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## Space data and information transfer systems — Cross support reference model — Space link extension services

*Systèmes de transfert des données et informations spatiales — Modèle  
de référence pour le support croisé — Services d'extension de liaisons  
spatiales*



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## Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

This second edition cancels and replaces the first edition (ISO 15396:1998), which has been technically revised.

ISO 15396 was prepared by the Consultative Committee for Space Data Systems (CCSDS) (as CCSDS 910.4-B-2, October 2005) and was adopted (without modifications except those stated in Clause 2 of this International Standard) by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 13, *Space data and information transfer systems*.



# Space data and information transfer systems — Cross support reference model — Space link extension services

## 1 Scope

This International Standard defines a cross support reference model which provides a common basis for coordinating the development of CCSDS Recommended Standards for space link extension (SLE) service specifications and serves as a reference to maintain the consistency of these Recommended Standards.

The scope and field of application are furthermore detailed in subclauses 1.2 and 1.3 of the enclosed CCSDS publication.

## 2 Requirements

Requirements are the technical recommendations made in the following publication (reproduced on the following pages), which is adopted as an International Standard:

CCSDS 910.4-B-2, October 2005, *Cross support reference model — Space link extension services*.

For the purposes of international standardization, the modifications outlined below shall apply to the specific clauses and paragraphs of publication CCSDS 910.4-B-2.

*Pages i to v*

This part is information which is relevant to the CCSDS publication only.

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Add the following information to the reference indicated:

- [1] Document CCSDS 132.0-B-1, September 2003, is equivalent to ISO 22645:2005.
- [2] Document CCSDS 131.0-B-1, September 2003, is equivalent to ISO 22641:2005.
- [3] Document CCSDS 732.0-B-1, September 2003, is equivalent to ISO 22666:2005.
- [4] Document CCSDS 231.0-B-1, September 2003, is equivalent to ISO 22642:2005.

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Add the following information to the reference indicated:

- [5] Document CCSDS 232.0-B-1, September 2003, is equivalent to ISO 22664:2005.
- [6] Document CCSDS 133.0-B-1, September 2003, is equivalent to ISO 22646:2005.

[10] ISO/IEC 8824:1990 has been cancelled and replaced by ISO/IEC 8824:2002, *Information technology — Abstract Syntax Notation One (ASN.1)*.

### 3 Revision of publication CCSDS 910.4-B-2

It has been agreed with the Consultative Committee for Space Data Systems that Subcommittee ISO/TC 20/SC 13 will be consulted in the event of any revision or amendment of publication CCSDS 910.4-B-2. To this end, NASA will act as a liaison body between CCSDS and ISO.



## **Recommendation for Space Data System Standards**

# **CROSS SUPPORT REFERENCE MODEL— PART 1: SPACE LINK EXTENSION SERVICES**

## **Recommended Standard**

**CCSDS 910.4-B-2**

**Blue Book  
October 2005**

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## CROSS SUPPORT REFERENCE MODEL—PART 1: SPACE LINK EXTENSION SERVICES

**AUTHORITY**

|           |                               |
|-----------|-------------------------------|
| Issue:    | Recommended Standard, Issue 2 |
| Date:     | October 2005                  |
| Location: | Washington, DC, USA           |

This document has been approved for publication by the Management Council of the Consultative Committee for Space Data Systems (CCSDS) and represents the consensus technical agreement of the participating CCSDS Member Agencies. The procedure for review and authorization of CCSDS Recommendations is detailed in the *Procedures Manual for the Consultative Committee for Space Data Systems*, and the record of Agency participation in the authorization of this document can be obtained from the CCSDS Secretariat at the address below.

This Recommendation is published and maintained by:

CCSDS Secretariat  
Office of Space Communication (Code M-3)  
National Aeronautics and Space Administration  
Washington, DC 20546, USA

## STATEMENT OF INTENT

The Consultative Committee for Space Data Systems (CCSDS) is an organization officially established by the management of its members. The Committee meets periodically to address data systems problems that are common to all participants, and to formulate sound technical solutions to these problems. Inasmuch as participation in the CCSDS is completely voluntary, the results of Committee actions are termed **Recommended Standards** and are not considered binding on any Agency.

This **Recommended Standard** is issued by, and represents the consensus of, the CCSDS members. Endorsement of this **Recommendation** is entirely voluntary. Endorsement, however, indicates the following understandings:

- o Whenever a member establishes a CCSDS-related **standard**, this **standard** will be in accord with the relevant **Recommended Standard**. Establishing such a **standard** does not preclude other provisions which a member may develop.
- o Whenever a member establishes a CCSDS-related **standard**, that member will provide other CCSDS members with the following information:
  - The **standard** itself.
  - The anticipated date of initial operational capability.
  - The anticipated duration of operational service.
- o Specific service arrangements shall be made via memoranda of agreement. Neither this **Recommended Standard** nor any ensuing **standard** is a substitute for a memorandum of agreement.

