
**Space data and information transfer
systems — Space link extension (SLE)
— Forward space packet service
specification**

*Systèmes de transfert des informations et données spatiales —
Extension de liaisons spatiales (SLE) — Spécification d'envoi de
données spatiales par paquets*

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted (see www.iso.org/directives).

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This document was prepared by the Consultative Committee for Space Data Systems (CCSDS) (as CCSDS 912.3-B-3, August 2016) and was adopted (without modifications) by Technical Committee ISO/TC 20, *Space vehicles*, Subcommittee SC 13, *Space data and information transfer systems*.

This third edition cancels and replaces the second edition (ISO 22672:2011), which has been technically revised.

The main changes compared to the previous edition are as follows:

— adds clarifications and corrections.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

CONTENTS

<u>Section</u>	<u>Page</u>
1 INTRODUCTION	1-1
1.1 PURPOSE OF THIS RECOMMENDED STANDARD	1-1
1.2 SCOPE	1-1
1.3 APPLICABILITY	1-2
1.4 RATIONALE	1-2
1.5 DOCUMENT STRUCTURE	1-3
1.6 DEFINITIONS, NOMENCLATURE, AND CONVENTIONS	1-5
1.7 REFERENCES	1-14
2 DESCRIPTION OF THE FORWARD SPACE PACKET SERVICE	2-1
2.1 OVERVIEW	2-1
2.2 SPACE LINK EXTENSION REFERENCE MODEL	2-1
2.3 SERVICE MANAGEMENT	2-3
2.4 ARCHITECTURE MODEL—FUNCTIONAL VIEW	2-3
2.5 ARCHITECTURE MODEL—CROSS SUPPORT VIEW	2-8
2.6 FUNCTIONAL DESCRIPTION	2-9
2.7 OPERATIONAL SCENARIO	2-16
2.8 SECURITY ASPECTS OF THE SLE FORWARD SPACE PACKET (FSP) TRANSFER SERVICE	2-18
3 FSP SERVICE OPERATIONS	3-1
3.1 GENERAL CONSIDERATIONS	3-1
3.2 FSP-BIND	3-10
3.3 FSP-UNBIND	3-17
3.4 FSP-START	3-20
3.5 FSP-STOP	3-24
3.6 FSP-TRANSFER-DATA	3-27
3.7 FSP-ASYNC-NOTIFY	3-38
3.8 FSP-SCHEDULE-STATUS-REPORT	3-53
3.9 FSP-STATUS-REPORT	3-57
3.10 FSP-GET-PARAMETER	3-64
3.11 FSP-THROW-EVENT	3-70
3.12 FSP-INVOKE-DIRECTIVE	3-75
3.13 FSP-PEER-ABORT	3-80
4 FSP PROTOCOL	4-1
4.1 GENERIC PROTOCOL CHARACTERISTICS	4-1
4.2 FSP SERVICE PROVIDER BEHAVIOR	4-4

CCSDS RECOMMENDED STANDARD FOR SLE FSP SERVICE

CONTENTS (continued)

<u>Section</u>	<u>Page</u>
ANNEX A DATA TYPE DEFINITIONS (NORMATIVE)	A-1
ANNEX B FSP QUEUES AND MULTIPLEXING BEHAVIOR DEFINITION (NORMATIVE)	B-1
ANNEX C PRODUCTION STATUS (NORMATIVE)	C-1
ANNEX D FUNCTIONAL GROUP PRODUCTION REQUIREMENTS FOR FSP (NORMATIVE)	D-1
ANNEX E CONFORMANCE MATRIX (NORMATIVE)	E-1
ANNEX F INDEX TO DEFINITIONS (INFORMATIVE)	F-3
ANNEX G ACRONYMS (INFORMATIVE)	G-1
ANNEX H THROW EVENT DEFINITIONS (INFORMATIVE)	H-1
ANNEX I INFORMATIVE REFERENCES (INFORMATIVE)	I-1

Figure

1-1 SLE Services Documentation	1-4
2-1 Forward Telecommand Functional Groups	2-4
2-2 FSP Service Production and Provision	2-7
2-3 Example of the Management and Provision of FSP Service	2-8
2-4 Simplified FSP Service Provider State Transition Diagram	2-11
2-5 Communications Realization of FSP Service	2-14
B-1 FSP MAP and TC Frame Multiplexing	B-1
B-2 MAP and VC Multiplexing	B-2
B-3 FSP Queues	B-4
C-1 FSP Production Status Diagram	C-1

