CCSDS

The Consultative Committee for Space Data Systems

Recommendation for Space Data System Practices

SPACECRAFT ONBOARD INTERFACE SERVICES— SUBNETWORK DEVICE DISCOVERY SERVICE

RECOMMENDED PRACTICE

CCSDS 854.0-M-1

MAGENTA BOOK
December 2009

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STATEMENT OF INTENT

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CCSDS Recommendations take two forms: **Recommended Standards** that are prescriptive and are the formal vehicles by which CCSDS Agencies create the standards that specify how elements of their space mission support infrastructure shall operate and interoperate with others; and **Recommended Practices** that are more descriptive in nature and are intended to provide general guidance about how to approach a particular problem associated with space mission support. This **Recommended Practice** is issued by, and represents the consensus of, the CCSDS members. Endorsement of this **Recommended Practice** is entirely voluntary and does not imply a commitment by any Agency or organization to implement its recommendations in a prescriptive sense.

No later than five years from its date of issuance, this **Recommended Practice** will be reviewed by the CCSDS to determine whether it should: (1) remain in effect without change; (2) be changed to reflect the impact of new technologies, new requirements, or new directions; or (3) be retired or cancelled.

In those instances when a new version of a **Recommended Practice** is issued, existing CCSDS-related member Practices and implementations are not negated or deemed to be non-CCSDS compatible. It is the responsibility of each member to determine when such Practices or implementations are to be modified. Each member is, however, strongly encouraged to direct planning for its new Practices and implementations towards the later version of the Recommended Practice.

FOREWORD

This document is a technical **Recommended Practice** for use in developing flight and ground systems for space missions and has been prepared by the **Consultative Committee for Space Data Systems** (CCSDS). The *Subnetwork Device Discovery Service* described herein is intended for missions that are cross-supported between Agencies of the CCSDS, in the framework of the Spacecraft Onboard Interface Services (SOIS) CCSDS area.

This **Recommended Practice** specifies a service to be used by space missions to identify the presence of subnetwork data systems. The SOIS Subnetwork Device Discovery Service is a simple service which is provided by data link-specific mechanisms within the subnetwork layers. The service may be invoked by a subnetwork user entity or by mechanisms internal to the subnetwork (e.g., when a device is first connected to the subnetwork). The SOIS Subnetwork Device Discovery Service provides a common service interface regardless of the particular type of data link being used for communication.

Through the process of normal evolution, it is expected that expansion, deletion, or modification of this document may occur. This Recommended Practice is therefore subject to CCSDS document management and change control procedures, which are defined in the *Procedures Manual for the Consultative Committee for Space Data Systems*. Current versions of CCSDS documents are maintained at the CCSDS Web site:

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DOCUMENT CONTROL

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CONTENTS

1 INTRODUCTION

1.1 PURPOSE AND SCOPE OF THIS DOCUMENT

This document is one of a family of documents specifying the SOIS-compliant services to be provided by onboard subnetworks.

The purpose of this document is to define services and service interfaces provided by the SOIS Subnetwork Device Discovery Service. Its scope is to specify the service only and not to specify methods of providing the service over a variety of onboard data links.

This document conforms to the principles set out in the Spacecraft Onboard Interface Services Green Book (reference [A1]) and is intended to be applied together with it. The protocols which provide this service are to be documented for individual links, and this can be in the purview of individual missions, agencies, or CCSDS, depending on future circumstance.

1.2 APPLICABILITY

This document applies to any mission or equipment claiming to provide a CCSDS SOIS-compliant Subnetwork Device Discovery Service.

1.3 RATIONALE

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

1.4 DOCUMENT STRUCTURE

The document has five major sections:

- this section, containing administrative information, definitions and references;

- section 2, describing general concepts and assumptions;

- section 3, containing the Subnetwork Device Discovery Service specification;

- section 4, containing the Management Information Base (MIB) for the service;

- section 5, comprising a Service Conformance Statement Proforma.

