The Consultative Committee for Space Data Systems

**Draft Specification Concerning
Space Data System Standards**

**SPACE LINK EXTENSION—
APPLICATION PROGRAM
INTERFACE FOR RETURN
ALL FRAMES SERVICE**

DRAFT RECOMMENDED PRACTICE

CCSDS 915.1-M-0

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FOREWORD

(WHEN THIS RECOMMENDED PRACTICE IS FINALIZED, IT WILL CONTAIN THE FOLLOWING FOREWORD:)

This document is a technical **Recommended Practice** for use in developing ground systems for space missions and has been prepared by the **Consultative Committee for Space Data Systems** (CCSDS). The Application Program Interface described herein is intended for missions that are cross-supported between Agencies of the CCSDS.

This **Recommended Practice** specifies service type specific extensions of the Space Link Extension Application Program Interface for Transfer Services specified by CCSDS (reference [4]). It allows implementing organizations within each Agency to proceed with the development of compatible, derived Standards for the ground systems that are within their cognizance. Derived Agency Standards may implement only a subset of the optional features allowed by the **Recommended Practice** and may incorporate features not addressed by the **Recommended Practice**.

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PREFACE

This document is a draft CCSDS Recommended Practice. Its draft status indicates that the CCSDS believes the document to be technically mature and has released it for formal review by appropriate technical organizations. As such, its technical contents are not stable, and several iterations of it may occur in response to comments received during the review process.

Implementers are cautioned **not** to fabricate any final equipment in accordance with this document's technical content.

DOCUMENT CONTROL

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1   INTRODUCTION

1.1   PURPOSE

The Recommended Practice 'Application Program Interface for Transfer Services – Core Specification' (reference [4]) specifies a C++ API for CCSDS Space Link Extension Transfer Services. The API is intended for use by application programs implementing SLE transfer services.

Reference [4] defines the architecture of the API and the functionality on a generic level, which is independent of specific SLE services and communication technologies. It is thus necessary to add service-type specific specifications in supplemental Recommended Practices. The purpose of this document is to specify extensions to the API needed for support of the Return All Frames (RAF) service defined in reference [3].

1.2   SCOPE

This Recommended Practice defines extensions to the SLE API in terms of:

   a) the RAF specific functionality provided by API components;

   b) the RAF specific interfaces provided by API components; and

   c) the externally visible behavior associated with the RAF interfaces exported by the components.

It does not specify

   a) individual implementations or products;

   b) the internal design of the components; and

   c) the technology used for communications.

This Recommended Practice only defines interfaces and behavior that must be provided by implementations supporting the Return All Frames service in addition to the specification in reference [4].

1.3   APPLICABILITY

The RAF Application Program Interface specified in this document supports two versions of the RAF service, namely:

   a) version 1 as specified by reference [2]; and

   b) version 2 as specified by reference [3].

Support for version 1 of these services is included for backward compatibility purposes for a limited time and may not be continued in future versions of this specification. Support for version 1 of the RAF service implies that SLE API implementations of this specification are

able to interoperate with peer SLE systems that comply with the specification of the Transport Mapping Layer (TML) in 'Specification of a SLE API Proxy for TCP/IP and ASN.1', ESOC, SLES-SW-API-0002-TOS-GCI, Issue 1.1, February 2001.

Any version dependent provisions within this Recommended Practice are marked as follows:

    a) [V1:] for provisions specific to version 1; and

    b) [V2:] for provisions specific to version 2.

1.4   RATIONALE

This Recommended Practice specifies the mapping of the RAF service specification to specific functions and parameters of the SLE API. It also specifies the distribution of responsibility for specific functions between SLE API software and application software.

The goal of this Recommended Practice is to create a standard for interoperability between:

    a) application software using the SLE API and SLE API software implementing the SLE API; and

    b) service user and service provider applications communicating with each other using the SLE API on both sides.

This interoperability standard also allows exchangeability of different products implementing the SLE API, as long as they adhere to the interface specification of this Recommended Practice.

1.5   DOCUMENT STRUCTURE

1.5.1   ORGANIZATION

This document is organized as follows:

    a) Section 1 provides purpose and scope of this specification, identifies conventions, and lists definitions and references used throughout the document;

    b) Section 2 provides an overview of the RAF service and describes the API model extension including support for the RAF service;

    c) Section 3 contains detailed specifications for the API components and for applications using the API;

    d) Annex A provides a formal specification of the API interfaces and data types specific to the RAF service;

    e) Annex B lists all acronyms used within this document;

    f) Annex C lists informative references.

1.5.2   SLE SERVICE DOCUMENTATION TREE

The SLE suite of recommendations is based on the cross support model defined in the SLE Reference Model (reference [1]). The services defined by the reference model constitute one of the three types of Cross Support Services:

   a)   Part 1: SLE Services;

   b)   Part 2: Ground Domain Services; and

   c)   Part 3: Ground Communications Services.

The SLE services are further divided into SLE service management and SLE transfer services.

The basic organization of the SLE services and SLE documentation is shown in figure 1-1. The various documents are described in the following paragraphs.
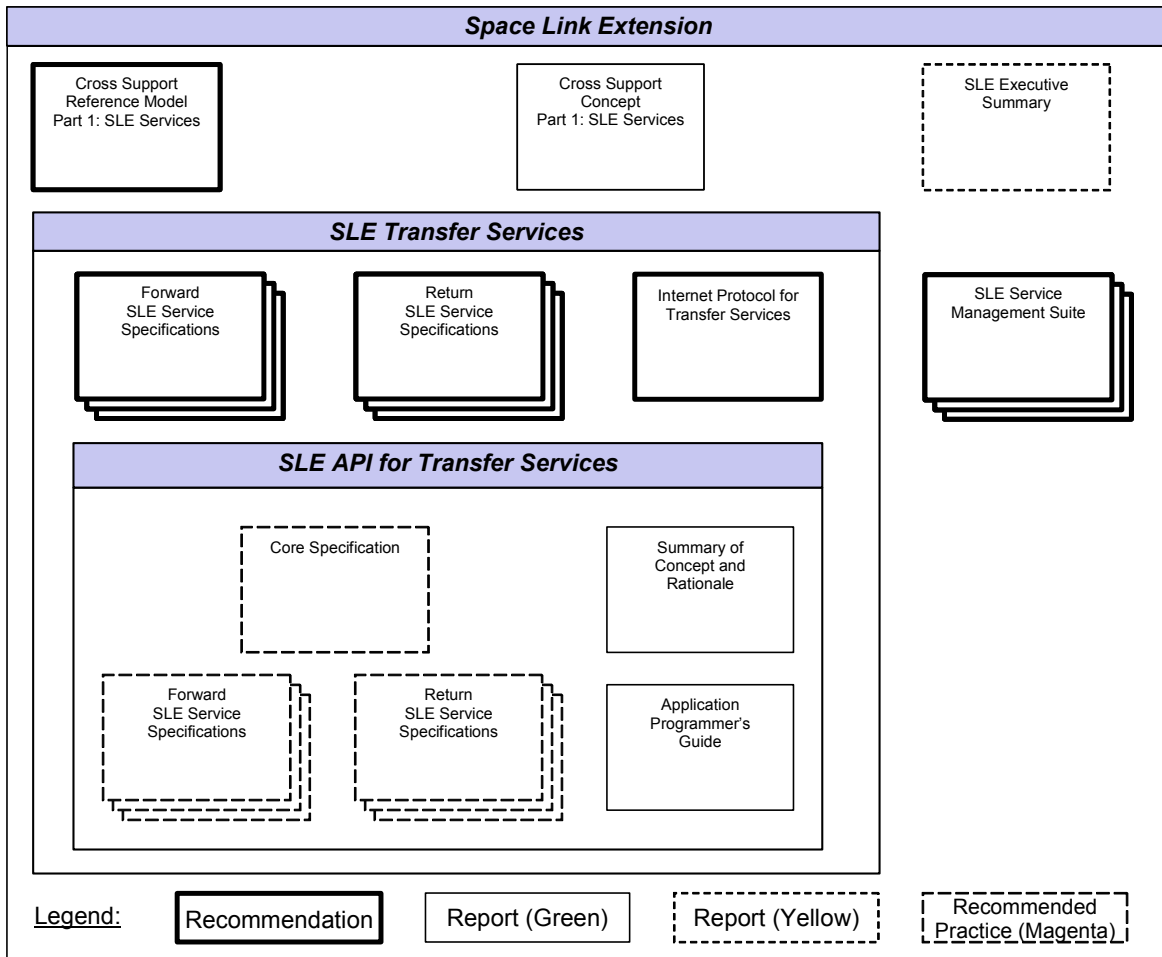

Figure 1-1: SLE Services and SLE API Documentation

a) *Cross Support Reference Model—Part 1: Space Link Extension Services*; a Recommendation that defines the framework and terminology for the specification of SLE services.

b) *Cross Support Concept—Part 1: Space Link Extension Services;* a Report introducing the concepts of cross support and the SLE services.

c) *Space Link Extension Services—Executive Summary;* an Administrative Report providing an overview of Space Link Extension (SLE) Services. It is designed to assist readers with their review of existing and future SLE documentation.

d) *Forward SLE Service Specifications;* a set of Recommendations that provide specifications of all forward link SLE services.

e) *Return SLE Service Specifications;* a set of Recommendations that provide specifications of all return link SLE services.

f) *Internet Protocol for Transfer Services;* a Recommendation providing the specification of the wire protocol used for SLE transfer services.

g) *SLE Service Management Specifications;* a set of Recommendations that establish the basis of SLE service management.

h) *Application Program Interface for Transfer Services—Core Specification;* a Recommended Practice document specifying the generic part of the API for SLE transfer services.

i) *Application Program Interface for Transfer Services—Summary of Concept and Rationale*; a Report describing the concept and rationale for specification and implementation of a Application Program Interface for SLE Transfer Services.

j) *Application Program Interface for Return Services;* a set of Recommended Practice documents specifying the service-type specific extensions of the API for return link SLE services.

k) *Application Program Interface for Forward Services;* a set of Recommended Practice documents specifying the service-type specific extensions of the API for forward link SLE services.

l) *Application Program Interface for Transfer Services—Application Programmer's Guide*; a Report containing guidance material and software source code examples for software developers using the API.

