Event Names used in the event-name parameter of the NOTIFY operation (3.11.2.2.3.1) and the list-of-events parameter of the Notification procedure START operation (4.11.4.1.2.2);

c) to form the Parameter Names that might be used in the directive-qualifier parameter of the EXECUTE-DIRECTIVE operation (3.13.2.2.3);

d) to form the logical records that constitute the named and default parameter lists used in the list-of-parameters parameters of the GET operation (3.12.2.2.2) and the Cyclic Report procedure START operation (4.10.4.1.2.3);

e) to form the logical records that constitute the named and default event lists used in the list-of-events parameter of the Notification procedure START operation (4.11.4.1.2.2);

f) to form the Functional Resource Names used (1) in the list-of-parameters parameters of the GET operation (3.12.2.2.2) and the Cyclic Report procedure START operation (4.10.4.1.2.3), and (2) in the list-of-events parameter of the Notification procedure START operation (4.11.4.1.2.2);
g) to form the procedure instance identifier used in the list-of-parameters parameters of the GET operation (3.12.2.2.2), the Cyclic Report procedure START operation (4.10.4.1.2.3) and the list-of-events parameter of the Notification procedure START operation (4.11.4.1.2.2).

This annex defines the composition of Functional Resource Names, Parameter Names, Event Names, Directive Names, Parameter Lists, and Event Lists using Published Identifiers of the appropriate types.

E2 FUNCTIONAL RESOURCE NAME

E2.1 Each Functional Resource Name shall be composed of a Functional Resource Type Published Identifier and a Functional Resource Instance Number.

E2.2 The Functional Resource Type shall be registered on one of the following CCSDS Object Identifier subtrees:

a) \{ccsds css crossSupportResources crossSupportFunctionalities\} for a CCSDS-standard Functional Resource Type; or

b) \{ccsds css crossSupportResources agenciesFunctionalities <Agency X>\} for an Agency-unique Functional Resource Type.

E3 PROCEDURE INSTANCE IDENTIFIER

E3.1 Each procedure instance identifier shall be composed of a Procedure Type Published Identifier and the procedure role. If the role is ‘association control’ or ‘prime procedure’, no instance number is defined, as the procedure is already unambiguously identified. If the role is ‘secondary procedure’, an instance number is part of the procedure instance identifier.

E3.2 The Procedure Type shall be registered on the CCSDS Object Identifier subtree \{ccsds css csts framework procedures\}.

E4 PARAMETER NAME

E4.1 A Parameter Name shall be composed of a Parameter Identifier and either the Functional Resource Name of the Functional Resource Instance that generates the values for that instance of the parameter or the procedure instance identifier of the procedure that generates the value for that instance of the procedure configuration parameter.

E4.2 If a Functional Resource Name is used to form the Parameter Name, then the Parameter Identifier shall be registered on one of the following CCSDS Object Identifier subtrees:
a) \{ccsds css csts framework serviceGenericIdentifiers svcParametersId\} for a parameter that is defined as part of the CSTS Specification Framework;

b) \{ccsds css crossSupportResources crossSupportFunctionalities <functional resource type A> parametersId\} for a parameter that is specified as part of a CCSDS-standard Functional Resource Type definition; or

c) \{ccsds css crossSupportResources agenciesFunctionalities <Agency X> <functional resource type A> parametersId\} for a parameter that is specified as part of an Agency-unique Functional Resource Type definition or an Agency-specific extension of a CCSDS-standard Functional Resource Type.

NOTES

1 If an Agency uses the ‘agenciesFunctionalities’ subtree to register additional Agency-specific parameters for a CCSDS-standard Functional Resource Type, there is not necessarily any relationship between the integer value of the Functional Resource Type node under that Agency’s ‘agenciesFunctionalities’ subtree and the value of the Functional Resource Type node under the ‘crossSupportFunctionalities’ subtree.

2 A Functional Resource Type that is registered under the ‘crossSupportResources’ subtree may generate values for parameter types that are registered under \{serviceGenericIdentifiers svcParametersId\}. In such cases, the Parameter Identifier component of the Parameter Name is that which is registered under the \{serviceGenericIdentifiers svcParametersId\} subtree. For such parameters, the reporting of the parameter by the Functional Resource Type is documented as part of the registration tree of that Functional Resource Type.

E4.3 If a procedure instance identifier is used to form the Parameter Name, then the Parameter Identifier shall be registered on the \{ccsds css csts framework fwProceduresFunctionalities proc<Procedure Long Name> p<PROCEDURE SHORT NAME>parametersId\} subtree for a configuration parameter that is defined for that framework procedure.

NOTE – The <Procedure Long Name> and <Procedure Short Name> strings used for the procedures contained in this Recommended Standard are specified in F4.16.

E5 EVENT NAME

E5.1 An Event Name shall be composed of an Event Identifier and either the Functional Resource Name of the Functional Resource Instance that generates the notifications for that instance of the event or the procedure instance identifier of the framework procedure that issues the notification.

E5.2 If a Functional Resource Name is used to form the Event Name, then the Event Identifier shall be registered on one of the following CCSDS Object Identifier subtrees:
CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

a) \{ccsds css csts framework serviceGenericIdentiﬁers svcEventsId\} for an event that is deﬁned as part of the CSTS Speciﬁcation Framework;

b) \{ccsds css crossSupportResources crossSupportFunctionali¬ties <functional resource type A> eventsId\} for an event that is speciﬁed as part of a CCSDS-standard Functional Resource Type deﬁnition; or

c) \{ccsds css crossSupportResources agenciesFunctionali¬ties <Agency X> <functional resource type A> eventsId\} for an event that is speciﬁed as part of an Agency-unique Functional Resource Type deﬁnition or an Agency-speciﬁc extension of a CCSDS-standard Functional Resource Type.

NOTES

1  If an Agency uses the ‘agenciesFunctionali¬ties’ subtree to register additional Agency-speciﬁc events for a CCSDS-standard Functional Resource Type, there is not necessarily any relationship between the integer value of the Functional Resource Type node under that Agency’s ‘agenciesFunctionali¬ties’ subtree and the value of the Functional Resource Type node under the ‘crossSupportFunctionali¬ties’ subtree.

A Functional Resource Type that is registered under the ‘crossSupportResources’ subtree may generate notifications for event types that are registered under \{serviceGenericIdentiﬁers svcEventsId\}. In such cases, the Event Identiﬁer component of the Event Name is that which is registered under the \{serviceGenericIdentiﬁers svcEventsId\} subtree. For such events, the reporting of the event by the Functional Resource Type is documented as part of the registration tree of that Functional Resource Type.

E5.3 If a procedure instance identiﬁer is used to form the Event Name, then the Event Identiﬁer shall be registered on the \{ccsds css csts framework fwProceduresFunctionali¬ties proc<Procedure Long Name> p<PROCEDURE SHORT NAME>eventsId\} subtree for a notification that is deﬁned for a framework procedure.

NOTE – The <Procedure Long Name> and <Procedure Short Name> strings used for the procedures contained in this Recommended Standard are speciﬁed in E3.16.

E6  DIRECTIVE NAME

E6.1 A Directive Name shall be composed of a Directive Identiﬁer and either the Functional Resource Name of the Functional Resource Instance that receives that instance of the directive or the procedure instance identiﬁer of the framework procedure that shall be acted on by that directive.

E6.2 If a Functional Resource is used to form the Directive Name, then the Directive Identiﬁer shall be registered on one of the following CCSDS Object Identiﬁer subtrees:
a) \{ccsds css crossSupportResources crossSupportFunctionalities <functional resource type A> directivesId\} for a directive that is specified as part of a CCSDS-standard Functional Resource Type definition; or

b) \{ccsds css crossSupportResources agenciesFunctionalities <Agency X> <functional resource type A> directivesId\} for a directive that is specified as part of an Agency-unique Functional Resource Type definition or an Agency-specific extension of a CCSDS-standard Functional Resource Type.

NOTE – If an Agency uses the ‘agenciesFunctionalities’ subtree to register additional Agency-specific directives for a CCSDS-standard Functional Resource Type, there is not necessarily any relationship between the integer value of the Functional Resource Type node under that Agency’s ‘agenciesFunctionalities’ subtree and the value of the Functional Resource Type node under the ‘crossSupportFunctionalities’ subtree.

E6.3 If a procedure instance identifier is used to form the Directive Name, then the Directive Identifier shall be registered on the \{ccsds css csts framework fwProceduresFunctionalities proc<Procedure Long Name> p<PROCEDURE SHORT NAME> directivesId\} subtree for a directive that is defined for a framework procedure.

NOTE – The <Procedure Long Name> and <Procedure Short Name> strings used for the procedures contained in this Recommended Standard are specified in E3.16.

E7 PARAMETER LABEL

A Parameter Label shall be the Published Identifier of that parameter. Given the way that Published Identifier is constructed, it identifies the parameter and either the associated Functional Resource Type or the associated procedure type.

E8 EVENT LABEL

An Event Label shall be the Published Identifier of that event. Given the way that Published Identifier is constructed, it identifies the event and either the associated Functional Resource Type or the associated procedure type.

E9 PARAMETER LIST

E9.1 A parameter list shall contain a set of one or more Parameter Labels.

E9.2 Each parameter list record shall represent all instances of the parameter type represented by the Parameter Identifier for all instances of the Functional Resource Type or procedure type that are associated with the service executing the procedure that uses the parameter list.
NOTE – For example, assume that one of the Parameter Labels of a parameter list includes return-buffer-size Parameter Identifier specified for the Buffered Data Delivery procedure. If that parameter list is put into the list-of-parameters parameter of the GET invocation or the Cyclic Report procedure START invocation, it signifies that the return-buffer-size parameter value is to be sent for every instance of the Buffered Data Delivery procedure that is active and executing within the service instance that executes the Information Query or the Cyclic Report procedure.

E10 EVENT LIST

E10.1 An event list shall logically consist of a set of one or more Event Labels, each of which is an Event Identifier Published Identifier. Because of the way such Published Identifier is constructed, it identifies the event and the associated Functional Resource Type or procedure type.

E10.2 Each event list record shall represent all instances of the event type represented by the Event Identifier for all instances of the Functional Resource Type or procedure type that are associated with the service instance executing the Notification procedure.

NOTE – For example, assume that one of the Event Labels of an event list includes the configuration-change Event Identifier of the Buffered Data Delivery procedure. If that event list is put into the list-of-parameters parameter of the Notification procedure START invocation, it signifies that the pBDPconfigurationChange notification is to be sent whenever it occurs on any of the instances of the Buffered Data Delivery procedure type that are active and being executed by the service instance that is executing the Notification procedure.

E11 PARAMETERS, EVENTS, AND DIRECTIVES DEFINITION

E11.1 A parameter, an event, and a directive shall be defined using the following definition:

a) a classifier, i.e., a compact string in ‘camel case’ notation and using standard abbreviations (e.g., ‘fwd’ for ‘forward’) indicating the purpose of the parameter, event, or directive;

b) the semantic definition of the parameter in the form of free text;

c) a name in the form of an Object Identifier where the last digit indicates the version of the definition (see Parameter Name definition in 1.6.1.7.33, Event Name definition in 1.6.1.7.18, and Directive Name definition in 1.6.1.7.15);
NOTE – In those cases where, e.g., a suitable parameter has already been registered on the serviceGenericIdentifiers subbranch of the OID tree, such OID is used to name such parameter although the Functional Resource the parameter is associated with is registered on a different OID subbranch. An example of such parameter is `svcProductionStatus` which is used also for the Functional Resource type which has the classifier ‘mdServiceProductionStatus’.

d) a syntax specification, the syntax to be used when transferring the parameter, the event, or the directive:

1) the syntax shall identify one of the ASN.1 types defined by the TypeAndValueComplex syntax (see F4.3);

2) in the case where none of the predefined types would be suitable, the definition may use the extension capability and define a specific syntax associated with a dedicated Object Identifier referencing the extended syntax;

e) in case of a parameter, a flag indicating if this parameter can be configured;

f) in case of a directive acting on one or more parameters flagged as ‘configured’ a guard condition; if that guard condition does not evaluate to true, the directive must not be executed on that parameter; i.e., the parameter value must not be modified;

g) if applicable and not implied by the data type specification, the range and other constraints (limits) shall be defined;

h) if applicable, the engineering unit(s), preferably SI units, shall be stated;

i) a flag indicating if the definition has been deprecated or not;

NOTE – The deprecation flag indicates that at least one more recent version of the specification of the given parameter, event, or directive exists. The deprecated version can no longer be expected to be supported by providers of CSTSes. In case one or more parameters, events, or directives of a Functional Resource shall no longer be supported at all regardless of their version, a new Functional Resource Type is to be specified.

j) the authorizing entity (e.g., CSS Area);

k) the creation date.

E11.2 Requests to add assignments to this registry shall be submitted to SANA and come from a member Agency, or an observer Agency, or a CCSDS Associate, or an industry partner supported by a member Agency. The request shall be related to a cross support activity. After evaluation of the request and approval by the CSS Area chair or deputy or a person duly authorized by her/him, a new Object Identifier will be allocated and added to the existing list.
ANNEX F

DATA TYPES DEFINITION

(NORMATIVE)

F1 OVERVIEW

F1.1 This annex defines the data types that are used by the procedures defined in this Recommended Standard. It is intended to provide a clear specification of these data types and to avoid ambiguity. It is not intended to constrain how these data types are implemented or encoded. These definitions are suitable for inclusion in any type of ASN.1-based protocol that implements Cross Support Services.

F1.2 The data type definitions are presented in ASN.1 modules.

F1.3 Conceptually, the CSTS Specification Framework ASN.1 definitions break into three levels (putting aside for the moment the top-level data structure that contains a Framework PDU). The lowest level consists of data types; these are used as building blocks. The middle level consists of operation messages (invocations, returns, and acknowledgments); these are generic definitions that can be extended by procedures. The highest level consists of procedure-specific information (e.g., extensions of the generic operation messages).

F1.4 The ASN.1 definitions are broken down into modules. A distinction is made between general purpose items (items used by multiple procedures) and procedure-specific items (items used by only a single procedure). General purpose building blocks are defined in a single module called ‘Cross Support Transfer Service – Common Types’ (F4.3). General purpose operation messages are defined in a single module called ‘Common Operation PDUs’ (F4.4). For each procedure, there is a dedicated module that contains procedure-specific building blocks (if any), procedure-specific operation messages (if any), and procedure-specific extensions to the generic operation messages (if any). Generally, the modules are arranged in bottom-up order:

a) F4.1 – list of Object Identifiers for Framework operations and procedures;
b) F4.2 – building blocks that are used only by the Bind-Invocation message (the Service-Instance-Id);
c) F4.3 – CSTS common types;
d) F4.4 – common operations PDUs;
e) F4.5 – procedure-specific information for the Association Control procedure;
f) F4.6 through F4.14 – procedure-specific information (each subsection dedicated to one procedure);
g) F4.15 – the top-level CSTS Specification Framework PDUs;

h) F4.16 – procedure-specific Object Identifiers associated with parameters, events and directives;

i) F4.17 – the generic service level Object Identifiers.

F1.5 The top-level Framework PDU specifies an operation (e.g., Bind) and a specific message type within that operation (i.e., invocation, return, or acknowledgement). The combination is an operation message (e.g., Bind-Invocation). As mentioned above, if the operation is of general purpose, its messages will be defined in the ‘Common Operation PDUs’ subsection (F4.4). Otherwise, the operation’s messages will be defined within one of the subsections dedicated to specific procedures; e.g., the Bind, Unbind, and PEER-ABORT operations are defined in the subsection dedicated to the Association Control procedure (F4.5).

F2 EXTENSION

F2.1 The extension capability may or may not be used using the Extended parameter. If not used the Extended parameter shall carry a ‘null’ value, also referred to a ‘notUsed’.

F2.2 Extension is defined by means of ‘EMBEDDED PDV’. The ASN.1 EMBEDDED PDV type is a type used to include non-ASN.1 or other data within an ASN.1 encoded message. This type is described using the following ASN.1 SEQUENCE:

```asn1
EMBEDDED PDV ::= [UNIVERSAL 11] SEQUENCE
{  identification CHOICE
   {     sytaxes SEQUENCE
       {     abstract OBJECT IDENTIFIER
           ,     transfer OBJECT IDENTIFIER
       }
     ,     syntax OBJECT IDENTIFIER
     ,     presentation-context-id INTEGER
     ,     context-negotiation SEQUENCE
       {     presentation-context-id INTEGER
           ,     transfer-syntax OBJECT IDENTIFIER
       }
     ,     transfer-syntax OBJECT IDENTIFIER
     ,     fixed NULL
   }
   ,     data-value OCTET STRING
}
```

F2.3 The extension shall make use of the ‘syntax’ definition in the ‘identification’ CHOICE. The ‘syntax’ is assigned an Object Identifier (see F4.1) that is unique for all extensions and clearly indicates that all external syntaxes carried by this definition belong to the Cross Support Services.

F2.4 The syntax used for the extension (see F2.2) shall follow the requirements defined in annex D.
F3 PARAMETERS WITH ENUMERATED VALUES

Although ASN.1 has the built-in simple type ENUMERATED, this type is not used in the modules specified in annex F4 for the following reasons: (a) For a parameter of the type ENUMERATED, the permitted values must be specified; i.e., it is not possible to create a generic enumerated parameter. However, such a generic enumerated type is needed in the specification of the TypeAndValue construct (see F4.3). (b) A new service version adding permitted values to an enumerated type cannot interact with an older version even if the newly added values are not used in a specific cross-support scenario because the PDU decoding would fail.

Enumerated parameters are therefore represented as ‘named integers’. An example is given below.

```plaintext
EnumeratedParameter ::= INTEGER
  { valueA   (0),
    valueB   (1),
    valueC   (2)   }
```
F4  DATA TYPE SPECIFICATION

F4.1  LIST OF OBJECT IDENTIFIERS

This module defines the Object Identifiers required for all syntaxes used for the definition of extended types.

