The Consultative Committee for Space Data Systems

Draft Recommendation for
Space Data System Standards

SPACECRAFT ON-BOARD INTERFACE SERVICES— DEVICE ENUMERATION SERVICE

DRAFT RECOMMENDED STANDARD

CCSDS 871.3-R-1

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PREFACE

This document is a draft CCSDS Recommended Standard. Its 'Red Book' 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

Document	Title	Date	Status
CCSDS 871.3-R-0.1	Spacecraft On-Board Interface Services—Device Enumeration Service, Draft Recommended Standard, Issue 0.1	March 2009	Original draft, superseded
CCSDS 871.3-R-0.1	Spacecraft On-Board Interface Services—Device Enumeration Service, Draft Recommended Standard, Issue 0.2	April 2012	Second draft, superceded
CCSDS 871.3-R-1	Spacecraft On-Board Interface Services—Device Enumeration Service, Draft Recommended Standard, Issue 1	April 2012	Current issue

CONTENTS

1 INTRODUCTION

1.1 PURPOSE AND SCOPE OF THIS DOCUMENT

This document is one of a family of documents specifying the Spacecraft Onboard Interface Services (SOIS)-compliant service to be provided in support of applications.

The purpose of this document is to define services and service interfaces provided by the SOIS Device Enumeration Service (DES). Its scope is to specify the service only and not to specify methods of providing the service, although use of the SOIS subnetwork services is assumed.

This document conforms to the principles set out in the SOIS Green Book (reference [B3]) and is intended to be applied together with it.

1.2 APPLICABILITY

This document applies to any mission or equipment claiming to provide a SOIS-compatible Device Enumeration Service.

1.3 RATIONALE

SOIS provide service interface specifications in order to promote application portability and development reuse via peer-to-peer and vertical standardisation.

1.4 DOCUMENT STRUCTURE

This document comprises seven sections:

a) this section, containing administrative information, definitions, and references;

b) section 2 containing general concepts and assumptions, including security issues;

c) section 3 containing the Device Enumeration Service specification;

d) section 4 containing the Management Information Base (MIB) for this service;

e) section 5 comprising the Service Conformance Statement Proforma;

In addition, two informative annexes are provided:

- ANNEX A, containing a list of acronyms;

- ANNEX B containing a list of informative references.

1.5 DEFINITIONS

1.5.1 GENERAL

For the purpose of this document the following definitions apply.

1.5.1.1 Definitions from the Open Systems Interconnection (OSI) Basic Reference Model

This document is defined using the style established by the Open Systems Interconnection (OSI) Basic Reference Model (reference [B2]). This model provides a common framework for the development of standards in the field of systems interconnection.

The following terms used in this Recommended Standard are adapted from definitions given in reference [B2]:

layer: a subdivision of the architecture, constituted by subsystems of the same rank.

service: a capability of a layer, and the layers beneath it (a service provider), which is provided to the service-users at the boundary between the service-providers and the service-users.

1.5.2 TERMS DEFINED IN THIS RECOMMENDED STANDARD

For the purposes of this Recommended Standard, the following definitions also apply.

Application: Any component of the on-board software that makes use of the Device Enumeration Service. This includes flight software applications and higher-layer services.

Device: A real hardware component of the spacecraft, such as a sensor or actuator, or a single register within such a component.

1.6 HOW THIS DOCUMENT FITS INTO THE SOIS DOCUMENTATION TREE

This document conforms to the principles set out in the Spacecraft Onboard Interface Services Green Book (reference [B3]) and should not be applied without first consulting this reference.

1.7 DOCUMENT 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.

1.8 REFERENCES

The following documents contain provisions which, through reference in this text, constitute provisions of this Recommended Standard. At the time of publication, the editions indicated were valid. All documents are subject to revision, and users of this Recommended Standard 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 Recommended Standards.

[1] *Spacecraft On-Board Interface Services—Device Access Service*. Draft Recommendation for Space Data Standards, CCSDS 871.0-R-2.2. Red Book. Issue 2.2. Washington, D.C.: CCSDS. April 2012.

[2] *Spacecraft On-Board Interface Services—Device Virtualisation Service*. Draft Recommendation for Space Data Standards, CCSDS 871.2-R-1. Red Book. Issue 1. Washington, D.C.: CCSDS. April 2012.

[3] *Spacecraft On-Board Interface Services—Subnetwork Device Discovery Service*. Recommendation for Space Data Standards, CCSDS 854.0-M-1. Magenta Book. Issue 1. Washington, D.C.: CCSDS. December 2009.

NOTE – Informative references are contained in ANNEX B.

2 OVERVIEW

2.1 CONTEXT

The SOIS Device Enumeration Service (DES) is defined within the context of the overall SOIS architecture [B3] as one of the services of the Application Support Layer, as illustrated in Figure 2-1.