1.6 DEFINITIONS, NOMENCLATURE, AND CONVENTIONS

1.6.1 DEFINITIONS

1.6.1.1 Definitions from SLE Reference Model

This Recommended Practice makes use of the following terms defined in reference [1]:

    a) Return All Frames service (RAF service);

    b) operation;

    c) service provider (provider);

    d) service user (user);

    e) SLE transfer service instance;

    f) SLE transfer service production;

    g) SLE transfer service provision.

1.6.1.2 Definitions from RAF Service

This Recommended Practice makes use of the following terms defined in reference [3]

    a) association;

    b) communications service;

    c) confirmed operation;

    d) delivery mode;

    e) invocation;

    f) latency limit;

    g) lock status;

    h) notification;

    i) offline processing latency;

    j) parameter;

    k) performance;

    l) port identifier;

    m) production status;

    n) return;

o) service instance provision period;

p) transfer buffer;

q) unconfirmed operation.

1.6.1.3 Definitions from ASN.1 Specification

This Recommended Practice makes use of the following terms defined in reference [6]:

a) Object Identifier;

b) Octet String.

1.6.1.4 Definitions from UML Specification

This Recommended Practice makes use of the following terms defined in reference [C7]:

a) Attribute;

b) Base Class;

c) Class;

d) Data Type;

e) Interface;

f) Method.

1.6.1.5 Definitions from API Core Specification

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

a) Application Program Interface;

b) Component.

1.6.2 NOMENCLATURE

The following conventions apply throughout this Recommended Practice:

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.

1.6.3 CONVENTIONS

This document applies the conventions defined in reference [4].

The RAF specific model extensions in section 2 are presented using the Unified Modelling Language (UML) and applying the conventions defined in reference [4].

The RAF specific specifications for API components in section 3 are presented using the conventions specified in reference [4].

The RAF specific data types and interfaces in annex A are specified in the notation of the C++ programming language using the conventions defined in reference [4].

1.7 REFERENCES

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

NOTE — A list of informative references is provided in annex C.

[1] *Cross Support Reference Model – Part 1: Space Link Extension Services*. Recommendation for Space Data System Standards, CCSDS 910.4-B-1, Blue Book. Issue 1, Washington, D.C.: CCSDS, May 1996.

[2] *Space Link Extension – Return All Frames Service Specification*, Draft Recommendation for Space Data System Standards, CCSDS 911.1-R1.7, Red Book, Issue 1.7, September 1999.

[3] *Space Link Extension – Return All Frames Service Specification.* Recommendation for Space Data System Standards, CCSDS 911.1-B-2, Blue Book, Issue 1, Washington, D.C.: CCSDS, November 2004.

[4] *Space Link Extension – Application Program Interface for Transfer Services — Core Specification.* Draft Recommended Practice for Space Data System Standards, CCSDS 914.0-W-1, White Book, Issue 1, Washington, D.C.: CCSDS, To be issued.

[5] *Programming Languages – C++.* International Standard, ISO/IEC 14882, Geneva, ISO, 2003.

[6] *Information Technology — Open Systems Interconnection — Specification of Abstract Syntax Notation One (ASN.1)*. International Standard, ISO/IEC 8824:1990, 2nd ed. Geneva: ISO, 1990.

2   OVERVIEW

2.1   INTRODUCTION

This section describes the extension of the SLE API model in reference [4] for support of the RAF service. Extensions are needed for the API components API Service Element and SLE Operations.

In addition to the extensions defined in this section, the component API Proxy must support encoding and decoding of RAF specific protocol data units.

2.2   PACKAGE RAF SERVICE INSTANCES

2.2.1   OVERVIEW

The RAF extensions to the component API Service Element are defined by the package RAF Service Instances. Figure 2-1 provides an overview of this package. The diagram includes classes from the package API Service Element specified in reference [4], which provide applicable specifications for the RAF service.

The package adds two service instance classes:

   a) RAF SI User, supporting the service user role; and

   b) RAF SI Provider, supporting service provider role.

These classes correspond to the placeholder classes I<SRV>_SI User and I<SRV>_SI Provider defined in reference [4].

Both classes are able to handle the specific RAF operations.

For the class RAF SI User, this is the only extension of the base class SI User.

The class RAF SI Provider adds two new interfaces:

   a) `IRAF_SIAdmin` by which the application can set RAF specific configuration parameters; and

   b) `IRAF_SIUpdate` by which the application must update dynamic status information, required for generation of status reports.

These interfaces correspond to the placeholder interfaces `I<SRV>_SIAdmin` and `I<SRV>_SIUpdate` defined in reference [4].

RAF specific configuration parameters are defined by the internal class RAF Configuration. The class RAF Status Information defines dynamic status parameters maintained by the service instance.

All specifications provided in this section refer to a single service instance. If more than one service instance is used, each service instance must be configured and updated independently.

2.2.2 COMPONENT CLASS RAF SI USER

The class defines a RAF service instance supporting the service user role. It ensures that SLE PDUs passed by the application and by the association are supported by the RAF service and handles the RAF operation objects defined in 2.3. It does not add further features to those provided by the base class SI User.
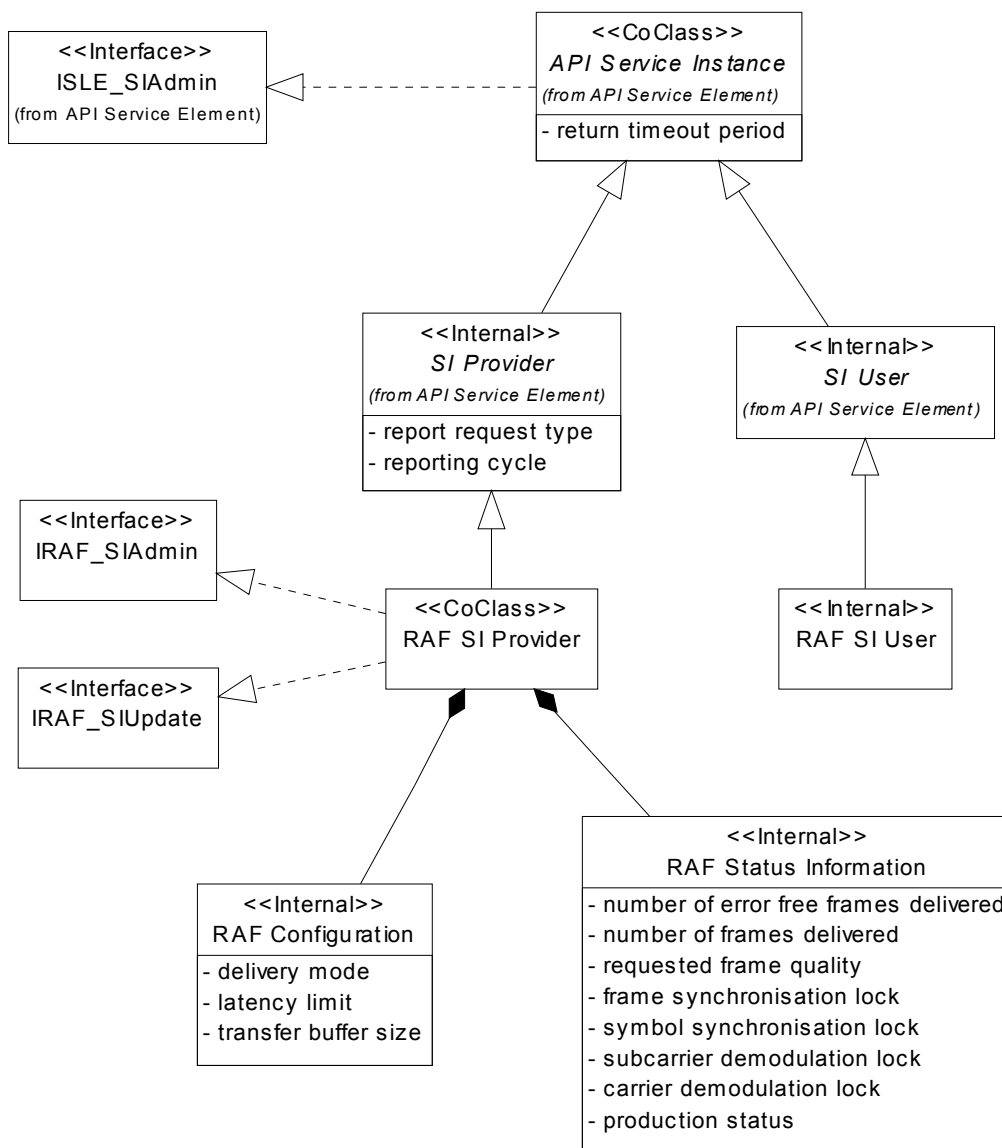

Figure 2-1: RAF Service Instances

2.2.3   COMPONENT CLASS RAF SI PROVIDER

The class defines a RAF service instance supporting the service provider role. It exports the interfaces `IRAF_SIAdmin` for configuration of the service instance after creation and `IRAF_SIUpdate` for update of dynamic status parameters during operation.

2.2.3.1   Responsibilities

2.2.3.1.1   Service Specific Configuration

The service instance implements the interface `IRAF_SIAdmin` to set the RAF specific configuration parameters defined by the class RAF Configuration. The methods of this interface must be called after creation of the service instance. When all configuration parameters (including those set via the interface `ISLE_SIAdmin`) have been set, the method `ISLE_SIAdmin::ConfigCompleted()` must be called. This method verifies that all configuration parameters values are defined and are in the range defined in reference [3].

In addition, the interface `IRAF_SIAdmin` provides read access to the configuration parameters.

2.2.3.1.2   Update of Dynamic Status Parameters

The class implements the interface `IRAF_SIUpdate`. The methods of this interface update status parameters defined by the class RAF Status Information. In order to ensure that the status information is always up to date, all changes of status parameters must be reported to the service instance during its complete lifetime, independent of the state of the service instance.

In addition, the class derives some of the parameters in RAF Status Information from RAF PDUs exchanged between the service provider and the service user. The method used to update each of the parameters is defined in 2.2.5.

The interface `IRAF_SIUpdate` provides read access to all status parameters.

2.2.3.1.3   Handling of the RAF–GET-PARAMETER Operation

The class responds autonomously to RAF–GET–PARAMETER invocations. It generates the appropriate RAF–GET–PARAMETER return using the parameters maintained by the classes RAF Configuration and RAF Status Information.

2.2.3.1.4   Status Reporting

The class generates RAF–STATUS–REPORT invocations when required using the parameters maintained by the class RAF Status Information.