No later than five years from its date of issuance, this **Recommended Standard** 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 canceled.

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

## CROSS SUPPORT REFERENCE MODEL—PART 1: SPACE LINK EXTENSION SERVICES

**FOREWORD**

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

This **Recommended Standard** establishes a common framework and provides a common basis for the specification of data services that extend the space to ground communication services previously defined by CCSDS. It allows implementing organizations within each Agency to proceed coherently 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 Standard** and may incorporate features not addressed by the **Recommended Standard**.

Details of the relationship of this SLE Reference Model with the set of other SLE services documents are presented in subsection 2.3 of this document.

Through the process of normal evolution, it is expected that expansion, deletion or modification to this document may occur. This **Recommended Standard** is therefore subject to CCSDS document management and change control procedures, as defined in reference the *Procedures Manual for the Consultative Committee for Space Data Systems*.

CROSS SUPPORT REFERENCE MODEL—PART 1: SPACE LINK EXTENSION SERVICES

At time of publication, the active Member and Observer Agencies of the CCSDS were:

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- Canadian Space Agency (CSA)/Canada.
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- National Space Program Office (NSPO)/Taipei.
- Space and Upper Atmosphere Research Commission (SUPARCO)/Pakistan.
- Swedish Space Corporation (SSC)/Sweden.
- United States Geological Survey (USGS)/USA.

## CROSS SUPPORT REFERENCE MODEL—PART 1: SPACE LINK EXTENSION SERVICES

## DOCUMENT CONTROL

| Document           | Title                                                                              | Date            | Status/Remarks                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|--------------------|------------------------------------------------------------------------------------|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CCSDS<br>910.4-B-1 | Cross Support Reference<br>Model—Part 1: Space Link<br>Extension Services          | May<br>1996     | Original Issue, superseded.                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| CCSDS<br>910.0-B-2 | Cross Support Reference<br>Model—Part 1: Space Link<br>Extension Services, Issue 2 | October<br>2005 | Current Issue: <ul style="list-style-type: none"> <li>– New subsections on cross support security and the time span of SLE agreements/packages have been added; these additions and changes related to them are marked with change bars in the inside margin.</li> <li>– Various changes have been made to correct errors, increase clarity, and bring terminology in line with current CCSDS usage; these editorial changes are pervasive and are generally not marked.</li> </ul> |

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## CROSS SUPPORT REFERENCE MODEL—PART 1: SPACE LINK EXTENSION SERVICES

# 1 INTRODUCTION

## 1.1 PURPOSE OF THIS RECOMMENDED STANDARD

### 1.1.1 BASELINE AND REFERENCE FOR SLE SERVICE SPECIFICATIONS

This Recommended Standard defines a Cross Support reference model which provides a common basis for coordinating the development of CCSDS Recommended Standards for Space Link Extension (SLE) service specifications and serves as a reference to maintain the consistency of these Recommended Standards.

### 1.1.2 RELATIONSHIP TO SPACE LINK RECOMMENDED STANDARDS

CCSDS Space Link Recommended Standards (Advanced Orbiting System (AOS), Packet Telemetry, and Telecommand, references [2]–[7]) define formats and protocols for the transfer of data between data sources and sinks on board a space vehicle and data sinks and sources on the ground as shown in figure 1-1. These Space Link protocols are designed to work efficiently in the noisy, high-delay environment of space/ground radio links; so they do not carry information needed to configure and operate the ground systems that link numerous ground stations with the ground sinks and sources of data.

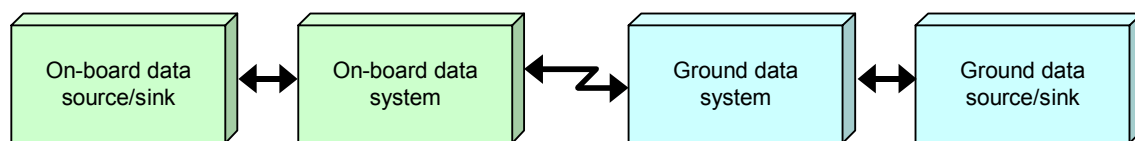


**Figure 1-1: CCSDS Space Mission Data System**

The SLE Recommended Standards complement the CCSDS Space Link Recommended Standards with a range of services that are required to configure, operate, and supervise the ground data systems.

The SLE Recommended Standards apply to data systems that are able 1) to receive CCSDS Space Link data structures from a spacecraft via a Space Link, or 2) to send CCSDS Space Link data structures to a spacecraft via a Space Link, or 3) to transfer such CCSDS Space Link data structures between ground-based entities.

The relationship between SLE services and CCSDS Space Link protocols is described in *Cross Support Concept — Part 1: Space Link Extension Services*, reference [10].

CROSS SUPPORT REFERENCE MODEL—PART 1: SPACE LINK EXTENSION SERVICES

### 1.1.3 SLE SERVICES

SLE services comprise:

- a) SLE transfer services, which are concerned with the ground part of the data transfer described in 1.1.2. This transfer is either within the ground data system or between the ground data system and the ground data sources/sinks.
- b) SLE management services, which control the scheduling and provision of SLE transfer services by ground systems.