Table

2-1 FSP Service Operations	2-10
3-1 Setting of FSP Service Operation Parameters	3-6
3-2 FSP-BIND Parameters	3-11
3-3 FSP-UNBIND Parameters	3-18
3-4 FSP-START Parameters	3-20
3-5 FSP-STOP Parameters	3-24
3-6 FSP-TRANSFER-DATA Parameters	3-28
3-7 FSP-ASYNC-NOTIFY Parameters	3-38
3-8 FSP-SCHEDULE-STATUS-REPORT Parameters	3-53
3-9 FSP-STATUS-REPORT Parameters	3-57
3-10 FSP-GET-PARAMETER Parameters	3-64
3-11 FSP Service Parameters	3-65
3-12 FSP-THROW-EVENT Parameters	3-71

CONTENTS (continued)

<u>Table</u>	<u>Page</u>
3-13 FSP-INVOKE-DIRECTIVE Parameters	3-75
3-14 FSP-PEER-ABORT Parameters	3-80
4-1 Provider Behavior	4-6
4-2 Event Description References	4-10
4-3 Predicate Definitions	4-11
4-4 Boolean Flags	4-11
4-5 Compound Action Definitions	4-12
C-1 Production Status Transitions	C-2
C-2 Effects of Production Status on Operations	C-4
D-1 Forward CLTU Generation Aggregate Production Status	D-3
D-2 Forward TC VC Data Insertion Aggregate Production Status	D-5
E-1 Conformance Matrix for FSP Service (Operations)	E-1
E-2 Conformance Matrix for FSP Service (Other Requirements)	E-2
H-1 Throw Event Examples	H-1

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CCSDS RECOMMENDED STANDARD FOR SLE FSP SERVICE

1 INTRODUCTION

1.1 PURPOSE OF THIS RECOMMENDED STANDARD

This Recommended Standard defines the Forward Space Packet (FSP) service in conformance with the transfer services specified in reference [1], *Cross Support Reference Model—Part 1: SLE Services*. The FSP service is a Space Link Extension (SLE) transfer service that enables a mission to send Space Packets to a spacecraft in sequence-controlled or expedited mode.

1.2 SCOPE

This Recommended Standard defines, in an abstract manner, the FSP service in terms of:

- a) the operations necessary to provide the transfer service;
- b) the parameter data associated with each operation;
- c) the behaviors that result from the invocation of each operation; and
- d) the relationship between, and the valid sequence of, the operations and resulting behaviors.

It does not specify:

- a) individual implementations or products;
- b) the implementation of entities or interfaces within real systems;
- c) the methods or technologies required to radiate Space Packets to a spacecraft and to acquire telemetry frames from the signals received from that spacecraft for extraction of the Operational Control Field;
- d) the methods or technologies required for communications; or
- e) the management activities necessary to schedule, configure, and control the FSP service.

NOTE – While the FSP service as described in reference [1] is conceived to handle a variety of packet data structures, this version of the FSP Recommended Standard is restricted to the handling of Space Packets as defined in reference [6].

This version of the FSP Recommended Standard is specific to the transfer of Space Packets to be transmitted via the Telecommand protocol stack as defined in references [3], [4], and [5]. The Cross Support Reference Model (reference [1]) specifies that the FSP service may also be used in conjunction with the Advanced Orbiting System protocol stack, but that mode of operation is outside the scope of this version of the Recommended Standard.

The FSP service is provided in the online delivery mode, as defined in reference [1]. The offline delivery mode is the subject of further study.

1.3 APPLICABILITY

1.3.1 APPLICABILITY OF THIS RECOMMENDED STANDARD

This Recommended Standard provides a basis for the development of real systems that implement the FSP service. Implementation of the FSP service in a real system additionally requires the availability of a communications service to convey invocations and returns of FSP service operations between FSP service users and providers. This Recommended Standard requires that such a communications service ensures that invocations and returns of operations are transferred:

- a) in sequence;
- b) completely and with integrity;
- c) without duplication;
- d) with flow control that notifies backpressure to the application layer in the event of congestion; and
- e) with notification to the application layer in the event that communications between the FSP service user and the FSP service provider are disrupted, possibly resulting in a loss of data.

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It is the specific intent of this Recommended Standard to define the FSP service in a manner that is independent of any particular communications services, protocols, or technologies.