In addition, annex A contains informative references.

1.5 CONVENTIONS AND DEFINITIONS

1.5.1 BIT NUMBERING CONVENTION AND NOMENCLATURE

In this document, the following convention is used to identify each bit in an *N*-bit field. The first bit in the field to be transmitted (i.e., the most left justified when drawing a figure) is defined to be 'Bit 0'; the following bit is defined to be 'Bit 1' and so on up to 'Bit *N*–1'. When the field is used to express a binary value (such as a counter), the Most Significant Bit (MSB) shall be the first transmitted bit of the field, i.e., 'Bit 0' (see figure 1-1).
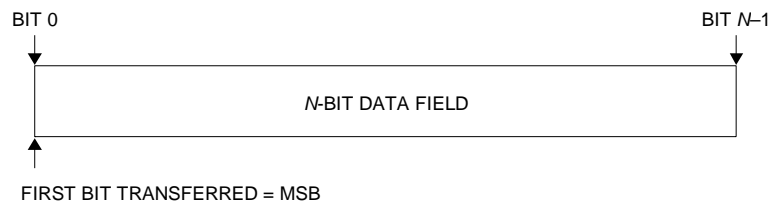

Figure 1-1: Bit Numbering Convention

In accordance with modern data communications practice, spacecraft data fields are often grouped into eight-bit 'words' widely known as bytes. Throughout this Recommended Practice, such an eight-bit word is called an 'octet'.

The numbering for octets within a data structure starts with zero. By CCSDS convention, any 'spare' bits are permanently set to '0'.

1.5.2 DEFINITIONS

1.5.2.1 General

For the purpose of this document the following definitions apply.

1.5.2.2 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 [A3]). This model provides a common framework for the development of standards in the field of systems interconnection.

The following terms, used in this Recommended Practice, are adapted from definitions given in reference [A3]:

device discovery service access point (DDSAP): the point at which SOIS **Device Discovery** service is provided by a **Device Discovery** service entity to a **Device Discovery** service user entity.

device discovery service access point address (DDSAP Address): a **Device Discovery** service address that is used to identify a single DDSAP.

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

protocol data unit (PDU): unit of data specified in a protocol and consisting of Protocol Control Information (PCI) and possibly user data.

protocol ID: identifier which uniquely identifies a SOIS Subnetwork user within a data system.

service: capability of a layer (service provider) together with the layers beneath it, which is provided to the service users.

subnetwork: an abstraction of a collection of equipment and physical media, such as a local area network or a data bus, which forms and autonomous whole and can be used to interconnect real systems for the purpose of data transfer.

1.5.2.3   Terms Defined in this Recommended Practice

For the purposes of this Recommended Practice, the following definitions also apply. Many other terms that pertain to specific items are defined in the appropriate sections.

channel: identifier for subnetwork resources associated with a resource reservation.

NOTE –   A channel can be a list of time slots in a time division multiplexed system or a bandwidth limit in a bandwidth division multiplexed system. The subnetwork resources required for the communication can also be defined to allow simultaneous use of non-conflicting resources on subnetworks that support this feature.

data system: addressable entity, situated in a subnet, which hosts an instance of the subnetwork protocols, subnetwork services, and subnetwork users.

NOTE –   The subnetwork users are uniquely identifiable in a subnetwork by a combination of data system address and a protocol ID. A data system is typically a computer or a device.

data system address: identifier which uniquely identifies a data system in a subnetwork.

NOTE –   The data system address can be referred to as a destination address or a source address depending on the context of its invocation at the subnetwork service interface.

octet: eight-bit word.

NOTE –   An eight-bit word is commonly referred to as a byte.

priority: transmit precedence of an SDU relative to other SDUs.

quality of service (QoS): ability of a communication system to provide predictable and differentiated services.

NOTE – Quality of service for a communication service may be characterised in terms of important features relevant to that communications service, for example: reliability, transmission rate, effective bandwidth and latency, error rate.

1.6 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.