### 1.1.4 SLE SYSTEMS

Ground systems providing services that comply with the CCSDS Recommended Standards for SLE service specifications are called SLE systems.

### 1.1.5 FRAMEWORK FOR SLE SERVICES

This Recommended Standard provides the framework for definition of SLE service specifications to be used in support of space missions. This framework comprises:

- a) the identification of an SLE system and of its environment;
- b) an architectural model of an SLE system including:
  - 1) a functional view;
  - 2) a management view;
- c) the common characteristics of SLE services and the template for SLE service specifications:
  - 1) each individual SLE service specification expresses its requirement on supporting telecommunication services in a respective quality-of-service clause;
  - 2) it is assumed that the provider and user of a given SLE service ensure that appropriate telecommunication facilities are in place;
- d) the identification of the SLE transfer services.

NOTE – In item d), SLE transfer services are identified; however, the complete service specification will be provided in a separate Recommended Standard.

## CROSS SUPPORT REFERENCE MODEL—PART 1: SPACE LINK EXTENSION SERVICES

**1.2 SCOPE**

The scope of this Recommended Standard is the definition of all concepts and terms that establish a common basis for coordinating the development of CCSDS Recommended Standards for SLE services specifications. In defining these concepts and terms the following assumptions are made:

- a) the context is that of a single space mission;
- b) within this space mission a single spacecraft is considered;
- c) this spacecraft's telemetry and telecommand are compliant with CCSDS Space Link Recommended Standards;
- d) all ground end-users (i.e., data sinks or sources) are affiliated with a single mission management entity.

The following points are not covered by this Recommended Standard:

- a) Although sharing ground systems between multiple space missions or between multiple spacecraft of the same space mission is not explicitly modeled, this Recommended Standard does not in any way preclude sharing ground systems.
- b) Ground systems and/or services that are not directly concerned with the transport of data compliant to CCSDS Space Link Recommended Standards are not described. Processing data held within the data fields of Source Packet Protocol Data Units (PDUs) described in CCSDS Packet Telemetry, Telecommand, and AOS Recommended Standards (references [2]–[7]) is outside the scope of this Recommended Standard.
- c) This reference model assumes that ground communications services are used in conjunction with the SLE services to support a space mission, but does not explicitly model these communications services.

**1.3 APPLICABILITY****1.3.1 APPLICABILITY OF THIS RECOMMENDED STANDARD**

This Recommended Standard serves as a guideline for the development of compatible Agency standards for SLE systems. Systems embraced by this Recommended Standard include manned and unmanned free-flying spacecraft and space transportation systems. This Recommended Standard is particularly relevant to the SLE systems that are involved in cross support.

**1.3.2 LIMIT OF APPLICABILITY**

This Recommended Standard is neither a specification of, nor a design for, real SLE systems that may be implemented for the control and monitoring of existing or future missions.

## CROSS SUPPORT REFERENCE MODEL—PART 1: SPACE LINK EXTENSION SERVICES

## 1.4 RATIONALE

The primary goal of CCSDS is to increase the level of interoperability among Agencies. This Recommended Standard furthers that goal by establishing the basis for a set of SLE services to be used in the area where most cross support activity occurs: between the tracking stations or ground data handling systems of various Agencies and the mission specific components of a mission ground system. Reference [10], *Cross Support Concept — Part 1: Space Link Extension Services*, provides further discussion of the rationale for this Recommended Standard.

## 1.5 DOCUMENT STRUCTURE

This Recommended Standard is organized as follows:

- a) Section 1 provides purpose, scope, applicability and rationale of this Recommended Standard and lists the definitions, conventions, and references used throughout the document.
- b) Section 2 provides the context of cross support, presents the cross support documentation structure, and shows how this Recommended Standard fits into that framework. It expands on the scope of this document to provide an overview.
- c) Section 3 defines the SLE system environment, data handled by an SLE system, and introduces SLE services.
- d) Section 4 defines an architectural model for the SLE system. This architectural model comprises two views:
  - 1) A functional view which defines the system concepts, including functions and data, from which the SLE services are derived. In this functional view, the SLE system is decomposed into SLE Functional Groups (SLE-FGs), which implement and augment the ground side of the Space Link protocols described in CCSDS Packet Telemetry, Telecommand, and AOS Recommended Standards (references [2]-[7]).
  - 2) A cross support management view, which defines the management interactions between the entities involved in the provision of SLE services and provides the baseline for the SLE Service Management Specification. In this management view, the SLE system is decomposed into SLE Complexes and the notion of SLE Service Package is introduced.
- e) Section 5 defines the common characteristics of SLE services, provides the template for SLE transfer services specifications, and provides an initial description of each SLE service including operations and parameters at the corresponding ports.
- f) Annex A expands upon the description, in section 3, of the data handled in SLE systems.