1.3.2 LIMITS OF APPLICABILITY

This Recommended Standard specifies the FSP service that may be provided by an SLE System for inter-Agency cross support. It is neither a specification of, nor a design for, real systems that may be implemented for the control and monitoring of existing or future missions.

1.4 RATIONALE

The goal of this Recommended Standard is to create a standard for interoperability between the tracking stations and/or ground data handling systems of various agencies and the users of forward services.

CCSDS RECOMMENDED STANDARD FOR SLE FSP SERVICE

1.5 DOCUMENT STRUCTURE**1.5.1 ORGANIZATION**

This Recommended Standard is organized as follows:

- a) section 0 provides the purpose, scope, applicability, and rationale of this Recommended Standard and lists definitions, nomenclature, conventions, and references used throughout the Recommended Standard;
- b) section 2 provides an overview of the FSP service including a functional description, the service management context, and protocol considerations;
- c) section 3 specifies the operations of the FSP service;
- d) section 4 specifies the dynamic behavior of the FSP service in terms of the state transitions of the FSP service provider;
- e) annex A provides a formal specification of FSP service data types, using the Abstract Syntax Notation One (ASN.1);
- f) annex B provides a specification of the multiplexing between concurrent FSP service instances sharing the same TC Virtual Channel (VC) as well as the multiplexing between TC VCs sharing the same physical space link data channel;
- g) annex C presents the FSP production status and its transitions;
- h) annex D defines the production requirements the FSP service imposes on the forward Functional Groups;
- i) annex E provides a conformance matrix that defines what capabilities must be provided for an implementation to be considered compliant with this Recommended Standard;
- j) annex F lists all terms used in this document and identifies where they are defined;
- k) annex G lists all acronyms used within this document;
- l) annex H contains examples of usage of the FSP-THROW-EVENT operation;
- m) annex I contains a list of informative references.

1.5.2 SLE SERVICES DOCUMENTATION TREE

This Recommended Standard is based on the architectural model for cross support defined in reference [1]. It expands upon the concept of an SLE Transfer Service as interactions between an SLE Mission User Entity (MUE) and an SLE Transfer Service provider for the purpose of providing the FSP Transfer Service.

CCSDS RECOMMENDED STANDARD FOR SLE FSP SERVICE

This Recommended Standard is part of a suite of documents specifying the SLE services. The SLE services constitute one of the three types of Cross Support Services:

- a) Part 1: SLE Services;
- b) Part 2: Ground Communications Services;
- c) Part 3: Ground Domain Services.