2.2.3.1.5   Processing of RAF Protocol Data Units

The class ensures that SLE PDUs passed by the application and by the association are supported by the RAF service and handles the RAF operation objects defined in 2.3.

2.2.4   INTERNAL CLASS RAF CONFIGURATION

The class defines the configuration parameters that can be set via the interface `IRAF_SIAdmin`. These parameters are defined by reference [3]. Table 2-1 describes how the service instance uses these parameters.

2.2.5   INTERNAL CLASS RAF STATUS INFORMATION

The class defines dynamic status parameters handled by the service instance. The parameters are defined by reference [3]. Table 2-2 describes how the service element updates each of the parameters and how it uses the parameters.

Table 2-1: RAF Configuration Parameters

Parameter	Used for
`delivery-mode`	handling of the transfer buffer (enables / disables discarding of data) checking of PDUs RAF–GET–PARAMETER returns
`latency-limit`	handling of the transfer buffer in the 'timely online' and 'complete online' delivery modes RAF–GET–PARAMETER returns
`transfer-buffer-size`	handling of the transfer buffer RAF–GET–PARAMETER returns

Table 2-2: RAF Status Information

Parameter	Update	Used for
`number-of-error-free-frames-delivered`	count of RAF–TRANSFER–DATA invocations transmitted with the parameter 'frame quality' set to 'good'	status reports
`number-of-frames-delivered`	count of RAF–TRANSFER–DATA invocations transmitted	status reports
`requested-frame-quality`	set to 'undefined' at configuration time extracted from accepted RAF–START invocations set to 'undefined' after RAF–STOP, RAF–PEER–ABORT and protocol abort	RAF–GET–PARAMETER
`frame-sync-lock-status`	set by a method of `IRAF_SIUpdate`	status reports
`symbol-sync-lock-status`	set by a method of `IRAF_SIUpdate`	status reports

Parameter	Update	Used for
`subcarrier-lock-status`	set by a method of `IRAF_SIUpdate`	status reports
`carrier-lock-status`	set by a method of `IRAF_SIUpdate`	status reports
`production-status`	set by a method of `IRAF_SIUpdate`	status reports

2.3 PACKAGE RAF OPERATIONS

Figure 2-2 shows the operation object interfaces required for the RAF service. The package RAF Operations adds operation objects for the following RAF operations:

a) RAF–START;

b) RAF–TRANSFER–DATA;

c) RAF–SYNC–NOTIFY;

d) RAF–STATUS–REPORT;

e) RAF–GET–PARAMETER.

For other operations the API uses the common operation objects defined in reference [4].

Table 2-3 maps RAF operations to operation object interfaces.

Table 2-3: Mapping of RAF Operations to Operation Object Interfaces

RAF Operation	Operation Object Interface	Defined in Package
RAF–BIND	`ISLE_Bind`	SLE Operations
RAF–UNBIND	`ISLE_Unbind`	SLE Operations
RAF–START	`IRAF_Start`	RAF Operations
RAF–STOP	`ISLE_Stop`	SLE Operations
RAF–TRANSFER–DATA	`IRAF_TransferData`	RAF Operations
RAF–SYNC–NOTIFY	`IRAF_SyncNotify`	RAF Operations
[TRANSFER-BUFFER] (see note)	`ISLE_TransferBuffer`	SLE Operations
RAF–SCHEDULE–STATUS–REPORT	`ISLE_ScheduleStatusReport`	SLE Operations
RAF–STATUS–REPORT	`IRAF_StatusReport`	RAF Operations
RAF–GET–PARAMETER	`IRAF_GetParameter`	RAF Operations
RAF–PEER–ABORT	`ISLE_PeerAbort`	SLE Operations

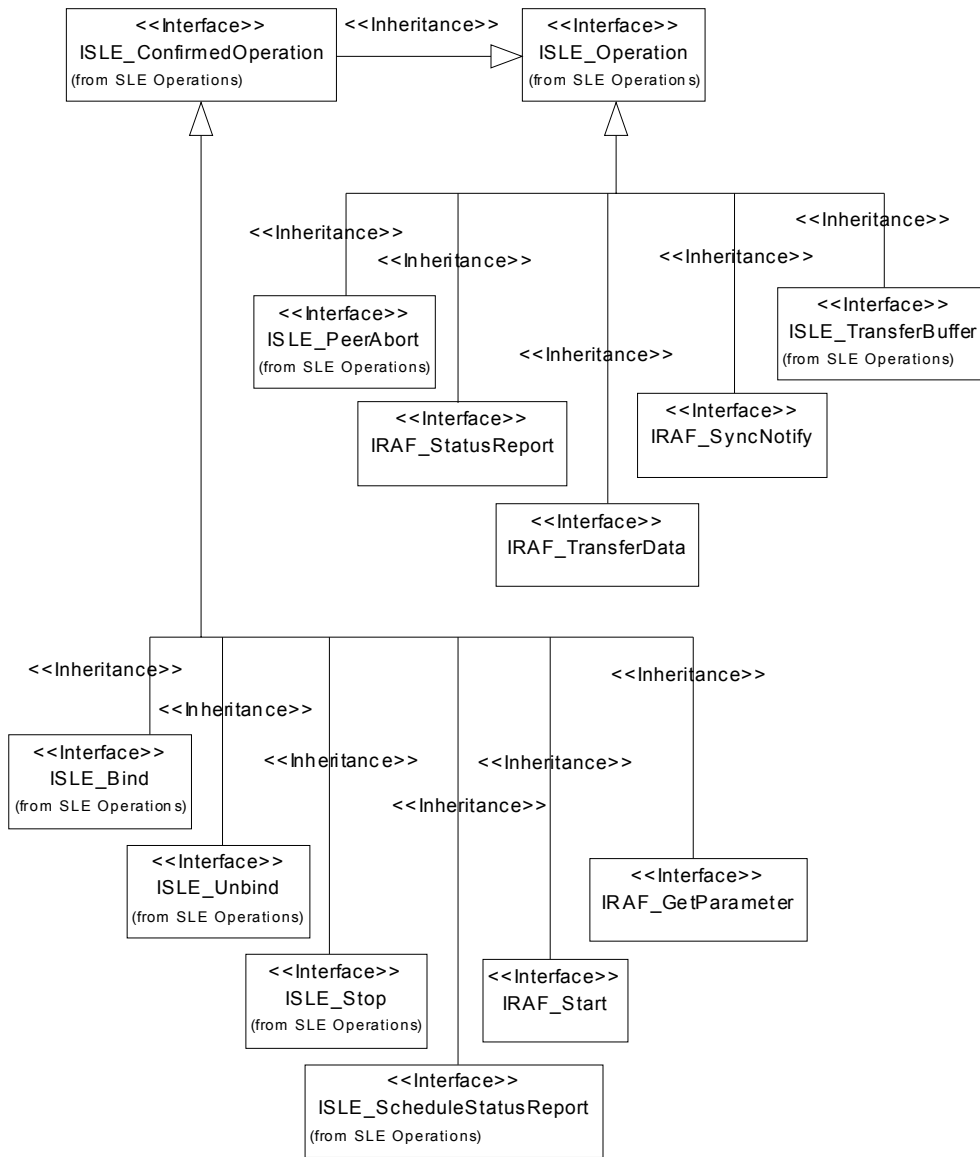NOTE — TRANSFER-BUFFER is a pseudo-operation used to handle the transfer buffer defined in reference [3].

Figure 2-2: RAF Operation Object Interfaces

3 RAF SPECIFIC SPECIFICATIONS FOR API COMPONENTS

3.1 API SERVICE ELEMENT

3.1.1 SERVICE INSTANCE CONFIGURATION

3.1.1.1 The service element shall provide the interface `IRAF_SIAdmin` for configuration of a provider-side service instance after creation.

3.1.1.2 The interface shall provide methods to set the following parameters, which the service element needs for handling of the transfer buffer and delivers to the user in response to a RAF–GET–PARAMETER invocation:

   a) `delivery-mode`;

   b) `transfer-buffer-size`, i.e. the maximum number of RAF–TRANSFER–BUFFER invocations and RAF–SYNC–NOTIFY invocations that can be stored to a transfer buffer PDU submitted to the service user; and

   c) `latency-limit`, if the delivery mode is either 'timely online' or 'complete online'.

NOTE — These parameters are defined in reference [3] for the operation RAF-GET-PARAMETER. Handling of the transfer buffer by the service element is defined in reference [4].

3.1.1.3 The interface shall provide methods to set the following parameters, which the service instance uses to initialize parameters of the status report:

   a) the value of the production status at the time the service instance is configured;

   b) the lock status of the frame synchronization process at the time the service instance is configured;

   c) the lock status of the symbol synchronization process at the time the service instance is configured;

   d) the lock status of the sub-carrier demodulation process at the time the service instance is configured;

   e) the lock status of the carrier demodulation process at the time the service instance is configured.

NOTES

1   For the delivery mode 'offline', status reporting is not supported. Therefore, these parameters need not be specified.

2 Further configuration parameters must be set using the interface ISLE_SIAdmin specified in reference [4]. These include the parameter return-timeout-period required for the RAF-GET-PARAMETER operation.

3.1.1.4 All configuration parameters must be set before the method `ConfigCompleted()` of the interface `ISLE_SIAdmin` is called. If one of the parameters is omitted or the value of a parameter is not within the range specified by reference [3], the method `ConfigCompleted()` shall return an error.

NOTES

1 As defined in reference [4], the service element shall start processing of the service instance only after successful configuration.

2 The range of specific parameter values might be further constrained by service management. The service element shall only perform checks on the limits specified by reference [3].

3.1.1.5 If the delivery mode is 'offline', the service element shall accept the configuration when the parameters defined in 3.1.1.3 have not been specified.

3.1.1.6 Configuration parameters must not be modified after successful return of the method `ConfigCompleted()` defined in the interface `ISLE_SIAdmin`. The effect of an attempt to set these parameters after completion of the configuration is undefined.

3.1.1.7 The values of all configuration parameters shall remain unmodified following a RAF-UNBIND or RAF-PEER-ABORT operation and following a protocol-abort.

3.1.1.8 The interface `IRAF_SIAdmin` shall provide methods to retrieve the values of the configuration parameters. The values returned by these methods before configuration has been completed are undefined.

3.1.2 STATUS INFORMATION

3.1.2.1 The service element shall maintain status parameters for every service instance and uses them for generation of status reports and for RAF–GET–PARAMETER returns.

