EUROPEAN COOPERATION

ECSS

FOR SPACE STANDARDIZATION

Space engineering

SpaceWire - CCSDS packet transfer protocol

Foreword

This Standard is one of the series of ECSS Standards intended to be applied together for the management, engineering and product assurance in space projects and applications. ECSS is a cooperative effort of the European Space Agency, national space agencies and European industry associations for the purpose of developing and maintaining common standards. Requirements in this Standard are defined in terms of what shall be accomplished, rather than in terms of how to organize and perform the necessary work. This allows existing organizational structures and methods to be applied where they are effective, and for the structures and methods to evolve as necessary without rewriting the standards.

This Standard has been prepared by the ECSS-E-ST-50-53 Working Group, reviewed by the ECSS Executive Secretariat and approved by the ECSS Technical Authority.

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Change log

ECSS-E-ST-50-53A	Never issued
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Scope

There is a number of communication protocols that can be used in conjunction with the SpaceWire Standard (ECSS-E-ST-50-12), to provide a comprehensive set of services for onboard user applications. To distinguish between the various protocols a protocol identifier is used, as specified in ECSS-E-ST-50-51.

This Standard specifies the CCSDS packet transfer protocol, which is one of these protocols that works over SpaceWire.

The aim of the CCSDS Packet Transfer Protocol is to transfer CCSDS Packets across a SpaceWire network. It does this by encapsulating the CCSDS Packet in a SpaceWire packet, transferring it across the SpaceWire network and then extracting the CCSDS Packet at the target.

This standard may be tailored for the specific characteristic and constrains of a space project in conformance with ECSS-S-ST-00.

2
Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this ECSS Standard. For dated references, subsequent amendments to, or revision of any of these publications do not apply. However, parties to agreements based on this ECSS Standard are encouraged to investigate the possibility of applying the more recent editions of the normative documents indicated below. For undated references, the latest edition of the publication referred to applies.

ECSS-S-ST-00-01	ECSS system - Glossary of terms
ECSS-E-ST-50-12	Space engineering - SpaceWire - Links, nodes, routers and networks
ECSS-E-ST-50-51	Space engineering - SpaceWire protocol identification
CCSDS 133.0-B-1	Space Packet Protocol, Blue Book

3
Terms, definitions and abbreviated terms

3.1 Terms defined in other standards

For the purpose of this Standard, the terms and definitions from ECSS-S-ST-00-01 and ECSS-E-ST-50-51 apply.

3.2 Terms specific to the present standard

None.

3.3 Abbreviated terms

The following abbreviations are defined and used within this standard:

Abbreviation	Meaning
CCSDS	Consultative Committee for Space Data Systems
EEP	error end of packet
EOP	end of packet
SpW	SpaceWire

3.4 Conventions

In this document hexadecimal numbers are written with the prefix 0x, for example 0x34 and 0xDF15.

Binary numbers are written with the prefix 0b, for example 0b01001100 and 0b01.

Decimal numbers have no prefix.

4
Principles

4.1   Purpose

The CCSDS Packet Transfer Protocol has been designed to encapsulate a CCSDS Space Packet into a SpaceWire packet, transfer it from an initiator to a target across a SpaceWire network, extract it from the SpaceWire packet and pass it to a target user application. This protocol does not provide any means for ensuring delivery of the packet nor is it responsible for the contents of the packet being a CCSDS Space Packet.

The CCSDS Space Packet Protocol is defined in the following document:

> CCSDS 133.0-B-1 Space Packet Protocol. Blue Book. Issue 1. September 2003 or a later issue

Figure 4-1 illustrates the location of the CCSDS Space Packet transfer Protocol in a typical onboard protocol stack. The CCSDS Space Packet transfer Protocol provides a unidirectional data transfer service from a single source user application to a single destination user application through a SpaceWire network.
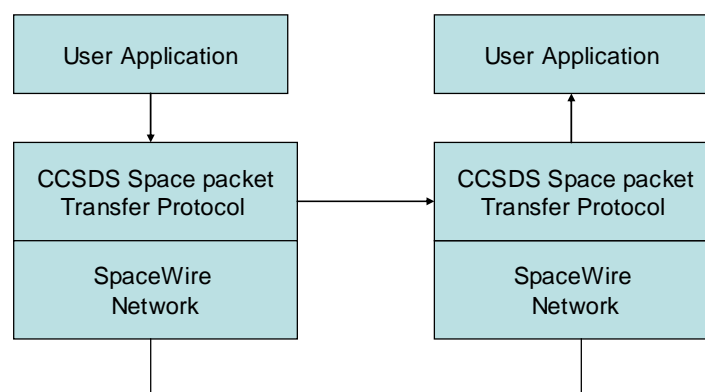
Figure 4-1: Protocol configuration