## CROSS SUPPORT REFERENCE MODEL—PART 1: SPACE LINK EXTENSION SERVICES

## 1.6 DEFINITIONS

This Architecture Model is composed of objects with ports, through which they provide services to other objects.

- a) **Port Types.** Ports that are involved in providing different services are said to be of different types.
- b) **Symmetric/Asymmetric Ports.** Two ports (of two objects) involved in the provision of a service may be either symmetric ports or asymmetric ports. The ports are symmetric if each offers all of the operations associated with the service. The ports are asymmetric if each offers different operations; in this case, one port is called a consumer, and the other is called a supplier.
- c) **Service User/Provider.** An entity that offers a service to another by means of one or more of its ports is called a service provider (provider). The other entity is called a service user (user). An entity may be a provider of some services and a user of others.

NOTE – ‘Provide’ is used in the sense of ‘make available to be used’ and does not necessarily imply that the service is being used.

- d) **Binding.** When two ports of the same type have an association established between them such that a service can be provided, the two ports are said to be bound. The act of establishing such an association is called binding.
- e) **Initiator.** The initiator is the object that issues the request to bind to another object (the responder).
- f) **Responder.** The responder is the object that receives a request to bind and completes the binding (if possible) with the initiator in order for a service association to exist between the two objects.
- g) **Operation.** An operation is a procedure that one entity (the invoker) can request of another (the performer) through a port pair bound within the terms of an agreement.

## NOTES

- 1 The relationships among the terms user/provider, supplier/consumer, and invoker/performer are explained in reference [10].
- 2 The terms user and provider distinguish the roles of two interacting objects. Usually these terms are applied to indicate which object (the provider) is performing a function on behalf of the other object (the user). In this Recommended Standard, when two objects are involved in provision of a service, the object closer to the Space Link is considered to be the provider of the service, and the object further from the Space Link is considered to be the user, regardless of the direction of data flow.

CROSS SUPPORT REFERENCE MODEL—PART 1: SPACE LINK EXTENSION SERVICES

- 3 The terms consumer and supplier are used to distinguish the roles of two ports, each attached to one of two objects, that are bound. In this Recommended Standard, these terms indicate direction of transfer of data: from the supplier port to the consumer port.
- 4 The terms invoker and performer are used to describe the interaction between two objects, as the operations that constitute the service occur. One object invokes an operation, which is performed by the other. For most services, each object, whether consumer or supplier, invokes some operations and performs others.
- h) **Return Data.** For the purposes of this Recommended Standard, Return Data is all data that is sent from the space element to the ground element (e.g., telemetry).
- i) **Forward Data.** For the purposes of this Recommended Standard, Forward Data is all data that is sent from the ground element to the space element (e.g., telecommand).
- j) **User Data.** For the purposes of this Recommended Standard, User Data is data contained in a field that is neither a header nor a trailer.

## 1.7 CONVENTIONS

### 1.7.1 STYLE

Within this Recommended Standard, each formal statement stands in a paragraph by itself and is identified uniquely by a subsection number or by a combination of subsection number and list item number.

### 1.7.2 NOTES

Notes are not formally part of this Recommended Standard. They are isolated from the formal statements and are introduced by the word NOTE.

NOTE – This is an example of a note.

### 1.7.3 USE OF CAPITAL LETTERS

Names of system components, data units, and other elements of the reference model are shown with the first letter of each word capitalized.

### 1.7.4 DRAWING CONVENTIONS

In figures illustrating this reference model, the following conventions are used.

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- a) A type of (abstract) object is shown as a round-cornered box. The type-name is shown at the bottom of the box, preceded by the word 'Type' and a colon; see figure 1-2. The initial letter of the type-name is always upper case. The ports and services associated with an object type are also types.

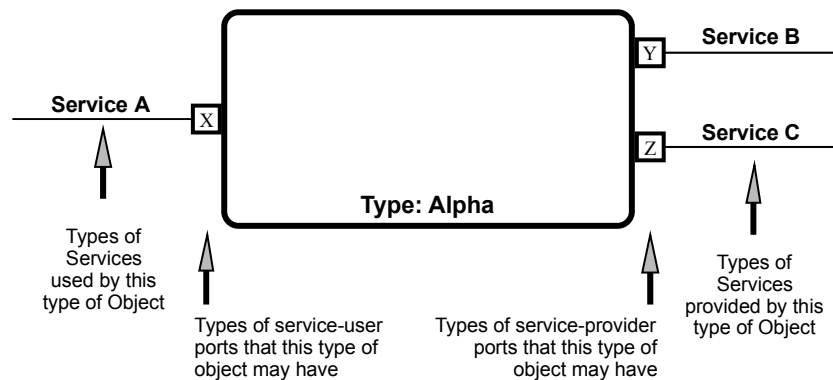


**Figure 1-2: Drawing Conventions for an Object-Type**

- b) An instance of an object is shown as a round-cornered box. The type-name is again shown at the bottom of the box, but is not preceded by the word 'Type' and a colon; see figure 1-3. The ports and services associated with an instance of an object type are also instances.