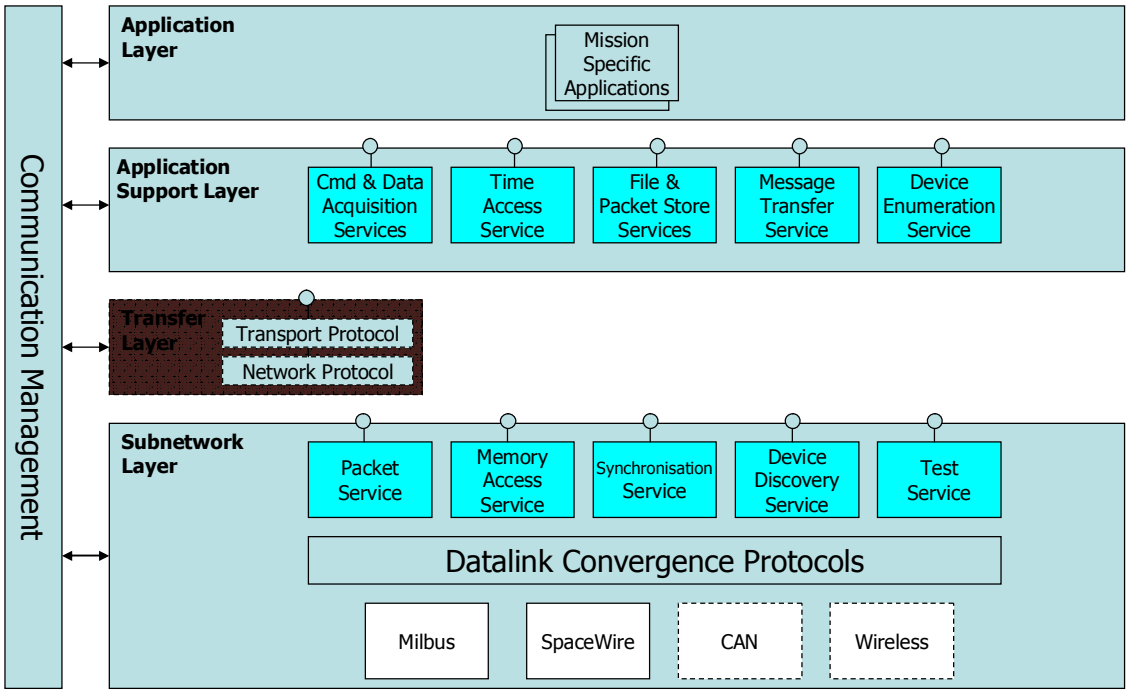

Figure 2-1: Device Enumeration Service Context

The relationship of the DES to the other SOIS services is illustrated in the following Figure 2-2.

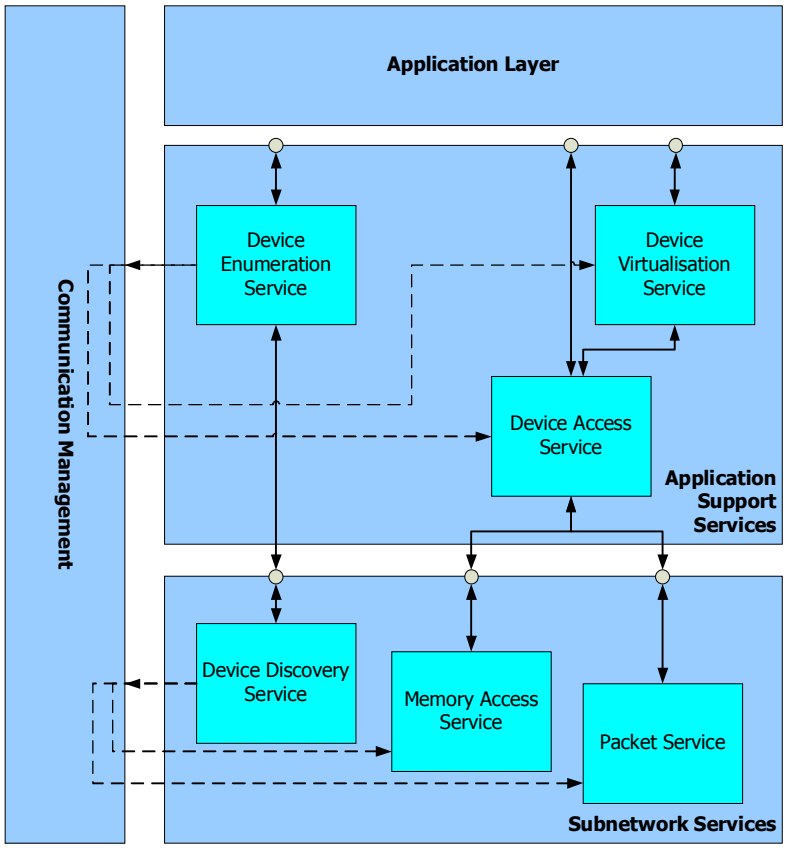

Figure 2-2: Relationship between Device Enumeration Service and other SOIS Services

The DES provides management and user-notification of added or removed devices from a spacecraft. Management of added devices consists of assigning a (system-wide unique) virtual device identifier and verifying that the functions and configuration of the discovered device match the ones required by the system. Management of removed devices consists of revoking the (system-wide unique) virtual device identifier so that the user can not access anymore the functions provided by the device using the other Application Support Services.

The service also provides the capability to enumerate the identifiers associated to the devices currently added and to perform queries on device metadata such as device serial number.

The DES main goal is to assist the onboard reconfiguration functions such as mode management or fault detection, isolation and recovery regarding the notification of changes in the spacecraft configuration and the execution the needed operations to adjust the onboard software to the new configuration. While the reconfiguration strategy is responsibility of the user-applications, the DES is in charge to detect the addition or removal of devices and the reconfiguration of the other SOIS services used to access these devices. In addition the DES also supports the spacecraft integration and test by managing the verification of the correct configuration of the onboard devices with respect to the spacecraft desired configuration or by easing the insertion/removal of device simulators in replacement of the real equipment.

The basic identification information for the devices installed in the system are retrieved by the subnetwork Device Discovery Service (DDS) and used by the DES to assign a system-wide unique identifier to each device so that can be accessed by the user-applications using the adequate functional interface (using the Device Virtualisation Service – DVS), device access protocol (using the Device Access Service – DAS) and subnetwork services (namely Memory Access Service – MAS – or Packet Service – PS).