4.2   Protocol features

The CCSDS Space Packet transfer Protocol provides the capability to transfer CCSDS Space Packets between onboard users of a SpaceWire network. The CCSDS space packets may be of variable length or fixed size at the discretion of the user and may be submitted for transmission at variable intervals. The

composition of the CCSDS space packet is under the responsibility of the user application and is not checked by the CCSDS space packet transfer protocol.

4.3 Services

The CCSDS Space Packet Transfer Protocol provides users with data transfer services. The point at which a service is provided by a protocol entity to a user is called a Service Access Point. A Service Access Point of the Space Packet Transfer Protocol is identified by a SpaceWire address and each service user is also identified by a SpaceWire Address.

Service data units submitted to a Service Access Point are processed in the order of submission.

Implementations may be required to perform flow control at a Service Access Point between the service user and the service provider. However, this standard does not recommend a scheme for flow control between the user and the provider.

The followings features are offered by the data transfer service defined in this Standard:

● Unidirectional (one way) data transfer service.

● Asynchronous Service. There are no predefined timing rules for the transfer of service data units supplied by the service user. The user may request data transfer at any time it desires, but there may be restrictions imposed by the provider on the data generation rate.

● Unconfirmed Service: the sending user does not receive confirmation from the receiving end that data has been received.

● Incomplete Services. The services do not guarantee completeness, nor do they provide a retransmission mechanism.

● SDU format: the service does not check the format of the submitted CCSDS Space packet.

● Non sequence Preserving Service. The sequence of service data units supplied by the sending user may not be preserved through the underlying network

The end-to-end quality-of-service provided to service users is the one that is provided by the underlying SpaceWire network. The Space Packet Transfer Protocol does not provide any mechanisms for guaranteeing a particular quality-of-service; it is the responsibility of implementing organizations to ensure that the end-to-end performance of a particular service instance meets the requirements of its users.

Sequence preservation of packets in a SpaceWire network is dependent on the underlying network topology and configuration. Topologies and configurations which allow only a single route from the source to the destination, i.e. configurations that are not using group adaptive routing, are sequence preserving.

4.4 Guide to this document

Clause 4 presents the purpose, protocol features and an overview of the services the CCSDS packet transfer protocol offers.

Clause 5.1 defines the service parameters.

Clause 5.2 specifies the service primitives provided by the protocol.

Clause 5.3 defines the protocol fields used in the CCSDS packet transfer protocol packets.

Clause 5.4 specifies the format of the packets used by the CCSDS packet transfer protocol.

Clause 5.5 specified the action of the CCSDS packet transfer protocol.

Annex A lists the managed parameters associated with this protocol.

5
Requirements

5.1 Service parameters

5.1.1 CCSDS packet

a. The CCSDS packet parameter, intended as the service data unit transferred by the CCSDS packet transfer service, shall be the CCSDS Space Packet as defined in CCSDS 133.0-B-1 Space Packet Protocol, Blue Book, Issue 1, September 2003.

5.1.2 Packet length

a. The value of the packet length shall be equal to at least 7 and at most 65542 octets.

b. Individual project organizations may establish the maximum length for a particular mission.

> NOTE   The length parameter defines the length of the Data Unit submitted by the user.

5.1.3 Status code

a. The Status code parameter shall be used to indicate the validity of the packet to the receiving service user.

b. The Status code parameter shall take one of the following values:

1. 0x00 indicates that the packet is ok

2. 0x01 indicates packet arrived terminated by EEP

3. 0x02 indicates reserved field was non-zero

5.1.4 Target SpaceWire Address

a. The Target SpaceWire Address parameter shall be used to define the path to the Target when SpaceWire path addressing is being used.