CCSDS–CSTS–OBJECT–IDENTIFIERS
{  iso(1) identified–organization(3) standards–producing–organization(112)
   ccsds(4) css(4) csts(1) framework(1) modules(1) object–identifiers(1)
 }

DEFINITIONS
IMPLICIT TAGS
::= BEGIN

EXPORTS   acExtProcedureParam
           , agenciesFunctionalties
           , bddExtProcedureParam
           , bdpExtProcedureParam
           , crExtProcedureParam
           , crossSupportFunctionalties
           , dpExtProcedureParam
           , executeDirectiveAcknowledge
           , executeDirectiveReturn
           , externallyDefinedTypeAndValueExtension
           , fwProceduresFunctionalties
           , getReturn
           , modules
           , nExtProcedureParam
           , operations
           , procedures
           , scdpExtProcedureParam
           , serviceGenericIdentifiers
           , services
           , startReturn
           , teExtProcedureParam;

css
OBJECT IDENTIFIER ::= {1 3 112 4 4}
csts
OBJECT IDENTIFIER ::= {css 1}
crossSupportResources
OBJECT IDENTIFIER ::= {css 2}
framework
OBJECT IDENTIFIER ::= {csts 1}
services
OBJECT IDENTIFIER ::= {csts 2}
externallyDefinedTypeAndValueExtension
OBJECT IDENTIFIER ::= {csts 3}

--炟 IPT Framework OBJECT IDENTIFIERS

fwProceduresFunctionalties
OBJECT IDENTIFIER ::= {framework 4}
modules
OBJECT IDENTIFIER ::= {framework 1}
operations
OBJECT IDENTIFIER ::= {framework 2}
procedures
OBJECT IDENTIFIER ::= {framework 3}
serviceGenericIdentifiers
OBJECT IDENTIFIER ::= {framework 5}
FRAMEWORK OPERATIONS IDENTIFIERS:
bindInvocation OBJECT IDENTIFIER ::= {operations 1}
bindReturn OBJECT IDENTIFIER ::= {operations 2}
unbindInvocation OBJECT IDENTIFIER ::= {operations 3}
unbindReturn OBJECT IDENTIFIER ::= {operations 4}
peerAbortInvocation OBJECT IDENTIFIER ::= {operations 5}
startInvocation OBJECT IDENTIFIER ::= {operations 6}
startReturn OBJECT IDENTIFIER ::= {operations 7}
stopInvocation OBJECT IDENTIFIER ::= {operations 8}
stopReturn OBJECT IDENTIFIER ::= {operations 9}
executeDirectiveInvocation OBJECT IDENTIFIER ::= {operations 10}
executeDirectiveAcknowledge OBJECT IDENTIFIER ::= {operations 11}
executeDirectiveReturn OBJECT IDENTIFIER ::= {operations 12}
getInvocation OBJECT IDENTIFIER ::= {operations 13}
getReturn OBJECT IDENTIFIER ::= {operations 14}
notifyInvocation OBJECT IDENTIFIER ::= {operations 15}
transferDataInvocation OBJECT IDENTIFIER ::= {operations 16}
processDataInvocation OBJECT IDENTIFIER ::= {operations 17}
processDataReturn OBJECT IDENTIFIER ::= {operations 18}

FRAMEWORK PROCEDURES IDENTIFIERS:
associationControl OBJECT IDENTIFIER ::= {procedures 1}
unbufferedDataDelivery OBJECT IDENTIFIER ::= {procedures 2}
bufferedDataDelivery OBJECT IDENTIFIER ::= {procedures 3}
dataProcessing OBJECT IDENTIFIER ::= {procedures 4}
informationQuery OBJECT IDENTIFIER ::= {procedures 5}
notification OBJECT IDENTIFIER ::= {procedures 6}
throwEvent OBJECT IDENTIFIER ::= {procedures 7}
acDerivedProcedures OBJECT IDENTIFIER ::= {associationControl 1}
acExtProcedureParam OBJECT IDENTIFIER ::= {associationControl 2}
uddDerivedProcedures OBJECT IDENTIFIER ::= {unbufferedDataDelivery 1}
uddExtProcedureParam OBJECT IDENTIFIER ::= {unbufferedDataDelivery 2}
bdDerivedProcedures OBJECT IDENTIFIER ::= {bufferedDataDelivery 1}
bdExtProcedureParam OBJECT IDENTIFIER ::= {bufferedDataDelivery 2}
dpDerivedProcedures OBJECT IDENTIFIER ::= {dataProcessing 1}
dpExtProcedureParam OBJECT IDENTIFIER ::= {dataProcessing 2}
iqDerivedProcedures OBJECT IDENTIFIER ::= {informationQuery 1}
iqExtProcedureParam OBJECT IDENTIFIER ::= {informationQuery 2}
nDerivedProcedures OBJECT IDENTIFIER ::= {notification 1}
nExtProcedureParam OBJECT IDENTIFIER ::= {notification 2}
teDerivedProcedures OBJECT IDENTIFIER ::= {throwEvent 1}
teExtProcedureParam OBJECT IDENTIFIER ::= {throwEvent 2}
bufferedDataProcessing OBJECT IDENTIFIER ::= {dpDerivedProcedures 1}
cyclicReport OBJECT IDENTIFIER ::= {ucxDerivedProcedures 1}
sequenceControlledDataProcessing OBJECT IDENTIFIER ::= {dpDerivedProcedures 2}

crDerivedProcedures OBJECT IDENTIFIER ::= {cyclicReport 1}
crExtProcedureParam OBJECT IDENTIFIER ::= {cyclicReport 2}
bdpDerivedProcedures OBJECT IDENTIFIER ::= {bufferedDataProcessing 1}
bdpExtProcedureParam OBJECT IDENTIFIER ::= {bufferedDataProcessing 2}
scdpDerivedProcedures  OBJECT IDENTIFIER ::=  
  {sequenceControlledDataProcessing 1}
scdpExtProcedureParam    OBJECT IDENTIFIER ::=  
  {sequenceControlledDataProcessing 2}

-- CROSS SUPPORT RESOURCES

crossSupportFunctionalities  OBJECT IDENTIFIER ::=  
  {crossSupportResources 1}
agenciesFunctionalities     OBJECT IDENTIFIER ::=  
  {crossSupportResources 2}

END
F4.2 SERVICE-INSTANCE-ID

NOTE – This module defines the format of the Service Instance Identifier (see 3.4.2.2.7) used in the BIND operation.

CCSDS-CSTS-SERVICE-INSTANCE-ID
{ iso(1) identified-organization(3) standards-producing-organization(112)
  ccsds(4) css(4) csts(1) framework(1) modules(1) service-instance(2)
}

DEFINITIONS
IMPLICIT TAGS
::= BEGIN

EXPORTSServiceInstanceIdentifier
;
IMPORTS IntUnsigned

, PublishedIdentifier

FROM CCSDS-CSTS-COMMON-TYPES

;

ServiceInstanceIdentifier ::= SEQUENCE

{ spacecraftId PublishedIdentifier

, facilityId PublishedIdentifier

, serviceType PublishedIdentifier

, serviceInstanceNumber IntUnsigned

}

END
F4.3 CROSS SUPPORT TRANSFER SERVICE — COMMON TYPES

CCSDS-CSTS-COMMON-TYPES
{ iso(1) identified-organization(3) standards-producing-organization(112)
  ccsds(4) css(4) csts(1) framework(1) modules(1) common-types(3)
}

DEFINITIONS
IMPLICIT TAGS
::= BEGIN

EXPORTS AbstractChoice
  , AdditionalText
  , AuthorityIdentifier
  , BufferSize
  , ConditionalTime
  , DataTransferMode
  , DataUnitId
  , DeliveryLatencyLimit
  , DeliveryMode
  , Diagnostic
  , Duration
  , Embedded
  , EventValue
  , Extended
  , FRorProcedureName
  , FunctionalResourceInstanceNumber
  , FunctionalResourceType
  , IdentifierString
  , IntPos
  , IntUnsigned
  , InvokeId
  , Label
  , ListOfNamesDiagnosticExt
  , ListOfParametersEvents
  , ListOfParamEventsDiagnostics
  , LogicalPortName
  , Name
  , PortId
  , ProcedureInstanceId
  , ProcessingLatencyLimit
  , ProductionStatus
  , PublishedIdentifier
  , QualifiedParameter
  , ServiceUserRespTimer
  , StandardAcknowledgeHeader
  , StandardInvocationHeader
  , StandardReturnHeader
  , Time
  , TypeAndValue
  , TypeAndValueComplex
  , UnknownName
;
This type is used by operations allowing the procedures using them to
select two possibilities for the definition of the data parameter:
1. opaqueString: direct use, no extension required;
2. extendedData: definition of a complex type using a constructed
   syntax

AbstractChoice ::= CHOICE
   { opaqueString [0] OCTET STRING,
     extendedData [1] Embedded }

In the event of a negative result, the value of the diagnostic
is complemented by the following type (see 3.2.1.6 a)):
AdditionalText ::= VisibleString

Appellation is used between the service provider and the service user.
This appellation not being formally agreed can only be used for logging
or tracing.
Appellation ::= VisibleString (SIZE (1 .. 128))

AuthorityIdentifier ::= IdentifierString (SIZE (3 .. 16))

BufferSize ::= IntPos

ConditionalTime ::= CHOICE
   { undefined [0] NULL,
     known [1] Time }

If credentials are used, it will be necessary that the internal
structure of the octet string is known to both parties. Since the
structure will depend on the algorithm used, it is not specified here.
However, the peer entities may use ASN.1 encoding to make the internal
structure visible.
Credentials ::= CHOICE
   { unused [0] NULL,
     used [1] OCTET STRING (SIZE (8 .. 256)) }

DataTransferMode ::= INTEGER
   { undefined (0),
     timely (1),
     complete (2) }

DataUnitId ::= IntUnsigned

DeliveryLatencyLimit ::= IntPos

DeliveryMode ::= INTEGER
   { undefined (0),
     realTime (1),
     complete (2) }
The diagnostics defined here are to be used with all operation returns.

Note:
By means of the 'diagnosticExtension' CHOICE additional values of the diagnostic parameter can be introduced if that is necessary for the negative return or acknowledgement of an operation.

```
Diagnostic ::= CHOICE
  { invalidParameterValue [1] SEQUENCE
    { text AdditionalText
      , appellations Appellation -- of the invalid parameter
    }
  , conflictingValues [2] SEQUENCE
    { text AdditionalText
      , appellations SEQUENCE OF Appellation
    }
  , diagnosticExtension [100] Embedded
}
```

The Duration maybe expressed in seconds, milliseconds, or microseconds

```
Duration ::= CHOICE
  { seconds [0] IntUnsigned
    , milliseconds [1] IntUnsigned
    , microseconds [2] IntUnsigned
  }
```

```
Embedded ::= EMBEDDED PDV
```

```
EventValue ::= CHOICE
  { qualifiedValues [1] SequenceOfQualifiedValue
    , empty [2] NULL
    , eventValueExtension [100] Embedded
  }
```

```
Extended ::= CHOICE
  { external [0] Embedded
    , notUsed [1] NULL
  }
```

```
ForProcedureName ::= CHOICE
  { functionalResourceName [0] FunctionalResourceName
    , procedureInstanceId [1] ProcedureInstanceId
  }
```

```
FunctionalResourceName ::= SEQUENCE
  { functionalResourceType FunctionalResourceType
    , functionalResourceInstanceNumber FunctionalResourceInstanceNumber
  }
```

```
FunctionalResourceInstanceNumber ::= IntPos
```

```
FunctionalResourceType ::= PublishedIdentifier
```

```
IdentifierString ::= VisibleString (FROM (ALL EXCEPT " "))
```

1 to (2^32)-1

```
IntPos ::= INTEGER (1 .. 4294967295)
```
IntUnsigned ::= INTEGER (0 .. 4294967295)

InvokeId ::= IntUnsigned

Label ::= PublishedIdentifier

ListOfNamesDiagnosticExt ::= CHOICE

-- The Label structure is used to identify:
-- 1. the Label of a parameter
-- 2. the Label of an event

ListOfParametersEvents ::= CHOICE

-- The type ListOfParametersEvents is used by the service user to select
-- the parameters by means of the START of the Cyclic Report procedure and
-- by means of the GET operation. While the choices [0] to [5] relate to
-- cross support resources, the choices [6] and [7] relate to the
-- configuration parameters registered in the framework resources branch.

ListOfParamEventsDiagnostics ::= CHOICE

LogicalPortName ::= IdentifierString (SIZE (1 .. 128))

MaxFwdBufferSize ::= IntPos

Name ::= SEQUENCE

-- The Name structure is used to identify:
-- 1. the Name of a parameter
-- 2. the Name of an event
-- 3. the Name of a directive

ProcedureInstanceId ::= SEQUENCE
{ procedureType ProcedureType,
  procedureRole CHOICE
  { primeProcedure [1] NULL,
    secondaryProcedure [2] IntPos,
    associationControl [3] NULL
  }
}

-- The ProcedureType is an Object Identifier the allocation of which is
-- under control of CCSDS. It is declared in the ASN.1 module
-- CCSDS-CSTS-OBJECT-IDENTIFIERS (see F1.1).
ProcedureType ::= OBJECT IDENTIFIER

ProcessingLatencyLimit ::= IntUnsigned

ProductionStatus ::= INTEGER
{ configured (0),
  operational (1),
  interrupted (2),
  halted (3)
}

-- A PublishedIdentifier is an identifier agreed between the service
-- provider and the service user. The identifier is registered in SANA
-- (See D2)
PublishedIdentifier ::= OBJECT IDENTIFIER

-- The definition of the parameters can be found in annex C2.1
QualifiedParameter ::= SEQUENCE
{ parameterName Name,
  qualifiedValues SequenceOfQualifiedValue
}

QualifiedValue ::= CHOICE
{ valid [0] TypeAndValueComplex -- Valid value,
  unavailable [1] NULL -- Unknown or unavailable value,
  undefined [2] NULL -- Undefined in the context,
  error [3] NULL -- Processing resulted in an error
}

SequenceOfQualifiedValue ::= SEQUENCE OF QualifiedValue

ServiceUserRespTimer ::= IntPos

StandardAcknowledgeHeader ::= StandardReturnHeader

StandardInvocationHeader ::= SEQUENCE
{ invokerCredentials Credentials,
  invokeId InvokeId,
  procedureInstanceId ProcedureInstanceId
}
StandardReturnHeader ::= SEQUENCE
  { performerCredentials Credentials,
    invokeId InvokeId,
    result CHOICE
      { positive [0] Extended -- To carry the positive results
        negative [1] SEQUENCE
          { diagnostic Diagnostic
            , negExtension Extended -- The default value of the negExtension parameter is
              -- 'notUsed'.
              -- Unless a PDU that uses the StandardReturnHeader
              -- explicitly defines an extension type to be used
              -- as the value of negExtension for that PDU, the
              -- value shall be 'notUsed'.
          }
      }
  }

Time ::= CHOICE
  { ccsdsFormatMilliseconds [0] TimeCCSDSMilli,
    ccsdsFormatPicoseconds [1] TimeCCSDSPico
  }

TimeCCSDSMilli ::= OCTET STRING (SIZE(8))
  -- P-field is implicit (not present, defaulted to 41 hex
  -- T-field:
  -- 2 octets: number of days since 1958/01/01 00:00:00;
  -- 4 octets: number of milliseconds of the day;
  -- 2 octets: number of microseconds of the millisecond (set to 0 if not used).
  -- This definition reflects exactly the format of the CCSDS defined
  -- time tag as used in space link data units (see reference [5]).

TimeCCSDSPico ::= OCTET STRING (SIZE(10))
  -- P-field is implicit (not present, defaulted to 42 hex
  -- T-field:
  -- 2 octets: number of days since 1958/01/01 00:00:00;
  -- 4 octets: number of milliseconds of the day;
  -- 4 octets: number of picoseconds of the millisecond (set to 0 if not used).
  -- This definition reflects exactly the format of the CCSDS defined
  -- time tag as used in space link data units (see reference [5]).

TypeAndValue ::= CHOICE
  { integer [0] SEQUENCE OF INTEGER,
    integerPositive [1] SEQUENCE OF IntPos,
    intUnsigned [2] SEQUENCE OF IntUnsigned,
    duration [3] SEQUENCE OF Duration,
    characterString [4] SEQUENCE OF VisibleString,
    boolean [5] SEQUENCE OF BOOLEAN,
    octetString [6] SEQUENCE OF OCTET STRING,
    float [7] SEQUENCE OF REAL,
    time [8] SEQUENCE OF Time,
    enumerated [9] SEQUENCE OF INTEGER,
    objectIdentifier [10] SEQUENCE OF OBJECT IDENTIFIER,
    publishedIdentifier [11] SEQUENCE OF PublishedIdentifier,
    typeAndValueExtension [100] Embedded
  }
TypeAndValueComplex ::= CHOICE
  { typeAndValue [0] TypeAndValue
    , complexSequence [1] SEQUENCE OF TypeAndValue
    , complexSet [2] SET OF TypeAndValue
  }

UnknownName ::= SEQUENCE
  { text AdditionalText
    , name Name
  }

END
F4.4 COMMON OPERATIONS PDUS

CCSDS-CSTS—COMMON—OPERATIONS—PDUS
{ iso(1) identified-organization(3) standards-producing-organization(112)
  ccsds(4) css(4) csts(1) framework(1) modules(1) common-operations(4)
}

DEFINITIONS
IMPLICIT TAGS
::= BEGIN

EXPORTS
  ExecuteDirectiveAcknowledge
  ,
  ExecuteDirectiveInvocation
  ,
  ExecuteDirectiveReturn
  ,
  GetInvocation
  ,
  GetReturn
  ,
  NotifyInvocation
  ,
  ProcessDataInvocation
  ,
  ProcessDataReturn
  ,
  StartInvocation
  ,
  StartReturn
  ,
  StopInvocation
  ,
  StopReturn
  ,
  TransferDataInvocation
  ;

IMPORTS
  AbstractChoice
  ,
  Addit
  ,
  DataUnitId
  ,
  EventValue
  ,
  Extended
  ,
  Embedded
  ,
  FunctionalResourceInstanceNumber
  ,
  IntUnsigned
  ,
  ListOfParametersEvents
  ,
  ListOfParamEventsDiagnostics
  ,
  Name
  ,
  ProcedureInstanceId
  ,
  PublishedIdentifier
  ,
  QualifiedParameter
  ,
  StandardAcknowledgeHeader
  ,
  StandardInvocationHeader
  ,
  StandardReturnHeader
  ,
  Time
  ,
  TypeAndValueComplex
FROM CCSDS-CSTS—COMMON—TYPES

  executeDirectiveAcknowledge
  ,
  executeDirectiveReturn
  ,
  getReturn
  ,
  startReturn
FROM CCSDS-CSTS—OBJECT—IDENTIFIERS
;
The first part of the module is left empty as there are no PDUs defined in this module.

The second part of the module defines the common operations the service provider may receive.

```
DirectiveQualifierValues ::= CHOICE
  { sequenceOfParamIdsAndValues [1] SequenceOfParameterIdsAndValues,
    parameterlessValues            [2] TypeAndValueComplex,
    noQualifierValues              [3] NULL
  }

ExecuteDirectiveInvocation ::= SEQUENCE
  { standardInvocationHeader StandardInvocationHeader,
    directiveId                PublishedIdentifier,
    directiveQualifier         CHOICE
      { localProcDirQualifier   [1] DirectiveQualifierValues,
        serviceProcDirQualifier [2] SEQUENCE
          { targetProcedureInstanceId ProcedureInstanceId,
            serviceProcDirQualifierValues DirectiveQualifierValues
          }
      , functResourceDirQualifier [3] SEQUENCE
          { functResourceInstanceId FunctionalResourceIdentifier,
            functionalResourceQualifiers DirectiveQualifierValues
          }
      , directiveQualifierExtension [4] Embedded
    }
  , executeDirectiveInvocationExtension Extended
}

GetInvocation ::= SEQUENCE
  { standardInvocationHeader StandardInvocationHeader,
    listOfParameters ListOfParametersEvents -- See 3.12.2.2.2,
    getInvocationExtension Extended
  }

ProcessDataInvocation ::= SEQUENCE
  { standardInvocationHeader StandardInvocationHeader,
    dataUnitId                  DataUnitId,
    data                       AbstractChoice-- See 3.10.2.2.4.
    processData InvocationExtension Extended
  }

SequenceOfParameterIdsAndValues ::= SEQUENCE OF Sequence
  { parameterIdentifier PublishedIdentifier,
    parameterValue         TypeAndValueComplex
  }

StartInvocation ::= SEQUENCE
  { standardInvocationHeader StandardInvocationHeader,
    startInvocationExtension Extended
  }
```
StopInvocation := SEQUENCE
{ standardInvocationHeader StandardInvocationHeader
, stopInvocationExtension Extended
}

The third part of the module defines the common operations
the service provider may send.

ExecuteDirectiveAcknowledge := StandardAcknowledgeHeader
ExecuteDirectiveReturn := StandardReturnHeader
GetReturn := StandardReturnHeader

The Published Identifier part of the eventName is defined by the Object
Identifiers svcProductionStatusChange or
svcProductionConfigurationChange or by procedure type
specific Published Identifiers (see F4.16 and F4.17).
NotifyInvocation := SEQUENCE
{ standardInvocationHeader StandardInvocationHeader
, eventTime Time
, eventName Name
, eventValue EventValue
, notifyInvocationExtension Extended
}

ProcessDataReturn := StandardReturnHeader
StartReturn := StandardReturnHeader
StopReturn := StandardReturnHeader

TransferDataInvocation := SEQUENCE
{ standardInvocationHeader StandardInvocationHeader
, generationTime Time
, sequenceCounter IntUnsigned
, data AbstractChoice
, transferDataInvocationExtension Extended
}

The fourth part of the module defines the extensions
of the common operations the service provider may send.

*****
EXECUTE-DIRECTIVE invocation
The EXECUTE-DIRECTIVE invocation is not extended, i.e.,
'ExecuteDirectiveInvocation': 'executeDirectiveInvocationExtension' is
set to 'notUsed'.