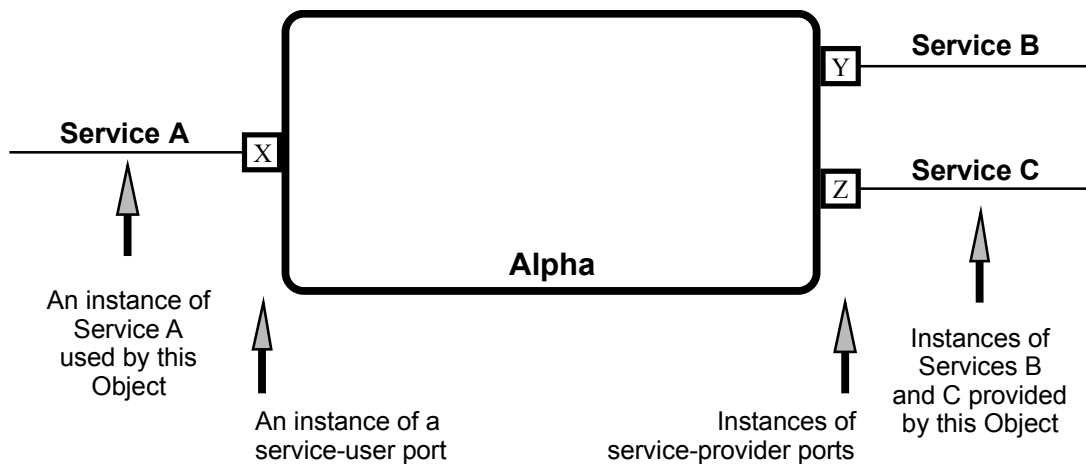


**Figure 1-3: Drawing Conventions for an Object-Instance**

- c) If a figure shows two or more instances of the same type of object, each is given a name by showing the type-name followed by a colon and the name of the instance. The initial letter of the instance-name is always lower case. See figure 1-4.

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- d) Instances of a port type are distinguished by the names of the service instances that are provided at the port. Multiple instances of a single service are permitted. See example instances 1 and 2 of service D in figure 1-4.

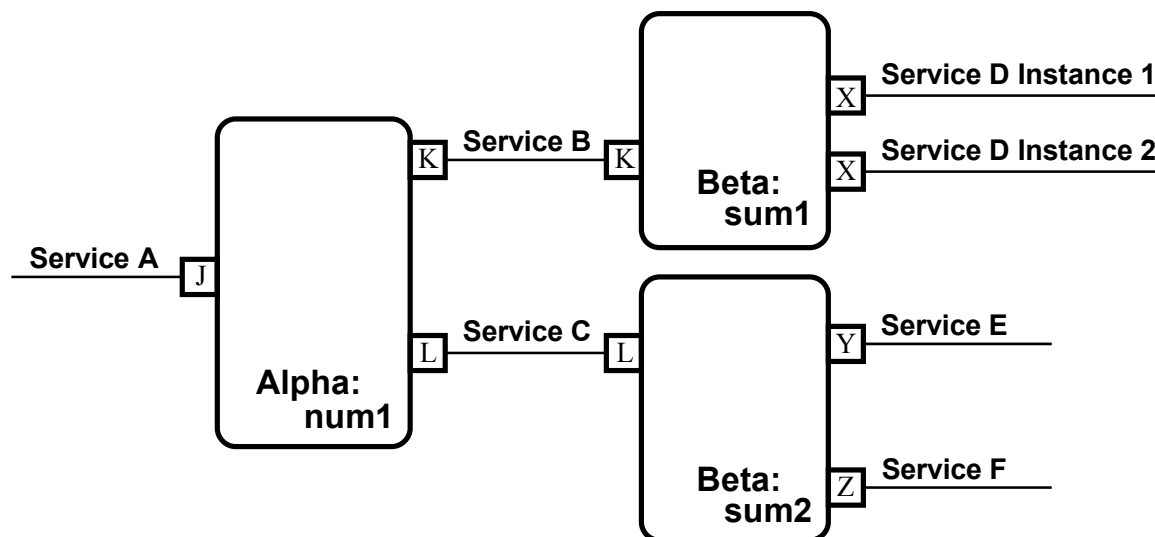


Figure 1-4: Drawing Conventions for Multiple Object-Instances

## 1.8 REFERENCES

The following documents are referenced in the text 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] *TM Space Data Link Protocol*. Recommendation for Space Data System Standards, CCSDS 132.0-B-1. Blue Book. Issue 1. Washington, D.C.: CCSDS, September 2003.
- [2] *TM Synchronization and Channel Coding*. Recommendation for Space Data System Standards, CCSDS 131.0-B-1. Blue Book. Issue 1. Washington, D.C.: CCSDS, September 2003.
- [3] *AOS Space Data Link Protocol*. Recommendation for Space Data System Standards, CCSDS 732.0-B-1. Blue Book. Issue 1. Washington, D.C.: CCSDS, September 2003.
- [4] *TC Synchronization and Channel Coding*. Recommendation for Space Data System Standards, CCSDS 231.0-B-1. Blue Book. Issue 1. Washington, D.C.: CCSDS, September 2003.