5.1.5 Target Logical Address

a. The Target Logical Address parameter shall be used to define the logical address of the Target that is to receive the CCSDS packet.

5.1.6 User Application Value

a. The User Application Value shall be an 8-bit value which is transferred along with the CCSDS packet to the Target.

> NOTE   Its value and use is user specific.

5.2 Service primitives

5.2.1 CCSDS Packet Transfer Service

a. The service primitives associated with this service shall be the following

1. CCSDS_PACKET_SEND.request,

2. CCSDS_PACKET_RECEIVE.indication.

5.2.2 CCSDS_PACKET_SEND.request

5.2.2.1 Function

a. At the initiator, the CCSDS Packet Transfer service user shall pass a CCSDS_PACKET_SEND.request primitive to the service provider to request that a CCSDS Packet is transferred to the user at the target across the SpaceWire network.

5.2.2.2 Semantics

a. The CCSDS_PACKET.request primitive shall provide the following parameters:

1. CCSDS_PACKET_SEND.request (CCSDS Packet, Packet Length, Target SpaceWire Address, Target Logical Address, User Application Value).

5.2.2.3 When Generated

a. The CCSDS_PACKET_SEND.request primitive shall be passed to the service provider to request it to send the CCSDS Packet.

5.2.2.4 Effect On Receipt

a. Receipt of the CCSDS_PACKET_SEND.request primitive shall cause the service provider to transfer the CCSDS Packet.

5.2.2.5 Additional Comments

a. The CCSDS_PACKET_SEND.request primitive shall be used to transfer CCSDS Packets across the SpaceWire network along the route defined by the Target SpaceWire Address and Target Logical Address parameters.

5.2.3 CCSDS_PACKET_RECEIVED.indication

5.2.3.1 Function

a. At the target, the service provider shall pass a CCSDS_PACKET_RECEIVED.indication to the CCSDS Packet Service user to deliver a Packet.

5.2.3.2 Semantics

a. The CCSDS_PACKET_RECEIVED.indication primitive shall provide parameters as follows:

1. CCSDS_PACKET_RECEIVED.indication (CCSDS Packet, User Application Value, Status)

b. If the packet arrived is terminated by EEP or the Reserved field is non-zero the CCSDS Packet and the User Application Value shall be null.

c. The Status parameter shall be one of the following codes:

1. 0x00 indicates that the packet arrived with no known error,

2. 0x01 indicates that the packet arrived terminated by EEP,

3. 0x02 indicates that the Reserved field was non-zero.

5.2.3.3 When Generated

a. The CCSDS_PACKET_RECEIVED.indication primitive shall be passed from the service provider to the CCSDS Packet Service user at the target to deliver a CCSDS Packet.

5.2.3.4 Effect On Receipt

a. The effect of receipt of the CCSDS_PACKET_RECEIVED.indication primitive by the CCSDS Packet Service user shall be defined by the user.

5.2.3.5 Additional Comments

a. The CCSDS_PACKET_RECEIVED.indication primitive shall be used to deliver CCSDS Packets to the CCSDS Packet Service user at the target.

5.3   CCSDS Packet Transfer Protocol fields

5.3.1   Target SpaceWire Address field

a.   The Target SpaceWire Address field shall comprise zero or more data characters forming the SpaceWire address which is used to route the CCSDS Packet Transfer Protocol packet to the target.

>   NOTE   The Target SpaceWire Address is stripped off by the time the packet reaches the target.

b.   SpaceWire path addressing and regional addressing may be used.

c.   The Target SpaceWire Address field shall not be used when a single logical address is being used for routing the CCSDS Packet Transfer Protocol packet to the target.

>   NOTE   In this case the CCSDS Packet Transfer Protocol packet is routed to the target by the Target Logical Address contained in the Target Logical Address field.

5.3.2   Target Logical Address field

a.   Target Logical Address field shall be an 8-bit field that contains a logical address of the target.

>   NOTE 1   The Target Logical Address field is normally set to a logical address recognised by the target.
>
>   NOTE 2   If the target does not have a specific logical address then the Target Logical Address field can be set to the default value 254 (0xFE).
>
>   NOTE 3   A target can have more than one logical address.