The mapping between the identifiers used by the services and protocols is also illustrated in 3.

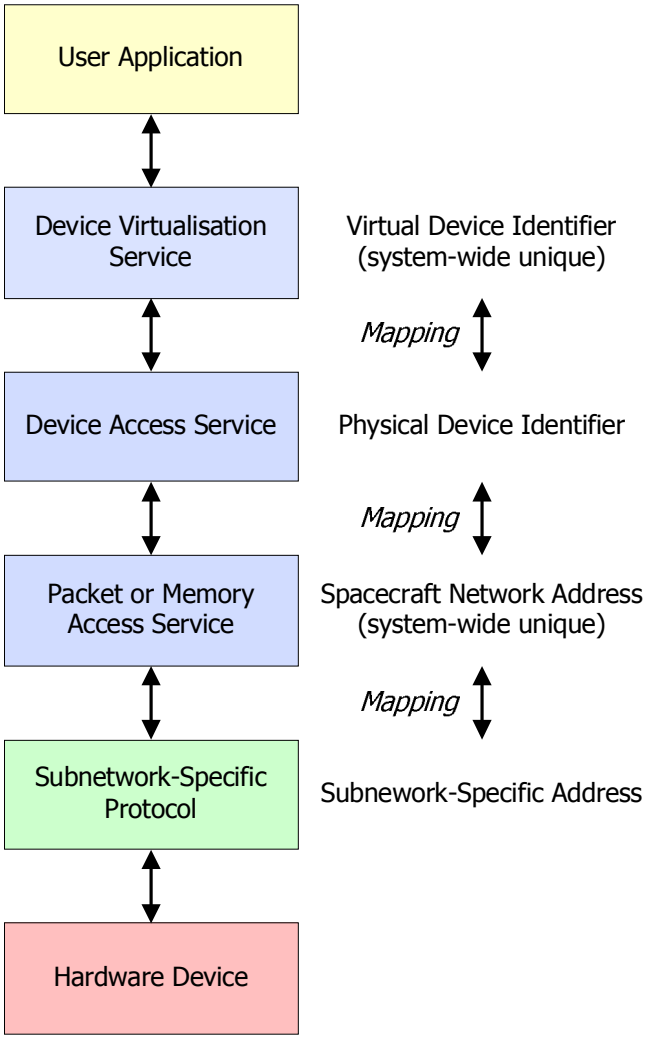

Figure 2-3: Identifiers mapping in SOIS Services

Service and protocols parameters as well as device specific access algorithms are supposed to be already integrated in the onboard software and to be selected based on the device identification attributes collected by the DES.

It is assumed that the interactions within the other SOIS services for what concerns the device ids and subnetwork addresses assignments are done via the Communication Management entity, therefore these operations are not covered by the service interface specified in this document.

2.1.1 ADDING DEVICES

Two mechanisms are available for adding a device by mean of the DES:

1. "Bottom-up". Discovery of added devices is provided by DDSs within the different subnetworks and this is notified to the DES.

2. "Top-down". Service users (higher level services or applications) notify the DES of an added device.

In either case, the following information is provided to the DES:

a) Device Serial Number, the unique identifier of the physical device to distinguish between devices of the same type (e.g. gyro mounted on axis X, gyro mounted on axis Y, etc...).

b) Device Type, the identifier of the functional interface supported by the device when accessed using the DVS.

c) Spacecraft Network Address, the identifier of the device in the spacecraft network. it identifies the subnetwork and the device within the subnetwork.

The DES joins information from two sources. One is the DDS (real configuration), which provides as minimum the Spacecraft Network Address and Device Serial Number. The other is the spacecraft configuration data provided by the spacecraft designers as a configuration table (stored inside the DES or made available though an onboard file system) and providing for each device the association between Device Serial Number, Spacecraft Network Address and Device Type, device location/orientation.

Matching these two sets of information, the DES then manipulates the configuration of the DVS and DAS to enable user access to the service provided by the device. Management consists of:

a) Verification that a device with the attributes mentioned above is foreseen by the Spacecraft configuration, if the check is negative an error is reported; otherwise

b) The Virtual Device Identifier (system-wide unique) to be used in the DVS primitives is assigned;

NOTE – To ease system integration and space operations, it is advised to use a deterministic algorithm to assign the device identifiers so that a given device always receives the same identifier every time it is added/discovered.

c) The Virtual Device Identifier assigned at b) is associated in the DVS MIB to the Physical Device Identifier used by DAS to the added device;

d) The Physical Device Identifier (system wide unique) is associated in the DAS MIB to the Spacecraft Network Address in order to access the device in its subnetwork.

Finally, the DES notifies any associated application of the added device. This notification contains the device attributes defined at a), b), c) and d).

NOTE – The mechanism to associate an application with DES notification is implementation-dependent.

2.1.2 REMOVING DEVICES

Two mechanisms are available for removing devices by mean of the DES:

1. "Bottom-up". Discovery of removed devices is provided by the DDS within the different subnetworks and this is notified to the DES.

   In this case, the following information is provided to the DES:

   a) Spacecraft Network Address associated to the removed device. The remaining associated device identifiers can be derived from the Spacecraft Network Address using the MIBs of the DAS and DVS where the associations between identifiers are maintained.

2. "Top-down". Service users (higher level services or applications) notify the DES of a removed device.