## CROSS SUPPORT REFERENCE MODEL—PART 1: SPACE LINK EXTENSION SERVICES

- [5] *TC Space Data Link Protocol*. Recommendation for Space Data System Standards, CCSDS 232.0-B-1. Blue Book. Issue 1. Washington, D.C.: CCSDS, September 2003.
- [6] *Space Packet Protocol*. Recommendation for Space Data System Standards, CCSDS 133.0-B-1. Blue Book. Issue 1. Washington, D.C.: CCSDS, September 2003.
- [7] *CCSDS Global Spacecraft Identification Field Code Assignment Control Procedures*. Recommended Standard for Space Data Systems Standards, CCSDS 320.0-B-3. Blue Book. Issue 3. Washington, D.C.: CCSDS, April 2003.
- [8] *CCSDS Publications Manual*. CCSDS Record, CCSDS A20.0-Y-2. Yellow Book. Issue 2. Washington, D.C.: CCSDS, June 2005.
- [9] *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.
- [10] *Information technology — Open Systems Interconnection — Specification of Abstract Syntax Notation One (ASN.1)*. ISO 8824. 2nd ed. Geneva: ISO, 1990.

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## CROSS SUPPORT REFERENCE MODEL—PART 1: SPACE LINK EXTENSION SERVICES

## 2 OVERVIEW

### 2.1 PURPOSE OF THIS SECTION

Section 2 of this Recommended Standard provides the context for reading this Recommended Standard. Subsections 2.2 and 2.3 introduce the Cross Support Context and the associated SLE services documentation tree.

### 2.2 CROSS SUPPORT CONTEXT

The term Cross Support is applied when one Agency uses part of another Agency's resources to complement its own for the purpose of operating a spacecraft.

#### 2.2.1 CROSS SUPPORT SERVICES

Cross Support Services is a generic term that encompasses all services that can be provided by one Agency to support another Agency in operating a spacecraft. On the ground, cross support services are of three kinds:

- a) SLE services: defined to extend CCSDS Space Link services as defined in CCSDS Space Link Recommended Standards (references [1]–[6]);
- b) ground communications services: to provide ground communications support, e.g., to relay operational data;
- c) ground domain services: which cover all services which handle data related to spacecraft operations but not directly 'mappable' to Space Link data structures defined in CCSDS Space Link Recommended Standards. Examples of ground domain services are tracking a spacecraft, exchanging spacecraft data bases, mission planning.

#### 2.2.2 CROSS SUPPORT DOCUMENTATION

The cross support documentation is divided according to the kinds of services listed in 2.2.1:

- a) Part 1 of the Cross Support Recommended Standard will address SLE services;
- b) Part 2 of the Cross Support Recommended Standard will address ground communications services;
- c) Part 3 of the Cross Support Recommended Standard will address ground domain services.

## CROSS SUPPORT REFERENCE MODEL—PART 1: SPACE LINK EXTENSION SERVICES

**2.3 SLE SERVICES DOCUMENTATION SET**

This document constitutes the root of the SLE services documentation tree shown in figure 2-1. Directly related to it are:

- SLE Executive Summary: A high-level summary of the features and benefits of SLE.
- Cross Support Concept — Part 1: Space Link Extension Services: a Report introducing the concepts of cross support and SLE services. Those considering adopting SLE should read this high-level document.
- SLE Transfer Service Specifications: Recommended Standard(s) will provide specification of all SLE transfer services. Those implementing the SLE transfer services should read this set of documents.
- SLE Service Management suite: a set of Recommended Standards that defines the management services required for the provision of one or more SLE transfer services. Those implementing SLE's service management capabilities should read this set of documents.

**NOTE** – It is anticipated that a similar document approach will be adopted for Part 2 and 3 of this Recommended Standard (for the ground communications services and ground domain services).