NOTES

1 The parameters are defined in reference [3] for the operations RAF–STATUS–REPORT and RAF–GET–PARAMETER.

2 Handling of the parameter reporting-cycle defined for the RAF–GET–PARAMETER operation is specified in reference [3].

3.1.2.2 The service element shall update the following status parameters in the methods of the interface `IRAF_SIUpdate` described in 3.1.2.6.

a) `frame-sync-lock-status;`

b) `symbol-sync-lock-status;`

c) `subcarrier-lock-status;`

d) `carrier-lock-status;`

e) `production-status.`

NOTE — The initial values of these parameters following configuration of the service instance are defined in A4.2.

3.1.2.3 The service element shall handle the parameter `number-of-error-free-frames-delivered` as defined by the following specifications:

a) the parameter shall be set to zero when the service instance is configured;

b) when a TRANSFER–BUFFER PDU is transmitted to the service user, the parameter shall be incremented by the number of RAF–TRANSFER–DATA invocations in that PDU, for which the parameter `frame-quality` is set to 'good'.

NOTE — Frames in a TRANSFER–BUFFER PDU that is discarded shall not be included in the count of error free frames delivered.

3.1.2.4 The service element shall handle the parameter `number-of-frames-delivered` as defined by the following specifications:

a) the parameter shall be set to zero when the service instance is configured;

b) when a TRANSFER–BUFFER PDU is transmitted to the service user, the parameter shall be incremented by the number of RAF–TRANSFER–DATA invocations in that PDU.

NOTE — Frames in a TRANSFER–BUFFER PDU that is discarded shall not be included in the count of frames delivered.

3.1.2.5 The service element shall handle the parameter `requested-frame-quality` as defined by the following specifications:

a) the parameter shall be set to 'undefined' when the service instance is configured;

b) when the application transmits a RAF–START return with a positive result, the value of the parameter shall be extracted from the RAF–START invocation;

c) the parameter shall be set to 'undefined' following an accepted RAF–STOP invocation, and following RAF–PEER–ABORT and protocol abort.

NOTE — The parameter `requested-frame-quality` can be requested by a RAF-GET-PARAMETER invocation.

3.1.2.6 The service element shall provide the interface `IRAF_SIUpdate` for every service instance. This interface must be used by the application to update the status parameters defined in 3.1.2.2.

3.1.2.7 If more than one service instance exists, each service instance must be updated independently.

3.1.2.8 In order to keep the status information up to date and consistent, the methods of the interface `IRAF_SIUpdate` must be invoked for every change, independent of the state of the service instance.

3.1.2.9 The interface `IRAF_SIUpdate` shall provide read access to all status parameters, including those that are derived by other means.

NOTE — In the delivery mode 'offline', status reporting is not supported. Therefore, the application can opt not to update status information in that mode. If status information is not initialized and not updated, retrieval methods shall return the initial parameter values defined in A4.2.

3.1.2.10 The service element shall keep the status parameters defined in 3.1.2.3, 3.1.2.4, and 3.1.2.5 up to date for all delivery modes including the delivery mode 'offline'.

3.1.2.11 Except for the parameter `requested-frame-quality`, status parameters defined in this specification shall not be modified as result of RAF-UNBIND, RAF-PEER-ABORT, or protocol abort.

3.1.3 PROCESSING OF RAF PROTOCOL DATA UNITS

NOTES

1   The service element shall process RAF PDUs according to the general specifications in reference [4]. This section only addresses additional checks and processing steps defined for the RAF service. RAF specific checks defined in reference [3], but not listed in this section, must be performed by the application.

2   It is noted that 3.1.2 defines further processing requirements for PDUs with respect to update of status information. Annex A3 defines the checks that operation objects perform when the methods `VerifyInvocationArguments()` and `VerifyReturnArguments()` are called. Reference [4] contains specifications defining how the service element handles error codes returned by these methods.

3.1.3.1 RAF START

3.1.3.1.1 When receiving a RAF–START invocation, the service element shall perform the following checks:

a) if the delivery mode is 'offline', the start time must not be null;

b) if the start time is defined and the delivery mode is 'online':

　　1) the start time must be equal to or later than the start time of the scheduled provision period of the service instance; and

　　2) the start time must be earlier than the stop time of the scheduled provision period.

c) if the delivery mode is 'offline':

　　1) the stop time must not be null; and

　　2) the stop time must be earlier than current time.

　　NOTE — Reference [3] defines an `offline-processing-latency` and requires that the stop time plus the offline processing latency be earlier than current time. If the application makes use of the offline processing latency, the associated checks must be performed by the application.

d) if the stop time is defined and the delivery mode is online, the stop time must be earlier than or equal to the stop time of the scheduled provision period.

NOTES

1　　If the start time and the stop time are defined, the start time must be earlier than the stop time. This check shall be performed by the operation object.

2　　The service element shall not check the production status, as this could change before the PDU is processed by the application.

3.1.3.1.2　　If any of the checks defined in 3.1.3.1.1 fail, the service element on the provider side shall not forward the PDU to the application but shall respond with a RAF–START return with a negative result and the appropriate diagnostic.

NOTE　—　As specified in reference [4], the service element shall reject PDUs with errors received from the local application with an appropriate result code.

3.1.3.2　RAF SYNC NOTIFY

3.1.3.2.1　　When receiving a RAF–SYNC–NOTIFY invocation, the service element on the provider side shall perform the following checks:

a) if the delivery mode is 'offline', the notification type must not be 'loss of frame synchronization', 'production status change', or 'data discarded due to excessive backlog';

b) if the delivery mode is 'timely online', the notification type must not be 'data discarded due to excessive backlog'.

NOTE — This check cannot be performed on the user side, because the service element does not have the required information.

3.1.4 SERVICE INSTANCE SPECIFIC OPERATION FACTORY

3.1.4.1 For RAF service instances, the interface `ISLE_SIOpFactory` specified in reference [4] shall support creation and configuration of operation objects for the operations specified in 3.2 with exception of the interfaces `IRAF_StatusReport` and `ISLE_TransferBuffer`.

NOTES

1   The initial values of parameters that shall be set for RAF specific operation objects are defined in annex A.

2   Status reports and the transfer buffer shall be handled by the API Service Element without involvement of the application.

3.2 SLE OPERATIONS

3.2.1 The component SLE Operations shall provide operation objects for the following RAF operations in addition to those specified in reference [4]:

a) RAF–START;

b) RAF–TRANSFER–DATA;

c) RAF–SYNC–NOTIFY;

d) RAF–STATUS–REPORT; and

e) RAF–GET–PARAMETER.

3.2.2 The operation factory shall create the operation objects specified in 3.2.1 when the requested service type is RAF.

3.2.3 The operation factory shall additionally create the following operation objects specified in reference [4] when the requested service type is RAF:

a) SLE–BIND;

b) SLE–UNBIND;

c) SLE–PEER–ABORT;

d) SLE–STOP; and

e) SLE–SCHEDULE–STATUS–REPORT.

3.3 SLE APPLICATION

This section summarizes specific obligations of a RAF provider application using the SLE API.

3.3.1 Following creation of a service instance, and setting of the configuration parameters defined in reference [4], the application shall set the configuration parameters defined in 3.1.1 via the interface `IRAF_SIAdmin`.

3.3.2 The application shall update every service instance in the service element with the status information defined in 3.1.2 by invocation of the appropriate methods in the interface `IRAF_SIUpdate`.

3.4 SEQUENCE OF DIAGNOSTIC CODES

Reference [4] requires provider applications that do not perform checks in the sequence of the diagnostic codes defined in the Recommendation to document the sequence in which checks are actually performed.

The specification in 3.1.3.1 does not preserve the sequence of the diagnostic codes defined in reference [3] for the operation RAF–START. This section defines the actual sequence of checks performed by the API Service Element. For the checks that remain to be performed by the provider application, the sequence defined in reference [3] is maintained. Applications applying a different sequence must provide a modified documentation.

3.4.1 SEQUENCE OF RAF START DIAGNOSTIC CODES

3.4.1.1 Codes set by the API Service Element

    a) 'duplicate invoke id';

    b) 'invalid start time';

    c) 'invalid stop time'; and

    d) 'missing time value'.

3.4.1.2 Codes set by the Application

    a) 'out of service';

    b) 'unable to comply';

    c) 'invalid stop time' (for the delivery mode 'offline' if an offline processing latency is used); and

    d) 'other'.

ANNEX A

RAF SPECIFIC INTERFACES

(This annex **is** part of the Recommended Practice)

A1   INTRODUCTION

This annex specifies RAF-specific

    a) data types;

    b) interfaces for operation objects; and

    c) interfaces for service instances.

The specification of the interfaces follows the design patterns, conventions and the additional conventions described in reference [4].

The presentation uses the notation and syntax of the C++ programming language as specified in reference [5].

A2   RAF TYPE DEFINITIONS

File   `RAF_Types.h`

The following types have been derived from the ASN.1 module CCSDS-SLE-TRANSFER-SERVICE-RAF-STRUCTURES in reference [3]. The source ASN.1 type is indicated in brackets. For all enumeration types a special value 'invalid' is defined, which is returned if the associated value in the operation object has not yet been set, or is not applicable in case of a choice.

Antenna Id Format [`AntennaId`]

```
typedef enum RAF_AntennaIdFormat
{
  rafAF_global                    =   0,
  rafAF_local                     =   1,
  rafAF_invalid                   =  -1
} RAF_AntennaIdFormat;
```

Reference [3] defines a local form (LF) and a global form (GF) for the antenna identifier. The local form is a string of octets and the global form is an ASN.1 object identifier.