-- EXECUTE-DIRECTIVE acknowledgement
-- The EXECUTE-DIRECTIVE positive acknowledgement does not extend
-- ExecuteDirectiveAcknowledge, i.e., 'ExecuteDirectiveAcknowledge' :
-- 'StandardAcknowledgeHeader': 'StandardReturnHeader': 'result':
-- 'positive' shall be set to 'notUsed'.
-- The EXECUTE-DIRECTIVE negative acknowledgement does not extend
-- ExecuteDirectiveAcknowledge, i.e., 'ExecuteDirectiveAcknowledge' :
-- 'StandardAcknowledgeHeader': 'StandardReturnHeader': 'result':
-- 'negative': 'negExtension' shall be set to 'notUsed'.
-- The EXECUTE-DIRECTIVE negative acknowledgement makes use of: (a) one of
-- the common diagnostics of the StandardReturnHeader type (see diagnostic
-- parameter defined in 3.3.2.7) except 'diagnosticExtension'; or (b) one
-- of the diagnostic values defined by 'ExecuteDirectiveAcknowledge' :
-- 'StandardAcknowledgeHeader': 'StandardReturnHeader': 'result':
-- 'negative': 'diagnostic': 'Diagnostic': 'diagnosticExtension':
-- 'execDirAckDiagExt': 'ExecDirNegAckDiagnosticExt' in F4.4 except
-- 'execDirNegAckDiagnosticExtExtension'.
execDirNegAckDiagnosticExt ::= CHOICE
  { unknownDirective [1] NULL
  , unknownQualifier [2] NULL
  , invalidProcedureInstance [3] NULL
  , invalidProcedureParameter [6] SET OF Name
  , parameterValueOutOfRange [7] SET OF Name
  , execDirNegAckDiagnosticExtExtension [100] Embedded
  }

execDirAckDiagExt OBJECT IDENTIFIER ::= {executeDirectiveAcknowledge 1}

-- EXECUTE-DIRECTIVE return
-- The EXECUTE-DIRECTIVE positive return does not extend
-- ExecuteDirectiveReturn, i.e., 'ExecuteDirectiveReturn' :
-- 'StandardReturnHeader': 'result': 'positive' shall be set to 'notUsed'.
-- The EXECUTE-DIRECTIVE negative return does not extend
-- ExecuteDirectiveReturn, i.e., 'ExecuteDirectiveReturn' :
-- 'StandardReturnHeader': 'result': 'negative': 'negExtension' shall be
-- set to 'notUsed'.
-- The EXECUTE-DIRECTIVE negative return makes use of: (a) one of the
-- common diagnostics of 'StandardReturnHeader': 'result': 'negative':
-- 'diagnostic': 'Diagnostic' (see 3.3.2.7 and F4.3) except
-- 'diagnosticExtension'; or (b) one of the diagnostic values defined by
-- 'ExecuteDirectiveReturn': 'StandardReturnHeader': 'result': 'negative':
-- 'diagnostic': 'Diagnostic': 'diagnosticExtension':
-- 'execDirNegReturnDiagnosticExt': 'ExecDirNegReturnDiagnosticExt' in F4.4
-- except 'execDirNegReturnDiagnosticExtExtension'.
ExecDirNegReturnDiagnosticExt ::= CHOICE
  { actionNotCompleted [0] ActionNotCompletedDiag
  , execDirNegReturnDiagnosticExtExtension [100] Embedded
  }

ActionNotCompletedDiag ::= CHOICE
  { parameterNames [0] SET OF Name
  , noParameterNames [1] NULL
  }
**GET invocation**

The GET invocation is not extended, i.e., 'GetInvocation':

'getInvocationExtension' shall be set to 'notUsed'.

**GET Return**

The GET positive return extends the GetReturn by adding the parameters

- 'qualifiedParameters' and 'getPosReturnExtExtension' defined by
- 'GetReturn': 'StandardReturnHeader': 'result': 'positive':
- 'getPosReturnExt': 'GetPosReturnExt'. This extension only defines the
  - 'qualifiedParameters' parameter. 'getPosReturnExtExtension' shall be set
  - to 'notUsed'.

getPosReturnExt ::= SEQUENCE { qualifiedParameters QualifiedParametersSequence,
  getPosReturnExtExtension Extended }

getPosReturnExt OBJECT IDENTIFIER ::= {getReturn 1}

The GET negative return does not extend GetReturn, i.e., 'GetReturn':

- 'StandardReturnHeader': 'result': 'negative': 'negExtension' shall be
  - set to 'notUsed'.

The GET negative return makes use of:

- (a) one of the common diagnostics
  - of 'StandardReturnHeader': 'result': 'negative': 'diagnostic':
  - 'Diagnostic' (see diagnostic parameter defined in 3.3.2.7 and F4.3)
  - except 'diagnosticExtension'; or
- (b) one of the additional diagnostic
  - values defined by 'GetReturn': 'StandardReturnHeader': 'result':
  - 'negative': 'diagnostic': 'Diagnostic': 'diagnosticExtension':
  - 'getDiagnosticExt': 'GetDiagnosticExt' in F4.4 except
  - 'getDiagnosticExtExtension'.

getDiagnosticExt ::= CHOICE

- common [0] ListOfParamEventsDiagnostics
- getDiagnosticExtExtension [100] Embedded

getDiagnosticExt OBJECT IDENTIFIER ::= {getReturn 2}

QualifiedParametersSequence ::= SEQUENCE OF QualifiedParameter

**START invocation**

The START invocation is not extended, i.e., 'StartInvocation':

'startTimeInvocationExtension' shall be set to 'notUsed'.

---
-- START return
-- The START positive return does not extend StartReturn, i.e.,
-- 'StartReturn' : 'StandardReturnHeader' : 'result' : 'positive' shall be set
-- to 'notUsed'.
-- The START negative return does not extend StartReturn, i.e.,
-- 'StartReturn' : 'StandardReturnHeader' : 'result' : 'negative':
-- 'negExtension' shall be set to 'notUsed'.
-- The START negative return makes use of: (a) one of the common
-- diagnostics of 'StandardReturnHeader' : 'result' : 'negative':
-- 'diagnostic' : 'Diagnostic' (see 3.3.2.7 and F4.3) except
-- 'diagnosticExtension', or (b) one of the additional values specified by
-- 'StartReturn' : 'StandardReturnHeader' : 'result' : 'negative':
-- 'diagnostic' : 'Diagnostic' : 'diagnosticExtension' : 'startDiagnosticExt':
-- 'StartDiagnosticExt' in F4.4 except 'startDiagnosticExtExtension'.

StartDiagnosticExt ::= CHOICE
  { unableToComply [0] AdditionalText,
    outOfService [1] AdditionalText,
    startDiagnosticExtExtension [100] Embedded
  }

startDiagnosticExt OBJECT IDENTIFIER ::= {startReturn 1}

-- *****
-- STOP invocation
-- The STOP invocation is not extended, i.e., 'StopInvocation':
-- 'stopInvocationExtension' shall be set to 'notUsed'.

-- STOP return
-- The STOP positive return does not extend StopReturn, i.e., 'StopReturn':
-- 'StandardReturnHeader' : 'result' : 'positive' shall be set to 'notUsed'.
-- The STOP negative return does not extend StopReturn, i.e., 'StopReturn':
-- 'StandardReturnHeader' : 'result' : 'negative' : 'negExtension' shall be
-- set to 'notUsed'.
-- The STOP negative return makes use of one of the common diagnostics
-- of 'StandardReturnHeader' : 'result' : 'negative' : 'diagnostic':
-- 'Diagnostic' (see 3.3.2.7 and F4.3) except 'diagnosticExtension'.

END
F4.5 PROCEDURE — ASSOCIATION CONTROL PDUS

CCSDS-CSTS-ASSOCIATION-CONTROL-TYPES
{ iso(1) identified-organization(3) standards-producing-organization(112)
  ccsds(4) css(4) csts(1) framework(1) modules(1)
  associationControlPdus(5)
}

DEFINITIONS
IMPLICIT TAGS
::= BEGIN

EXPORTS AssociationPdu
  , BindInvocation
  , BindReturn
  , PeerAbortInvocation
  , UnbindInvocation
  , UnbindReturn
;

IMPORTS AdditionalText
  , AuthorityIdentifier
  , Embedded
  , Extended
  , IntPos
  , PortId
  , PublishedIdentifier
  , StandardInvocationHeader
  , StandardReturnHeader
FROM CCSDS-CSTS-COMMON-TYPES

  ServiceInstanceIdentifier
FROM CCSDS-CSTS-SERVICE-INSTANCE-ID

  acExtProcedureParam
FROM CCSDS-CSTS-OBJECT-IDENTIFIERS

  CstsFrameworkPdu
FROM CCSDS-CSTS-PDUS
;

-- The first part of the module definition defines the PDU containing
-- the operations used by the Association Control procedure.
-- **********************************************************************

AssociationPdu ::= CstsFrameworkPdu (WITH COMPONENTS
  { bindInvocation
    , bindReturn
    , unbindInvocation
    , unbindReturn
    , peerAbortInvocation
  }
)
The second part of the module defines the operations of the Association Control procedure.

BindInvocation ::= SEQUENCE {
    standardInvocationHeader StandardInvocationHeader,
    initiatorIdentifier AuthorityIdentifier,
    responderPortIdentifier PortId,
    serviceType ServiceType,
    versionNumber VersionNumber,
    serviceInstanceIdentifier ServiceInstanceIdentifier,
    bindInvocationExtension Extended
}

BindReturn ::= SEQUENCE {
    standardReturnHeader StandardReturnHeader,
    responderIdentifier AuthorityIdentifier
}

PeerAbortInvocation ::= SEQUENCE {
    diagnostic PeerAbortDiagnostic
}

UnbindInvocation ::= SEQUENCE {
    standardInvocationHeader StandardInvocationHeader,
    unbindInvocationExtension Extended
}

UnbindReturn ::= StandardReturnHeader

The third part contains the types used by the operations defined in the second part.
Peer Abort diagnostic values definition:
- 0–39: SLE (usage: 0–8 and 127 for all SLE services)
- 128–199: ISP
- 200–250: Application

The diagnostic of the PEER-ABORT only allows to carry one
octet of information (see ISP-1, reference [2]).
The following ASN.1 definition is a dummy definition:
PeerAbortDiagnostic ::= OCTET STRING (SIZE(1))

The standard Association Control procedure as defined in this
Recommended Standard reserves the PEER-ABORT diagnostic values from 40
to 69 and 126. The values of the PEER-ABORT diagnostic defined (as
integers) by the Association Control procedure (see 3.6.2.2) are:
- accessDenied (40)
- unexpectedResponderId (41)
- operationalRequirement (42)
- protocolError (43)
- communicationsFailure (44)
- encodingError (45)
- returnTimeout (46)
- endOfServiceProvisionPeriod (47)
- unsolicitedInvokeId (48)
- duplicateInvokeId (49)
- invalidProcedureInstanceIdentifier (50)
- unrecognizedType (51)
- otherReason (126)
As per 4.3.3.1.11.4 a procedure may trigger an abort of the association
and passing the desired diagnostic value. Values in the range from 70 to
125 are reserved for this purpose.

The Buffered Data Processing procedure may use the following diagnostic:
- forwardBufferTooLarge (70)

Future versions of this Recommended Standard may specify additional
procedures and additional procedure specific diagnostic values in the
range 71 to 125.

Service-type specific procedures (derived or service-original) may use
diagnostic values in the range reserved for applications 200 to 250.
Since the the service type is known when a PEER-ABORT is received,
different service types can choose the diagnostic values independently
of each other.

The Service Type is an Object Identifier the allocation of which is
under control of CCSDS. See the example in annex K.

ServiceType ::= PublishedIdentifier
VersionNumber ::= IntPos

The fourth part of the module definition contains the Extended
types used by the operations defined in the second part.

*****
BIND invocation
The BIND invocation is not extended, i.e., 'BindInvocation':
'bindInvocationExtension' shall be set to 'notUsed'.
-- BIND return
-- The BIND positive return does not extend BindReturn, i.e., 'BindReturn':
-- 'StandardReturnHeader': 'result': 'positive' shall be set to 'notUsed'.
-- The BIND negative return does not extend BindReturn, i.e., 'BindReturn':
-- 'StandardReturnHeader': 'result': 'negative': 'negExtension' shall be
-- set to 'notUsed'.
-- The BIND negative return makes use of: (a) one of the common
-- diagnostics of 'StandardReturnHeader': 'result': 'negative':
-- 'diagnostic': 'Diagnostic' (see 3.3.2.7 and F4.3) except
-- 'diagnosticExtension'; or (b) one of the additional diagnostics
-- specified by 'BindReturn': 'StandardReturnHeader': 'result': 'negative':
-- 'diagnostic': 'Diagnostic': 'diagnosticExtension': 'acBindDiagExt':
-- 'AssocBindDiagnosticExt' in F4.5 except
-- 'assocBindDiagnosticExtExtension'.
AssocBindDiagnosticExt ::= CHOICE
  { accessDenied [1] AdditionalText
    , serviceTypeNotSupported [2] AdditionalText
    , siNotAccessibleToThisInitiator [6] AdditionalText
    , inconsistentServiceType [7] AdditionalText
    , outOfService [8] AdditionalText
    , assocBindDiagnosticExtExtension [100] Embedded
  }

acBindDiagExt OBJECT IDENTIFIER ::= {acExtProcedureParam 1}

-- *****
-- UNBIND invocation
-- The UNBIND invocation is not extended, i.e., 'UnbindInvocation':
-- 'unbindInvocationExtension' shall be set to 'notUsed'.

-- UNBIND return
-- The UNBIND positive return does not extend UnbindReturn, i.e.,
-- 'UnbindReturn': 'StandardReturnHeader': 'result': 'positive' shall be
-- set to 'notUsed'.
-- The UNBIND negative return is not used, i.e., 'UnbindReturn':
-- 'StandardReturnHeader': 'result' must not be set to 'negative'.

END
F4.6 PROCEDURE — UNBUFFERED DATA DELIVERY PDUS

CCSDS-CSTS-UNBUFFERED-DATA-DELIVERY-PDUS

{ iso(1) identified-organization(3) standards-producing-organization(112)
  ccsds(4) css(4) csts(1) framework(1) modules(1) unbuffDataDeliveryPdus(6) }

DEFINITIONS
IMPLICIT TAGS
::= BEGIN

-- Main PDU exported to allow possible extension by derived procedures
EXPORTS UnbufferedDataDeliveryPdu;

IMPORTS CstsFrameworkPdu
FROM CCSDS-CSTS-PDUS
;

--- ========================================================================

--- The first part of the module definition defines the PDU containing
--- the operations used by the Unbuffered Data Delivery procedure.
--- ========================================================================

UnbufferedDataDeliveryPdu ::= CstsFrameworkPdu (WITH COMPONENTS
  { startInvocation
    , startReturn
    , stopInvocation
    , stopReturn
    , transferDataInvocation
  })

--- ========================================================================

--- The second part of the module defines the operations
--- of the Unbuffered Data Delivery procedure.
--- ========================================================================

--- All operations are defined in the module
--- CCSDS-CSTS-COMMON-OPERATIONS-PDUS (see F4.4)
--- ========================================================================

--- The third part contains the types used by the operations
--- defined in the second part.
--- ========================================================================

--- This procedure does not have specific definitions.
--- ========================================================================

--- The fourth part of the module definition contains the Extended
--- types used by the operations defined in the second part.
--- ========================================================================

--- *****
--- START invocation
--- The START invocation is not extended, i.e., 'StartInvocation':
--- 'startInvocationExtension' shall be set to 'notUsed'.

---
-- START return
-- The START positive return does not extend StartReturn, i.e.,
-- 'StartReturn': 'StandardReturnHeader': 'result': 'positive' shall be set
-- to 'notUsed'.
-- The START negative return does not extend StartReturn, i.e.,
-- 'StartReturn': 'StandardReturnHeader': 'result': 'negative':
-- 'negExtension' shall be set to 'notUsed'.
-- The START negative return makes use of: (a) one of the common
-- diagnostics of 'StandardReturnHeader': 'result': 'negative':
-- 'diagnostic': 'Diagnostic' (see 3.3.2.7 and F4.3) except
-- 'diagnosticExtension'; or (b) one of the additional values specified by
-- 'StartReturn': 'StandardReturnHeader': 'result': 'negative':
-- 'diagnostic': 'Diagnostic': 'diagnosticExtension': 'startDiagnosticExt':
-- 'StartDiagnosticExt' in F4.6 except 'startDiagnosticExtExtension'.
-- *****
-- STOP Invocation
-- The STOP invocation is not extended, i.e., 'StopInvocation':
-- 'stopInvocationExtension' shall be set to 'notUsed'.
-- STOP return
-- The STOP positive return does not extend StopReturn, i.e., 'StopReturn':
-- 'StandardReturnHeader': 'result': 'positive' shall be set to 'notUsed'.
-- The STOP negative return does not extend StopReturn, i.e., 'StopReturn':
-- 'StandardReturnHeader': 'result': 'negative': 'negExtension' shall be
-- set to 'notUsed'.
-- The STOP negative return makes use of one of the common diagnostics
-- of 'StandardReturnHeader': 'result': 'negative': 'diagnostic':
-- 'diagnostic' (see 3.3.2.7 and F4.3) except 'diagnosticExtension'.
-- TRANSFER-DATA Invocation
-- The TRANSFER-DATA invocation is not extended, i.e.,
-- 'TransferDataInvocation': 'transferDataInvocationExtension' shall be set
-- to 'notUsed'.

END
F4.7 PROCEDURE — BUFFERED DATA DELIVERY PDUS

CCSDS-CSTS-BUFFERED-DATA-DELIVERY-PDUS
{ iso(1) identified-organization(3) standards-producing-organization(112)
  cccds(4) css(4) csts(1) framework(1) modules(1) buffDataDeliveryPdus(7)
}

DEFINITIONS
IMPLICIT TAGS
::= BEGIN

-- Main PDU exported to allow possible extension by derived procedures
EXPORTS BufferedDataDeliveryPdu
  ,
    ReturnBuffer
  ;

IMPORTS AdditionalText
  ,
    ConditionalTime
  ,
    Embedded
  ,
    Extended
  FROM CCSDS-CSTS-COMMON-TYPES

    bddExtProcedureParam
  FROM CCSDS-CSTS-OBJECT-IDENTIFIERS

    NotifyInvocation
  ,
    TransferDataInvocation
  FROM CCSDS-CSTS-COMMON-OPERATIONS-PDUS

    CstsFrameworkPdu
  FROM CCSDS-CSTS-PDUS
;

-- The first part of the module definition defines the PDU containing
-- the operations used by the Buffered Data Delivery procedure.

BufferedDataDeliveryPdu ::= CstsFrameworkPdu (WITH COMPONENTS
  { startInvocation
    , startReturn
    , stopInvocation
    , stopReturn
    , returnBuffer
  })

-- The second part of the module defines the operations
-- of the Buffered Data Delivery procedure.

-- All operations are defined in the module
-- CCSDS-CSTS-COMMON-OPERATIONS-PDUS (see F4.4)

-- The ReturnBuffer is not an operation but is the concatenation of
-- one or more TRANSFER-DATA and/or NOTIFY invocations.
ReturnBuffer ::= SEQUENCE OF TransferDataOrNotification
The third part contains the types used by the operations defined in the second part.

TransferDataOrNotification ::= CHOICE
  { transferDataInvocation  [0] TransferDataInvocation
    , notifyInvocation       [1] NotifyInvocation }

The fourth part of the module definition contains the Extended types used by the operations defined in the second part.

START invocation

The START invocation is extended with the additional parameters 'startGenerationTime' and 'stopGenerationTime'. This extension is defined by 'startInvocation': 'startInvocationExtension':

'bddStartInvocExt': '_buffDataDelStartInvocExt'. No further parameters are added, i.e., 'startInvocation': 'startInvocationExtension':

'bddStartInvocExt': 'buffDataDelStartInvocExt':

'buffDataDelStartInvocExtExtension' shall be set to 'notUsed'.

buffDataDelStartInvocExt ::= SEQUENCE
  { startGenerationTime ConditionalTime
    , stopGenerationTime ConditionalTime
    , buffDataDelStartInvocExtExtension Extended }

---

BUFFDATADELSTARTDIAGNOSEXT

---

START return

The START positive return does not extend StartReturn, i.e., 'StartReturn': 'StandardReturnHeader': 'result': 'positive' shall be set to 'notUsed'.