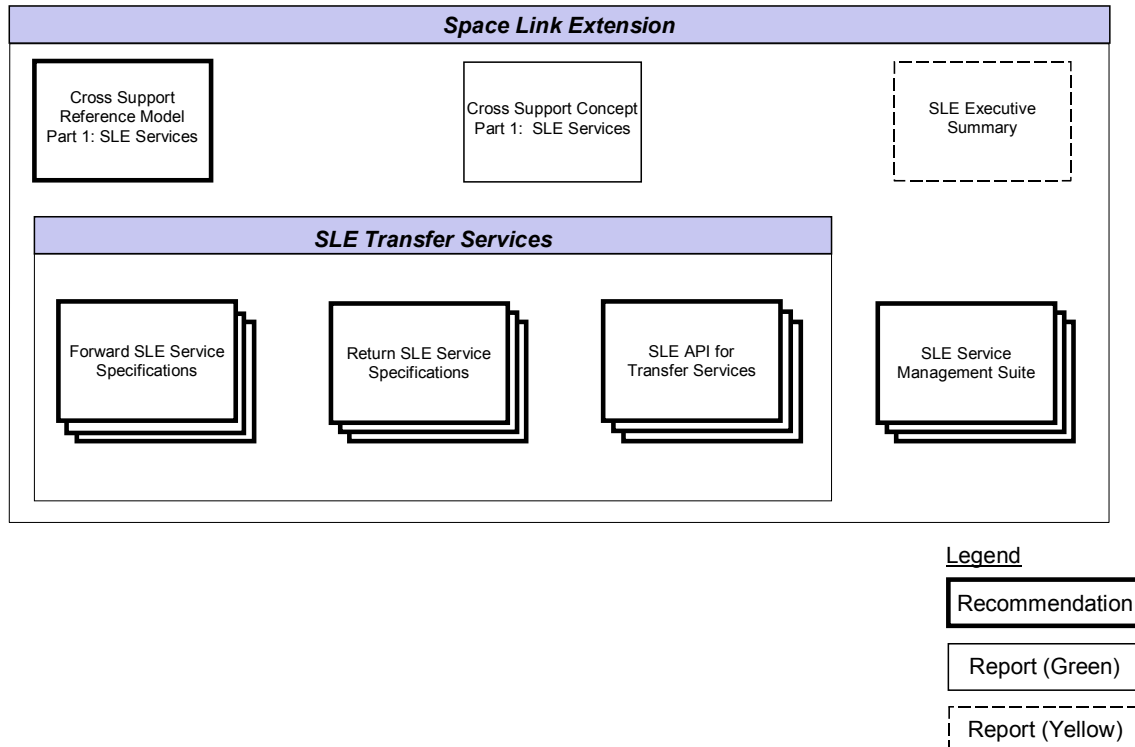


**Figure 2-1: SLE Services Documentation Set**

## CROSS SUPPORT REFERENCE MODEL—PART 1: SPACE LINK EXTENSION SERVICES

## 2.4 CROSS SUPPORT SECURITY

The CCSDS has identified six security areas that all CCSDS Recommended Standards must address: data privacy, data integrity, authentication, access control, availability of resources, and auditing. This section identifies the effect of each of these areas on SLE services and what provisions are made in the SLE Recommended Standards.

### 2.4.1 DATA PRIVACY

Data privacy (also known as *confidentiality*) ensures that the contents of communications are understandable to only the authorized participants in that communication. Failure of the SLE services to protect the privacy of mission data could result in a hostile party reading and processing confidential data (which could reveal spacecraft operations information that could be used in subsequent attacks on the spacecraft).

The SLE data transfer specifications do not define capabilities to ensure data privacy. Data privacy is expected to be ensured outside of the SLE layer, by the mission application processes that communicate over the SLE service, in the communication service that underlies the SLE service, or some combination of both.

An option for ensuring data privacy is to encrypt the SLE protocol data unit and, for SLE Service Management, consider the use of XML encryption, so that only authorized users can recognize the data and process it correctly.

### 2.4.2 DATA INTEGRITY

The SLE data transfer service requires that the data is transferred in sequence, completely and with integrity, without duplication and with flow control. However, this does not necessarily provide the desired protection against alterations to the data content by an intermediary process. One way to avoid any such alterations is for the user and provider to agree to produce credentials based on the contents of the entire PDU.

The use of sequence numbers supports data integrity in SLE service management services.

Failure of SLE services to protect the integrity of data could allow a hostile party to substitute commands in the data stream, to corrupt telemetry data prior to delivery to the user, and to degrade or eliminate the ability to establish and operate SLE services.

The SLE services define and enforce a strict sequence of operations that constrain the ability of a hostile party to inject operations into the association between a service user and provider. This constrains the ability of a hostile party to seize control of an active service without detection.

### 2.4.3 AUTHENTICATION

Authentication is the process of verifying that an entity (person, computer, etc.) is what it identifies itself to be. Failure of SLE services to authenticate the source of SLE data units could, for example, allow a hostile party to masquerade as a legitimate user to establish the communication link to the spacecraft via the SLE transfer service in order to command the spacecraft and receive telemetry data.

The SLE data transfer service specifications define authentication requirements involving the computation and subsequent verification of credentials that are carried as part of the transfer service data units. The process by which authentication is performed is described in annex F of the Cross Support Concept (reference [9]). However, the specific algorithms by which these credentials are computed and verified are outside the scope of the SLE transfer service specifications.

A further consideration for SLE data transfer is the distribution of secret keys in a secure manner.

SLE service management recommends the use of digital signatures for authentication.

### 2.4.4 ACCESS CONTROL

Access control is the process of permitting access only to entities that have been explicitly granted access privileges. Failure of the SLE services to control access can allow a party to establish a connection for which they are not authorized, for example, allowing that party to command the spacecraft and receive the spacecraft's telemetry data.