1.7 REFERENCES

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

None.

NOTE – Informative references are contained in annex A.

2 OVERVIEW

2.1 FUNCTION

The SOIS Subnetwork Device Discovery Service provides a means for a user entity to receive notification of data systems' presence on the subnetwork.

2.2 CONTEXT

The SOIS Subnetwork Layer provides the Device Discovery Service to user applications. The service can be provided over a variety of data links, and the method of such provision is not in the scope of this document.

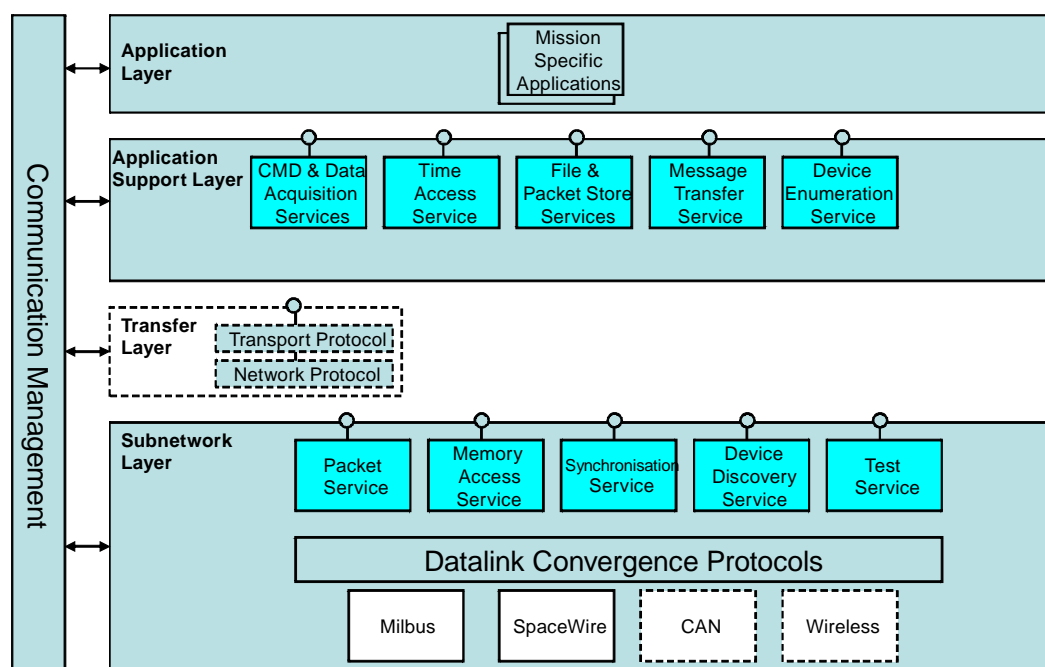As shown in figure 2-1, the service is one of a number of services which can be provided by the SOIS Subnetwork.

Figure 2-1: Subnetwork Device Discovery Service Context

The Subnetwork Device Discovery Service makes use of the data link to transfer data and control information. A variety of data links can be suited to provision of the service and the strategy for such service provision is outlined in reference [A1].

The Device Discovery Service can be invoked either by a subnetwork user entity or by mechanisms internal to the subnetwork. The recipient of the Device Discovery Service data is always the subnetwork user entity. In the case of service invocation by a user entity the recipient of the Device Discovery Service data will be the same user entity. The method of service provision is data-link layer specific.

2.3 ASSUMPTIONS

The following assumptions have been made in designing the SOIS Subnetwork Device Discovery Service:

– The SOIS Subnetwork Device Discovery Service is provided across single subnetworks.

– The SOIS Subnetwork Device Discovery Service is made available to protocol entities in the Transfer, Application Support, and User Application Layers.

2.4 QUALITY OF SERVICE

The Device Discovery Service operates with Best-effort quality of service. This service makes a single attempt to provide the requested service but cannot ensure that it will be completed successfully.