5.3.3   Protocol Identifier field

a.   The Protocol Identifier field shall be an 8-bit field that contains the Protocol Identifier.

b.   The Protocol Identifier field shall be set to the value 2 (0x02) which is the Protocol Identifier for the CCSDS Packet Encapsulation Protocol.

5.3.4   Reserved field

a.   The Reserved shall be an 8-bit field that is set to 0x00.

5.3.5   User Application field

a.   The User Application field shall be an 8-bit field which is transferred along with the CCSDS packet to the Target.

>   NOTE 1   Its value and use is user specific.

NOTE 2   If for example the target supports virtual channels, the User Application field can be set to a virtual channel number.
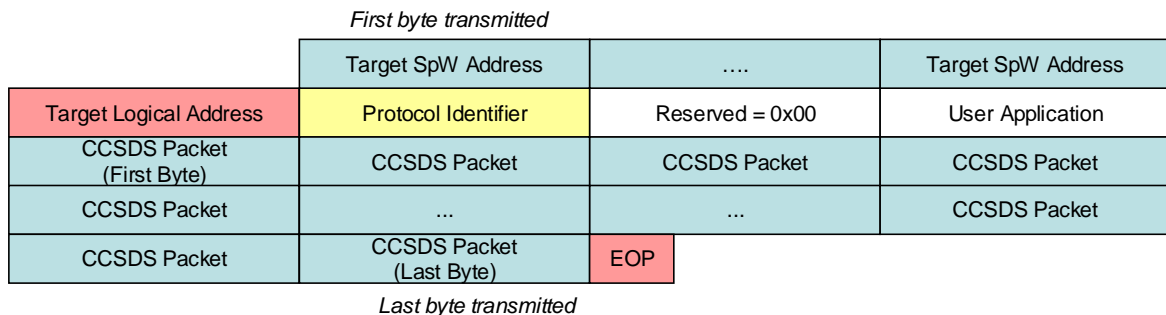
5.3.6   Packet field

a.   The CCSDS Packet field shall be a variable length field that contains the CCSDS Packet.

b.   The first byte of the CCSDS Packet field shall be the first byte of the CCSDS Packet.

c.   The byte order of the CCSDS Packet field shall be the same as the CCSDS Packet.

5.4   CCSDS Packet Transfer Protocol format

5.4.1.1   Fields

a.   The CCSDS Packet Transfer Protocol packet shall contain the fields shown in Figure 5-1.

First byte transmitted

	Target SpW Address	….	Target SpW Address
Target Logical Address	Protocol Identifier	Reserved = 0x00	User Application
CCSDS Packet (First Byte)	CCSDS Packet	CCSDS Packet	CCSDS Packet
CCSDS Packet	...	...	CCSDS Packet
CCSDS Packet	CCSDS Packet (Last Byte)	EOP	

Last byte transmitted

Figure 5-1: Encapsulated CCSDS Packet format

5.4.1.2   Target SpaceWire Address field

a.   The Target SpaceWire Address field shall be as defined in clause 5.3.1.

5.4.1.3   Target Logical Address field

a.   The Target Logical Address field shall be as defined in clause 5.3.2.

5.4.1.4   Protocol Identifier field

a.   The Protocol Identifier field shall be as defined in clause 5.3.3.

5.4.1.5   Reserved field

a.   The Reserved field format shall be as defined in clause 5.3.4.

5.4.1.6 User Application field

a.   The User Application field format shall be as defined in clause 5.3.5.

5.4.1.7 CCSDS Packet field

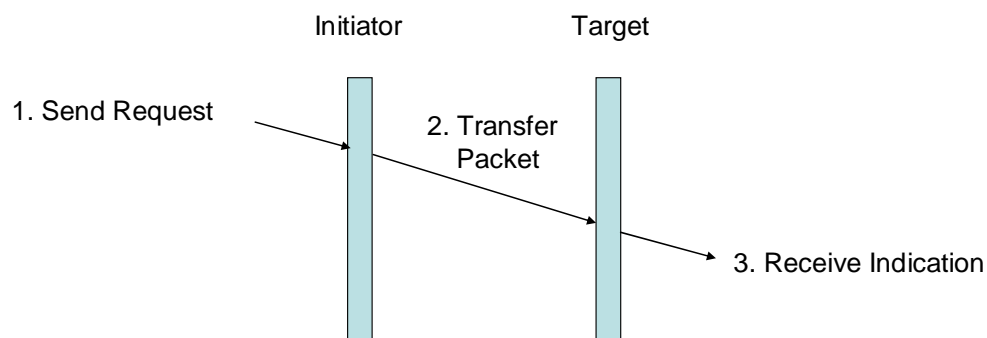a.   The CCSDS Packet field format shall be as defined in clause 5.3.6.