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

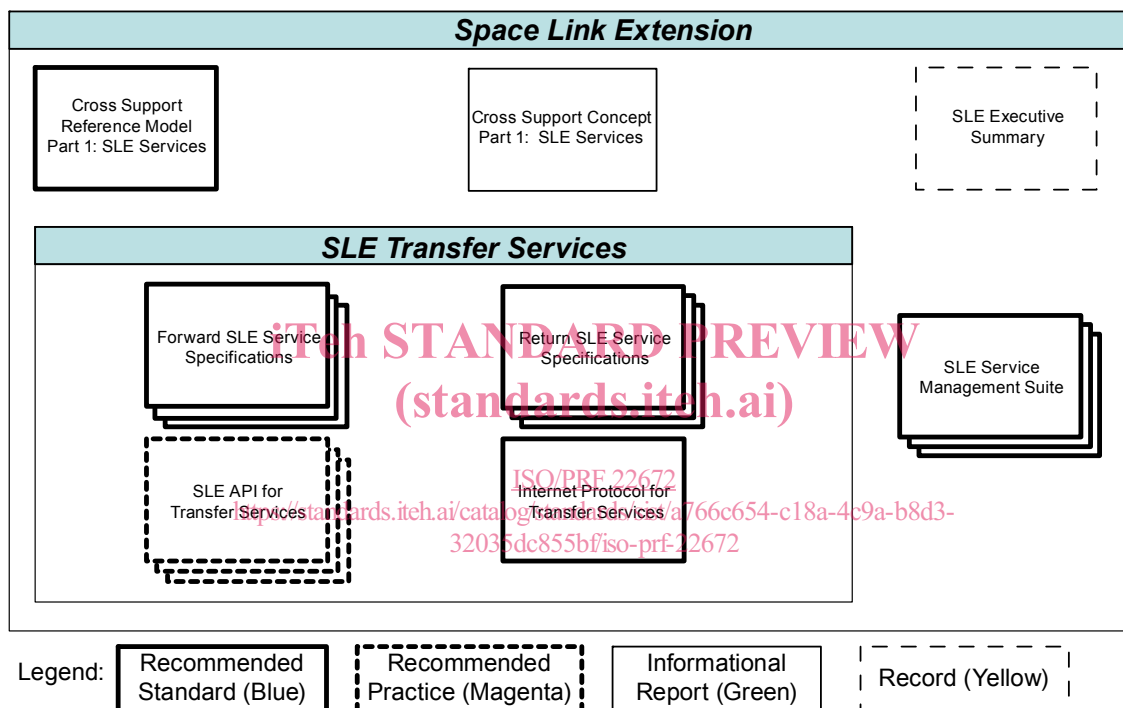


Figure 1-1: SLE Services Documentation

- a) *Cross Support Concept—Part 1: Space Link Extension Services* (reference [I3]): a Report introducing the concepts of cross support and SLE services;
- b) *Cross Support Reference Model—Part 1: Space Link Extension Services* (reference [1]): a Recommended Standard that defines the reference model that provides a common framework and terminology for the specification of SLE services;
- c) *Return SLE Transfer Service Specifications*: a set of Recommended Standards that will provide specification of all return link SLE transfer services.
- d) *Forward SLE Transfer Service Specifications*: a set of Recommended Standards that will provide specification of all forward link SLE transfer services (this Recommended Standard is one of the specifications in that set);

CCSDS RECOMMENDED STANDARD FOR SLE FSP SERVICE

- e) *SLE API for Transfer Services Specifications*: a set of Recommended Practices that provide specifications of an Application Program Interface; a set of Recommended Standards that provide specifications of an Application Program Interface and a mapping to TCP/IP as underlying communications service for SLE services;
- f) *Internet Protocol for Transfer Services*: defines a protocol for transfer of SLE Protocol Data Units using TCP/IP as underlying communications service for SLE services;
- g) *SLE Service Management Specification Suite*: a set of Recommended Standards that establish the basis for SLE service management.

1.6 DEFINITIONS, NOMENCLATURE, AND CONVENTIONS

1.6.1 DEFINITIONS

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

This Recommended Standard makes use of a number of terms defined in reference [8]. The use of those terms in this Recommended Standard shall be understood in a generic sense, i.e., in the sense that those terms are generally applicable to technologies that provide for the exchange of information between real systems. Those terms are:

- a) abstract syntax;
- b) application entity; [ISO/PRF 22672](https://standards.iteh.ai/catalog/standards/sist/a766c654-c18a-4c9a-b8d3-32035dc855bf/iso-prf-22672)
- c) application layer; <https://standards.iteh.ai/catalog/standards/sist/a766c654-c18a-4c9a-b8d3-32035dc855bf/iso-prf-22672>
- d) flow control;
- e) Open Systems Interconnection (OSI);
- f) real system;
- g) service access point (SAP).

1.6.1.2 Definitions from Abstract Syntax Notation One

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

- a) Abstract Syntax Notation One (ASN.1);
- b) object identifier;
- c) (data) type;
- d) (data) value.

NOTE – In annex A of this Recommended Standard, ASN.1 is used for specifying the abstract syntax of the invocations and returns of the operations of the FSP service. The use of ASN.1 as a descriptive language is intended to support the specification of the abstract FSP service; it is not intended to constrain implementations. In particular, there is no requirement for implementations to employ ASN.1 encoding rules. ASN.1 is simply a convenient tool for formally describing the abstract syntax of the invocations and returns of the FSP service.

1.6.1.3 Definitions from TC Synchronization and Channel Coding

This Recommended Standard makes use of the following term defined in reference [3]:

Communications Link Transmission Unit (CLTU).

1.6.1.4 Definitions from TC Space Data Link Protocol

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

- a) AD, BD, BC;
- b) Communications Link Control Word (CLCW);
- c) Communications Operation Procedure (COP);
- d) Control Word Type; [ISO/PRF 22672](https://standards.iteh.ai/catalog/standards/sist/a766c654-c18a-4c9a-b8d3-926594c855bf/iso-prf-22672)
- e) Frame Operation Procedure (FOP); <https://standards.iteh.ai/catalog/standards/sist/a766c654-c18a-4c9a-b8d3-926594c855bf/iso-prf-22672>
- f) Frame Sequence Number;
- g) Multiplexer Access Point (MAP);
- h) Operational Control Field (OCF);
- i) Segment;
- j) Telecommand Transfer Frame (TC Transfer Frame or TC frame);
- k) Virtual Channel (VC).