Channel and Priority parameters are not provided in the Device Discovery Service. Were a subnetwork to provide channelisation and prioritisation to users of other subnetwork services, it would fall to the subnetwork Management Information Base (MIB) to set default channel and priority levels to ensure that the Device Discovery Service adhere to an overall subnetwork prioritisation and resource-reservation scheme.

2.5 SECURITY

2.5.1 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 outside the scope of this document.

2.5.2 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. More information regarding the choice of service and where it can be implemented can be found in reference [A2].

2.5.3 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.

2.5.4   CONSEQUENCES OF NOT APPLYING SECURITY

The security services are outside the 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 SUBNETWORK DEVICE DISCOVERY SERVICE

3.1 SERVICE PARAMETERS

3.1.1 GENERAL

The Subnetwork Device Discovery Service shall use the parameters specified in 3.1.2 to 3.1.4.

3.1.2 DEVICE DISCOVERY SERVICE ACCESS POINT ADDRESS

a) The DDSAP Address shall identify the SAP of the user entity that is the recipient of a Device Discovery Service indication.

b) In the case of service invocation by a user entity the same DDSAP Address shall identify the invoking user entity.

3.1.3 DEVICE ADDRESS

The Device Address shall identify a data system connected to the subnetwork.

3.1.4 DEVICE METADATA

a) The Device metadata parameter shall describe the device undergoing discovery.

b) The Device metadata should include class characteristics.

NOTE – For example, star tracker, reaction wheel, thermistor, or mass memory.

c) The Device metadata may also include specific device type information, including identification of the manufacturer, the series, model, variant, part number and unique device instance identifier.

NOTE – The metadata can be organised in a hierarchical fashion; e.g., a Reaction Wheel class is a subset of the Actuator class.

3.2 DEVICE DISCOVERY SERVICE PRIMITIVES

3.2.1 GENERAL

The SOIS Subnetwork Test Service shall use the following three primitives:

a) DEVICE_DISCOVERY.request (which requests that device identities be retrieved from the subnetwork), as specified in 3.2.2.

b) DEVICE_DISCOVERY.indication (which returns device identities and optional metadata), as specified in 3.2.3.

c) DEVICE_DISCOVERY_LOSS.indication (which notifies the loss of a device), as specified in 3.2.4.

3.2.2 DEVICE_DISCOVERY.REQUEST

3.2.2.1 Function

The **DEVICE_DISCOVERY.request** primitive shall be used to request the service to retrieve device addresses from the subnetwork.

3.2.2.2 Semantics

The **DEVICE_DISCOVERY.request** primitive shall use the following semantics, with the meaning of the parameter specified in 3.2.2.5:

DEVICE_DISCOVERY.request (DDSAP Address)

3.2.2.3 When Generated

The **DEVICE_DISCOVERY.request** primitive shall be passed to the SOIS Subnetwork Service provider to request that device addresses be retrieved.

3.2.2.4 Effect on Receipt

Receipt of the **DEVICE_DISCOVERY.request** primitive shall cause the SOIS Subnetwork Device Discovery Service provider to retrieve the addresses and optional metadata of devices on the subnetwork.

3.2.2.5 Additional Comments

a) The DDSAP Address parameter shall identify the invoking user entity.

b) Invocation of this request may result in multiple Device Discovery indications as each indication only contains a single device address.

3.2.3 DEVICE_DISCOVERY.INDICATION

3.2.3.1 Function

The **DEVICE_DISCOVERY.indication** shall be used to pass the device address and metadata of a device or data system to the user entity.

3.2.3.2 Semantics

The **DEVICE_DISCOVERY.indication** primitive shall use the following semantics, with the meaning of the parameters specified in 3.2.3.5:

DEVICE_DISCOVERY.indication (DDSAP Address, Device Address, Device Metadata (optional))

3.2.3.3 When Generated

The **DEVICE_DISCOVERY.indication** primitive shall be issued by the Device Discovery service provider to the receiving application on receipt of subnetwork information pertaining to a device address, either:

    a) in response to a DEVICE_DISCOVERY.request; or

    b) as a result of internal subnetwork mechanisms.