   In this case, the following information is provided to the DES:

   b) Virtual Device Identifier. System-wide unique identifier for the removed device.

The DES then manipulates the configuration of the DAS and DVS to remove user access to the service provided by the device. Management consists of:

c) invalidation of the Spacecraft Network Address in the DAS MIB;

d) invalidation of the Physical Device Identifier in the DVS MIB;

e) revoking of the Virtual Device Identifier;

Finally, the DES notifies any associated applications of the removed device. This notification contains the Virtual Device Identifier of the removed device.

NOTE – The mechanism to associate an application with the DES notification is implementation dependent.

2.1.3 REDUNDANCY CONSIDERATIONS

The DES doesn't explicitly manage redundancies among devices of the same type. It however provides the redundancy control function in the application layer with the mechanisms to configure the SOIS services in accordance with the spacecraft FDIR strategy.

Figure 2-4 shows the relationship between the DES, the redundancy control application and the regular user applications making use of Command and Data Acquisition Services configured by the DES.

In the figure it is assumed that the redundancy control gives visibility only of DVS-1 (device in use) to the rest of the applications and filters out DVS-2 (backup).

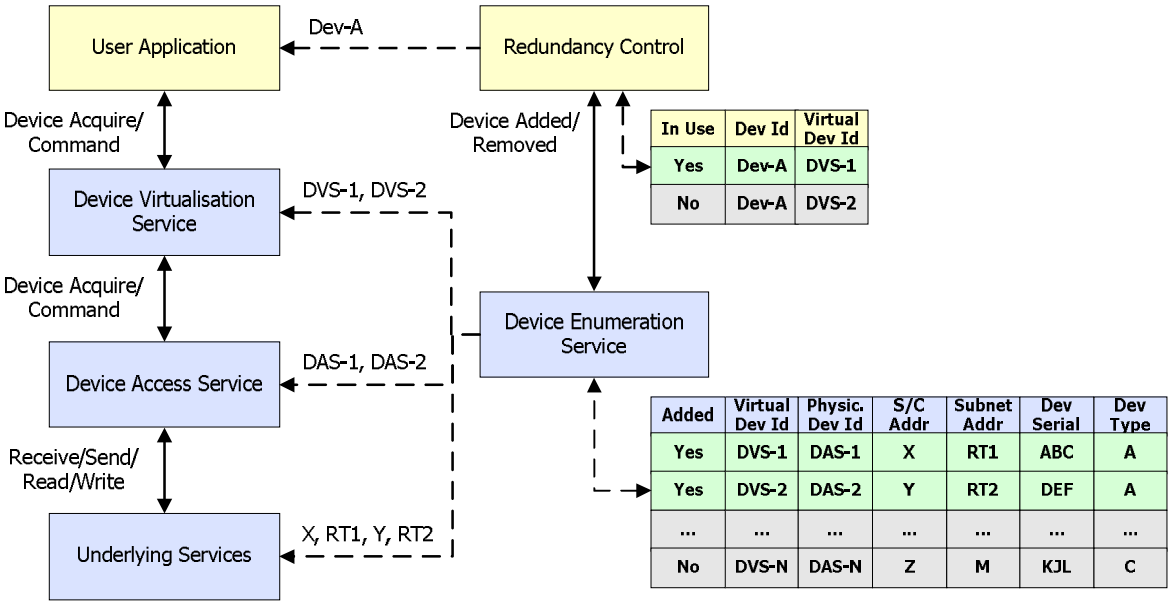

Figure 2-4: Device Enumeration Service and Redundancy

It is out of scope of the DES to actually command the switch on or off of the devices. This can be achieved by means of the Command and Data Acquisition services.

2.2 PURPOSE AND OPERATION OF THE DEVICE ENUMERATION SERVICE

Application software uses the Device Enumeration Service to manage (and be notified or notify it of) added or removed devices from a spacecraft, rather than having to discover the added or removed devices itself. From the application software perspective, use of the DES will result in applications that are more portable, that are easier to develop, and that can tolerate changes in the spacecraft hardware configuration, communications or physical devices. From the spacecraft platform implementers' perspective, use of the DES will make it easier to control the configuration of the hardware resources.

The DES is part of the SOIS Plug-and-Play architecture, however it can also be adopted in a traditional non-plug-and-play software architecture to help the application software in the configuration management of the devices and Command and Data Acquisition Services.

The DES is operated by service indications passed from the service provider and the service user, and optionally using service requests and associated service indications passed between the service user and the service provider.

2.3 SECURITY

2.3.1 SECURITY BACKGROUND

The SOIS services are intended for use with protocols that operate solely within the confines of an onboard subnet. It is therefore assumed that SOIS services operate in an isolated environment which is protected from external threats. Any external communication is assumed to be protected by services associated with the relevant space-link protocols. The specification of such security services is out of scope of this document.

2.3.2 SECURITY CONCERNS

At the time of writing there are no identified security concerns. If confidentiality of data is required within a spacecraft it is assumed it is applied at the Application layer. For more information regarding the choice of service and where it can be implemented, see reference [B4].

2.3.3 POTENTIAL THREATS AND ATTACK SCENARIOS

Potential threats and attack scenarios typically derive from external communication and are therefore not the direct concern of the SOIS services, which make the assumption that the services operate within a safe and secure environment. It is assumed that all applications executing within the spacecraft have been thoroughly tested and cleared for use by the mission implementer. Confidentiality of applications can be provided by Application layer mechanisms or by specific implementation methods such as time and space partitioning. Such methods are outside the scope of SOIS.