The START negative return does not extend StartReturn, i.e.,

'StartReturn': 'StandardReturnHeader': 'result': 'negative':

'negExtension' shall be set to 'notUsed'.

The START negative return makes use of: (a) one of the common diagnostics of 'StandardReturnHeader': 'result': 'negative':

'diagnostic': 'Diagnostic' (see 3.3.2.7 and F4.3) except
'diagnosticExtension'; or (b) one of the additional diagnostics defined by 'StartReturn': 'StandardReturnHeader': 'result': 'negative':

'diagnostic': 'Diagnostic': 'diagnosticExtension': 'startDiagnosticExt':

'startDiagnosticExt' in F4.4 except 'startDiagnosticExtExtension'; or

(c) one of the additional values defined by 'StartReturn':

'StandardReturnHeader': 'result': 'negative': 'diagnostic':

'Diagnostic': 'diagnosticExtension': 'startDiagnosticExt':

'startDiagnosticExt': 'startDiagnosticExtExtension': 'bddStartDiagExt':

'startDiagnosticExtExtension' in F4.7 except

'buffDataDelStartDiagnosticExtExtension'.

---

BUFFDATADELSTARTDIAGNOSEXT

---

missingTimeValue AdditionalText
, invalidStartGenerationTime AdditionalText
, inconsistentTime AdditionalText
, buffDataDelStartDiagnosticExtExtension Embedded
bddStartDiagExt OBJECT IDENTIFIER ::= {bddExtProcedureParam 2}

   -- *****
   -- STOP Invocation
   -- The STOP invocation is not extended, i.e., 'StopInvocation':
   -- 'stopInvocationExtension' shall be set to 'notUsed'.
   -- STOP return
   -- The STOP positive return does not extend StopReturn, i.e., 'StopReturn':
   -- 'StandardReturnHeader': 'result': 'positive' shall be set to 'notUsed'.
   -- The STOP negative return does not extend StopReturn, i.e., 'StopReturn':
   -- 'StandardReturnHeader': 'result': 'negative': 'negExtension' shall be
   -- set to 'notUsed'.
   -- The STOP negative return makes use of one of the common diagnostics
   -- of 'StandardReturnHeader': 'result': 'negative': 'diagnostic':
   -- 'Diagnostic' (see 3.3.2.7 and F4.3) except 'diagnosticExtension'.
   -- NOTIFY:
   -- The NotifyInvocation type is defined in F4.4.
   -- NOTIFY invocation extension:
   -- This procedure defines the additional eventName values 'data discarded due to
   -- excessive backlog', 'bdd recording buffer overflow', 'end of data' and
   -- 'buffered data delivery configuration change'(see
   -- 4.5.4.2.2.1). The associated Published Identifiers are
   -- pBDDdataDiscardedExcessBacklog, pBDDrecordingBufferOverflow,
   -- pBDDendOfData and pBDDconfigurationChange as defined in F4.16).
   -- No other extension is specified, i.e., 'notifyInvocationExtension' shall
   -- be set to 'notUsed'.
   -- TRANSFER-DATA Invocation
   -- The TRANSFER-DATA invocation is not extended, i.e.,
   -- 'TransferDataInvocation': 'transferDataInvocationExtension' shall be set
   -- to 'notUsed'.

END
F4.8 PROCEDURE — DATA PROCESSING PDUS

CCSDS—CSTS—DATA—PROCESSING—PDUS
{ iso(1) identified-organization(3) standards-producing-organization(112) ccnds(4)
  css(4) csts(1) framework(1) modules(1) dataProcessingPdus(8) }

DEFINITIONS
IMPLICIT TAGS
::= BEGIN

-- Main PDU exported to allow possible extension by derived procedures
EXPORTS DataProcessingPdu;

IMPORTS DataUnitId,
  Embedded,
  Extended,
  ProductionStatus,
  Time
FROM CCSDS—CSTS—COMMON—TYPES

dpExtProcedureParam
FROM CCSDS—CSTS—OBJECT—IDENTIFIERS

CstsFrameworkPdu
FROM CCSDS—CSTS—PDUS
;

-- ____________________________________________
-- The first part of the module definition defines the PDU containing
-- the operations used by the Data Processing procedure.
-- ____________________________________________

DataProcessingPdu ::= CstsFrameworkPdu (WITH COMPONENTS
  { startInvocation,
  startReturn,
  stopInvocation,
  stopReturn,
  processDataInvocation,
  notifyInvocation
  })

-- ____________________________________________
-- The second part of the module defines the operations
-- of the Data Processing procedure.
-- ____________________________________________

-- All operations are defined in the module
-- CCSDS—CSTS—COMMON—OPERATIONS—PDUS (see F4.4)

-- ____________________________________________
-- The third part contains the types used by the operations
-- defined in the second part.
-- ____________________________________________

-- This procedure does not have specific definition.
*****
START Invocation

The START invocation is not extended, i.e., 'StartInvocation':
'startInvocationExtension' shall be set to 'notUsed'.

START return

The START positive return does not extend StartReturn, i.e.,
'StartReturn': 'StandardReturnHeader': 'result': 'positive' shall be set
to 'notUsed'.

The START negative return does not extend StartReturn, i.e.,
'StartReturn': 'StandardReturnHeader': 'result': 'negative':
'negExtension' shall be set to 'notUsed'.

The START negative return makes use of: (a) one of the common
diagnostics of 'StandardReturnHeader': 'result': 'negative':
'diagnostic': 'Diagnostic' (see 3.3.2.7 and F4.3) except
diagnosticExtension'; or (b) one of the additional values specified by
'StartReturn': 'StandardReturnHeader': 'result': 'negative':
'diagnostic': 'Diagnostic': 'diagnosticExtension': 'startDiagnosticExt':
'StartDiagnosticExt' in F4.4 except 'startDiagnosticExtExtension'.

*****
STOP Invocation

The STOP invocation is not extended, i.e., 'StopInvocation':
'stopInvocationExtension' shall be set to 'notUsed'.

STOP return

The STOP positive return does not extend StopReturn, i.e., 'StopReturn':
'StopReturn': 'StandardReturnHeader': 'result': 'positive' shall be set
to 'notUsed'.

The STOP negative return does not extend StopReturn, i.e., 'StopReturn':
'StopReturn': 'StandardReturnHeader': 'result': 'negative':
'negExtension' shall be set to 'notUsed'.

The STOP negative return makes use of one of the common
diagnostics of 'StandardReturnHeader': 'result': 'negative': 'diagnostic':
'Diagnostic' (see 3.3.2.7 and F4.3) except 'diagnosticExtension'.

*****
PROCESS-_DATA Invocation

The PROCESS-_DATA invocation is extended with the additional parameter
'processCompletionReport'. This extension is defined by
'processDataInvocation': 'processDataInvocationExtension':
dpProcDataInvocExt': 'DataProcProcDataInvocExt':
'processCompletionReport'. No further parameters are added, i.e.,
'processDataInvocation': 'processDataInvocationExtension':
dpProcDataInvocExt': 'DataProcProcDataInvocExt':
'dataProcProcDataInvocExtExtension' shall be set to 'notUsed'.

DataProcProcDataInvocExt ::= SEQUENCE
{
  processCompletionReport CHOICE
  {  doNotProduceReport [0] NULL
  ,  produceReport [1] NULL
  }
,  dataProcProcDataInvocExtExtension Extended
}

dpProcDataInvocExt OBJECT IDENTIFIER ::= 
  (dpExtProcedureParam 1)
-- *****
-- NOTIFY:
-- The NotifyInvocation type is defined in F4.4.
-- NOTIFY invocation extension:
-- This procedure defines the additional eventName values 'data processing completed' and 'data processing configuration change' (see 4.6.4.2.3).
-- The associated Published Identifiers are pDPdataProcessingCompleted and pDPconfigurationChange as defined in F4.16).
-- The NOTIFY invocation is extended with the additional parameters
-- 'dataUnitIdLastProcessed', 'dataUnitIdLastOk' and 'productionStatus'.
-- This extension is defined by 'NotifyInvocation':
-- 'notifyInvocationExtension': 'dpNotifyInvocExt':
- 'DataProcNotifyInvocExt'. No further parameters are added, i.e.,
- 'NotifyInvocation': 'notifyInvocationExtension': 'dpNotifyInvocExt':
- 'DataProcNotifyInvocExt': 'dataProcNotifyInvocExtExtension' shall be set
to 'notUsed'. No additional values of the 'dataProcessingStatus'
parameter are defined, i.e., 'NotifyInvocation':
- 'notifyInvocationExtension': 'dpNotifyInvocExt':
- 'DataProcNotifyInvocExt': 'dataUnitIdLastProcessed':
- 'dataUnitLastProcessed': 'dataProcessingStatus' must not be set to
- 'dataProcessingStatusExtension'.

DataProcNotifyInvocExt ::= SEQUENCE
{ dataUnitIdLastProcessed CHOICE
  { noDataProcessed [0] NULL
    , dataUnitIdLastProcessed [1] SEQUENCE
      { lastProcessedDataUnitId DataUnitId
        , dataProcessingStatus CHOICE
          { successfullyProcessed [0] DataProcessingStartTime
            , processingInterrupted [1] DataProcessingStartTime
            , dataProcessingStatusExtension [100] Embedded
          }
        }
    }
  , dataUnitIdLastOk CHOICE
    { noSuccessfulProcessing [0] NULL
      , dataUnitIdLastOk [1] SEQUENCE
        { lastOkDataUnitId DataUnitId
          , dataProcessingStopTime Time
        }
    }
  , productionStatus CHOICE
    { productionStatusChange [0] NULL
      , anyOtherEvent [1] ProductionStatus
    }
  , dataProcNotifyInvocExtExtension Extended
}

dpNotifyInvocExt OBJECT IDENTIFIER ::= (dpExtProcedureParam 2)

-- The following type is not an extension but a type used by
-- DataProcNotifyInvocExt.
DataProcessingStartTime ::= Time

END
F4.9 PROCEDURE — BUFFERED DATA PROCESSING PDUS

CCSDS-CSTS-BUFFERED-DATA-PROCESSING-PDUS
{ iso(1) identified-organization(3) standards-producing-organization(112) ccsds(4)
css(4) csts(1) framework(1) modules(1) bufferedDataProcessingPdus(9)
}

DEFINITIONS
IMPLICIT TAGS
::= BEGIN

— Main PDU exported to allow possible extension by derived procedures
EXPORTS BufferedDataProcessingPdu
,
  ForwardBuffer
;

IMPORTS CstsFrameworkPdu
FROM CCSDS-CSTS-PDUS
;

—=============================================================
— The first part of the module definition defines the PDU containing
— the operations used by the Buffered Data Processing procedure.
—=============================================================
— The Buffered Data Processing procedure is derived from the
— Data Processing procedure.
BufferedDataProcessingPdu ::= CstsFrameworkPdu (WITH COMPONENTS
{ startInvocation
, startReturn
, stopInvocation
, stopReturn
, processDataInvocation
, notifyInvocation
, forwardBuffer
}
)

— The Buffered Data Processing Procedure uses an additional diagnostic
— passed to the Association Control Procedure in case a too large Transfer
— Buffer PDU is retransmitted. The diagnostic value 70 shall signify
— "forward buffer too large".
—=============================================================
— The second part of the module defines the operations
— of the Data Processing procedure.
—=============================================================
— All operations are defined in the module
— CCSDS-CSTS-COMMON-OPERATIONS-PDUS (see F4.4)
—=============================================================
— The third part contains the types used by the operations
— defined in the second part.
—=============================================================

ForwardBuffer ::= SEQUENCE OF ProcessDataInvocation
Processing procedure. The extension
The NOTIFY Invocation

*****

- **START invocation**
- The **START** invocation is not extended, i.e., 'StartInvocation':
- 'startInvocationExtension' shall be set to 'notUsed'.

- **START return**
- The **START** positive return does not extend **StartReturn**, i.e.,
- 'StartReturn': 'StandardReturnHeader': 'result': 'positive' shall be set
- to 'notUsed'.
- The **START** negative return does not extend **StartReturn**, i.e.,
- 'StartReturn': 'StandardReturnHeader': 'result': 'negative':
- 'negExtension' shall be set to 'notUsed'.
- The **START** negative return makes use of: (a) one of the common
- diagnostics of 'StandardReturnHeader': 'result': 'negative':
- 'diagnostic': 'Diagnostic' (see 3.3.2.7 and F4.3) except
- 'diagnosticExtension'; or (b) one of the additional values specified by
- 'StartReturn': 'StandardReturnHeader': 'result': 'negative':
- 'diagnostic': 'Diagnostic': 'diagnosticExtension': 'startDiagnosticExt':
- 'StartDiagnosticExt' in F4.4 except 'startDiagnosticExtExtension'.

*****

- **STOP invocation**
- The **STOP** invocation is not extended, i.e., 'StopInvocation':
- 'stopInvocationExtension' shall be set to 'notUsed'.

- **STOP return**
- The **STOP** positive return does not extend **StopReturn**, i.e., 'StopReturn':
- 'StartReturn': 'StandardReturnHeader': 'result': 'positive' shall be set
- to 'notUsed'.
- The **STOP** negative return does not extend **StopReturn**, i.e., 'StopReturn':
- 'StartReturn': 'StandardReturnHeader': 'result': 'negative': 'negExtension' shall be
- set to 'notUsed'.
- The **STOP** negative return makes use of one of the common diagnostics
- of 'StandardReturnHeader': 'result': 'negative': 'diagnostic':
- 'Diagnostic' (see 3.3.2.7 and F4.3) except 'diagnosticExtension'.

*****

- **PROCESS-DATA Invocation**
- The **PROCESS-DATA** invocation is extended with the additional parameter
- 'processCompletionReport'. This extension is defined by
- 'ProcessDataInvocation': 'processDataInvocationExtension':
- 'dpProcProcDataInvocExt': 'DataProcProcDataInvocExt':
- 'processCompletionReport' inherited from the parent **Data Processing**
- procedure. No further extension is defined, i.e.,
- 'ProcessDataInvocation': 'processDataInvocationExtension':
- 'dpProcProcDataInvocExt': 'DataProcProcDataInvocExt':
- 'dataProcProcDataInvocExtExtension' shall be set to 'notUsed'.

*****

- **NOTIFY Invocation**
- The extension of the **NOTIFY** invocation is inherited from the **Data**
- Processing procedure. The extension is defined in F4.8.
F4.10 PROCEDURE — SEQUENCE-CONTROLLED DATA PROCESSING PDUS

CCSDS—CSTS—SEQUENCE-CONTROLLED—DATA—PROCESSING—PDUS

{ iso(1) identified-organization(3) standards-producing-organization(112) ccsds(4)
  ccss(4) csts(1) framework(1) modules(1)
  sequenceControlledDataProcessingPdus(10)
}

DEFINITIONS
IMPLICIT TAGS ::= BEGIN

-- Main PDU exported to allow possible extension by derived procedures
EXPORTS SequContrDataProcessingPdu;

IMPORTS ConditionalTime
, DataUnitId
, Embedded
, Extended
FROM CCSDS-CSTS-COMMON-TYPES

  scdpExtProcedureParam
FROM CCSDS-CSTS-OBJECT-IDENTIFIERS

  CstsFrameworkPdu
FROM CCSDS-CSTS-PDUS
;

--=====================================================================
-- The first part of the module definition defines the PDU containing
-- the operations used by the Sequence-Controlled Data Processing
-- procedure.
--=====================================================================

SequContrDataProcessingPdu ::= CstsFrameworkPdu (WITH COMPONENTS
{ startInvocation
, startReturn
, stopInvocation
, stopReturn
, processDataInvocation
, processDataReturn
, notifyInvocation
, executeDirectiveInvocation
, executeDirectiveAcknowledge
, executeDirectiveReturn
} )

--=====================================================================
-- The second part of the module defines the operations
-- of the Data Processing procedure.
--=====================================================================

-- All operations are defined in the module
-- CCSDS-CSTS-COMMON-OPERATIONS-PDUS (see F4.4).
-- The third part contains the types used by the operations
-- defined in the second part.

-- This procedure does not have specific definitions.

-- The fourth part of the module definition contains the Extended
-- types used by the operations defined in the second part.

-- *****
-- START Invocation
-- The START invocation is extended with the additional parameter
-- 'firstDataUnitId'. This extension is defined by 'StartInvocation' :
-- 'startInvocationExtension': 'scdpStartInvocExt':
-- 'SeqContrDataProcStartInvocExt'. No further parameters are added, i.e.,
-- 'StartInvocation': 'startInvocationExtension': 'scdpStartInvocExt':
-- 'SeqContrDataProcStartInvocExt':
-- 'seqContrDataProcStartInvocExtExtension' shall be set to 'notUsed'.

sequContrDataProcStartInvocExt ::= SEQUENCE
{ firstDataUnitId          DataUnitId
  , seqContrDataProcStartInvocExtExtension
}

scdpStartInvocExt OBJECT IDENTIFIER ::= (scdpExtProcedureParam 1)

-- START return
-- The START positive return does not extend StartReturn, i.e.,
-- 'StartReturn': 'StandardReturnHeader': 'result': 'positive' shall be set
to 'notUsed'.
-- The START negative return does not extend StartReturn, i.e.,
-- 'StartReturn': 'StandardReturnHeader': 'result': 'negative':
-- 'negExtension' shall be set to 'notUsed'.
-- The START negative return makes use of: (a) one of the common
diagnostics of 'StandardReturnHeader': 'result': 'negative':
-- 'diagnostic': 'Diagnostic' (see 3.3.2.7 and F.4.3) except
-- 'DiagnosticExtension', or (b) one of the additional values specified by
-- 'StartReturn': 'StandardReturnHeader': 'result': 'negative':
-- 'diagnostic': 'Diagnostic': 'diagnosticExtension': 'startDiagnosticExt':
-- 'StartDiagnosticExt' in F.4.4 except 'startDiagnosticExtExtension'.

-- *****
-- STOP Invocation
-- The STOP invocation is not extended, i.e., 'StopInvocation' :
-- 'stopInvocationExtension' shall be set to 'notUsed'.

-- STOP return
-- The STOP positive return does not extend StopReturn, i.e., 'StopReturn':
-- 'StandardReturnHeader': 'result': 'positive' shall be set to 'notUsed'.
-- The STOP negative return does not extend StopReturn, i.e., 'StopReturn':
-- 'StandardReturnHeader': 'result': 'negative': 'negExtension' shall be
to 'notUsed'.
-- The STOP negative return makes use of one of the common diagnostics
-- of 'StandardReturnHeader': 'result': 'negative': 'diagnostic':
-- 'Diagnostic' (see 3.3.2.7 and F.4.3) except 'DiagnosticExtension'.

October 2018
**CCSDS 921.1**

**SequContrDataProcProcDataNegReturnExt** -

The PROCESS-DATA invocation is extended with the additional parameter 'earliestDataProcessingTime' and 'latestDataProcessingTime' defined by 'ProcessDataInvocation': 'processDataInvocationExtension':

- 'dpProcDataInvocExt': 'DataProcDataInvocExt':
- 'dataProcDataInvocExtExtension': 'scdpProcDataInvocExt':
- 'SequContrDataProcDataInvocExtExtension': No further parameters are added to the PROCESS-DATA invocation, i.e., 'ProcessDataInvocation':
- 'processDataInvocationExtension': 'dpProcDataInvocExt':
- 'DataProcDataInvocExt': 'dataProcDataInvocExtExtension':
- 'scdpProcDataInvocExt': 'SequContrDataProcDataInvocExt':
- 'sequContrDataProcDataInvocExtExtension' shall be set to 'notUsed'.