    NOTE – Multiple instances of DEVICE_DISCOVERY.indication can arise as a result of a DEVICE_DISCOVERY.request invocation.

3.2.3.4 Effect on Receipt

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

3.2.3.5 Additional comments

    a) The DDSAP Address parameter shall be:

        1) In the case of a solicited device discovery (see 3.2.3.3 a)), the DDSAP Address identifies the invoking user entity.

        2) In the case of an unsolicited device discovery (see 3.2.3.3 b)), the Service Access Point to which device discovery parameters are sent.

    b) The Device Address parameter shall be a subnetwork address, identifying the address of the device.

c) The Device Metadata parameter (optional) may be used to provide information on the device.

d) Internal subnetwork mechanisms causing a DEVICE_DISCOVERY.indication could be, for example, a device being attached, powered up or undergoing a change of operating mode.

3.2.4 DEVICE_DISCOVERY_LOSS.INDICATION

3.2.4.1 Function

The **DEVICE_DISCOVERY_LOSS.indication** shall be used to pass the device address of a device or data system which is no longer present on the subnetwork.

3.2.4.2 Semantics

The **DEVICE_DISCOVERY_LOSS.indication** primitive shall use the following semantics, with the meaning of the parameters specified in 3.2.4.5:

DEVICE_DISCOVERY.indication (DDSAP, Device Address, Device Metadata (optional))

3.2.4.3 When Generated

The **DEVICE_DISCOVERY.indication** primitive shall be issued by the service provider to the receiving application on receipt of subnetwork information pertaining to the device address in response to detection of loss of the device or data system by internal subnetwork mechanisms.

3.2.4.4 Effect on Receipt

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

3.2.4.5 Additional Comments

a) The DDSAP parameter shall be the Service Access Point to which device discovery loss parameters are sent.

b) The Device Address parameter shall be a subnetwork address, identifying the address of the device.

c) The Device Metadata parameter (optional) may be used to provide information on loss of the device.

4 MANAGEMENT INFORMATION BASE

4.1 OVERVIEW

There is currently no Management Information Base (MIB) associated with this service. All management items are associated with the protocol providing the service. However, guidance is provided as to MIB contents in 4.3.

4.2 SPECIFICATIONS

Any protocol claiming to provide this service in a SOIS-compliant manner shall publish its MIB as part of the protocol specification.

4.3 MIB GUIDANCE

The MIB of the protocol providing the Device Discovery service should consider the following aspects:

- Device Metadata semantics;

- managed allocation of Device Discovery PDUs to:

  - priority,

  - channel;

- causality of unsolicited DEVICE_DISCOVERY.Indication primitives.

NOTE – These aspects are not in any way an indication of the complete contents of a MIB for a protocol providing the Device Discovery service but are offered as guidance as to those aspects of the MIB which may relate to the Device Discovery service interface.

5   SERVICE CONFORMANCE STATEMENT PROFORMA

For any protocol implementation claiming to provide this service, this proforma shall be completed, giving details of the capabilities of the implementation, and made available to any party evaluating the use of the implementation to which the completed proforma refers.

Service Conformance Statement **SOIS Subnetwork Device Discovery Service**

Implementation Information

Protocol Specification Identification	
Version	
Underlying Data Link	

Mandatory Features

DEVICE_ DISCOVERY.indication	√

Optional Features

DEVICE_ DISCOVERY.request	
DEVICE_ DISCOVERY_LOSS.indication	
Device Metadata Parameter	

Additional Information

ANNEX A

INFORMATIVE REFERENCES

[A1] *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.

[A2] *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.

[A3] *Information Technology—Open Systems Interconnection—Basic Reference Model: The Basic Model*. International Standard, ISO/IEC 7498-1:1994. 2nd ed. Geneva: ISO, 1994.

NOTE – Normative references are listed in 1.7.