The SLE transfer service specifications define access control requirements involving the use of *initiator-identifier* and *responder-identifier* parameters of the service operation invocations and returns. The process by which access control is performed is described in annex F of the Cross Support Concept (reference [9]).

SLE service management uses unique identification parameters to control access to the CM. The CM manages the access to provider resources using parameter values that are created initially by the UM and which are carried in each message from the UM to the CM.

### 2.4.5 AVAILABILITY OF RESOURCES

The provision of SLE services depends upon the availability of resources such as network bandwidth allocation, processor speed, mass storage, etc. Actions taken by hostile parties to reduce or eliminate the resources available to the provision of SLE services (in what is commonly known as 'denial of service') may cause the loss of mission data, the ability to command a spacecraft, and possibly the loss of the mission itself.

The SLE data transfer service specifications do not define capabilities to ensure availability of resources, although they do define the configuration files needed to manage the resources

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that the CM declares will be available. Such capabilities are assumed to depend upon the technologies used in the underlying communication service and the security environment in which the transfer service user and provider operate.

SLE service management is able to accept or reject Service Requests, depending on the availability of resources in the CM. Guarding against denial of service attacks at the service management level is assumed to be handled by the underlying communication service e.g., at routers and firewalls.

#### 2.4.6 AUDITING

Auditing the execution of SLE services can provide valuable information about attempts (successful and unsuccessful) to access the services by unauthorized parties. Failure to recognize unauthorized access attempts in a timely manner may allow such parties to learn how to exploit vulnerabilities in the system and eventually to exploit these vulnerabilities to compromise mission safety.

The SLE data transfer service specifications do not define security auditing requirements or capabilities. Security auditing functions are expected to be negotiated and implemented bilaterally between the spaceflight mission and the service provider. However, it is a standard feature of the SLE API to log attempts at access. This is additional to information provided in firewall logs.

SLE service management does not define the audit requirements that users and providers must meet. It is assumed that implementing agencies will maintain an audit trail of the messages conveyed by service management and of any attempts to breach security.

#### 2.4.7 POTENTIAL THREATS AND ATTACK SCENARIOS

Potential threats and attack scenarios specific to particular services are addressed within the appropriate service specification.

#### 2.4.8 CONSEQUENCES OF NOT APPLYING SECURITY

In addition to the general consequences of not applying security that are mentioned in the previous paragraphs, specific consequences of not applying security are addressed within the appropriate service specification.

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## CROSS SUPPORT REFERENCE MODEL—PART 1: SPACE LINK EXTENSION SERVICES

### 3 SLE SYSTEM ENVIRONMENT, DATA, AND SERVICES

#### 3.1 PURPOSE OF THIS SECTION

Section 3 of this Recommended Standard defines the SLE system environment, data, and services. It introduces terms and concepts of the SLE System Architectural Model that will be formally defined in section 4.

#### 3.2 SLE SYSTEM ENVIRONMENT—SPACE MISSION DATA SYSTEM

A Space Mission Data System, as illustrated in figure 3-1, is the set of on-board and ground data systems that support a mission. It consists of a space element and a ground element connected via the Space Link. The space element and ground element exchange return and forward data.

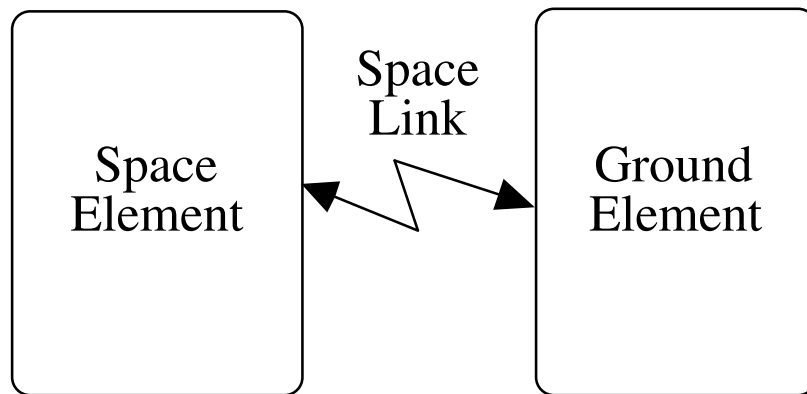


**Figure 3-1: Space Mission Data System**

**NOTE** – The Space Mission Data System corresponds to the CCSDS AOS/Packet data system illustrated in figure 1-1.

- a) **Space Element.** The space element acts as a source of return data and as a sink for forward data. From the viewpoint of this Recommended Standard, the space element represents a single spacecraft and comprises the platform and all payloads/instruments of this spacecraft.

#### NOTES

- 1 The space vehicles in a multi-spacecraft mission are treated as individual space elements, from the SLE point of view.
- 2 Platform and payloads/instruments are considered here only for their capability of generating or receiving data. Processing they perform on this data is not within the scope of this Recommended Standard.