**SequContrDataProcProcDataInvocExt** ::= SEQUENCE

```plaintext
{   earliestDataProcessingTime                     ConditionalTime
,   latestDataProcessingTime                      ConditionalTime
,   sequContrDataProcDataInvocExtExtension       Extended }
```

**scdpProcDataInvocExt** OBJECT IDENTIFIER ::= (scdpExtProcedureParam 2)

**--- ***** ---**

**SequContrDataProcProcDataPosReturnExt** -

The PROCESS-DATA positive return extends ProcessDataReturn defined below by adding the parameter 'dataUnitId'. This extension is defined by 'ProcessDataReturn': 'StandardReturnHeader': 'result':

- 'positive': 'scdpProcDataPosReturnExt':
- 'sequContrDataProcDataPosReturnExt': No further parameters are added to the PDU, i.e., 'ProcessDataReturn': 'StandardReturnHeader': 'result':

**SequContrDataProcProcDataPosReturnExt** ::= SEQUENCE

```plaintext
{   dataUnitIdPosRtn                                DataUnitId
,   sequContrDataProcDataPosReturnExtExtension    Extended }
```

**scdpProcDataPosReturnExt** OBJECT IDENTIFIER ::= (scdpExtProcedureParam 3)

**SequContrDataProcProcDataNegReturnExt** -

The PROCESS-DATA negative return extends ProcessDataReturn by adding the parameter 'dataUnitId'. This extension is defined by 'ProcessDataReturn': 'StandardReturnHeader': 'result': 'negative':

- 'negExtension': 'scdpProcDataNegReturnExt':
- 'sequContrDataProcDataNegReturnExt': No further parameters are added to the PDU, i.e., 'ProcessDataReturn':

**SequContrDataProcProcDataNegReturnExt** ::= SEQUENCE

```plaintext
{   dataUnitIdNegRtn                                DataUnitId
,   sequContrDataProcDataNegReturnExtExtension    Extended }
```
scdpProcDataNegReturnExt OBJECT IDENTIFIER ::= {scdpExtProcEDUREParaM 5}

-- The PROCESS-DATA negative return makes use of: (a) one of the common
-- diagnostics of 'StandardReturnHeader': 'result': 'negative';
-- 'diagnostic': 'Diagnostic' (see 3.3.2.7 and F4.3) except
-- 'diagnosticExtension'; or (b) one of the additional diagnostics defined
-- by 'ProcessDataReturn': 'StandardReturnHeader': 'result': 'negative';
-- 'diagnostic': 'Diagnostic': 'diagnosticExtension':
-- 'scdpProcDataDiagExt': 'SequContrDataProcProcDataDiagnosticExt' in F4.10
-- except 'sequContrDataProcProcDataDiagnosticExtExtension'.
SeqContrDataProcProcDataDiagnosticExt ::= CHOICE
  { unableToProcess [0] NULL,
    serviceInstanceLocked [1] NULL,
    outOfSequence [2] NULL,
    inconsistentTimeRange [3] NULL,
    invalidTime [4] NULL,
    lateData [5] NULL,
    dataError [6] NULL,
    unableToStore [7] NULL,
    sequContrDataProcProcDataDiagnosticExtExtension [100] Embedded
  }

scdpProcDataDiagExt OBJECT IDENTIFIER ::= {scdpExtProcEDUREParaM 4}

-- *****
-- NOTIFY:
-- The NotifyInvocation type is defined in F4.4.
-- NOTIFY invocation extension:
-- This procedure defines the additional eventName values 'expired' and
-- 'locked' (see 4.8.4.3.4). The associated Published Identifiers are
-- pSCDPexpired and pSCDPlocked as defined in F4.16.
-- Further NOTIFY invocation extensions are inherited from the parent Data
-- Processing procedure. These extensions are defined in F4.8. Additional
-- values of the processing-status parameter are introduced by means of the
-- extension 'NotifyInvocation': 'notifyInvocationExtension':
-- 'dpNotifyInvocExt': 'DataProcNotifyInvocExt': 'dataUnitIdLastProcessed':
-- 'dataProcessingStatusExtension': 'scdpNotifyProcStatusExt':
-- 'SequContrDataProcStatus'. No further processing-status values are
-- added, i.e., 'NotifyInvocation': 'notifyInvocationExtension':
-- 'dpNotifyInvocExt': 'DataProcNotifyInvocExt': 'dataUnitLastProcessed':
-- 'dataProcessingStatus':
-- 'dataProcessingStatusExtension': 'scdpNotifyProcStatusExt':
-- 'SequContrDataProcStatus' must not be set to
-- 'sequContrDataProcStatusExtension'.
SequContrDataProcStatus ::= CHOICE
  { expired [1] NULL,
    processingNotStarted [2] NULL,
    sequContrDataProcStatusExtension[100] Embedded
  }

scdpNotifyProcStatusExt OBJECT IDENTIFIER ::= {scdpExtProcEDUREParaM 6}
*****
EXECUTE-DIRECTIVE invocation
In the EXECUTE-DIRECTIVE invocation the parameter directive-identifier
shall be set to 'reset', i.e., 'ExecuteDirectiveInvocation':
'directiveIdentifier' shall be set to the Published Identifier
(pSCDPdirectivesId 1).
The directive-qualifier parameter is defined by
'ExecuteDirectiveInvocation': 'directiveQualifier':
'localProcDirQualifier': 'DirectiveQualifierValues':
'parameterlessValues': 'TypeAndValueComplex': 'TypeAndValue':
'TypeAndValue': 'intUnsigned': 'SEQUENCE OF intUnsigned' where this
SEQUENCE has the length 1. The 'directiveQualifier' parameter is
not extended and must therefore not be set to
'directiveQualifierExtension'.

The EXECUTE-DIRECTIVE invocation is not extended, i.e.,
'ExecuteDirectiveInvocation': 'execute DirectiveInvocationExtension'
shall be set to 'notUsed'.

EXECUTE-DIRECTIVE acknowledgement
The EXECUTE-DIRECTIVE positive acknowledgement is not extended, i.e.,
'ExecuteDirectiveAcknowledge': 'StandardAcknowledgeHeader':
'StandardReturnHeader': 'result': 'positive' shall be set to 'notUsed'.
The EXECUTE-DIRECTIVE negative acknowledgement is not extended, i.e.,
'ExecuteDirectiveAcknowledge': 'StandardAcknowledgeHeader':
'StandardReturnHeader': 'result': 'negative': 'negExtension' shall be
set to 'notUsed'.

The EXECUTE-DIRECTIVE negative acknowledgement makes use of: (a) one of
the common diagnostics of 'StandardReturnHeader': 'result': 'negative':
'diagnostic': 'Diagnostic' (see 3.3.2.7); or (b) one of the additional
diagnostics defined by 'ExecuteDirectiveAcknowledge':
'StandardAcknowledgeHeader': 'StandardReturnHeader': 'result':
'negative': 'diagnostic': 'Diagnostic': 'diagnosticExtension':
'execDirAckDiagExt': 'ExecDirNegAckDiagnosticExt'. No further
diagnostics are specified, i.e., 'ExecuteDirectiveAcknowledge':
'StandardAcknowledgeHeader': 'StandardReturnHeader': 'result':
'negative': 'diagnostic': 'Diagnostic': 'diagnosticExtension':
'execDirAckDiagExt': 'ExecDirNegAckDiagnosticExt' must not be set to
'execDirNegAckDiagnosticExtExtension'.

EXECUTE-DIRECTIVE return
The EXECUTE-DIRECTIVE positive return is not extended, i.e.,
'ExecuteDirectiveReturn': 'StandardReturnHeader': 'result': 'positive'
shall be set to 'notUsed'.
The EXECUTE-DIRECTIVE negative return is not extended, i.e.,
'ExecuteDirectiveReturn': 'StandardReturnHeader': 'result': 'negative':
'negExtension' shall be set to 'notUsed'.
The EXECUTE-DIRECTIVE negative return makes use of: (a) one of the
common diagnostics of 'StandardReturnHeader': 'result': 'negative':
'diagnostic': 'Diagnostic' (see 3.3.2.7 and F4.3) except
'diagnosticExtension'; or (b) one of the additional diagnostics defined
by 'ExecuteDirectiveReturn': 'StandardReturnHeader': 'result':
'negative': 'diagnostic': 'Diagnostic': 'diagnosticExtension':
'execDirNegReturnDiagnosticExt': 'ExecDirNegReturnDiagnosticExt'in F4.4
except 'execDirNegReturnDiagnosticExtExtension'.

END
F4.11 PROCEDURE — INFORMATION QUERY PDUS

CCSDS—CSTS—INFORMATION—QUERY—PDUS
{ iso(1) identified-organization(3) standards-producing-organization(112)
  ccsds(4) css(4) csts(1) framework(1) modules(1) informationQueryPdus(11)
}

DEFINITIONS
IMPLICIT TAGS
::= BEGIN

-- Main PDU exported to allow possible extension by derived procedures
EXPORTS InformationQueryPdu
;

IMPORTSCstsFrameworkPdu
  FROM CCSDS—CSTS—PDUS

-- The first part of the module definition defines the PDU containing
-- the operations used by the Information Query procedure.

InformationQueryPdu ::= CstsFrameworkPdu (WITH COMPONENTS
  { getInvocation,
    getReturn
  })

-- The second part of the module defines the operations
-- of the Information Query procedure.

-- All operations are defined in the module
-- CCSDS—CSTS—COMMON—OPERATIONS—PDUS (see F4.4)

-- The third part contains the types used by the operations
-- defined in the second part.
-- This procedure does not have specific definitions.

-- The fourth part of the module definition contains the Extended
-- types used by the operations defined in the second part.
-- This procedure does not have specific extensions.

END
F4.12 PROCEDURE — CYCLIC REPORT PDUS

CCSDS-CSTS-CYCLIC-REPORT-PDUS
{ iso(1) identified-organization(3) standards-producing-organization(112)
  ccsds(4) css(4) csts(1) framework(1) modules(1) cyclicReportPdus(12) }

DEFINITIONS
IMPLICIT TAGS
 ::= BEGIN

-- Main PDU exported to allow possible extension by derived procedures
EXPORTSCyclicReportPdu;

IMPORTSAdditionalText
  , Embedded
  , Extended
  , IntPos
  , ListOfParametersEvents
  , ListOfParamEventsDiagnostics
  , QualifiedParameter
FROM CCSDS-CSTS-COMMON-TYPES

UnbufferedDataDeliveryPdu
FROM CCSDS-CSTS-UNBUFFERED-DATA-DELIVERY-PDUS

crExtProcedureParam
FROM CCSDS-CSTS-OBJECT-IDENTIFIERS
;

-- The first part of the module definition defines the PDU containing
-- the operations used by the Cyclic Report procedure.
-- The Cyclic Report procedure is derived from the Unbuffered Data
-- Delivery procedure. Its PDU is cast as the type of the PDU defined in
-- the Unbuffered Data Delivery procedure: UnbufferedDataDeliveryPdu type
-- defined in F4.6.

CyclicReportPdu ::= UnbufferedDataDeliveryPdu

-- The second part of the module defines the operations
-- of the Cyclic Report procedure.
-- All operations are defined in the module
-- CCSDS-CSTS-COMMON-OPERATIONS-PDUS (see F4.4)

-- The third part contains the types used by the operations
-- defined in the second part.
-- This procedure does not have specific definitions.
-- The fourth part of the module definition contains the Extended
-- types used by the operations defined in the second part.

-- *****
-- START Invocation
-- The START invocation is extended with the additional parameters
-- 'deliveryCycle' and 'listOfParameters'. This extension is defined by
-- 'StartInvocation': 'startInvocationExtension': 'crStartInvocExt':
-- 'CyclicReportStartInvocExt'. No further parameters are added to
-- StartInvocation, i.e., 'StartInvocation': 'startInvocationExtension':
-- 'crStartInvocExt': 'CyclicReportStartInvocExt':
-- 'cyclicReportStartInvocExt Extension' shall be set to 'notUsed'.

CyclicReportStartInvocExt ::= SEQUENCE
{   deliveryCycle IntPos,
    listOfParametersListOfParametersEvents,
    cyclicReportStartInvocExtExtension Extended
}


-- START return
-- The START positive return does not extend StartReturn, i.e.,
-- 'StartReturn': 'StandardReturnHeader': 'result': 'positive' shall be set
-- to 'notUsed'.
-- The START negative return does not extend StartReturn, i.e.,
-- 'StartReturn': 'StandardReturnHeader': 'result': 'negative':
-- 'negExtension' shall be set to 'notUsed'.
-- The START negative return makes use of: (a) one of the common
-- diagnostics of 'StandardReturnHeader': 'result': 'negative':
-- 'diagnostic': 'Diagnostic' (see 3.3.2.7 and F4.3) except
-- 'diagnosticExtension'; or (b) one of the additional
-- diagnostics defined by 'StartReturn': 'StandardReturnHeader': 'result':
-- 'negative': 'diagnostic': 'Diagnostic': 'diagnosticExtension':
-- 'startDiagnosticExt': 'StartDiagnosticExt' in F4.4 except
-- 'startDiagnosticExtExtension'; or (c) one of the additional
-- diagnostics defined by 'StartReturn': 'StandardReturnHeader': 'result':
-- 'negative': 'diagnostic': 'Diagnostic': 'diagnosticExtension':
-- 'startDiagnosticExt': 'StartDiagnosticExt':
-- 'startDiagnosticExtExtension': 'crStartDiagExt':
-- 'CyclicReportStartDiagnosticExt' in F4.12 except
-- 'cyclicReportStartDiagnosticExtExtension'.

CyclicReportStartDiagnosticExt ::= CHOICE
{   common [0]ListOfParamEventsDiagnostics,
    outOfRange [1] AdditionalText,
    cyclicReportStartDiagnosticExtExtension[100] Embedded
}


-- *****
-- STOP Invocation
-- The STOP invocation is not extended, i.e., 'StopInvocation':
-- 'stopInvocationExtension' shall be set to 'notUsed'.

---
— STOP return
— The STOP positive return does not extend StopReturn, i.e., 'StopReturn':
— 'StandardReturnHeader': 'result': 'positive' shall be set to 'notUsed'.
— The STOP negative return does not extend StopReturn, i.e., 'StopReturn':
— 'StandardReturnHeader': 'result': 'negative': 'negExtension' shall be
— set to 'notUsed'.
— The STOP negative return makes use of one of the common diagnostics
— of 'StandardReturnHeader': 'result': 'negative': 'diagnostic':
— 'Diagnostic' (see 3.3.2.7 and F4.3) except 'diagnosticExtension'.

*****
— TRANSFER-DATA invocation
— The TRANSFER-DATA invocation is not extended, i.e.,
— 'TransferDataInvocation': 'transferDataInvocationExtension' shall be set
— to 'notUsed'.
— The TRANSFER-DATA invocation parameter data is refined to carry
— the list-of-parameters-values information and is therefore defined as
— follows: 'TransferDataInvocation': 'data': 'AbstractChoice':
— 'extendedData': 'crTransferDataInvocDataRef':
— 'CyclicReportTransferDataInvocDataRef'. 'TransferDataInvocation':
— 'data': 'AbstractChoice': 'extendedData': 'crTransferDataInvocDataRef':
— 'CyclicReportTransferDataInvocDataRef':
— 'cyclicReportTransferDataInvocDataRefExtension' shall be set to
— 'notUsed'.

CyclicReportTransferDataInvocDataRef ::= SEQUENCE
{ qualifiedParameters SEQUENCE OF QualifiedParameter
, cyclicReportTransferDataInvocDataRefExtension Extended
}

crTransferDataInvocDataRef OBJECT IDENTIFIER ::= {crExtProcedureParam 3}

END
F4.13  PROCEDURE — NOTIFICATION PDUS

CCSDS-CSTS-NOTIFICATION-PDUS
{ iso(1) identified-organization(3) standards-producing-organization(112)
  ccsds(4) css(4) csts(1) framework(1) modules(1) notificationPdus(13)
}

DEFINITIONS
IMPLICIT TAGS
::= BEGIN

-- Main PDU exported to allow possible extension by derived procedures
EXPORTS NotificationPdu
;

IMPORTS Embedded,
   Extended,
   ListOfParametersEvents,
   ListOfParamEventsDiagnostics
FROM CCSDS-CSTS-COMMON-TYPES

nExtProcedureParam
FROM CCSDS-CSTS-OBJECT-IDENTIFIERS

CstsFrameworkPdu
FROM CCSDS-CSTS-PDUS
;

-- ==============================================================
-- The first part of the module definition defines the PDU containing
-- the operations used by the Notification procedure.
-- ==============================================================
NotificationPdu ::= CstsFrameworkPdu (WITH COMPONENTS
{ startInvocation
 , startReturn
 , stopInvocation
 , stopReturn
 , notifyInvocation
 })

-- ==============================================================
-- The second part of the module defines the operations
-- of the Notification procedure.
-- ==============================================================
-- All operations are defined in the module
-- CCSDS-CSTS-COMMON-OPERATIONS-PDUS (see F4.4)
-- ==============================================================
-- The third part contains the types used by the operations
-- defined in the second part.
-- ==============================================================
-- This procedure does not have specific definitions.
The fourth part of the module definition contains the Extended types used by the operations defined in the second part.

**START Invocation**

The START invocation is extended with the additional parameter 'listOfEvents' specifying the events that shall be notified. This extension is defined by 'StartInvocation': 'startInvocationExtension': 'nStartInvocExt': 'NotificationStartInvocExt': 'notificationStartInvocExtExtension' shall be set to 'notUsed'.

```
NotificationStartInvocExt ::= SEQUENCE {
  listOfEvents ListOfParametersEvents,
  notificationStartInvocExtExtension Extended
}
```

```
nStartInvocExt OBJECT IDENTIFIER ::= {nExtProcedureParam 1}
```

**START return**

The START positive return does not extend StartReturn, i.e., 'StartReturn': 'StandardReturnHeader': 'result': 'positive' shall be set to 'notUsed'.

**STOP Invocation**

The STOP invocation is not extended, i.e., 'StopInvocation': 'stopInvocationExtension' shall be set to 'notUsed'.
-- STOP return
-- The STOP positive return does not extend StopReturn, i.e., 'StopReturn':
-- 'StandardReturnHeader': 'result': 'positive' shall be set to 'notUsed'.
-- The STOP negative return does not extend StopReturn, i.e., 'StopReturn':
-- 'StandardReturnHeader': 'result': 'negative': 'negExtension' shall be
-- set to 'notUsed'.
-- The STOP negative return makes use of one of the common diagnostics
-- of 'StandardReturnHeader': 'result': 'negative': 'diagnostic':
-- 'Diagnostic' (see 3.3.2.7 and F4.3) except 'diagnosticExtension'.