5.4.1.8 EOP character

a.   The end of the CCSDS Packet Transfer Protocol packet shall be indicated by an EOP character.

5.5 CCSDS Packet Transfer Protocol Action

5.5.1 Overview

The normal sequence of actions for a CCSDS Packet Transfer Protocol packet transfer is illustrated in Figure 5-2.

Figure 5-2: CCSDS Packet Transfer Protocol Packet Transfer

5.5.2 Send request

a.   The CCSDS Packet Transfer Protocol packet transfer shall begin when an initiator user application requests to send a CCSDS Packet Transfer Protocol packet (Send Request).

b.   The initiator user application shall pass the following information to the initiator:

1.   Target SpaceWire Address

2.   Target Logical Address

3.   CCSDS Packet

4.   Packet Length

5.   User Application Value

c.   If the Packet Length of the CCSDS Packet is greater than the maximum acceptable length, the following shall be done:

1.   Reject the Send Request

2.   Inform the initiator user application.

5.5.3   Transfer packet

a.   In response to the send request the initiator shall encapsulate the CCSSDS Space Packet into a SpaceWire packet as described in clause 5.4 and send it across the SpaceWire network to the target (Transfer Packet).

> NOTE   The Target SpaceWire Address and Target Logical Address are used to route the command packet to the target.

5.5.4   Receive indication

5.5.4.1   Protocol identifier

a.   When a SpaceWire packet is received at the target and the Protocol Identifier field is 0x02 the packet shall be regarded as a CCSDS Packet Transfer Protocol packet.

5.5.4.2   Reserved field zero

a.   If the CCSDS Packet Transfer Protocol packet arrives at the target with the Reserved field set to 0x00 and is terminated by an EOP, the CCSDS Packet shall be extracted from the SpaceWire packet and passed to the target user application.

b.   If the CCSDS Packet Transfer Protocol packet arrives at the target with the Reserved field set to 0x00 and is terminated by an EOP, the value of the User Application field shall be passed to the target user application.

5.5.4.3   Reserved field not zero

a.   If the CCSDS Packet Transfer Protocol packet arrives at the target with the Reserved field set to a non-zero value and is terminated by an EOP the CCSDS Packet Transfer Protocol packet shall be discarded,

b.   If the CCSDS Packet Transfer Protocol packet arrives at the target with the Reserved field set to a non-zero value and is terminated by an EOP, the target user application should be informed that an invalid CCSDS Packet Transfer Protocol packet has been received.

5.5.4.4   Error End of Packet

a.   If the CCSDS Packet Transfer Protocol packet arrives at the target terminated by an EEP, the CCSDS Packet Transfer Protocol packet shall be discarded.

b.   If the CCSDS Packet Transfer Protocol packet arrives at the target terminated by an EEP, the target user application should be informed that an invalid CCSDS Packet Transfer Protocol packet has been received.

Annex A (informative)
Managed parameters

In order to provide an optimised implementation, some parameters associated with the CCSDS Packet Transfer service are handled by management, rather than by inline communications protocol. The managed parameters are those which tend to be static for long periods of time, and whose change generally signifies a major reconfiguration of the service provider associated with a particular mission. Through the use of a management system, management conveys the required information to the service provider.

The managed parameters used for the CCSDS Packet Transfer Service are listed in Table A-1. These parameters are defined in an abstract sense, and are not intended to imply any particular implementation of a management system.

The value of these parameters are defined for a specific mission implementation.

Table A-1: Managed parameters

Managed parameter	Allowed value
Minimum CCSDS Space packet length (bytes)	Integer
Maximum CCSDS Space packet size (bytes)	Integer

Bibliography

ECSS-ST-S-00   ECSS system - Description, implementation and
                                general requirements

http://www.spacewire.esa.int   SpaceWire website