RAF Get Parameter Diagnostic [`DiagnosticRafGet`]

```
typedef enum RAF_GetParameterDiagnostic
{
  rafGP_unknownParameter          =   0,
  rafGP_invalid                   =  -1
} RAF_GetParameterDiagnostic;
```

RAF Start Diagnostic [`DiagnosticRafStart`]

```
typedef enum RAF_StartDiagnostic
{
  rafSD_outOfService              =   0,
  rafSD_unableToComply            =   1,
  rafSD_invalidStartTime          =   2,
  rafSD_invalidStopTime           =   3,
  rafSD_missingTimeValue          =   4,
  rafSD_invalid                   =  -1
} RAF_StartDiagnostic;
```

Delivered Frame Quality [`FrameQuality`]

```
typedef enum RAF_FrameQuality
{
  rafFQ_good                      =   0,
  rafFQ_erred                     =   1,
  rafFQ_undetermined              =   2,
  rafFQ_invalid                   =  -1
} RAF_FrameQuality;
```

Lock Status [`LockStatus`]

```
typedef enum RAF_LockStatus
{
  rafLS_inLock                      =   0,
  rafLS_outOfLock                   =   1,
  rafLS_notInUse                    =   2, /* for sub-carrier lock */
  rafLS_unknown                     =   3,
  rafLS_invalid                     =  -1
} RAF_LockStatus;
```

Notification Type [`Notification`]

```
typedef enum RAF_NotificationType
{
  rafNT_lossFrameSync               =   0,
  rafNT_productionStatusChange      =   1,
  rafNT_excessiveDataBacklog        =   2,
  rafNT_endOfData                   =   3,
  rafNT_invalid                     =  -1
} RAF_NotificationType;
```

Production Status [`RafProductionStatus`]

```
typedef enum RAF_ProductionStatus
{
  rafPS_running                     =   0,
  rafPS_interrupted                 =   1,
  rafPS_halted                      =   2,
  rafPS_invalid                     =  -1
} RAF_ProductionStatus;
```

Requested Frame Quality [`RequestedFrameQuality`]

```
typedef enum RAF_RequestedFrameQuality
{
  rafRQ_goodFramesOnly              =   0,
  rafRQ_erredFramesOnly             =   1,
  rafRQ_allFrames                   =   2,
  rafRQ_invalid                     =  -1
} RAF_RequestedFrameQuality;
```

Parameter Frame Quality Requested [`RafGetParameter`]

```
typedef enum RAF_ParFrameQuality
{
  rafPQ_goodFramesOnly              =   0,
  rafPQ_erredFramesOnly             =   1,
  rafPQ_allFrames                   =   2,
  rafPQ_undefined                   =   3,
  rafPQ_invalid                     =  -1
} RAF_ParFrameQuality;
```

This type is used to report the requested frame quality in RAF GET–PARAMETER returns. The value 'undefined' is set when the state of the service instance is 'ready'.

RAF Parameter Names [`RafGetParameter`]

```
typedef enum RAF_ParameterName
```

```
{
  rafPN_bufferSize              =   4,
  rafPN_deliveryMode            =   6,
  rafPN_latencyLimit            =  15,
  rafPN_reportingCycle          =  26,
  rafPN_requestedFrameQuality   =  27,
  rafPN_returnTimeoutPeriod     =  29,
  rafPN_invalid                 =  -1
} RAF_ParameterName;
```

Parameters that can be read using a RAF–GET–PARAMETER operation. The parameter name values are taken from the type `ParameterName` in ASN.1 module CCSDS-SLE-TRANSFER-SERVICE-COMMON-TYPES in reference [3].

Delivery Modes

```
typedef enum RAF_DeliveryMode
{
  rafDM_timelyOnline    = sleDM_rtnTimelyOnline,
  rafDM_completeOnline  = sleDM_rtnCompleteOnline,
  rafDM_offline         = sleDM_rtnOffline,
  rafDM_invalid         = -1
} RAF_DeliveryMode;
```

The delivery modes are defined as a subset of `SLE_DeliveryMode` in reference [4].

A3   RAF OPERATION OBJECTS

A3.1   RAF START OPERATION

Name   IRAF_Start
GUID   {2F5AEB20-7C28-11d3-9F15-00104B4F22C0}
Inheritance: IUnknown – ISLE_Operation – ISLE_ConfirmedOperation
File   IRAF_Start.H

The interface provides access to the parameters of the confirmed operation RAF– START.

Synopsis

```
#include <RAF_Types.h>
#include <ISLE_ConfirmedOperation.H>
interface ISLE_Time;

#define IID_IRAF_Start_DEF { 0x2f5aeb20, 0x7c28, 0x11d3, \
         { 0x9f, 0x15, 0x0, 0x10, 0x4b, 0x4f, 0x22, 0xc0 } }

interface IRAF_Start : ISLE_ConfirmedOperation
{
  virtual const ISLE_Time*
    Get_StartTime() const = 0;
  virtual const ISLE_Time*
    Get_StopTime() const = 0;
  virtual RAF_RequestedFrameQuality
    Get_RequestedFrameQuality() const = 0;
  virtual RAF_StartDiagnostic
    Get_StartDiagnostic() const = 0;
  virtual void
    Set_StartTime( const ISLE_Time& time ) = 0;
  virtual void
    Put_StartTime( ISLE_Time* ptime ) = 0;
  virtual void
    Set_StopTime( const ISLE_Time& time ) = 0;
  virtual void
    Put_StopTime( ISLE_Time* ptime ) = 0;
  virtual void
    Set_RequestedFrameQuality(RAF_RequestedFrameQuality quality) = 0;
  virtual void
    Set_StartDiagnostic( RAF_StartDiagnostic diagnostic ) = 0;
};
```

Methods

const ISLE_Time* Get_StartTime() const;

Returns the reception time of the first frame to be delivered, or NULL if the parameter is not defined.

const ISLE_Time* Get_StopTime() const;

Returns the reception time of the last frame to be delivered, or NULL if the parameter is not defined.

```
RAF_RequestedFrameQuality Get_RequestedFrameQuality() const;
```

Returns the requested frame quality.

```
RAF_StartDiagnostic Get_StartDiagnostic() const;
```

Returns the value of the diagnostic code.

Precondition: the result is negative, and the diagnostic type is set to 'specific'.

```
void Set_StartTime( const ISLE_Time& time );
```

Copies the argument to the receive time of the first frame to be delivered.

```
void Put_StartTime( ISLE_Time* ptime );
```

Stores the argument as receive time of the first frame to be delivered.

```
void Set_StopTime( const ISLE_Time& time );
```

Copies the argument to the receive time of the last frame to be delivered.

```
void Put_StopTime( ISLE_Time* ptime );
```

Stores the argument as receive time of the last frame to be delivered.

```
void Set_RequestedFrameQuality(RAF_RequestedFrameQuality quality);
```

Sets the requested frame quality to the value of the argument.

```
void Set_StartDiagnostic( RAF_StartDiagnostic diagnostic );
```

Sets the result to 'negative', the diagnostic type to 'specific', and stores the value of the diagnostic code passed by the argument.

Initial Values of Operation Parameters after Creation

Parameter	Created directly	Created by Service Instance
start time	NULL (not used)	NULL (not used)
stop time	NULL (not used)	NULL (not used)
requested frame quality	'invalid'	'invalid'
START diagnostic	'invalid'	'invalid'

Checking of Invocation Parameters

Parameter	Required condition
start time	if the start and the stop time are used, must be earlier than stop time
stop time	if the start and the stop time are used, must be later than start time
requested frame quality	must not be 'invalid'

Additional Return Codes for `VerifyInvocationArguments`

`SLE_E_TIMERANGE`   specification of the start and stop times is inconsistent.

Checking of Return Parameters

Parameter	Required condition
START diagnostic	must not be 'invalid' if the result is 'negative' and the diagnostic type is 'specific'

A3.2 RAF TRANSFER DATA OPERATION

Name   IRAF_TransferData
GUID   {2F5AEB21-7C28-11d3-9F15-00104B4F22C0}
Inheritance: IUnknown – ISLE_Operation
File   IRAF_TransferData.H

The interface provides access to the parameters of the operation RAF-TRANSFER-DATA.

Synopsis

```
#include <RAF_Types.h>
#include <ISLE_Operation.H>
interface ISLE_Time;

#define IID_IRAF_TransferData_DEF { 0x2f5aeb21, 0x7c28, 0x11d3, \
          { 0x9f, 0x15, 0x0, 0x10, 0x4b, 0x4f, 0x22, 0xc0 } }

interface IRAF_TransferData : ISLE_Operation
{
  virtual const ISLE_Time*
    Get_EarthReceiveTime() const = 0;
  virtual RAF_AntennaIdFormat
    Get_AntennaIdFormat () const = 0;
  virtual const SLE_Octet*
    Get_AntennaIdLF( size_t& size ) const = 0;
  virtual const int*
    Get_AntennaIdGF( int& length ) const = 0;
  virtual char*
    Get_AntennaIdGFString() const = 0;
  virtual int
    Get_DataLinkContinuity() const = 0;
  virtual RAF_FrameQuality
    Get_FrameQuality() const = 0;
  virtual const SLE_Octet*
    Get_PrivateAnnotation( size_t& size ) const = 0;
  virtual SLE_Octet*
    Remove_PrivateAnnotation( size_t& size ) = 0;
  virtual const SLE_Octet*
    Get_Data( size_t& size ) const = 0;
  virtual SLE_Octet*
    Remove_Data( size_t& size ) = 0;
  virtual void
    Set_EarthReceiveTime( const ISLE_Time& time ) = 0;
  virtual void
    Put_EarthReceiveTime( ISLE_Time* ptime ) = 0;
  virtual void
    Set_AntennaIdLF ( const SLE_Octet* id, size_t size ) = 0;
  virtual void
    Set_AntennaIdGF ( const int* id, int length ) = 0;
  virtual void
    Set_AntennaIdGFString( const char* id) = 0;
  virtual void
    Set_DataLinkContinuity( int numFrames ) = 0;
  virtual void
    Set_FrameQuality( RAF_FrameQuality quality ) = 0;
  virtual void
    Set_PrivateAnnotation( const SLE_Octet* pannotation,
                           size_t size ) = 0;
```

```
  virtual void
    Put_PrivateAnnotation( SLE_Octet* pannotation,
                           size_t size ) = 0;
  virtual void
    Set_Data( const SLE_Octet* pdata, size_t size ) = 0;
  virtual void
    Put_Data( SLE_Octet* pdata, size_t size ) = 0;
};
```

Methods

virtual const ISLE_Time* Get_EarthReceiveTime() const;

Returns the earth receive time of the frame delivered, if the parameter has been set in the object. Returns NULL otherwise.

RAF_AntennaIdFormat Get_AntennaIdFormat () const;

Returns the format of the antenna identifier (octet string or object identifier) or 'invalid' when the parameter has not been set.

const SLE_Octet* Get_AntennaIdLF(size_t& size) const;

Returns the antenna identifier in the local form, i.e. a string of octets.

<u>Arguments</u>
size   the number of octets in the antenna ID (1 to 16)

<u>Precondition</u>: Get_AntennaIdFormat returns rafAF_local.

const int* Get_AntennaIdGF(int& length) const;

Returns the antenna identifier in the global form, i.e. an object identifier as defined by ASN.1. In C++ this is represented as a sequence of integers.

