
**Space data and information transfer
systems — TM (telemetry) space data link
protocol**

*Systèmes de transfert des données et informations spatiales — Protocole de
liaison de données spatiales TM (télémétrie)*

Sample Document

get full document from standards.iteh.ai



Reference number
ISO 22645:2016(E)

© ISO 2016

Sample Document

get full document from standards.iteh.ai



COPYRIGHT PROTECTED DOCUMENT

© ISO 2016

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
copyright@iso.org
Web www.iso.org

Published in Switzerland

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2. www.iso.org/directives

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received. www.iso.org/patents

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: [Foreword - Supplementary information](#)

ISO 22645 was prepared by the Consultative Committee for Space Data Systems (CCSDS) (as CCSDS 132.0-B-2, September 2015) 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*.

This second edition cancels and replaces the first edition (ISO 22645:2005), which has been technically revised. It also incorporates the amendment ISO 22645:2005/Amd.1:2015.

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.

FOREWORD

This document is a technical Recommendation 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 TM Space Data Link Protocol described herein is intended for missions that are cross-supported between Agencies of the CCSDS.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CCSDS has processes for identifying patent issues and for securing from the patent holder agreement that all licensing policies are reasonable and non-discriminatory. However, CCSDS does not have a patent law staff, and CCSDS shall not be held responsible for identifying any or all such patent rights.

Through the process of normal evolution, it is expected that expansion, deletion, or modification of this document may occur. This Recommended Standard is therefore subject to CCSDS document management and change control procedures, which are defined in *Organization and Processes for the Consultative Committee for Space Data Systems* (CCSDS A02.1-Y-4). Current versions of CCSDS documents are maintained at the CCSDS Web site:

<http://www.ccsds.org/>

Questions relating to the contents or status of this document should be sent to the CCSDS Secretariat at the e-mail address indicated on page i.

get full document from standards.iteh.ai

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

Member Agencies

- Agenzia Spaziale Italiana (ASI)/Italy.
- Canadian Space Agency (CSA)/Canada.
- Centre National d'Etudes Spatiales (CNES)/France.
- China National Space Administration (CNSA)/People's Republic of China.
- Deutsches Zentrum für Luft- und Raumfahrt (DLR)/Germany.
- European Space Agency (ESA)/Europe.
- Federal Space Agency (FSA)/Russian Federation.
- Instituto Nacional de Pesquisas Espaciais (INPE)/Brazil.
- Japan Aerospace Exploration Agency (JAXA)/Japan.
- National Aeronautics and Space Administration (NASA)/USA.
- UK Space Agency/United Kingdom.

Observer Agencies

- Austrian Space Agency (ASA)/Austria.
- Belgian Federal Science Policy Office (BFSPPO)/Belgium.
- Central Research Institute of Machine Building (TsNIIMash)/Russian Federation.
- China Satellite Launch and Tracking Control General, Beijing Institute of Tracking and Telecommunications Technology (CLTC/BITTT)/China.
- Chinese Academy of Sciences (CAS)/China.
- Chinese Academy of Space Technology (CAST)/China.
- Commonwealth Scientific and Industrial Research Organization (CSIRO)/Australia.
- Danish National Space Center (DNSC)/Denmark.
- Departamento de Ciência e Tecnologia Aeroespacial (DCTA)/Brazil.
- Electronics and Telecommunications Research Institute (ETRI)/Korea.
- European Organization for the Exploitation of Meteorological Satellites (EUMETSAT)/Europe.
- European Telecommunications Satellite Organization (EUTELSAT)/Europe.
- Geo-Informatics and Space Technology Development Agency (GISTDA)/Thailand.
- Hellenic National Space Committee (HNSC)/Greece.
- Indian Space Research Organization (ISRO)/India.
- Institute of Space Research (IKI)/Russian Federation.
- KFKI Research Institute for Particle & Nuclear Physics (KFKI)/Hungary.
- Korea Aerospace Research Institute (KARI)/Korea.
- Ministry of Communications (MOC)/Israel.
- National Institute of Information and Communications Technology (NICT)/Japan.
- National Oceanic and Atmospheric Administration (NOAA)/USA.
- National Space Agency of the Republic of Kazakhstan (NSARK)/Kazakhstan.
- National Space Organization (NSPO)/Chinese Taipei.
- Naval Center for Space Technology (NCST)/USA.
- Scientific and Technological Research Council of Turkey (TUBITAK)/Turkey.
- South African National Space Agency (SANSA)/Republic of South Africa.
- Space and Upper Atmosphere Research Commission (SUPARCO)/Pakistan.
- Swedish Space Corporation (SSC)/Sweden.
- Swiss Space Office (SSO)/Switzerland.
- United States Geological Survey (USGS)/USA.

DOCUMENT CONTROL

Document	Title	Date	Status
CCSDS 132.0-B-1	TM Space Data Link Protocol, Recommended Standard, Issue 1	September 2003	Original issue, superseded
CCSDS 132.0-B-2	TM Space Data Link Protocol, Recommended Standard, Issue 2	September 2015	Current issue: – adds specifications to support the Space Data Link Security Protocol; – updates Frame Error Control Field Encoding Procedure to be consistent with other CCSDS Space Data Link Protocol specifications; – changes all occurrences of ‘Packet Service’ and ‘Packet Transfer Service’ to ‘Virtual Channel Packet Service’; – corrects/clarifies Service Specification ‘indication’ text; – updates/clarifies text relating to Idle Packet generation; – removes obsolete informative annex detailing changes from Historical Recommendations CCSDS 102.0-B-5-S (1984–2005) and CCSDS 103.0-B-2-S (1996–2005).