END
F4.14 PROCEDURE — THROW EVENTS PDUS

CCSDS-CSTS-THROW-EVENT-PDUS
{ iso(1) identified-organization(3) standards-producing-organization(112) ccsds(4)
  css(4) csts(1) framework(1) modules(1) throwEventPdus(14)
}

DEFINITIONS
IMPLICIT TAGS
::= BEGIN

-- Main PDU exported to allow possible extension by derived procedures
EXPORTS ThrowEventPdu;

IMPORTS Embedded
FROM CCSDS-CSTS-COMMON-TYPES
  teExtProcedureParam
FROM CCSDS-CSTS-OBJECT-IDENTIFIERS
  CstsFrameworkPdu
FROM CCSDS-CSTS-PDUS;

-- ===============================================================

-- The first part of the module definition defines the PDU containing
-- the operations used by the Throw Event procedure.
-- ==============================================================

ThrowEventPdu ::= CstsFrameworkPdu (WITH COMPONENTS
{ executeDirectiveInvocation,
  executeDirectiveAcknowledge,
  executeDirectiveReturn
})

-- ==============================================================

-- The second part of the module defines the operations
-- of the Throw Event procedure.
-- ==============================================================

-- All operations are defined in the module
-- CCSDS-CSTS-COMMON-OPERATIONS-PDUS (see F4.4)
-- ==============================================================

-- The third part contains the types used by the operations
-- defined in the second part.
-- ==============================================================

-- This procedure does not have specific definition.
-- ==============================================================

-- The fourth part of the module definition contains the Extended
-- types used by the operations defined in the second part.
-- ==============================================================
--- *****
- EXECUTE-DIRECTIVE invocation
  - The EXECUTE-DIRECTIVE invocation is not extended, i.e.,
    - 'ExecuteDirectiveInvocation': 'executeDirectiveInvocationExtension'
    - shall be set to 'notUsed'.
- EXECUTE-DIRECTIVE acknowledgement
  - The EXECUTE-DIRECTIVE positive acknowledgement is not extended, i.e.,
    - 'ExecuteDirectiveAcknowledge': 'StandardAcknowledgeHeader':
      - 'StandardReturnHeader': 'result': 'positive' shall be set to 'notUsed'.
  - The EXECUTE-DIRECTIVE negative acknowledgement is not extended, i.e.,
    - 'ExecuteDirectiveAcknowledge': 'StandardAcknowledgeHeader':
      - 'StandardReturnHeader': 'result': 'negative': 'negExtension' shall be
        - set to 'notUsed'.
  - The EXECUTE-DIRECTIVE negative acknowledgement makes use of: (a) one of
    - the common diagnostics of 'StandardReturnHeader': 'result': 'negative':
      - 'diagnostic': 'Diagnostic' (see 3.3.2.7); or (b) one of the additional
        - diagnostics defined by 'ExecuteDirectiveAcknowledge':
      - 'StandardReturnHeader': 'result': 'negative': 'diagnostic':
        - 'diagnosticExtension': 'execDirAckAckDiagExt':
      - 'ExecDirNegAckDiagnosticExt'. No further diagnostics are specified,
        - i.e., 'ExecuteDirectiveAcknowledge': 'StandardReturnHeader': 'result':
          - 'negative': 'diagnostic': 'Diagnostic': 'diagnosticExtension':
      - 'execDirAckAckDiagExt': 'ExecDirNegAckDiagnosticExt' must not be set to
        - 'execDirNegAckDiagnosticExtExtension'.
- EXECUTE-DIRECTIVE return
  - The EXECUTE-DIRECTIVE positive return is not extended, i.e.,
    - 'ExecuteDirectiveReturn': 'StandardReturnHeader': 'result': 'positive'
    - shall be set to 'notUsed'.
  - The EXECUTE-DIRECTIVE negative return is not extended, i.e.,
    - 'ExecuteDirectiveReturn': 'StandardReturnHeader': 'result': 'negative'
    - 'negExtension' shall be set to 'notUsed'.
  - The EXECUTE-DIRECTIVE negative return makes use of: (a) one of the
    - common diagnostics of 'StandardReturnHeader': 'result': 'negative':
      - 'diagnostic': 'Diagnostic' (see 3.3.2.7 and F4.3) except
        - 'diagnosticExtension'; or (b) one of the additional diagnostics defined
          - by 'ExecuteDirectiveReturn': 'StandardReturnHeader': 'result':
            - 'negative': 'diagnostic': 'Diagnostic': 'diagnosticExtension':
      - 'execDirNegReturnDiagnosticExt': 'ExecDirNegReturnDiagnosticExt' in F4.4
        - except 'execDirNegReturnDiagnosticExtExtension'; or (c) one of the
          - additional diagnostics defined by 'ExecuteDirectiveReturn':
            - 'StandardReturnHeader': 'result': 'negative': 'diagnostic':
              - 'Diagnostic': 'diagnosticExtension': 'execDirNegReturnDiagnosticExt':
                - 'ExecDirNegReturnDiagnosticExt':
      - 'execDirNegReturnDiagnosticExtExtension': 'teExecDirDiagExt':
    - 'teExecDirNegReturnDiagnosticExt' in F4.14 except
      - 'teExecDirNegReturnDiagnosticExtExtension'.
  TeExecDirNegReturnDiagnosticExt ::= CHOICE
    { guardConditionEvaluatedToFalse [0] NULL,
      teExecDirNegReturnDiagnosticExtExtension [100] Embedded
    }
  teExecDirDiagExt OCTET STRING IDENTIFIER ::= {teExtProcedureParam 1}

END
F4.15 CSTS FRAMEWORK PROTOCOL DATA UNITS

CCSDS-CSTS-PDUS
{ iso(1) identified-organization(3) standards-producing-organization(112)
  ccsds(4) css(4) csts(1) framework(1) modules(1) cstsFrameworkPdus(15)
 }

DEFINITIONS
IMPLICIT TAGS
::= BEGIN

EXPORTS CstsFrameworkPdu
;

IMPORTS BindInvocation
,   BindReturn
,   PeerAbortInvocation
,   UnbindInvocation
,   UnbindReturn
FROM CCSDS-CSTS-ASSOCIATION-CONTROL-TYPES

   ExecuteDirectiveAcknowledge
,   ExecuteDirectiveInvocation
,   ExecuteDirectiveReturn
,   GetInvocation
,   GetReturn
,   NotifyInvocation
,   ProcessDataInvocation
,   ProcessDataReturn
,   StartInvocation
,   StartReturn
,   StopInvocation
,   StopReturn
,   TransferDataInvocation
FROM CCSDS-CSTS-COMMON-OPERATIONS-PDUS

   ReturnBuffer
FROM CCSDS-CSTS-BUFFERED-DATA-DELIVERY-PDUS

   ForwardBuffer
FROM CCSDS-CSTS-BUFFERED-DATA-PROCESSING-PDUS
;


CCSDS RECOMMENDED STANDARD FOR CSTS SPECIFICATION FRAMEWORK

--================================================================================================
-- The Pdu type lists all possible PDUs that can be exchanged between
-- the user and the provider.
--================================================================================================

CstsFrameworkPdu ::= CHOICE
  { bindInvocation [0] BindInvocation,
    bindReturn [1] BindReturn,
    unbindInvocation [2] UnbindInvocation,
    unbindReturn [3] UnbindReturn,
    peerAbortInvocation [4] PeerAbortInvocation,
    startInvocation [10] StartInvocation,
    startReturn [11] StartReturn,
    stopInvocation [20] StopInvocation,
    stopReturn [21] StopReturn,
    executeDirectiveAcknowledge [31] ExecuteDirectiveAcknowledge,
    getInvocation [40] GetInvocation,
    getReturn [41] GetReturn,
    notifyInvocation [50] NotifyInvocation,
    processDataInvocation [60] ProcessDataInvocation,
    processDataReturn [61] ProcessDataReturn,
    forwardBuffer [62] ForwardBuffer,
    transferDataInvocation [70] TransferDataInvocation,
    returnBuffer [71] ReturnBuffer }

--================================================================================================
-- The CstsFrameworkTopPdu is another name for CstsFrameworkPdu.
-- This type is added to cover the case of a compiler that does not
-- recognize CstsFrameworkPdu as being a top level PDU.
--================================================================================================

CstsFrameworkTopPdu ::= CstsFrameworkPdu

END
F4.16 CSTS SPECIFICATION FRAMEWORK PROCEDURE PARAMETERS, EVENTS, AND DIRECTIVES

CCSDS–CSTS–FW–PROCEDURE–PARAMETERS–EVENTS–DIRECTIVES
{ iso(1) identified-organization(3) standards-producing-organization(112)
cosds(4) csi(4) csts(1) framework(1) modules(1)
procedureParamEventDirective(16)
}

DEFINITIONS
IMPLICIT TAGS
::= BEGIN

IMPORTS fwProceduresFunctionalities
FROM CCSDS–CSTS–OBJECT–IDENTIFIERS

ServiceInstanceIdentifier
FROM CCSDS–CSTS–SERVICE–INSTANCE–ID

AuthorityIdentifier,
BufferSize,
DataTransferMode,
DeliveryLatencyLimit,
DeliveryMode,
IntPos,
Label,
ProcessingLatencyLimit,
ServiceUserRespTimer
FROM CCSDS–CSTS–COMMON–TYPES
;

--======================================================================
-- FRAMEWORK CROSS SUPPORT IDENTIFIERS
--======================================================================

-- ASSOCIATION CONTROL
procAssociationControl OBJECT IDENTIFIER ::= { fwProceduresFunctionalities 1}
procAssociationControlParametersId OBJECT IDENTIFIER ::= { procAssociationControl 1}
procAssociationControlEventsId OBJECT IDENTIFIER ::= { procAssociationControl 2}
procAssociationControlDirectivesId OBJECT IDENTIFIER ::= { procAssociationControl 3}
procAssociationControlServiceUserRespTimer OBJECT IDENTIFIER ::= { procAssociationControlParametersId 1}
procAssociationControlInitiatorId OBJECT IDENTIFIER ::= { procAssociationControlParametersId 2}
procAssociationControlResponderId OBJECT IDENTIFIER ::= { procAssociationControlParametersId 3}
procAssociationControlServiceInstanceId OBJECT IDENTIFIER ::= { procAssociationControlParametersId 4}

PACserviceUserRespTimerType ::= ServiceUserRespTimer

PACinitiatorIdType ::= AuthorityIdentifier
PACinitiatorIdTypeExt OBJECT IDENTIFIER ::= { PACinitiatorId 1}

PACresponderIdType ::= AuthorityIdentifier
PACresponderIdTypeExt OBJECT IDENTIFIER ::= { PACresponderId 1}

PACserviceInstanceIdType ::= ServiceInstanceIdentifier
PACserviceInstanceIdTypeExt OBJECT IDENTIFIER ::= { PACserviceInstanceId 1}
-- UNBUFFERED DATA DELIVERY
procUnbuffDataDelivery  OBJECT IDENTIFIER ::= 
  {fwProceduresFunctionalities 2}

pUBDpparametersId  OBJECT IDENTIFIER ::= {procUnbuffDataDelivery 1}
pUBDeventsId  OBJECT IDENTIFIER ::= {procUnbuffDataDelivery 2}
pUBDdirectivesId  OBJECT IDENTIFIER ::= {procUnbuffDataDelivery 3}

-- BUFFERED DATA DELIVERY
procBuffDataDelivery  OBJECT IDENTIFIER ::= 
  {fwProceduresFunctionalities 3}

pBDpparametersId  OBJECT IDENTIFIER ::= {procBuffDataDelivery 1}
pBDeventsId  OBJECT IDENTIFIER ::= {procBuffDataDelivery 2}
pBDDirectivesId  OBJECT IDENTIFIER ::= {procBuffDataDelivery 3}
pBDDreturnBufferSize  OBJECT IDENTIFIER ::= {pBDpparametersId 1}
pBDDdeliveryMode  OBJECT IDENTIFIER ::= {pBDpparametersId 2}
pBDDdeliveryLatencyLimit  OBJECT IDENTIFIER ::= {pBDpparametersId 3}
pBDDbufferOverflow  OBJECT IDENTIFIER ::= {pBDpparametersId 4}
pBDDendOfData  OBJECT IDENTIFIER ::= {pBDpparametersId 5}
pBDDconfigurationChange  OBJECT IDENTIFIER ::= {pBDpparametersId 6}

pBDDreturnBufferSizeType  ::= BufferSize
pBDDdeliveryLatencyLimitType  ::= DeliveryLatencyLimit
pBDDdeliveryModeType  ::= DeliveryMode

-- DATA PROCESSING
procDataProcessing  OBJECT IDENTIFIER ::= {fwProceduresFunctionalities 4}

pDPparametersId  OBJECT IDENTIFIER ::= {procDataProcessing 1}
pDPeventsId  OBJECT IDENTIFIER ::= {procDataProcessing 2}
pDPDirectivesId  OBJECT IDENTIFIER ::= {procDataProcessing 3}
pDPinputQueueSize  OBJECT IDENTIFIER ::= {pDPparametersId 1}
pDPdataProcessingCompleted  OBJECT IDENTIFIER ::= {pDPeventsId 1}
pDPCconfigurationChange  OBJECT IDENTIFIER ::= {pDPeventsId 2}

pDPinputQueueSizeType  ::= BufferSize

-- BUFFERED DATA PROCESSING
procBufferDataProcessing  OBJECT IDENTIFIER ::= 
  {fwProceduresFunctionalities 5}

pBDpparametersId  OBJECT IDENTIFIER ::= {procBufferDataProcessing 1}
pBDpeventsId  OBJECT IDENTIFIER ::= {procBufferDataProcessing 2}
pBDDirectivesId  OBJECT IDENTIFIER ::= {procBufferDataProcessing 3}
pBDptransferMode  OBJECT IDENTIFIER ::= {pBDpparametersId 1}
pBDpmaxForwardBufferSize  OBJECT IDENTIFIER ::= {pBDpparametersId 2}
pBDpprocessingLatencyLimit  OBJECT IDENTIFIER ::= {pBDpparametersId 3}

pBDptransferModeType  ::= DataTransferMode
pBDpmaxForwardBufferSizeType  ::= BufferSize
pBDpprocessingLatencyLimitType  ::= ProcessingLatencyLimit
SEQUENCE CONTROLLED DATA PROCESSING

procSeqControlledDataProcess OBJECT IDENTIFIER ::= 

{fwProceduresFunctionalities 6}

pSCDPparametersId OBJECT IDENTIFIER ::= 

{procSeqControlledDataProcess 1}

pSCDPeventsId OBJECT IDENTIFIER ::= 

{procSeqControlledDataProcess 2}

pSCDPdirectivesId OBJECT IDENTIFIER ::= 

{procSeqControlledDataProcess 3}

pSCDexpired OBJECT IDENTIFIER ::= (pSCDPeventsId 1)

pSCDlocked OBJECT IDENTIFIER ::= (pSCDPeventsId 2)

pSCDPresetDirective OBJECT IDENTIFIER ::= (pSCDPdirectivesId 1)

INFORMATION QUERY

procInformationQuery OBJECT IDENTIFIER ::= 

{fwProceduresFunctionalities 7}

pIQparametersId OBJECT IDENTIFIER ::= (procInformationQuery 1)

pIQeventsId OBJECT IDENTIFIER ::= (procInformationQuery 2)

pIQdirectivesId OBJECT IDENTIFIER ::= (procInformationQuery 3)

pIQnamedLabelLists OBJECT IDENTIFIER ::= (pIQparametersId 1)

Note: In case the service user selects a procedure type in the GET
-- invocation, the service provider will return the same list of
-- parameters for each active instance of the selected procedure type.

pIQnamedLabelListsType Ext OBJECT IDENTIFIER ::= {pIQnamedLabelLists 1}

CYCLIC REPORT

procCyclicReport OBJECT IDENTIFIER ::= 

{fwProceduresFunctionalities 8}

pCparametersId OBJECT IDENTIFIER ::= (procCyclicReport 1)

pCeventsId OBJECT IDENTIFIER ::= (procCyclicReport 2)

pCdirectivesId OBJECT IDENTIFIER ::= (procCyclicReport 3)

pCnamedLabelLists OBJECT IDENTIFIER ::= (pCparametersId 1)

pCminimumAllowedDeliveryCycle OBJECT IDENTIFIER ::= (pCparametersId 2)

pCnamedLabelListsType ::= LabelListSet

pCminimumAllowedDeliveryCycleType ::= IntPos

pCnamedLabelListsTypeExt OBJECT IDENTIFIER ::= {pCnamedLabelLists 1}

NOTIFICATION

procNotification OBJECT IDENTIFIER ::= 

{fwProceduresFunctionalities 9}

pNparametersId OBJECT IDENTIFIER ::= (procNotification 1)

pNeventsId OBJECT IDENTIFIER ::= (procNotification 2)

pNdirectivesId OBJECT IDENTIFIER ::= (procNotification 3)

pNnamedLabelLists OBJECT IDENTIFIER ::= (pNparametersId 1)

pNnamedLabelListsType ::= LabelListSet

pNnamedLabelListsTypeExt OBJECT IDENTIFIER ::= {pNnamedLabelLists 1}
-- THROW EVENT
procThrowEvent OBJECT IDENTIFIER ::= {fwProceduresFunctionalities 10}
pTEparametersId OBJECT IDENTIFIER ::= {procThrowEvent 1}
pTEeventsId OBJECT IDENTIFIER ::= {procThrowEvent 2}
pTEDirectivesId OBJECT IDENTIFIER ::= {procThrowEvent 3}

-- Additional types for the Framework Functional Resource
LabelList ::= SEQUENCE {
  name VisibleString,
  defaultList BOOLEAN,
  labels SEQUENCE OF Label
}

LabelListSet ::= SET OF LabelList

-- Only one list in the set can be the default list.

END
F4.17 CSTS GENERIC SERVICE OBJECT IDENTIFIERS

CCSDS-CSTS-GENERIC-SERVICE-OBJECT-IDENTIFIERS
{ iso(1) identified-organization(3) standards-producing-organization(112)
  ccstds(4) css(4) csts(1) framework(1) modules(1)
  serviceGenericIdentifiers(17)
}

DEFINITIONS
IMPLICIT TAGS
::= BEGIN

IMPORTS serviceGenericIdentifiers
       FROM CCSDS-CSTS-OBJECT-IDENTIFIERS

       ProductionStatus
       FROM CCSDS-CSTS-COMMON-TYPES
;

-- -----------
-- FRAMEWORK CROSS SUPPORT SERVICE IDENTIFIERS
--
-- Service generic Identifiers:

svcParametersId OBJECT IDENTIFIER ::= {serviceGenericIdentifiers 1}
svcEventsId OBJECT IDENTIFIER ::= {serviceGenericIdentifiers 2}
svcDirectivesId OBJECT IDENTIFIER ::= {serviceGenericIdentifiers 3}

svcProductionStatus OBJECT IDENTIFIER ::= {svcParametersId 1}
svcProductionStatusVersion1 OBJECT IDENTIFIER ::= {svcProductionStatus 1}

SvcProductionStatusVersion1 ::= ProductionStatus

svcProductionStatusChange OBJECT IDENTIFIER ::= {svcEventsId 1}
svcProductionStatusChangeVersion1 OBJECT IDENTIFIER ::= {svcProductionStatusChange 1}

svcProductionConfigurationChange OBJECT IDENTIFIER ::= {svcEventsId 2}
svcProductionConfigurationChangeVersion1 OBJECT IDENTIFIER ::= {svcProductionConfigurationChange 1}

END
ANNEX G

SERVICE STATE TABLES

(NORMATIVE)

G1 OVERVIEW

The state machine of a CSTS is determined by the state type (stateless or stateful) of the procedure that the service uses for its prime procedure instance.

G2 STATE MACHINE FOR CSTSES WITH A STATELESS PRIME PROCEDURE INSTANCE

NOTE – This subsection specifies the state machine for a CSTS that has a stateless prime procedure.

G2.1 An instance of the CSTS shall have one of two states: ‘unbound’ (state 1) or ‘bound’ (state 2).

G2.2 When the state of a CSTS instance’s Association Control procedure is ‘unbound’, the state of the CSTS shall be ‘unbound’ (state 1).

G2.3 When the state of a CSTS instance’s Association Control procedure is ‘bound’, the state of the CSTS shall be ‘bound’ (state 2).

NOTE – The states of the Association Control procedure and the events that cause transitions between them are defined in 4.3.6.

G2.4 Each CSTS with stateless prime procedure shall conform to the state table for a CSTS instance defined in table Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 8,Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll.-1, supported by information in tables Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 8,Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll.-2 through Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 8,Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll.-4.