<u>Arguments</u>
length   the number of elements in the antenna ID

<u>Precondition</u>: Get_AntennaIdFormat returns rafAF_global.

char* Get_AntennaIdGFString() const;

Returns the antenna ID as a character string formatted as a dot separated list of numbers. The string is allocated on the heap and must be deleted by the client.

<u>Precondition</u>: Get_AntennaIdFormat returns rafAF_global.

int Get_DataLinkContinuity() const;

Returns the data link continuity parameter, if the parameter has been set in the object, or –2 if the parameter has not been set. A valid value can be –1, 0, or any positive number.

`RAF_FrameQuality Get_FrameQuality() const;`

Returns the quality of the delivered frame.

`const SLE_Octet* Get_PrivateAnnotation( size_t& size ) const;`

Returns a pointer to the private annotation in the object or NULL if the private annotation has not been set.

<u>Arguments</u>
`length`   the length of the private annotation in bytes

`SLE_Octet* Remove_PrivateAnnotation( size_t& size );`

Returns the private annotation data and removes them from the object. The memory allocated by the parameter must be released by the client. If the parameter has not been set returns NULL.

<u>Arguments</u>
`length`   the length of the private annotation in bytes

`const SLE_Octet* Get_Data( size_t& size ) const;`

Returns a pointer to the frame in the object or NULL if the frame has not been inserted.

<u>Arguments</u>
`length`   the length of the frame in bytes

`SLE_Octet* Remove_Data( size_t& size );`

Returns the frame and removes it from the object. The memory allocated by the frame must be released by the client. If the parameter has not been set returns NULL.

<u>Arguments</u>
`length`   the length of the frame in bytes

`void Set_EarthReceiveTime( const ISLE_Time& time );`

Copies the value of the argument to the earth receive time.

`void Put_EarthReceiveTime( ISLE_Time* ptime );`

Stores the argument to the parameter earth receive time.

void Set_AntennaIdLF (const SLE_Octet* id, size_t size);

Sets the antenna id format to 'local form' and the antenna id to the value of the argument. The local form of the antenna id is a string of octets.

void Set_AntennaIdGF (const int* id, int length);

Sets the antenna id format to 'global form' and the antenna id to the value of the argument. The global form the antenna id is an object identifier as defined by ASN.1, represented as a sequence of integers.

void Set_AntennaIdGFString(const char* id);

Sets the antenna id format to 'global form' and the antenna id to the value of the argument. If the argument is badly formatted, the parameter is reset to its initial state, i.e. 'not set'.

Arguments
id   an object identifier formatted as a dot separated list of numbers

void Set_DataLinkContinuity(int numFrames);

Sets the parameter data link continuity to the value of the argument.

void Set_FrameQuality(RAF_FrameQuality quality);

Sets the parameter frame quality to the value of the argument.

void Set_PrivateAnnotation(const SLE_Octet* pannotation,
                              size_t size);

Copies size bytes from the argument `pannotation` to the parameter private annotation.

Arguments
pannotation   pointer to the private annotation
length   the length of the annotation in bytes

void Put_PrivateAnnotation(SLE_Octet* pannotation, size_t size);

Stores the argument `pannotation` to the parameter private annotation.

Arguments
pannotation   pointer to the private annotation
length   the length of the annotation in bytes

void Set_Data(const SLE_Octet* pdata, size_t size);

Copies size bytes from the argument `pdata` to the parameter 'data'.

Arguments

`pdata`	pointer to the data
`length`	the length of the data in bytes

`void Put_Data( SLE_Octet* pdata, size_t size );`

Stores the argument `pdata` to the parameter 'data'.

Arguments

`pdata`	pointer to the data
`length`	the length of the data in bytes

Initial Values of Operation Parameters after Creation

Parameter	Created directly	Created by Service Instance
earth receive time	NULL	NULL
antenna id	NULL	NULL
antenna id format	'invalid'	'invalid'
data link continuity	-2	-2
frame quality	'invalid'	'invalid'
private annotation	NULL	NULL
data	NULL	NULL

Checking of Invocation Parameters

Parameter	Required condition
earth receive time	must not be NULL
antenna id	must not be NULL
data link continuity	must be > -2
frame quality	must not be 'invalid'
private annotation	if used, the size must be in the range of 1 to 128 octets
data	must not be NULL

A3.3   RAF SYNC NOTIFY OPERATION

Name   IRAF_SyncNotify

GUID   {2F5AEB22-7C28-11d3-9F15-00104B4F22C0}

Inheritance: IUnknown – ISLE_Operation

File   IRAF_SyncNotify.H

The interface provides access to the parameters of the unconfirmed operation
RAF-SYNC-NOTIFY.

Synopsis

```
#include <RAF_Types.h>
#include <ISLE_Operation.H>
interface ISLE_Time;

#define IID_IRAF_SyncNotify_DEF { 0x2f5aeb22, 0x7c28, 0x11d3, \
          { 0x9f, 0x15, 0x0, 0x10, 0x4b, 0x4f, 0x22, 0xc0 } }

interface IRAF_SyncNotify : ISLE_Operation
{
  virtual RAF_NotificationType
    Get_NotificationType() const = 0;
  virtual const ISLE_Time*
    Get_LossOfLockTime() const = 0;
  virtual RAF_LockStatus
    Get_CarrierDemodLock() const = 0;
  virtual RAF_LockStatus
    Get_SubCarrierDemodLock() const = 0;
  virtual RAF_LockStatus
    Get_SymbolSyncLock() const = 0;
  virtual RAF_ProductionStatus
    Get_ProductionStatus() const = 0;
  virtual void
    Set_LossOfFrameSync( const ISLE_Time& time,
                         RAF_LockStatus symbolSyncLock,
                         RAF_LockStatus subCarrierDemodLock,
                         RAF_LockStatus carrierDemodLock ) = 0;
  virtual void
    Set_ProductionStatusChange( RAF_ProductionStatus status ) = 0;
  virtual void
    Set_DataDiscarded() = 0;
  virtual void
    Set_EndOfData() = 0;
};
```

Methods

RAF_NotificationType Get_NotificationType() const;

Returns the type of the notification.

const ISLE_Time* Get_LossOfLockTime() const;

Returns the time at which the frame synchronizer lost lock.

Precondition: notification type is 'loss of frame synchronization'.

RAF_LockStatus Get_CarrierDemodLock() const;

Returns the lock status of the carrier demodulation process.

Precondition: notification type is 'loss of frame synchronization'.

RAF_LockStatus Get_SubCarrierDemodLock() const;

Returns the lock status of the sub-carrier demodulation process.

Precondition: notification type is 'loss of frame synchronization'.

RAF_LockStatus Get_SymbolSyncLock() const;

Returns the lock status of the symbol synchronization process.

Precondition: notification type is 'loss of frame synchronization'.

RAF_ProductionStatus Get_ProductionStatus() const;

Returns the production status.

Precondition: notification type is 'production status change'.

```
void Set_LossOfFrameSync( const ISLE_Time& time,
                          RAF_LockStatus symbolSyncLock,
                          RAF_LockStatus subCarrierDemodLock,
                          RAF_LockStatus carrierDemodLock );
```

Sets the notification type to 'loss of frame synchronization' and the notification values as specified by the arguments.

Arguments

time	the time at which the frame synchronizer lost lock
symbolSyncLock	the lock status of the symbol synchronization process
subCarrierDemodLock	the lock status of the sub-carrier demodulation process
carrierDemodLock	the lock status of the carrier demodulation process

void Set_ProductionStatusChange(RAF_ProductionStatus status);

Sets the notification type to 'production status change' and the notification value as defined by the argument.

void Set_DataDiscarded();

Sets the notification type to 'data discarded due to excessive backlog'.

void Set_EndOfData();

Sets the notification type to 'end of data'.

Initial Values of Operation Parameters after Creation

Parameter	Created directly	Created by Service Instance
notification-type	'invalid'	'invalid'
loss of lock time	NULL	NULL
symbol-sync-lock-status	'invalid'	'invalid'
subcarrier-lock-status	'invalid'	'invalid'
carrier-lock-status	'invalid'	'invalid'
production-status	'invalid'	'invalid'

Checking of Invocation Parameters

Parameter	Required condition
notification-type	must not be 'invalid'
loss of lock time	if notification type is 'loss of frame synchronization' must not be NULL
symbol-sync-lock-status	if notification type is 'loss of frame synchronization' must not be 'invalid' or 'not in use'
subcarrier-lock-status	if notification type is 'loss of frame synchronization' must not be 'invalid'
carrier-lock-status	if notification type is 'loss of frame synchronization' must not be 'invalid' or 'not in use'
production-status	if notification type is 'production status change' must not be 'invalid'

A3.4 RAF STATUS REPORT OPERATION

Name   IRAF_StatusReport
GUID   {2F5AEB23-7C28-11d3-9F15-00104B4F22C0}
Inheritance: IUnknown – ISLE_Operation
File   IRAF_StatusReport.H

The interface provides access to the parameters of the unconfirmed operation
RAF-STATUS-REPORT.