2.3.4 CONSEQUENCES OF NOT APPLYING SECURITY

The security services are out of scope of this document and are expected to be applied at layers above or below those specified in this document. If confidentiality is not implemented, science data or other parameters transmitted within the spacecraft might be visible to other applications resident within the spacecraft resulting in disclosure of sensitive or private information.

3 DEVICE ENUMERATION SERVICE

3.1 PROVIDED SERVICE

The Device Enumeration Service provides management and notification of added or removed devices from a spacecraft.

Management of added devices consists of assigning a system-wide unique device identifier and mapping it across the SOIS communication stack in order to allow the DVS, DAS and subnetwork services to access the physical devices. The detection of added devices or device attributes not originally foreseen by the spacecraft design is flagged as an error. Notification of an added device consists of an indication to a service user of the device identifier, together with the device's type and device's serial number.

Management of removed devices consists of revoking the related device identifier in order disable the user access to the functions that were provided by the device via the SOIS services. Notification of a removed device consists of an indication to a service user of the device identifier, together with the device's class and type.

3.2 EXPECTED SERVICE FROM UNDERLYING LAYERS

a) The minimum expected service from the underlying layers is a Device Discovery Service [3] for each supported subnetwork type.

b) Control of the MIB of the Device Virtualisation Service [2] is expected.

c) Control of the MIB of the Device Access Service [1] is expected.

NOTE – It is expected that in future there may be standardisation of protocols to discover the services provided by a physical device directly from the physical device itself. These protocols will have associated expected services from the underlying layers.

3.3 DEVICE ENUMERATION SERVICE PARAMETERS

3.3.1 GENERAL

The Device Enumeration Service shall use the parameters specified in 3.3.2 to 3.3.8.

3.3.2 TRANSACTION IDENTIFIER

a) The Transaction Identifier parameter shall be a value, assigned by the invoking user entity, which is subsequently used to associate indication primitives with the causal request primitives.

NOTE – The user entity is thus able to correlate all indications and confirmations with the originating service request.

b) Transaction Identifier shall be unique within the user application entity.

c) Uniqueness in the service provider shall be achieved by Transaction Identifier.

3.3.3 RESULT METADATA

The Result Metadata parameter shall be used to provide information generated by the Device Enumeration Service provider to the service invoking entity to provide information related to the successful or failed result of a device enumeration operation.

NOTE – The parameter can also include other information indicating failure conditions, e.g., the specified device type don't match with the device types supported by the spacecraft.

3.3.4 VIRTUAL DEVICE IDENTIFIER

The system-wide unique device identifier assigned by the service when the device is successfully added. The identifier is used in the Device Virtualisation Service primitive.

3.3.5 PHYSICAL DEVICE IDENTIFIER

The device identifier used in the Device Access Service primitive.

3.3.6 DEVICE SERIAL NUMBER

The unique identifier of the physical device added.

The parameter allows distinguishing between devices of the same type installed on the spacecraft. The device type does not provide complete discrimination of the functions that devices can provide. For example, there may be three identical reaction wheels on board a spacecraft, each spanning a different part of the attitude actuation space; in order for an attitude control system to use those reaction wheels correctly, it must know the orientations of the wheels in the vehicle frame. The function that a device can provide on board a spacecraft typically depends upon the transformation between device coordinates and vehicle coordinates.

This document assumes (without specifying the implementation) that the designers of a spacecraft have provided a manifest of devices with serial numbers and with the appropriate transformation for each device. Given the manifest, the device serial number completely identifies the function that the device may serve on board the spacecraft.

3.3.7 DEVICE TYPE

The identifier of the type of the device added. The parameter identifies the functional interface supported by the device itself.

3.3.8 SPACECRAFT NETWORK ADDRESS

The spacecraft network address of the device added, it identifies the subnetwork and the device within the subnetwork.

3.4 DEVICE ENUMERATION SERVICE PRIMITIVES

3.4.1 GENERAL

a) The Device Enumeration Service interface shall provide the following primitives:

1. DEVICE_FOUND.indication, as specified in 3.4.4.
2. DEVICE_LOST.indication, as specified in 3.4.7.
3. ENUMERATE_DEVICES.request as specified in 3.4.8.
4. ENUMERATE_DEVICE.indication as specified in 3.4.8.5.

b) The Device Enumeration Service interface may provide the following primitives:

1. ADD_DEVICE.request, as specified in 3.4.2.
2. ADD_DEVICE.indication, as specified in 3.4.2.5.
3. REMOVE_DEVICE.request, as specified in 3.4.5.
4. REMOVE_DEVICE.indication, as specified in 3.4.5.5.
5. QUERY_DEVICES.request as specified in 3.4.10.
6. QUERY_DEVICES.indication as specified in 3.4.10.5.

3.4.2 ADD_DEVICE.REQUEST

3.4.2.1 Function

The **ADD_DEVICE.request** primitive shall be used to request that a physical device be assigned a device identifier and be enabled in the SOIS architecture.

3.4.2.2 Semantics

The **ADD_DEVICE.request** primitive shall use the following semantics, with the meaning of the parameter specified in 3.3:

> **ADD_DEVICE.request**(Device Serial Number, Device Type, Spacecraft Network Address)

3.4.2.3 When generated

The **ADD_DEVICE.request** primitive shall be passed to the Device Enumeration Service provider to request to assign the device identifier and to enable the use in the SOIS architecture of the physical device specified by the primitive parameters.

3.4.2.4 Effect on Receipt

Receipt of the **ADD_DEVICE.request** primitive shall cause the Device Enumeration Service provider to retrieve the physical device attributes using Device Discovery Service and to verify that the match with input parameters.