G2.5 The state table for a CSTS with a stateless prime procedure instance may be extended to support extended behavior that is associated with that CSTS.
**Table 1:** State Table for CSTSes with a Stateless Prime Procedure Instance

<table>
<thead>
<tr>
<th>No.</th>
<th>Incoming Event</th>
<th>State 1 ('unbound')</th>
<th>State 2 ('bound')</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>(BindInvocation)</td>
<td>IF &quot;positive result&quot; THEN (+BindReturn) → 2 ELSE (-BindReturn) ENDIF</td>
<td>(PeerAbortInvocation 'protocol error') (clean up) → 1</td>
</tr>
<tr>
<td>2</td>
<td>‘abort-causing event xxx’</td>
<td>[ignore]</td>
<td>(PeerAbortInvocation ‘xxx’) (clean up) → 1</td>
</tr>
<tr>
<td>3</td>
<td>(UnbindInvocation)</td>
<td>[ignore]</td>
<td>IF &quot;positive result&quot; THEN (+unbindReturn) (clean up) → 1 ELSE (-unbindReturn) ENDIF</td>
</tr>
<tr>
<td>4</td>
<td>(PeerAbortInvocation)</td>
<td>[ignore]</td>
<td>(clean up) → 1</td>
</tr>
<tr>
<td>5</td>
<td>‘not authenticated PDU’</td>
<td>[ignore]</td>
<td>[ignore]</td>
</tr>
<tr>
<td>6</td>
<td>‘invalid PDU ‘xxx’’</td>
<td>(PeerAbortInvocation ‘xxx’)</td>
<td>(PeerAbortInvocation ‘xxx’) → 1</td>
</tr>
<tr>
<td>7</td>
<td>‘protocol abort’</td>
<td>[ignore]</td>
<td>(clean up) → 1</td>
</tr>
</tbody>
</table>

**Table 2:** State Table for CSTSes with a Stateless Prime Procedure Instance: Event Description References

<table>
<thead>
<tr>
<th>Event</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘abort-causing event xxx’</td>
<td>An event has occurred that is designated as resulting in an abort of the association (3.6). The values for ‘xxx’ are identical to the values of the diagnostic parameter of the PEER-ABORT operation defined in 3.6.2.2.</td>
</tr>
<tr>
<td>‘not authenticated PDU’</td>
<td>3.2.4.5.1</td>
</tr>
<tr>
<td>‘invalid PDU ‘xxx’’</td>
<td>3.2.3.6, 4.2.2.4. ‘xxx’ is one of the diagnostic values specified in 4.2.2.5</td>
</tr>
<tr>
<td>‘protocol abort’</td>
<td>4.3.3.1.11.5</td>
</tr>
</tbody>
</table>
**Table** Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 8, Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll.-3: State Table for CSTSes with a Stateless Prime Procedure Instance: Predicate Descriptions

<table>
<thead>
<tr>
<th>Predicate</th>
<th>Evaluates to TRUE if</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;positive result&quot;</td>
<td>No reason for sending a negative return has been detected.</td>
</tr>
</tbody>
</table>

**Table** Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 8, Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll.-4: State Table for CSTSes with a Stateless Prime Procedure Instance: Compound Action Definitions

<table>
<thead>
<tr>
<th>Name</th>
<th>Actions Performed</th>
</tr>
</thead>
</table>
| {clean up} | stop all return timers  
reset parameter values to those specified in the service package |

**G3** STATE MACHINE FOR CSTSES WITH A STATEFUL PRIME PROCEDURE INSTANCE

**NOTE** – This subsection specifies the state machine for a CSTS that has a stateful prime procedure instance.

**G3.1** An instance of a CSTS shall have one of two states: ‘unbound’ (state 1) or ‘bound’ (state 2).

**G3.2** When the state of a CSTS instance’s Association Control procedure is ‘unbound’, the state of the CSTS shall be ‘unbound’ (1).

**NOTE** – In state 1, all resources required to enable the provision of the service have been allocated and all objects required to provide the service have been instantiated. However, no association yet exists between the service user and the service provider (i.e., the transfer service provider port is not bound).

**G3.3** When the state of a CSTS instance’s Association Control procedure is ‘bound’, the state of the CSTS shall be ‘bound’ (2).

**NOTE** – The states of the Association Control procedure and the events that cause transitions between them are defined in 4.3.6. In state 2, an association has been established between the service user and the service provider, and they may interact by means of the operations defined by the procedures of which the service is composed.

**G3.4** An instance of a CSTS in the ‘bound’ state shall have one of two substates: ‘bound.ready’ (substate 2.1) or ‘bound.active’ (substate 2.2).
G3.5 The CSTS instance shall be in the ‘bound.ready’ (2.1) substate when the CSTS instance is in the ‘bound’ state and its prime procedure instance is in the ‘inactive’ state (see 4.2.4).

G3.6 The CSTS instance shall be in the ‘bound.active’ (2.2) substate when the CSTS instance is in the ‘bound’ state and its prime procedure instance is in the ‘active’ state.

NOTE – Secondary procedures required by the service may act independently of the substrates 2.1 and 2.2 of the state ‘bound’.

G3.7 The service instance shall remain in the ‘bound.active’ substate until the prime procedure instance transitions back to the state ‘inactive’ as specified 4.2.4.

G3.8 Each CSTS that has a stateful prime procedure instance shall conform to the state table for a CSTS defined in table Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 8,Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll.-5, supported by information in tables Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 8,Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll.-6 through Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 8,Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll.-8.

G3.9 The state table for a CSTS with a stateful prime procedure instance may be extended to support extended behavior that is associated with that CSTS.

Table Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 8,Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll.-5: State Table for CSTSes with a Stateful Prime Procedure Instance

<table>
<thead>
<tr>
<th>No.</th>
<th>Incoming Event</th>
<th>State 1 (‘unbound’)</th>
<th>State 2.1 (‘bound.ready’)</th>
<th>State 2.2 (‘bound.active’)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>(BindInvocation)</td>
<td>IF “positive result” THEN (+BindReturn) $\rightarrow$ 2.1 ELSE (-BindReturn) ENDIF</td>
<td>(PeerAbortInvocation ‘protocol error’) (clean up) $\rightarrow$ 1</td>
<td>(PeerAbortInvocation ‘protocol error’) (clean up) $\rightarrow$ 1</td>
</tr>
<tr>
<td>2</td>
<td>‘transition to active’</td>
<td>[ignore] $\rightarrow$ 2.2</td>
<td>Not applicable</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>‘transition to inactive’</td>
<td>[ignore]</td>
<td>(PeerAbortInvocation ‘protocol error’) $\rightarrow$ 1</td>
<td>$\rightarrow$ 2.1</td>
</tr>
<tr>
<td>4</td>
<td>‘abort-causing event xxx’</td>
<td>[ignore]</td>
<td>(PeerAbortInvocation ‘xxx’) $\rightarrow$ 1</td>
<td>(PeerAbortInvocation ‘xxx’) $\rightarrow$ 1</td>
</tr>
<tr>
<td>No.</td>
<td>Incoming Event</td>
<td>State 1 (‘unbound’)</td>
<td>State 2.1 (‘bound.ready’)</td>
<td>State 2.2 (‘bound.active’)</td>
</tr>
<tr>
<td>-----</td>
<td>----------------</td>
<td>---------------------</td>
<td>--------------------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>5</td>
<td>(UnbindInvocation)</td>
<td>[ignore]</td>
<td>IF “positive result” THEN (+unbindReturn) (clean up) → 1 ELSE (-unbindReturn) ENDIF</td>
<td>(PeerAbortInvocation ‘protocol error’) → 1</td>
</tr>
<tr>
<td>6</td>
<td>(PeerAbortInvocation)</td>
<td>[ignore]</td>
<td>[clean up] → 1</td>
<td>[clean up] → 1</td>
</tr>
<tr>
<td>7</td>
<td>‘protocol abort’</td>
<td>[ignore]</td>
<td>[clean up] → 1</td>
<td>[clean up] → 1</td>
</tr>
<tr>
<td>8</td>
<td>‘not authenticated PDU’</td>
<td>[ignore]</td>
<td>[ignore]</td>
<td>[ignore]</td>
</tr>
<tr>
<td>9</td>
<td>‘invalid PDU ’xxx’</td>
<td>[ignore]</td>
<td>(PeerAbortInvocation ‘xxx’) → 1</td>
<td>(PeerAbortInvocation ‘xxx’) → 1</td>
</tr>
</tbody>
</table>

**Table** Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 8, Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll.-6: **State Table for CSTSes with a Stateful Prime Procedure Instance: Event Description References**

<table>
<thead>
<tr>
<th>Event</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘abort-causing event xxx’</td>
<td>An event has occurred that is designated as resulting in an abort of the association (3.6). The values for ‘xxx’ are identical to the values of the diagnostic parameter of the PEER-ABORT operation defined in 3.6.2.2.</td>
</tr>
<tr>
<td>‘transition to active’</td>
<td>Internal event from the prime procedure signaling that it has transitioned to the ‘active’ state (see 4.2.4).</td>
</tr>
<tr>
<td>‘transition to inactive’</td>
<td>Internal event from the prime procedure signaling that it has transitioned to the ‘inactive’ state (see 4.2.4).</td>
</tr>
<tr>
<td>‘protocol abort’</td>
<td>4.3.3.1.11.5</td>
</tr>
<tr>
<td>‘not authenticated PDU’</td>
<td>3.2.4.5.1</td>
</tr>
<tr>
<td>‘invalid PDU ’xxx’</td>
<td>3.2.3.6, 4.2.2.4. ‘xxx’ is one of the diagnostic values specified in 4.2.2.5.</td>
</tr>
</tbody>
</table>

**Table** Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 8, Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll.-7: **State Table for CSTSes with a Stateful Prime Procedure Instance: Predicate Descriptions**

<table>
<thead>
<tr>
<th>Predicate</th>
<th>Evaluates to TRUE if</th>
</tr>
</thead>
<tbody>
<tr>
<td>“positive result”</td>
<td>No reason for sending a negative return has been detected.</td>
</tr>
</tbody>
</table>
### State Table for CSTSes with a Stateful Prime Procedure Instance: Compound Action Definitions

<table>
<thead>
<tr>
<th>Name</th>
<th>Actions Performed</th>
</tr>
</thead>
<tbody>
<tr>
<td>{clean up}</td>
<td>stop all return timers</td>
</tr>
<tr>
<td></td>
<td>reset parameter values to those specified in the service package</td>
</tr>
</tbody>
</table>
ANNEX H

SECURITY, SANA, AND PATENT CONSIDERATIONS

(INFORMATIVE)

H1 SECURITY ASPECTS OF CROSS SUPPORT TRANSFER SERVICES

H1.1 INTRODUCTION

This subsection describes security aspects that are common to CSTSes based on the CSTS Specification Framework. Service specifications based on this Recommended Standard are expected to reference the description provided herein and add a discussion of service-specific security aspects where applicable.

H1.2 SECURITY BACKGROUND AND OVERVIEW

The CSTS Specification Framework explicitly provides authentication and access control for CSTSes. Additional security capabilities, if required, are levied on the underlying communications services that support the CSTS. CSTSes are defined as layered application services operating over underlying communications services that must meet certain requirements but which are otherwise unspecified. Selection of the underlying communications services over which real CSTS implementations connect is based on the requirements of the communicating parties and/or the availability of CCSDS-standard communications technology profiles and proxy specifications. Different underlying communications technology profiles are intended to address not only different performance requirements but also different security requirements. Missions and service providers are expected to select from these technology profiles to acquire the performance and security capabilities appropriate to the mission. Specification of the various underlying communications technologies, and in particular their associated security provisions, are outside the scope of this Recommended Standard.

NOTE – A CCSDS-standard communications technology profile for CSTS is specified by reference [2].

H1.3 STATEMENTS OF SECURITY CONCERNS

H1.3.1 General

This subsection identifies the support of the CSTS Specification Framework for capabilities that respond to security concerns in the areas of data privacy, data integrity, authentication, access control, availability of resources, and auditing.
H1.3.2 Data Privacy (Also Known as Confidentiality)

The CSTS Specification Framework does not define explicit data privacy requirements or capabilities to ensure data privacy. Data privacy is expected to be ensured outside of the Cross Support Transfer Service layer in the underlying communications service.

H1.3.3 Data Integrity

The CSTS Specification Framework defines and enforces a strict sequence of operations that constrain the ability of a third party to inject operation invocations or responses into the transfer service association between a service user and service provider. This constrains the ability of a third party to seize control of an active Cross Support Transfer Service instance without detection.

NOTE – The CSTS Specification Framework requires that the underlying communications service transfer data in sequence, completely and with integrity, without duplication, with flow control that notifies the application layer in the event of congestion, and with notification to the application layer in the event that communication between the service user and the service provider is disrupted (see 1.3.1). The ISP-1 protocol (reference [2]) which is assumed to be used does provide these capabilities.

H1.3.4 Authentication

This CSTS Specification Framework defines authentication requirements (see 3.2.4), and defines initiator-identifier, responder-identifier, invoker-credentials, and performer-credentials parameters of the service operation invocations and responses that are used to perform CSTS authentication. The CSTS authentication capability can be selectively set to authenticate at one of three levels: authenticate every CSTS PDU, authenticate only the BIND operation invocation and return, or perform no authentication. Depending upon the inherent authentication available from the underlying communication network, the security environment in which the service user and service provider are operating, and the security requirements of the spaceflight mission, the CSTS authentication level can be adapted by choosing the operation invocation and responses that are to be authenticated. Furthermore the mechanism used for generating and checking the credentials, and thus the level of protection against masquerading (simple or strong authentication) can be selected in accordance with the results of a threat analysis. One possible procedure by which operation invocations and responses are authenticated is described in the Cross Support Service Green Book (reference [Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 8,Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll.2]). Although the procedure as presented in reference [Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 8,Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll.2] refers to SLE transfer services, it can equally be applied to CSTSes.
H1.3.5 Access Control

This CSTS Specification Framework defines access control requirements (see 4.3.3.1.12), and defines *initiator-identifier* and *responder-identifier* parameters of operation invocations and responses that are used to perform CSTS access control. The procedure by which access to a CSTS is controlled is described in the Cross Support Service Green Book (reference [Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 8,Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll.]). Although the procedure as presented in reference [Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 8,Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll.] refers to SLE transfer services, it can equally be applied to CSTSes.

H1.3.6 Availability of Resources

CSTSes are provided via communication networks that have some limit with respect to the resources available to support those services. If these resources can be diverted from their support of the CSTS (in what is commonly known as ‘denial of service’) then the performance of the CSTS may be curtailed or inhibited. This CSTS Specification Framework does not define explicit capabilities to prevent denial of service. Resource availability is expected to be ensured by appropriate capabilities in the underlying communications service. The specific capabilities will be dependent upon the technologies used in the underlying communications service and the security environment in which the transfer service user and service provider operate.

H1.3.7 Auditing

This CSTS Specification Framework does not define explicit security auditing requirements or capabilities. Security auditing is expected to be negotiated and implemented bilaterally between the spaceflight mission and the service provider.

H1.4 POTENTIAL THREATS AND ATTACK SCENARIOS

H1.4.1 Breach of Privacy

CSTSes in general depend on unspecified mechanisms operating in the underlying communications service or on privacy-ensuring capabilities in the service-specific application processes that interoperate through the CSTS Specification Framework procedures, to ensure data privacy (confidentiality). If no such mechanisms are actually implemented, or the mechanisms selected are inadequate or inappropriate to the network environment in which the mission is operating, an attacker could read the data contained in the CSTS protocol data units as they traverse the WAN between service user and service provider.
H1.4.2 PDU Interception and Replay

The CSTS Specification Framework constrains the ability of a third party to seize control of an active CSTS instance, but it does not specify mechanisms that would prevent an attacker from intercepting the protocol data units and replacing the contents of the parameter carried by the PDUs. The prevention of such a replacement attack depends on unspecified mechanisms in the underlying communications service, in unspecified (with respect to the CSTS Specification Framework) mechanisms in the service-specific application processes that interoperate through the CSTS Specification Framework procedures (e.g., specifying an encryption function as part of the standard service), or some combination of the two. If no such mechanisms are actually implemented, or the mechanisms selected are inadequate or inappropriate to the network environment in which the mission is operating, an attacker could substitute data transferred between the service user and the service provider without detection.

H1.4.3 Unauthenticated Access

If the CSTS authentication capability is not used and if authentication is not ensured by the underlying communications service, attackers could somehow obtain valid initiator-identifier values and use them to initiate CSTS instances by which they could gain access to the data transferred via these services or inject data for further processing by the service provider.

H1.4.4 Denial of Service Attacks

A CSTS depends on unspecified mechanisms operating in the underlying communications service to ensure that the supporting network has sufficient resources to provide sufficient support to legitimate service users. If no such mechanisms are actually implemented, or the mechanisms selected are inadequate or inappropriate to the network environment in which the mission is operating, an attacker could prevent legitimate service users from using the CSTS.

H1.4.5 Failure to Detect Breach Attempts

If the service provider of a CSTS provides no security auditing capabilities, or if a service user chooses not to employ auditing capabilities that do exist, then attackers may delay or escape detection while stealing or altering data exchanged via the service.

H1.5 CONSEQUENCES OF NOT APPLYING SECURITY

The consequences of not applying security to CSTS are possible degradation and loss of ability to use the service, or the substitution of altered data that are exchanged between the service user and service provider of that service. In particular the alteration of telecommand and telemetry data may seriously affect spacecraft safety.
H2 SANA CONSIDERATION

H2.1 GENERAL

This Recommended Standard requests SANA to extend the already existing registry for Object Identifiers and to create a new registry to capture the specification of Functional Resources as described below. New assignments in these registries, in conformance with the modifications identified, will be shown at the global SANA registry Web site: https://sanaregistry.org. Therefore, the reader shall look at the SANA Web site for all the assignments contained in these registries.

Already registered registry entries shall not be affected by this Recommended Standard.

This Recommended Standard makes extensive use of Object Identifiers. All Object Identifiers specified by this Recommended Standard are part of OID subtrees the management of which has been delegated to the CSS Area. The structure of those subtrees is specified in annex D and extends the already existing OID registry that is administered by SANA on behalf of CCSDS. The SANA registry containing the overall CCSDS OID tree may be found at https://sanaregistry.org/oid/tree.

Annex K provides a graphical representation of the OID tree structure and the OID values relevant in the context of this Recommended Standard. The normative specification of the OID tree structure is provided in annex D while the normative assignment of OID values can be found in annex F.

H2.2 FRAMEWORK OBJECT IDENTIFIERS

Within the OID subtree the management of which has been delegated to the CSS Area a subtree shall be created that accommodates all OIDs associated with the present version of this Recommended Standard. The root node of this subtree shall be

\{iso(1) identified-organization(3) standards-producing-organization(112) ccsds(4) css(4) csts(1) framework(1)\}

The recommendations in this document request SANA to update the ‘CCSDS Object Identifiers (OID)’ registry by adding the OIDs and labels contained in the above identified subtree. The CSS Area provides the new OIDs and their labels to SANA in an Extensible Markup Language (XML) formatted file.

The assignment policy for this ‘framework’ subtree is that

a) new Object Identifiers shall be constructed as specified in D4;

b) new Object Identifiers shall be allocated in one or more of the subbranches of this subtree only in the context of the definition of new operations and additional extensions of the definitions of the operations, in case of new or additional derived
procedures and/or new ASN.1 modules specified in this Recommended Standard, i.e., only when a new issue of this Recommended Standard is approved.

NOTE – The engineering review of the proposed registry changes is implied by the CCSDS publication and approval process for Recommended Standards.

H2.3 SERVICE SPECIFIC OIDS

Within the OID subtree the management of which has been delegated to the CSS Area a subtree shall be created that accommodates all OIDs of CSTS types and, as applicable, service-type-specific derived services, parameters, procedures and ASN.1 modules, and the reference to the Functional Resource Type modeling the given service type. The root node of this subtree shall be

\{iso(1) identified-organization(3) standards-producing-organization(112) ccsds(4) css(4) csts(1) services(2)\}

The recommendations in those Recommended Standards that specify CSTSes based on this document request SANA to update the ‘CCSDS Object Identifiers (OID)’ registry by adding the OIDs and labels contained in the CSTS type specific part of the above identified subtree. The CSS Area provides the new OIDs and their labels to SANA in an XML formatted file.

The assignment policy for this ‘services’ subtree is that

a) new Object Identifiers shall be constructed as specified in D5;

b) new Object Identifiers shall be allocated within the subtree part allocated to the given CSTS type only in the context of the publication of the Recommended Standard specifying that CSTS type.

NOTE – The engineering review of the proposed registry changes is implied by the CCSDS publication and approval process for Recommended Standards.

In the context of the specification of a new CSTS type, should a data type be required that cannot be defined using the existing ASN.1 (TypeAndValue definition in F4.3), then the OID of the externally defined extension of TypeAndValue shall be inserted on the ‘externallyDefinedTypeAndValueExtension’ branch. The root node of the arc for extensions of the TypeAndValue definition shall be

\{iso(1) identified-organization(3) standards-producing-organization(112) ccsds(4) css(4) csts(1) externallyDefinedTypeAndValueExtensions(3)\}

The assignment policy is the same as for the ‘services’ subtree.
H2.4 FUNCTIONAL RESOURCE REGISTRY

Some of the operations specified in this Recommended Standard interact with Functional Resources for instance to read or set parameters or to be informed of the occurrence of certain events. The necessary identification and definition of these Functional Resource Types and the associated parameters, events, and directives are provided in a dedicated registry.