Synopsis

```
#include <RAF_Types.h>
#include <ISLE_Operation.H>

#define IID_IRAF_StatusReport_DEF { 0x2f5aeb23, 0x7c28, 0x11d3, \
          { 0x9f, 0x15, 0x0, 0x10, 0x4b, 0x4f, 0x22, 0xc0 } }

interface IRAF_StatusReport : ISLE_Operation
{
  virtual unsigned long
    Get_NumErrorFreeFrames() const = 0;
  virtual unsigned long
    Get_NumFrames() const = 0;
  virtual RAF_LockStatus
    Get_FrameSyncLock() const = 0;
  virtual RAF_LockStatus
    Get_CarrierDemodLock() const = 0;
  virtual RAF_LockStatus
    Get_SubCarrierDemodLock() const = 0;
  virtual RAF_LockStatus
    Get_SymbolSyncLock() const = 0;
  virtual RAF_ProductionStatus
    Get_ProductionStatus() const = 0;
  virtual void
    Set_NumErrorFreeFrames( unsigned long count ) = 0;
  virtual void
    Set_NumFrames( unsigned long count ) = 0;
  virtual void
    Set_FrameSyncLock( RAF_LockStatus status ) = 0;
  virtual void
    Set_CarrierDemodLock( RAF_LockStatus status ) = 0;
  virtual void
    Set_SubCarrierDemodLock( RAF_LockStatus status ) = 0;
  virtual void
    Set_SymbolSyncLock( RAF_LockStatus status ) = 0;
  virtual void
    Set_ProductionStatus( RAF_ProductionStatus status ) = 0;
};
```

Methods

unsigned long Get_NumErrorFreeFrames() const;

Returns the number of error free frames delivered.

```
unsigned long Get_NumFrames() const;
```

Returns the total number of frames delivered.

```
RAF_LockStatus Get_FrameSyncLock() const;
```

Returns the lock status of the frame synchronization process.

```
RAF_LockStatus Get_CarrierDemodLock() const;
```

Returns the lock status of the carrier demodulation process.

```
RAF_LockStatus Get_SubCarrierDemodLock() const;
```

Returns the lock status of the sub-carrier demodulation process.

```
RAF_LockStatus Get_SymbolSyncLock() const;
```

Returns the lock status of the symbol synchronization process.

```
RAF_ProductionStatus Get_ProductionStatus() const;
```

Returns the production status.

```
void Set_NumErrorFreeFrames( unsigned long count );
```

Sets the number of error free frames delivered as defined by the argument.

```
void Set_NumFrames( unsigned long count );
```

Sets the total number of frames delivered as defined by the argument.

```
void Set_FrameSyncLock( RAF_LockStatus status );
```

Sets the frame synchronizer lock status as defined by the argument.

```
void Set_CarrierDemodLock( RAF_LockStatus status );
```

Sets the carrier demodulator lock status as defined by the argument.

```
void Set_SubCarrierDemodLock( RAF_LockStatus status );
```

Sets the sub-carrier demodulator lock status as defined by the argument.

```
void Set_SymbolSyncLock( RAF_LockStatus status );
```

Sets the symbol synchronizer lock status as defined by the argument.

`void Set_ProductionStatus( RAF_ProductionStatus status );`

Sets the production status as defined by the argument.

Initial Values of Operation Parameters after Creation

Parameter	Created directly
`number-of-error-free-frames-delivered`	0
`number-of-frames-delivered`	0
`frame-sync-lock-status`	'invalid'
`symbol-sync-lock-status`	'invalid'
`subcarrier-lock-status`	'invalid'
`carrier-lock-status`	'invalid'
`production-status`	'invalid'

NOTE — The interface `ISLE_SIOpFactory` does not support creation of status report operation objects, as this operation is handled by the service instance internally.

Checking of Invocation Parameters

Parameter	Required condition
`frame-sync-lock-status`	must not be 'invalid' or 'not in use'
`symbol-sync-lock-status`	must not be 'invalid' or 'not in use'
`subcarrier-lock-status`	must not be 'invalid'
`carrier-lock-status`	must not be 'invalid' or 'not in use'
`production-status`	must not be 'invalid'

A3.5   RAF GET PARAMETER OPERATION

Name   IRAF_GetParameter
GUID   {2F5AEB24-7C28-11d3-9F15-00104B4F22C0}
Inheritance: IUnknown – ISLE_Operation – ISLE_ConfirmedOperation
File   IRAF_GetParameter.H

The interface provides access to the parameters of the confirmed operation
RAF-GET-PARAMETER.

Synopsis

```
#include <RAF_Types.h>
#include <ISLE_ConfirmedOperation.H>

#define IID_IRAF_GetParameter_DEF { 0x2f5aeb24, 0x7c28, 0x11d3, \
          { 0x9f, 0x15, 0x0, 0x10, 0x4b, 0x4f, 0x22, 0xc0 } }

interface IRAF_GetParameter : ISLE_ConfirmedOperation
{
  virtual RAF_ParameterName
    Get_RequestedParameter() const = 0;
  virtual RAF_ParameterName
    Get_ReturnedParameter() const = 0;
  virtual RAF_DeliveryMode
    Get_DeliveryMode() const = 0;
  virtual RAF_ParFrameQuality
    Get_RequestedFrameQuality() const = 0;
  virtual unsigned short
    Get_LatencyLimit() const = 0;
  virtual unsigned long
    Get_TransferBufferSize() const = 0;
  virtual unsigned long
    Get_ReportingCycle() const = 0;
  virtual unsigned long
    Get_ReturnTimeoutPeriod() const = 0;
  virtual RAF_GetParameterDiagnostic
    Get_GetParameterDiagnostic() const = 0;
  virtual void
    Set_RequestedParameter( RAF_ParameterName name ) = 0;
  virtual void
    Set_DeliveryMode( RAF_DeliveryMode mode ) = 0;
  virtual void
    Set_RequestedFrameQuality( RAF_ParFrameQuality quality ) = 0;
  virtual void
    Set_LatencyLimit( unsigned short limit ) = 0;
  virtual void
    Set_TransferBufferSize( unsigned long size ) = 0;
  virtual void
    Set_ReportingCycle( unsigned long cycle ) = 0;
  virtual void
    Set_ReturnTimeoutPeriod( unsigned long period ) = 0;
  virtual void
    Set_GetParameterDiagnostic( RAF_GetParameterDiagnostic
                                diagostic ) = 0;
};
```

Methods

RAF_ParameterName Get_RequestedParameter() const;

Returns the identification of the parameter whose value shall be returned.

RAF_ParameterName Get_ReturnedParameter() const;

Returns the identification of the parameter whose value is reported.

RAF_DeliveryMode Get_DeliveryMode() const;

Returns the delivery mode of the service instance.

Precondition: the returned parameter is `delivery-mode`.

RAF_ParFrameQuality Get_RequestedFrameQuality() const;

Returns the requested frame quality as set by the RAF–START operation.

Precondition: the returned parameter is `requested-frame-quality`.

unsigned short Get_LatencyLimit() const;

Returns the latency limit defined by service management. If the delivery mode is 'offline', returns zero.

Precondition: the returned parameter is `latency-limit`.

unsigned long Get_TransferBufferSize() const;

Returns the size of the transfer buffer as the maximum number of RAF–TRANSFER–DATA invocations and RAF–SYNC–NOTIFY invocations that can be stored in the buffer.

Precondition: the returned parameter is `transfer-buffer-size`.

unsigned long Get_ReportingCycle() const;

Returns the reporting cycle requested by the user if periodic reporting is active. If reporting is not active, returns zero.

Precondition: the returned parameter is `reporting-cycle`.

unsigned long Get_ReturnTimeoutPeriod() const;

Returns the return timeout period used by the provider.

Precondition: the returned parameter is `return-timeout-period`.

RAF_GetParameterDiagnostic Get_GetParameterDiagnostic() const;

Returns the diagnostic code.

Precondition: the result is negative, and the diagnostic type is set to 'specific'.

void Set_RequestedParameter(RAF_ParameterName name);

Sets the parameter for which the provider shall report the value.

void Set_DeliveryMode(RAF_DeliveryMode mode);

Sets the returned parameter name to `delivery-mode` and the value as defined by the argument.

void Set_RequestedFrameQuality(RAF_ParFrameQuality quality);

Sets the returned parameter name to `requested-frame-quality` and the value as defined by the argument.

void Set_LatencyLimit(unsigned short limit);

Sets the returned parameter name to `latency-limit` and the value as defined by the argument.

void Set_TransferBufferSize(unsigned long size);

Sets the returned parameter name to `transfer-buffer-size` and the value as defined by the argument.

void Set_ReportingCycle(unsigned long cycle);

Sets the returned parameter name to `reporting-cycle` and the value as defined by the argument.

void Set_ReturnTimeoutPeriod(unsigned long period);

Sets the returned parameter name to `return-timeout-period` and the value as defined by the argument.

```
void Set_GetParameterDiagnostic( RAF_GetParameterDiagnostic
                                 diagostic );
```

Sets the result to 'negative', the diagnostic type to 'specific', and stores the value of the diagnostic code passed by the argument.

Initial Values of Operation Parameters after Creation

Parameter	Created directly	Created by Service Instance
requested parameter	'invalid'	'invalid'
returned parameter	'invalid'	'invalid'
delivery-mode	'invalid'	'invalid'
requested-frame-quality	'invalid'	'invalid'
latency-limit	0	0
transfer-buffer-size	0	0
reporting-cycle	0	0
return-timeout-period	0	0
GET PARAMETER diagnostic	'invalid'	'invalid'

Checking of Invocation Parameters

Parameter	Required condition
requested parameter	must not be 'invalid'

Checking of Return Parameters

Parameter	Required condition
returned parameter	must be the same as 'requested parameter'
delivery-mode	If the returned parameter is 'delivery mode' must not be 'invalid'
transfer-buffer-size	If the returned parameter is 'transfer buffer size' must not be 0
return-timeout-period	If the returned parameter is 'return timeout period' must not be 0
GET PARAMETER diagnostic	must not be 'invalid' if the result is 'negative' and the diagnostic type is 'specific'

The interface ensures consistency between the returned parameter name and the parameter value, as the client cannot set the returned parameter name. Therefore, this consistency need not be checked on the provider side. The checks defined above only need to be performed when the return is received by the service user.

A4   RAF SERVICE INSTANCE INTERFACES

A4.1   SERVICE INSTANCE CONFIGURATION

Name   IRAF_SIAdmin
GUID   {2F5AEB25-7C28-11d3-9F15-00104B4F22C0}
Inheritance: IUnknown
File   IRAF_SIAdmin.H

The interface provides write and read access to the RAF-specific service instance configuration-parameters.   All configuration parameters must be set as part of service instance configuration.   When the method ConfigCompleted() is called on the interface ISLE_SIAdmin, the service element checks that all required parameters have been set and returns an error when the configuration is not complete.

Configuration parameters must not be set after successful return of the method ConfigCompleted(). The effect of invoking these methods at a later stage is undefined.

As a convenience for the application, the interface provides read access to the configuration parameters, except for parameters used to initialize the status report. If retrieval methods are called before configuration, the value returned is undefined.