If the match is positive a new Virtual Device Identifier shall be assigned and the Device Virtualisation Service and Device Access Service MIB shall be configured to support the access to the device.

3.4.2.5 Additional Comments

None

3.4.3 ADD_DEVICE.INDICATION

3.4.3.1 Function

The **ADD_DEVICE.indication** shall be used to pass the result of a previous ADD_DEVICE.request to the user entity.

3.4.3.2 Semantics

The **ADD_DEVICE.indication** primitive shall use the following semantics, with the meaning of the parameter specified in 3.3:

> **ADD_DEVICE.indication**(Transaction Identifier, Device Serial Number, Device Type, Spacecraft Network Address, Virtual Device Identifier, Result Metadata)

3.4.3.3 When generated

The **ADD_DEVICE.indication** shall be issued by the service provider to the receiving user entity on the addition of a device:

a) in response to a ADD_DEVICE.request

3.4.3.4 Effect on Receipt

The response of the user entity to a **ADD_DEVICE.indication** primitive is unspecified.

3.4.3.5 Additional comments

a) The Result Metadata parameter shall be indicated if the addition of the device was successful or not.

3.4.4 DEVICE_FOUND.INDICATION

3.4.4.1 Function

The **ADD_DEVICE.indication** shall be used to notify the user entity that an added device has been detected by Device Discovery Service.

3.4.4.2 Semantics

The **DEVICE_FOUND.indication** primitive shall use the following semantics, with the meaning of the parameter specified in 3.3:

> **DEVICE_FOUND.indication**(Device Serial Number, Device Type, Spacecraft Network Address, Virtual Device Identifier, Result Metadata)

3.4.4.3 When generated

The **DEVICE_FOUND.indication** shall be issued by the service provider to the receiving user entity on the addition of a device:

a) as a consequence of notification by a subnetwork's Device Discovery Service that an added device has been detected.

3.4.4.4 Effect on Receipt

The response of the user entity to a **DEVICE_FOUND.indication** primitive is unspecified.

3.4.4.5 Additional comments

a) The Result Metadata parameter shall be indicated if the addition of the device was successful or not.

3.4.5 REMOVE_DEVICE.REQUEST

3.4.5.1 Function

The REMOVE_DEVICE.request primitive shall be used to request to revoke the Virtual Device Identifier (obtained by ADD_DEVICE.indication) and to disable the use of the associated a physical device in the SOIS architecture.

3.4.5.2 Semantics

The **REMOVE_DEVICE.request** primitive shall use the following semantics, with the meaning of the parameter specified in 3.3:

> **REMOVE_DEVICE.request**(Virtual Device Identifier)

3.4.5.3 When generated

The **REMOVE_DEVICE.request** primitive shall be passed to the Device Enumeration Service provider to request to revoke the device identifier and to disable the use in the SOIS architecture of the associated physical device.

3.4.5.4 Effect on Receipt

Receipt of the **REMOVE_DEVICE.request** primitive shall cause the Device Enumeration Service provider to revoke the specified Virtual Device Identifier and the Device Virtualisation Service and Device Access Service MIB shall be configured to have no access the device.

3.4.5.5 Additional Comments

None

3.4.6 REMOVE_DEVICE.INDICATION

3.4.6.1 Function

The REMOVE_DEVICE.indication shall be used to pass the result of a previous REMOVE_DEVICE.request to the user entity.

3.4.6.2 Semantics

The **REMOVE_DEVICE.indication** primitive shall use the following semantics, with the meaning of the parameter specified in 3.3:

> **REMOVE_DEVICE.indication**(Transaction Identifier, Virtual Device Identifier, Result Metadata)

3.4.6.3 When generated

The **REMOVE_DEVICE.indication** shall be issued by the service provider to the receiving user entity on the removal of a device, either:

a) in response to a REMOVE_DEVICE.request.

3.4.6.4 Effect on Receipt

The response of the user entity to a **REMOVE_DEVICE.indication** primitive is unspecified.

3.4.6.5 Additional comments

b) The Result Metadata parameter shall be indicated if the removal of the device was successful or not.

3.4.7 DEVICE_LOST.INDICATION

3.4.7.1 Function

The DEVICE_LOST.indication shall be used to notify the user entity that the loss of a device has been detected by Device Discovery Service.

3.4.7.2 Semantics

The **DEVICE_LOST.indication** primitive shall use the following semantics, with the meaning of the parameter specified in 3.3:

DEVICE_LOST.indication(Virtual Device Identifier, Result Metadata)

3.4.7.3 When generated

The **DEVICE_LOST.indication** shall be issued by the service provider to the receiving user entity on the removal of a device, either:

a) As a consequence of notification by a subnetwork's Device Discovery Service that the loss of a device has been detected.

3.4.7.4 Effect on Receipt

The response of the user entity to a **DEVICE_LOST.indication** primitive is unspecified.

3.4.7.5 Additional comments

a) The Result Metadata parameter shall be indicated if the removal of the device was successful or not.

3.4.8 ENUMERATE_DEVICES.REQUEST

3.4.8.1 Function

The **ENUMERATE_DEVICES.request** primitive shall be used to request a list of all devices known to Device Enumeration Service.

3.4.8.2 Semantics

The **ENUMERATE_DEVICES.request** primitive shall use the following semantics, with the meaning of the parameter specified in 3.3:

ENUMERATE_DEVICES.request(Transaction Identifier)

3.4.8.3 When generated

The **ENUMERATE_DEVICES.request** primitive shall be passed to the Device Enumeration Service provider to request a list of all devices known to Device Enumeration Service.