The recommendations in this document have created the local SANA registry named ‘Functional Resources’ located at https://sanaregistry.org/r/functional_resources/.

Informative material regarding the detailed content of this registry is provided in annex L of this Recommended Standard. The normative specification of how the records of this registry shall be built is provided in D6.

Within the OID subtree the management of which has been delegated to the CSS Area a subtree has been created that accommodates all the OIDs used to identify each record of the ‘Functional Resources’ registry. The root node of this subtree is

\{iso(1) identified-organization(3) standards-producing-organization(112) ccsds(4) css(4) crossSupportResources(2)\}

There are two subnodes under the ‘crossSupportResources’ node: ‘crossSupportFunctionalities’ and ‘agenciesFunctionalities’, used to register CCSDS-standard Functional Resource Types and Agency-specific Functional Resource Types, respectively. Under each Functional Resource Type OID, the parameters, events, and directives are registered, each under a dedicated subnode.

The Functional Resource registry is owned by the CSS Area which therefore is also the Review Authority of this registry. Any proposed change under the ‘crossSupportFunctionalities’ node of this registry, be it the addition of a Functional Resource type or the modification of a Functional Resource’s parameters, events, or directives, shall originate from the CSS Area and requires engineering review by that Area or an Expert Group, if such group is appointed by the CCSDS Management Council (CMC). The way that records of this part of the registry and in particular the associated OIDs shall be built is specified in D6.2.

Service providers, typically some Agency, may implement ‘private’ capabilities that are outside the functionality covered by the CCSDS specified Functional Resources but still of potential interest to cross support. Such service provider may, via a designated control authority, propose the registration of Functional Resources associated with such ‘private’ capabilities. If approved following the engineering review by the Review Authority, i.e., the CSS Area, SANA will be requested to update the registry part under the ‘agenciesFunctionalities’ node accordingly. The way that records of this part of the registry and in particular the associated OIDs shall be built is specified in D6.3.
H2.5 REGISTRIES OF ELEMENTS OF SERVICE INSTANCE IDENTIFIERS

A specific CSTS instance that a user wants to bind to is identified by means of the service-instance-identifier parameter of the BIND invocation. As specified in 3.4.2.2.7, the parameter consists of the following elements:

a) an identifier of the spacecraft being supported by the given CSTS instance;

b) an identifier of the facility where the CSTS provider is located;

c) an identifier of the CSTS type;

d) the service instance number.

The elements a), b), and c) are Object Identifiers.

Spacecraft are listed in the enterprise Spacecraft Registry located at http://sanaregistry.org/r/spacecraft. This registry among others assigns an OID to each spacecraft where all these OIDs are elements of the subtree the root node of which is

{iso(1) identified-organization(3) standards-producing-organization(112) ccsds(4) spacecraft(7)}

Facilities are listed in the enterprise Service Site and Aperture Registry located at http://sanaregistry.org/r/service_sites_apertures. This registry among others assigns an OID to each service site. The service site may be further broken down as applicable per aperture, per forward link and return link of that aperture and per frequency band supported on the forward link and return link, respectively. Depending on the entity the CSTS provider is associated with, the OID of the CSTS provider location is formed. The root node in any case is

{iso(1) identified-organization(3) standards-producing-organization(112) ccsds(4) service-site-and-aperture(6)}

Agencies or other service providers implementing CSTSes will also decide where these providers will be located in terms of facilities operated by this service provider and if such provider is common with respect to the given site or only available in conjunction with a specific aperture or frequency band of that aperture. The Registration Authority of this registry is SANA. Requests for the addition of new entries to this registry must come from the official representative, i.e., an Agency Representative (AR) with the service site Point of Contact (PoC) role, of a space agency or other organization that is a member of the CCSDS and desires to have a site registered as supporting the given CSTS type. The SANA Steering Group (SSG) serves as the Review Authority of this registry.

The subtree containing the CSTS type OIDs is addressed in H2.3. As to have the link between service sites discussed above and the CSTS types available at those sites it is recommended that service providing organizations offering CSTSes should add the OIDs of those CSTSes to the list of services available at that site in addition to the Initial Service Types listed in reference [6].
H3 PATENT CONSIDERATIONS

No patent rights are known to adhere to any of the specifications of this Recommended Standard
ANNEX I

INFORMATIVE REFERENCES

(INFORMATIVE)


ANNEX J

ABBREVIATIONS

(INFORMATIVE)

This annex lists the acronyms used in this Recommended Standard.

AD  Area Director
AR  Agency Representative
ASCII  American Standard Code for Information Interchange
ASN.1  Abstract Syntax Notation One
B  blocking operation
C  conditional
CCSDS  Consultative Committee for Space Data Systems
CMC  CCSDS Management Council
CSS  Cross Support Services
CSSS  Cross Support Service System
CSTS  Cross Support Transfer Services
DAD  Deputy Area Director
EM  Element Management (of an ESLT)
ESLT  Earth Space Link Terminal
ICS  implementation conformance statement
IEC  International Electrotechnical Commission
ISO  International Organization for Standardization
ISP  Internet Protocol for Transfer Services
M  mandatory
N/A  not applicable
NB  non-blocking operation
OID  object identifier
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>OSI</td>
<td>Open Systems Interconnection</td>
</tr>
<tr>
<td>PDU</td>
<td>protocol data unit</td>
</tr>
<tr>
<td>PICS</td>
<td>protocol implementation conformance statement</td>
</tr>
<tr>
<td>PM</td>
<td>Provision Management (of a Provider CSSS)</td>
</tr>
<tr>
<td>PoC</td>
<td>point of contact</td>
</tr>
<tr>
<td>RAF</td>
<td>Return All Frames (SLE)</td>
</tr>
<tr>
<td>RCF</td>
<td>Return Chanel Frame (SLE)</td>
</tr>
<tr>
<td>RL</td>
<td>requirements list</td>
</tr>
<tr>
<td>ROCF</td>
<td>Return Operational Control Field (SLE)</td>
</tr>
<tr>
<td>SANA</td>
<td>Space Assigned Numbers Authority</td>
</tr>
<tr>
<td>SF</td>
<td>stateful</td>
</tr>
<tr>
<td>SI</td>
<td>International System of Units</td>
</tr>
<tr>
<td>SL</td>
<td>stateless</td>
</tr>
<tr>
<td>SLE</td>
<td>Space Link Extension</td>
</tr>
<tr>
<td>TCP</td>
<td>Transmission Control Protocol</td>
</tr>
<tr>
<td>UM</td>
<td>Utilization Management (of an Earth User CSSS)</td>
</tr>
<tr>
<td>UTC</td>
<td>Universal Coordinated Time</td>
</tr>
<tr>
<td>WG</td>
<td>working group</td>
</tr>
<tr>
<td>XML</td>
<td>Extensible Markup Language</td>
</tr>
</tbody>
</table>
ANNEX K

OBJECT IDENTIFIERS

(INFORMATIVE)

Object identifiers (OID) are used for a unique and unambiguous identification of information exchanged by the services derived from the CSTS Specifications Framework. The Object Identifiers defined for the use by Cross Support Services as registered with SANA are shown in figure Figure: Cross Support Services Part of the CCSDS Object Identifiers Tree.

The Object Identifiers defined for the Cross Support Services are in turn broken down into two groups (see figure Figure: CSS Object Identifiers Tree):

a) the Object Identifiers defined for the use by CSTSes;

b) the Object Identifiers defined for the use of cross support resources.

The CSTS Object Identifiers are in turn subdivided into two subgroups, those required by this Recommended Standard, i.e., the CSTS Specification Framework, and those required by new
services. A third branch permits the external specification of data types for those cases where the types supported by this Recommended Standard are not sufficient (see figure Figure: CSTS Object Identifiers Tree).

The Object Identifiers defined for this Recommended Standard cover:

a) the modules: each ASN.1 module has its own identifier;

b) the identifiers of the operations specified in this Recommended Standard;

c) the identifiers of all procedures and associated extensions in terms of additional parameters;

d) procedure identifiers as used in the operations’ standard operation header and the identifiers of Framework Functional Resources of the Framework;

e) identifiers for generic service functionality such as production status or production configuration change events.

The Framework Object Identifier branches are shown in figure Figure: CSTS Object Identifiers Tree.
**Figure** Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 8,Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll.-4: CSTS Specification Framework

Object Identifiers Tree

This Recommended Standard defines the root Object Identifiers of new CSTSes (figure Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 8,Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll.-5). It is the responsibility of the service defining organization to specify individual Object Identifiers required by the new service, including the Object Identifiers of the derived procedures and of the transfer syntax used by the service (e.g., ASCII, XML, binary, …) as well as the OID of the reference towards the Functional Resource type modeling the given service type.

As an example the ASN.1 module as it would have to be created for the xyzService illustrated in figure Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 8,Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll.-5 is shown below. It should be
noted that this module does not reflect any real Object Identifier assignment; however, it is consistent with figure Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 8,Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll. The formal requirements for allocating the Object Identifiers can be found in annex D.

The Object Identifiers defined for individual services shall be used in the BIND operation for identifying the service type (see ServiceType definition in F4.5).

CCSDS-XYZ-SERVICE-OBJECT-IDENTIFIERS
{ iso(1) identifed-organization(3) standards-producing-organization(112)
ccsds(4) css(4) csts(1) services(2) xyzService(200)
xyzServiceModules(4) object-identifiers(1)
}

DEFINITIONS
IMPLICIT TAGS
::= BEGIN

IMPORTS services
FROM CCSDS-CSTS-OBJECT-IDENTIFIERS

PublishedIdentifier
FROM CCSDS-CSTS-COMMON-TYPES
;

— Object Identifiers definition for the service types (see annex D)
— -------------------------------------------------------------------------------------
— XYZ SERVICE OBJECT IDENTIFIERS

xyzService OBJECT IDENTIFIER ::= {services 200}
xyzDerivedServices OBJECT IDENTIFIER ::= {xyzService 1}
xyzExtendedServiceParameters OBJECT IDENTIFIER ::= {xyzService 2}
xyzServiceProcedures OBJECT IDENTIFIER ::= {xyzService 3}
xyzServiceModules OBJECT IDENTIFIER ::= {xyzService 4}
xyzServiceFrRef OBJECT IDENTIFIER ::= {xyzService 5}

xyzServiceFrRef ::= PublishedIdentifier

xyzExtSvcStartDataId OBJECT IDENTIFIER ::= {xyzExtendedServiceParameters 1}
xyzExtSvcTransferDataId OBJECT IDENTIFIER ::= {xyzExtendedServiceParameters 2}

badd OBJECT IDENTIFIER ::= {xyzServiceProcedures 1}
baddExtendedOpsParameters OBJECT IDENTIFIER ::= {badd 1}
baddExtendedProcParameters OBJECT IDENTIFIER ::= {badd 2}
baddEEventsId OBJECT IDENTIFIER ::= {badd 3}
baddDirectiveId OBJECT IDENTIFIER ::= {badd 4}

END

The Object Identifiers defined for Cross Support Resources cover the cross support functionalities defined by CCSDS and the specific functionalities defined by the Agencies making use of Cross Support Services (see figure Fehler! Verwenden Sie die Registerkarte
Cross Support Functionalities 

This branch lists the OIDs of the Functional Resource types defined by CCSDS. The list is registered with SANA.

Template FunctionalResourceType

This branch lists per Functional Resource type the Object Identifiers of the parameters, events and directives defined by CCSDS. The list is registered with SANA.

ParametersId

EventsId

DirectivesId

Agency Functionalities

This branch lists the OIDs of the Functional Resource types specific to an Agency.

Template FunctionalResourceType

This branch lists per Functional Resource type the Object Identifiers of agency-specific parameters, events and directives defined by the given agency.

ParametersId

EventsId

DirectivesId

Figure: Verwenden Sie die Registerkarte 'Start', um Heading 8, Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll.-6: CSTS Published Identifiers—Object Identifiers Tree
ANNEX L

PUBLISHED IDENTIFIERS FOR FUNCTIONAL RESOURCES REGISTERED UNDER THE CROSSESUPPORTFUNCTIONALITIES NODE

(INFORMATIVE)

An important aspect of cross support between agencies is that both parties have the same understanding of the applied configuration as well as of the status of service production and service provisioning. The details of service production in general depend on the specificities of the equipment deployed and the make of equipment varies with the service provider. A common understanding of configuration and status therefore must not be equipment specific. Rather a certain level of abstraction needs to be applied while maintaining an adequate level of detail overcomes equipment specific representation of the required information. To that end, CCSDS has developed a data dictionary specifying parameters, events, and directives needed to configure and monitor Cross Support Service production and provisioning.

In addition to identifying suitable parameters as such, these need to be grouped such that one can model the existence of multiple instances of the same functionality. For example, within the scope of a service package two physical return links may be processed, one in X-band and the other in Ka-band, each handled by a different receiver. Consequently one will need two instances of the parameters associated with a receiver. The granularity of the grouping of parameters must be chosen such that parameters associated with a functionality of which several instances may be required are grouped accordingly. Such functionality is referred to as Functional Resource.

Fundamental to the concept of Functional Resources is that each one represents a cohesive, atomic set of space communication functionality with which can be associated single instances of configuration parameters, monitored parameters, directives, and event notifications.

Functional Resources are not the physical resources (e.g., transmitters and receivers) that comprise real systems. Rather, they represent the functions or capabilities that are provided by those physical resources. A Functional Resource may be realized by several physical entities that work cooperatively to perform that function. Alternatively, for some types of Functional Resources, a single physical resource may be designed such that it instantiates several Functional Resources.

The concept of Functional Resources has been adopted as a core concept of this Recommended Standard, with standard Parameter Names being defined as having a Functional Resource identifier component. This Recommended Standard also defines a registration subtree for Functional Resource Type Object Identifiers (OIDs) under the CCSDS registration tree. Besides monitored parameters, the Functional Resource registration tree is
used to register OIDs for *notifiable events* and *directives* associated with each Functional Resource Type.

This annex is intended only to illustrate the registration tree by means of examples. The normative tree is registered with SANA and the examples provided in this annex may deviate from the SANA registry, which will evolve over time, e.g., because of the introduction of novel capabilities.

The root element of the registration tree is the `crossSupportFunctionalResources` node (cf. figure *Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 8,Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll.*). The branch under that node has a leaf for each of the Functional Resource Types. For each Functional Resource Type the associated parameters, notifiable events, and directives are specified. A subset of the Functional Resources is shown in figure *Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 8,Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll.*.

```
crossSupportFunctionalities (1)
  Antenna (1)
  Fwd401SpaceLinkCarrierXmit (2)
  FwdLinkRng (3)
  FwdTcPlopSyncAndChnlEncoding (4)
  FwdAosSyncAndChnlEncoding (5)
  Rtn401SpaceLinkCarrierRecpt (21)
  RtnLinkRngAndDopplerExtraction (22)
  RtnTmSyncAndChnlDecoding (23)
  RtnMcDemuxRecpt (24)
  RtnVcDemuxRecpt (25)
```
Since the number of parameters associated with a subcarrier on a return space link is moderate, this subset of parameters of the rtn401SpaceLinkCarrierReception is taken here as an example. For this Functional Resource neither notifiable events nor directives are discussed here. The parameters are shown in figure 1: Example Cross Support Functional Resources.

The structure shown so far illustrates how the Object Identifiers are constructed, and with that information individual Functional Resources and individual parameters can be accessed. For the information exchange between the parties participating in cross support more information on the parameters is required. As specified in E11.1, for each parameter, event, and directive the following items are to be specified:

a) a classifier;
b) a semantic definition;
c) a name in the form of an Object Identifier;
NOTE – If a suitable parameter already exists under on a subbranch different from the one where the parent Functional Resource is registered, the OID specified on the other subbranch will be used to name such parameter.

d) a syntax specification;
e) the value range;
f) the engineering unit(s);
g) a flag indicating if the definition has been deprecated;

NOTE – The deprecation flag indicates that at least one more recent version of the specification of the given parameter, event, or directive exists. The deprecated version can no longer be expected to be supported by providers of CSTSes.

h) a flag indicating if the given parameter can configured, i.e., if the Functional Resource has a directive that permits the setting of the value of this parameter;

NOTE – This flag does not imply that in a specific cross support scenario the given parameter can actually be set or modified by a CSTS user. The service provider may not have implemented such control capability or may decide not to grant such control in the context of a specific cross support scenario. The parameters that can be configured by a CSTS user should be identified in a service agreement governing the cross support arrangement.

i) the creation date.

Conceptually, all parameters specified for a given Functional Resource Type can be monitored. However, this does not imply that in a specific cross support scenario the given parameter can actually be monitored by a CSTS user. The service provider may not generate that parameter or may decide not to disclose it in the context of a specific cross support scenario. The parameters that are accessible by a CSTS user should be identified in a service agreement governing the cross support arrangement.

Tables Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 8,Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll.-1 and Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 8,Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll.-2 illustrate this using two parameters of the Rtn401SpaceLinkCarrierRecept Functional Resource Type. The semantic definition in table Fehler! Verwenden Sie die Registerkarte 'Start', um Heading 8,Annex Heading 1 dem Text zuzuweisen, der hier angezeigt werden soll.-1 shows that the parameter is expressed in dB. This is not an engineering unit per se, but a way to scale a dimensionless ratio. To ensure that the applied scaling is not overlooked, dB is shown as the applicable engineering unit.
### 1: Specification of the Subcarrier Level Estimate Parameter

<table>
<thead>
<tr>
<th>Classifier</th>
<th>rtn401CarrierRecptSubcarrierLevelEstimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Authorizing Entity</td>
<td>CSS Area</td>
</tr>
<tr>
<td>Creation Date</td>
<td>2016-02-07</td>
</tr>
<tr>
<td>Deprecation Flag</td>
<td>Not deprecated</td>
</tr>
<tr>
<td>Configured Flag</td>
<td>No</td>
</tr>
<tr>
<td>Object Identifier</td>
<td>1 3 112 4 4 2 1 21 1 20 1</td>
</tr>
<tr>
<td>Semantic Definition</td>
<td>This parameter reports the subcarrier to carrier power ratio expressed in (1/100 \text{ dBc}). If the applicable modulation scheme does not use a subcarrier, this parameter shall be flagged as undefined.</td>
</tr>
</tbody>
</table>
| Syntax Specification (see CCSDS 921.1) | 'QualifiedValue': 'valid': 'TypeAndValueComplexQualified': 'typeAndValue': 'TypeAndValue': 'integer': 'SEQUENCE (SIZE (1)) OF INTEGER (-20000 .. 0)'

<table>
<thead>
<tr>
<th>Value Range</th>
<th>Implied by syntax specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineering Unit(s)</td>
<td>(1/100 \text{ dBc})</td>
</tr>
</tbody>
</table>

### 2: Specification of the Subcarrier Lock Status Parameter

<table>
<thead>
<tr>
<th>Classifier</th>
<th>rtn401CarrierRecptSubcarrierLockStat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Authorizing Entity</td>
<td>CSS Area</td>
</tr>
<tr>
<td>Creation Date</td>
<td>2016-02-07</td>
</tr>
<tr>
<td>Deprecation Flag</td>
<td>Not deprecated</td>
</tr>
<tr>
<td>Configured Flag</td>
<td>No</td>
</tr>
<tr>
<td>Object Identifier</td>
<td>1 3 112 4 4 2 1 21 1 21 1</td>
</tr>
</tbody>
</table>
| Semantic Definition | This enumerated parameter reports on the subcarrier lock status of the BPSK subcarrier demodulator. The values the parameter may have are:
- 'locked' – the demodulator has locked on the return link subcarrier;
- 'notLocked' – the demodulator has not locked on the return link subcarrier and therefore cannot deliver telemetry.
If the applicable modulation scheme does not use a subcarrier, this parameter shall be flagged as undefined. |
| Syntax Specification (see CCSDS 921.1) | 'QualifiedValue': 'valid': 'TypeAndValueComplexQualified': 'typeAndValue': 'TypeAndValue': 'enumerated': 'SEQUENCE (SIZE (1)) OF INTEGER
{  locked (0)
,  notLocked (1)
}

| Value Range | Implied by syntax specification |
| Engineering Unit(s) | N/A |

All the above shown information items can be found for all parameters in the associated registry maintained by SANA.