Synopsis

```
#include <RAF_Types.h>
#include <SLE_SCM.H>

#define IID_IRAF_SIAdmin_DEF { 0x2f5aeb25, 0x7c28, 0x11d3, \
         { 0x9f, 0x15, 0x0, 0x10, 0x4b, 0x4f, 0x22, 0xc0 } }

interface IRAF_SIAdmin : IUnknown
{
  virtual void
    Set_DeliveryMode( RAF_DeliveryMode mode ) = 0;
  virtual void
    Set_LatencyLimit( unsigned short limit ) = 0;
  virtual void
    Set_TransferBufferSize( unsigned long size ) = 0;
  virtual void
    Set_InitialProductionStatus( RAF_ProductionStatus status ) = 0;
  virtual void
    Set_InitialFrameSyncLock( RAF_LockStatus status ) = 0;
  virtual void
    Set_InitialCarrierDemodLock( RAF_LockStatus status ) = 0;
  virtual void
    Set_InitialSubCarrierDemodLock( RAF_LockStatus status ) = 0;
  virtual void
    Set_InitialSymbolSyncLock( RAF_LockStatus status ) = 0;
  virtual RAF_DeliveryMode
    Get_DeliveryMode() const = 0;
  virtual unsigned short
    Get_LatencyLimit() const = 0;
  virtual unsigned long
    Get_TransferBufferSize() const = 0;
};
```

Methods

```
void Set_DeliveryMode( RAF_DeliveryMode mode );
```

Sets the delivery mode of the service instance.

```
void Set_LatencyLimit( unsigned short limit );
```

Sets the latency limit in seconds for transmission of the transfer buffer. If the delivery mode is 'offline', the parameter need not be set.

```
void Set_TransferBufferSize( unsigned long size );
```

Sets the maximum number of RAF–TRANSFER–DATA invocations and RAF–SYNC–NOTIFY invocations that shall be stored in one transfer buffer PDU.

```
void Set_InitialProductionStatus( RAF_ProductionStatus status );
```

Sets the value of the production status at the time of configuration. The parameter is used to initialize status report parameters. If the delivery mode is 'offline', this parameter need not be set.

```
void Set_InitialFrameSyncLock( RAF_LockStatus status );
```

Sets the lock status of the frame synchronization process at the time of configuration. The parameter is used to initialize status report parameters. If the delivery mode is 'offline', this parameter need not be set.

```
void Set_InitialCarrierDemodLock( RAF_LockStatus status );
```

Sets the lock status of the carrier demodulation process at the time of configuration. The parameter is used to initialize status report parameters. If the delivery mode is 'offline', this parameter need not be set.

```
void Set_InitialSubCarrierDemodLock( RAF_LockStatus status );
```

Sets the lock status of the sub-carrier demodulation process at the time of configuration. The parameter is used to initialize status report parameters. If the delivery mode is 'offline', this parameter need not be set.

```
void Set_InitialSymbolSyncLock( RAF_LockStatus status );
```

Sets the lock status of the symbol synchronization process at the time of configuration. The parameter is used to initialize status report parameters. If the delivery mode is 'offline', this parameter need not be set.

RAF_DeliveryMode Get_DeliveryMode() const;

Returns the value of the parameter `delivery-mode`.

unsigned short Get_LatencyLimit() const;

Returns the value of the parameter `latency-limit`.

unsigned long Get_TransferBufferSize() const;

Returns the value of the parameter `transfer-buffer-size`.

A4.2   UPDATE OF SERVICE INSTANCE PARAMETERS

Name   `IRAF_SIUpdate`
GUID   `{2F5AEB26-7C28-11d3-9F15-00104B4F22C0}`
Inheritance: `IUnknown`
File   `IRAF_SIUpdate.H`

The interface provides methods to update parameters that shall be reported to the service user via the operation STATUS-REPORT. In order to keep this information up to date the appropriate methods of this interface must be called whenever the information changes, independent of the state of the service instance.

The interface provides read access to the parameters set via this interface and to parameters accumulated or derived by the API according to the specifications in 3.1. The API sets the parameters to the initial values specified at the end of this section when the service instance is configured. Parameter values retrieved before configuration are undefined.

In the delivery mode 'offline', status reporting is not supported. Therefore configuration parameters used to initialize the status report need not be supplied and the status information need not be updated. If the initial values and updates are not supplied, the retrieval methods return the values defined at the end of this section. Values accumulated by the service element are kept up to date for all delivery modes, including the mode 'offline'.

Retrievable parameters include the `requested-frame-quality`. This parameter is not included in the status report but can be read by the service user via the operation RAF–GET–PARAMETER.

Synopsis

```
#include <RAF_Types.h>
#include <SLE_SCM.H>

#define IID_IRAF_SIUpdate_DEF { 0x2f5aeb26, 0x7c28, 0x11d3, \
          { 0x9f, 0x15, 0x0, 0x10, 0x4b, 0x4f, 0x22, 0xc0 } }

interface IRAF_SIUpdate : IUnknown
{
  virtual void
    Set_ProductionStatus( RAF_ProductionStatus status ) = 0;
  virtual void
    Set_FrameSyncLock( RAF_LockStatus status ) = 0;
  virtual void
    Set_CarrierDemodLock( RAF_LockStatus status ) = 0;
  virtual void
    Set_SubCarrierDemodLock( RAF_LockStatus status ) = 0;
  virtual void
    Set_SymbolSyncLock( RAF_LockStatus status ) = 0;
  virtual RAF_ProductionStatus
    Get_ProductionStatus() const = 0;
  virtual RAF_LockStatus
    Get_FrameSyncLock() const = 0;
  virtual RAF_LockStatus
```

```
      Get_CarrierDemodLock() const = 0;
   virtual RAF_LockStatus
      Get_SubCarrierDemodLock() const = 0;
   virtual RAF_LockStatus
      Get_SymbolSyncLock() const = 0;
   virtual unsigned long
      Get_NumErrorFreeFrames() const = 0;
   virtual unsigned long
      Get_NumFrames() const = 0;
   virtual RAF_ParFrameQuality
      Get_RequestedFrameQuality() const = 0;
};
```

Methods

void Set_ProductionStatus(RAF_ProductionStatus status);

The method must be called whenever the production status changes to set the new value.

void Set_FrameSyncLock(RAF_LockStatus status);

The method must be called whenever the lock status of the frame synchronization process changes to set the new value.

void Set_CarrierDemodLock(RAF_LockStatus status);

The method must be called whenever the lock status of the carrier demodulation process changes to set the new value.

void Set_SubCarrierDemodLock(RAF_LockStatus status);

The method must be called whenever the lock status of the sub-carrier demodulation process changes to set the new value.

void Set_SymbolSyncLock(RAF_LockStatus status);

The method must be called whenever the lock status of the symbol synchronization process changes to set the new value.

RAF_ProductionStatus Get_ProductionStatus() const;

Returns the value of the production status.

RAF_LockStatus Get_FrameSyncLock() const;

Returns the lock status of the frame synchronization process.

RAF_LockStatus Get_CarrierDemodLock() const;

Returns the lock status of the carrier demodulation process.

`RAF_LockStatus Get_SubCarrierDemodLock() const;`

Returns the lock status of the sub-carrier demodulation process.

`RAF_LockStatus Get_SymbolSyncLock() const;`

Returns the lock status of the symbol synchronization process.

`unsigned long Get_NumErrorFreeFrames() const;`

Returns the number of error free frames delivered by the service instance. In the delivery mode 'timely online' this number can be smaller than the number of error free frames passed to the service element because data might have been discarded because of excessive backlog.

`unsigned long Get_NumFrames() const;`

Returns the total number of frames delivered by the service instance. In the delivery mode 'timely online' this number can be smaller than the number of frames passed to the service element because data might have been discarded because of excessive backlog.

`RAF_ParFrameQuality Get_RequestedFrameQuality() const;`

Returns the frame quality requested by the service user. If the state of the service instance is not 'active' the method returns 'undefined'.

Initial Parameter Values

Parameter	Value
production-status	initial production status set via the interface IRAF_SIAdmin, in the delivery mode 'offline' set to 'invalid' if not set via IRAF_SIAdmin
frame-sync-lock-status	initial frame synchronizer lock set via the interface IRAF_SIAdmin, in the delivery mode 'offline' set to 'unknown' if not set via IRAF_SIAdmin
symbol-sync-lock-status	initial symbol synchronizer lock set via the interface IRAF_SIAdmin, in the delivery mode 'offline' set to 'unknown' if not set via IRAF_SIAdmin
subcarrier-lock-status	initial sub-carrier demodulator lock set via the interface IRAF_SIAdmin, in the delivery mode 'offline' set to 'unknown' if not set via IRAF_SIAdmin
carrier-lock-status	'initial carrier demodulator lock set via the interface IRAF_SIAdmin, in the delivery mode 'offline' set to 'unknown' if not set via IRAF_SIAdmin

Parameter	Value
number-of-error-free-frames	0
total-number-of-frames	0
requested-frame-quality	'undefined'

ANNEX B

ACRONYMS

(This annex is **not** part of the Recommended Practice)

This annex expands the acronyms used throughout this Recommended Practice.

API	Application Program Interface
CCSDS	Consultative Committee for Space Data Systems
GUID	Globally Unique Identifier
ID	Identifier
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
OMG	Object Management Group
PDU	Protocol Data Unit
RAF	Return All Frames
SI	Service Instance
SLE	Space Link Extension
UML	Unified Modelling Language

ANNEX C

INFORMATIVE REFERENCES

(This annex is **not** part of the Recommended Practice)

[C1] *Procedures Manual for the Consultative Committee for Space Data Systems*. CCSDS A00.0-Y-9, Yellow Book, Issue 9, Washington, D.C.: CCSDS, November 2003.

[C2] *Cross Support Concept – Part 1: Space Link Extension Services.* Report Concerning Space Data Systems Standards, CCSDS 910.3-G-2, Green Book, Issue 2, Washington, D.C.: CCSDS, April 2002.

[C3] *Space Link Extension – Internet Protocol for Transfer Services.* Draft Recommendation for Space Data System Standards, CCSDS 913.1-W-1, White Book, Issue 1, Washington, D.C.: CCSDS, To be issued.

[C4] *Space Link Extension – Application Program Interface for Transfer Services – Summary of Concept and Rationale.* Draft Report Concerning Space Data System Standards, CCSDS 914.1-W-1, White Book, Issue 1, Washington, D.C.: CCSDS, To be issued.

[C5] *Space Link Extension – Application Program Interface for Transfer Services – Application Programmer's Guide.* Draft Report Concerning Space Data System Standards, CCSDS 914.2-W-1, White Book, Issue 1, Washington, D.C.: CCSDS, To be issued.

[C6] *The COM/DCOM Reference,* The Open Group, Doc. Number AX-01, 1999 (http://www.opengroup.org/products/publications/catalog/ax01.htm).

[C7] *Unified Modelling Language (UML),* Version 1.5, Object Management Group, formal/2003-03-01, March 2003 (http://www.omg.org/technology/documents/modeling_spec_catalog.htm).