3.4.8.4 Effect on Receipt

Receipt of the **ENUMERATE_DEVICES.request** primitive shall cause the Device Enumeration Service provider to report the list of all known devices through ENUMERATE_DEVICES.indication.

3.4.8.5 Additional Comments

None

3.4.9 ENUMERATE_DEVICES.INDICATION

3.4.9.1 Function

The **ENUMERATE_DEVICES.indication** shall be used to pass the list of all known devices to the user entity that generated a previous ENUMERATE_DEVICES.request.

3.4.9.2 Semantics

The **ENUMERATE_DEVICES.indication** primitive shall use the following semantics for each device, with the meaning of the parameter specified in 3.3:

> **ENUMERATE_DEVICES.indication**(Transaction Identifier, Virtual Device Identifier, Device Serial Number, Device Type, Spacecraft Network Address, Result Metadata)

3.4.9.3 When generated

The **ENUMERATE_DEVICES.indication** shall be issued by the service provider to the receiving user entity once for each known device. Optionally, the service provider may issue an array of ENUMERATE_DEVICES.indication once for each request, with the number of items in the array preceding the array. Any enumerable container may be used to return a set of ENUMERATE_DEVICES.indication when the implementation of the DES interface is an application programming interface without messaging.

3.4.9.4 Effect on Receipt

The response of the user entity to a **ENUMERATE_DEVICES.indication** primitive is unspecified.

3.4.9.5 Additional comments

a) The Result Metadata parameter shall contain the following information:

   a. a sequence number for each indication issued for the request, starting with 1

   b. a count of the number of iterations being issued

3.4.10 QUERY_DEVICES.REQUEST

3.4.10.1 Function

The **QUERY_DEVICES.request** primitive shall be used to request a list of all devices known to Device Enumeration Service that satisfy specific criteria.

3.4.10.2 Semantics

The **QUERY_DEVICES.request** primitive shall use the following semantics, with the meaning of the parameter specified in 3.3:

QUERY_DEVICES.request(Transaction Identifier, Device Query String)

The QUERY_DEVICES primitive uses a string to describe the set of devices to be returned to the requester. The string is a list of constraints, which DES compares to the manifest of the devices in its inventory and optionally to the electronic datasheets if available onboard. The constraints limit the values of attributes, and their conjunction defines the set of devices to be returned. Each constraint consists of the name of an attribute, a value of the attribute, and a relation. The relations are listed below.

- The = sign indicates that the value of a discrete attribute must be equal to the value in the constraint.
- The < sign indicates that the value of an ordered attribute must be less than the value in the constraint. Similarly, the > sign indicates a lower bound on an ordered attribute.
- Any relation may be preceded by ! to indicate the complementary set of values.

The names of a minimal set of attributes appear in the list below.

- deviceSerialNumber: See section 3.3.6.
- deviceType: see section 3.3.7.
- spacecraftNetworkAddress: see section 3.3.8.

The syntax of a constraint is “attributeName relation value”, optionally separated by whitespace. A list of constraints is delimited by comma, optionally surrounded by whitespace.

Other attributes and relations will be defined in the dictionary of terms for electronic data sheets.

If the device query string is the empty string, the effect is the same as ENUMERATE_DEVICES.request.

3.4.10.3 When generated

The **QUERY_DEVICES.request** primitive shall be passed to the Device Enumeration Service provider to request a list of all devices known to Device Enumeration Service that satisfy the conditions of the Device Query String.

3.4.10.4 Effect on Receipt

Receipt of the **QUERY_DEVICES.request** primitive shall cause the Device Enumeration Service provider to report the list of all known devices that satisfy the query through QUERY_DEVICES.indication.

3.4.10.5 Additional Comments

None

3.4.11 QUERY_DEVICES.INDICATION

3.4.11.1 Function

The **QUERY_DEVICES.indication** shall be used to pass the list of all known devices that satisfy a query to the user entity that generated a previous QUERY_DEVICES.request.

3.4.11.2 Semantics

The **QUERY_DEVICES.indication** primitive shall use the following semantics for each device, with the meaning of the parameter specified in 3.3:

> **QUERY_DEVICES.indication**(Transaction Identifier, Virtual Device Identifier, Device Serial Number, Device Type, Spacecraft Network Address, Result Metadata)

3.4.11.3 When generated

The **QUERY_DEVICES.indication** shall be issued by the service provider to the receiving user entity once for each known device that satisfies the query. Optionally, the service provider may issue an array of QUERY_DEVICES.indication once for each request, with the number of items in the array preceding the array. Any enumerable container may be used to return a set of ENUMERATE_DEVICES.indication when the implementation of the DES interface is an application programming interface without messaging.

3.4.11.4 Effect on Receipt

The response of the user entity to a **QUERY_DEVICES.indication** primitive is unspecified.

3.4.11.5 Additional comments

b) The Result Metadata parameter shall contain the following information:

   c. a sequence number for each indication issued for the request, starting with 1

   d. a count of the number of iterations being issued

4 PROTOCOL SPECIFICATION

None.

NOTE – It is expected that in future there may be standardisation of protocols to discover the services provided by a physical device directly from the physical device itself.

5 PROTOCOL DATA UNITS

None.

NOTE – It is expected that in future there may be standardisation of protocols to discover the services provided by a physical device directly from the physical device itself.

6 MANAGEMENT INFORMATION BASE

None.