1.6.1.5 Definitions from Communications Operation Procedure-1

This Recommended Standard makes use of the following terms defined in reference [5]:

- a) FOP_Sliding_Window_Width;
- b) Receiver_Frame_Sequence_Number V(R);
- c) Timeout_Type;

CCSDS RECOMMENDED STANDARD FOR SLE FSP SERVICE

- d) Transmitter_Frame_Sequence_Number V(S);
- e) T1_Initial.

1.6.1.6 Definitions from Space Packet Protocol

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

- a) Application Process Identifier (APID);
- b) Space Packet.

1.6.1.7 Definitions from SLE Reference Model

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

- a) abstract binding;
- b) abstract object;
- c) abstract port;
- d) abstract service;
- e) Forward CLTU SLE data channel (Forward CLTU data channel);
- f) Forward Space Packet channel (FSP channel);
- g) Forward Space Packet service (FSP service);
- h) Forward Telecommand Frame SLE data channel (Forward TC Frame data channel);
- i) invoker;
- j) Mission Data Operation System (MDOS);
- k) Mission User Entity (MUE);
- l) offline delivery mode;
- m) online delivery mode;
- n) operation;
- o) Operational Control Field SLE data channel (OCF data channel);
- p) performer;
- q) physical channel;
- r) service agreement;
- s) service provider (provider);

- t) service user (user);
 - u) SLE Complex;
 - v) SLE Complex Management;
 - w) SLE data channel;
 - x) SLE Functional Group (SLE-FG);
 - y) SLE protocol data unit (SLE-PDU);
 - z) SLE service data unit (SLE-SDU);
 - aa) SLE service package;
 - bb) SLE transfer service instance;
 - cc) SLE transfer service production;
 - dd) SLE transfer service provision;
 - ee) SLE Utilization Management;
 - ff) space link;
 - gg) space link data channel;
 - hh) space link data unit (SL-DU);
 - ii) space link session.
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1.6.1.8 Additional Definitions

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

1.6.1.8.1 Acknowledged (Space Packet)

A Space Packet is said to be acknowledged when evaluation of the CLCWs returned by the space element shows that all TC frames containing parts of the Space Packet reported have been acknowledged by the space element.

NOTE — This status applies only to the sequence-controlled transmission mode (AD). Although a Space Packet is ‘acknowledged’, packet re-assembly and/or execution may still fail. This can only be determined by examining telemetry.

CCSDS RECOMMENDED STANDARD FOR SLE FSP SERVICE

1.6.1.8.2 Association

An association is a cooperative relationship between an SLE service-providing application entity and an SLE service-using application entity. An association is formed by the exchange of SLE protocol data units through the use of an underlying communications service.

1.6.1.8.3 CLTU Transfer Data SLE-SDU

A CLTU Transfer Data SLE-SDU contains a CLTU plus information (see D1.2.2.2) required by the Forward TC Space Link Processing SLE Functional Group (see 2.4.1.4) to process that CLTU. In the context of the FSP SLE transfer service, the CLTU Transfer Data SLE-SDU is generated by the Forward CLTU Generation SLE Functional Group (see 2.4.1.3).

NOTE – When the F-CLTU transfer service is used, the CLTU Transfer Data SLE-SDU is carried (along with other information) in the CLTU-TRANSFER-DATA invocation.

1.6.1.8.4 Communications Service

A communications service is a capability that enables an SLE service-providing application entity and an SLE service-using application entity to exchange information.

NOTE – If an SLE service user and an SLE service provider are implemented using different communications services, then interoperability between them is possible only by means of a suitable gateway. Adherence to this Recommended Standard ensures, at least in principle, that it is possible to construct such a gateway.

1.6.1.8.5 Confirmed Operation

A confirmed operation is an operation that requires the performer to return a report of its outcome to the invoker.

1.6.1.8.6 Initiator

The initiator is the object that issues the request to bind to another object (the responder).

NOTE – In other words, the initiator is always the invoker of the request to bind to another object. Therefore, in the context of the request to bind, the terms ‘initiator’ and ‘invoker’ refer to the same object and are synonyms.

1.6.1.8.7 Invocation

The invocation of an operation is the making of a request by an object (the invoker) to another object (the performer) to carry out the operation.