7 DEVICE ENUMERATION SERVICVE PROTOCOL IMPLEMENTATION CONFORMANCE STATEMENT PROFORMA

(Normative)

7.1 INTRODUCTION

This section provides the Protocol Implementation Conformance Statement (PICS) Requirements List (PRL) for implementation of the Device Enumeration Service, CCSDS 871.3-R-1, April 2012. The PICS for an implementation is generated by completing the PRL in accordance with the instructions below. An implementation shall satisfy the mandatory conformance requirements of the base standards referenced in the PRL.

The PRL in this section is blank. An implementation's complete PRL is called a PICS. The PICS states which capabilities and options of the services have been implemented. The following can be use the PICS:

- The service implementer, as a checklist to reduce the risk of failure to conform to the standard through oversight;
- The supplier and acquirer 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;
- The user or potential user of the implementation, as a basis for initially checking the possibility of interoperability with another implementation;
- A service tester, as a basis for selecting appropriate tests against which to assess the claim for conformance of the implementation.

7.2 NOTATION

The following are used in the PRL to indicate the status of features:

Status Symbols

M mandatory

O optional

Support Column Symbols

The support of every item as claimed by the implementer is stated by entering the appropriate answer (Y, N or N/A) in the Support column:

Y	Yes, supported by the implementation
N	No, not supported by the implementation
N/A	Not applicable

7.3 REFERENCED BASE STANDARDS

The base standards references in the PRL are:

– Device Enumeration Service – this document.

7.4 GENERATION INFORMATION

IDENTIFICATION OF PICS

Ref	Question	Response
1	Date of Statement (DD/MM/YYYY)	
2	PICS serial number	
3	System Conformance statement cross-reference	

7.5 IDENTIFICATION OF IMPLEMENTATION UNDER TEST (IUT)

Ref	Question	Response
1	Implementation name	
2	Implementation version	
3	Special configuration	
4	Other information	

7.6 IDENTIFICATION

Ref	Question	Response
1	Supplier	
2	Contact Point for Queries	

3	Implementation name(s) and Versions	
4	Other information necessary for full identification, e.g. name(s) and version(s) for machines and/or operating systems: System Name(s)	

7.7 SERVICE SUMMARY

Ref	Question	Response
1	Service Version	
2	Addenda implemented	
3	Amendments implemented	
4	Have any exceptions been required? (Note: a YES answer means that the implementation does not conform to the service. Non-supported mandatory capabilities are to be identified in the PICS, with an explanation of why the implementation is non-conforming.	Yes _____ No

7.8 INSTRUCTIONS FOR COMPLETING THE PRL

An implementer shows the extent of compliance to the protocol by completing the PRL; that is, compliance to all mandatory requirements and the options that are not supported are shown. The resulting completed PRL is called a PICS. In the Support column, each response shall be selected either from the indicated set of responses or it shall comprise one or more parameter values as requested. If a conditional requirement is inappropriate, N/A shall be used. If a mandatory requirement is not satisfied, exception information must be supplied by entering a reference X*i*, where *i* is a unique identifier, to an accompanying rationale for the non-compliance.

7.9 GENERAL/MAJOR CAPABILITIES

Item	Service Feature	Reference (Magenta Book)	Status	Support
	DEVICE_FOUND.indication	3.4.4	M	

Item	Service Feature	Reference (Magenta Book)	Status	Support
	DEVICE_LOST.indication	3.4.7	M	
	ENUMERATE_DEVICES.request	3.4.8	M	
	ENUMERATE_DEVICES.indication	3.4.8.5	M	
	ADD_DEVICE.request	3.4.2	O	
	ADD_DEVICE.indication	3.4.2.5	O	
	REMOVE_DEVICE.request	3.4.5	O	
	REMOVE_DEVICE.indication	3.4.5.5	O	
	QUERY_DEVICES.request	3.4.10	O	
	QUERY_DEVICES.indication	3.4.10.5	O	

7.10 UNDERLYING LAYERS PROVIDING SERVICES TO IMPLEMENTATION

This section provides identification of the Underlying Layers providing Services to the implementation.

Service Feature	Reference	Status	Support
DEVICE_DISCOVERY.indication	3.2.a)	M	
DEVICE_DISCOVERY.request	3.2.a)	O	
DEVICE_DISCOVERY_LOSS.indication	3.2.a)	M	
Device Virtualisation Service MIB	3.2.b)	M	
Device Access Service MIB	3.2.c)	M	

ANNEX A

ACRONYMS

(INFORMATIVE)

CCSDS	Consultative Committee for Space Data Standards
DAS	Device Access Service
DDS	Device Discovery Service
DES	Device Enumeration Service
DVS	Device Virtualisation Service
ID	Identifier
MAS	Memory Access Service
MIB	Management Information Base
OSI	Open Systems Interconnection
PDU	Protocol Data Unit
PS	Packet Service
SOIS	Spacecraft Onboard Interface Services

ANNEX B

INFORMATIVE REFERENCES

[B1] *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.

[B2] *The Open Group Base Specifications*. Issue 7. IEEE Std 1003.1-2008, pubs.opengroup.org/onlinepubs/9699919799/basedefs/contents.html.

[B3] *Spacecraft Onboard Interface Services*. Report Concerning Space Data System Standards, CCSDS 850.0-G-1. Green Book. Issue 1. Washington, D.C.: CCSDS, June 2007.

[B4] *The Application of CCSDS Protocols to Secure Systems*. Report Concerning Space Data System Standards, CCSDS 350.0-G-2. Green Book. Issue 2. Washington, D.C.: CCSDS, January 2006.

NOTE – Normative references are listed in 1.8.