NOTE – Substantive changes from the previous issue are marked by change bars in the inside margin. For terminology changes affecting the entire document, only the first instances are marked.

CONTENTS

<u>Section</u>	<u>Page</u>
1 INTRODUCTION.....	1-1
1.1 PURPOSE.....	1-1
1.2 SCOPE.....	1-1
1.3 APPLICABILITY	1-1
1.4 RATIONALE.....	1-2
1.5 DOCUMENT STRUCTURE	1-2
1.6 CONVENTIONS AND DEFINITIONS.....	1-2
1.7 REFERENCES	1-6
2 OVERVIEW	2-1
2.1 CONCEPT OF TM SPACE DATA LINK PROTOCOL	2-1
2.2 OVERVIEW OF SERVICES	2-4
2.3 OVERVIEW OF FUNCTIONS.....	2-12
2.4 SERVICES ASSUMED FROM LOWER LAYERS	2-14
3 SERVICE DEFINITION.....	3-1
3.1 OVERVIEW	3-1
3.2 SOURCE DATA.....	3-1
3.3 VIRTUAL CHANNEL PACKET (VCP) SERVICE	3-4
3.4 VIRTUAL CHANNEL ACCESS (VCA) SERVICE	3-8
3.5 VIRTUAL CHANNEL FRAME SECONDARY HEADER (VC_FSH) SERVICE.....	3-12
3.6 VIRTUAL CHANNEL OPERATIONAL CONTROL FIELD (VC_OCF) SERVICE.....	3-15
3.7 VIRTUAL CHANNEL FRAME (VCF) SERVICE	3-18
3.8 MASTER CHANNEL FRAME SECONDARY HEADER (MC_FSH) SERVICE.....	3-21
3.9 MASTER CHANNEL OPERATIONAL CONTROL FIELD (MC_OCF) SERVICE.....	3-24
3.10 MASTER CHANNEL FRAME (MCF) SERVICE.....	3-27
4 PROTOCOL SPECIFICATION WITHOUT SDLS OPTION	4-1
4.1 PROTOCOL DATA UNIT.....	4-1
4.2 PROTOCOL PROCEDURES AT THE SENDING END.....	4-15
4.3 PROTOCOL PROCEDURES AT THE RECEIVING END.....	4-22

CONTENTS (continued)

<u>Section</u>	<u>Page</u>
5 MANAGED PARAMETERS WITHOUT SDLS OPTION	5-1
5.1 MANAGED PARAMETERS FOR A PHYSICAL CHANNEL	5-1
5.2 MANAGED PARAMETERS FOR A MASTER CHANNEL.....	5-2
5.3 MANAGED PARAMETERS FOR A VIRTUAL CHANNEL.....	5-2
5.4 MANAGED PARAMETERS FOR PACKET TRANSFER.....	5-3
6 PROTOCOL SPECIFICATION WITH SDLS OPTION	6-1
6.1 OVERVIEW	6-1
6.2 USE OF SDLS PROTOCOL	6-1
6.3 TM TRANSFER FRAME WITH SDLS	6-1
6.4 SENDING END PROTOCOL PROCEDURES WITH SDLS.....	6-4
6.5 RECEIVING END PROTOCOL PROCEDURES WITH SDLS.....	6-7
6.6 MANAGED PARAMETERS WITH SDLS	6-9
ANNEX A ACRONYMS (INFORMATIVE)	A-1
ANNEX B INFORMATIVE REFERENCES (INFORMATIVE)	B-1

Figure

1-1 Bit Numbering Convention.....	1-5
2-1 Relationship with OSI Layers	2-1
2-2 Relationships Between Channels.....	2-3
2-3 Asynchronous Service Model	2-5
2-4 Synchronous Service Model	2-6
2-5 Internal Organization of Protocol Entity (Sending End).....	2-13
2-6 Internal Organization of Protocol Entity (Receiving End)	2-13
2-7 TM Space Data Link Protocol Channel Tree.....	2-14
4-1 TM Transfer Frame Structural Components.....	4-2
4-2 Transfer Frame Primary Header.....	4-2
4-3 Transfer Frame Data Field Status	4-5
4-4 Transfer Frame Secondary Header.....	4-8
4-5 Logic Diagram of the Encoder	4-13
4-6 Logic Diagram of the Decoder.....	4-14
4-7 Internal Organization of Protocol Entity (Sending End).....	4-15
4-8 Abstract Model of Packet Processing Function	4-16
4-9 Abstract Model of Virtual Channel Generation Function.....	4-18
4-10 Abstract Model of Virtual Channel Multiplexing Function	4-19
4-11 Abstract Model of Master Channel Generation Function.....	4-20

CONTENTS (continued)

<u>Figure</u>	<u>Page</u>
4-12 Abstract Model of Master Channel Multiplexing Function.....	4-21
4-13 Abstract Model of All Frames Generation Function	4-22
4-14 Internal Organization of Protocol Entity (Receiving End)	4-22
4-15 Abstract Model of Packet Extraction Function.....	4-24
4-16 Abstract Model of Virtual Channel Reception Function	4-25
4-17 Abstract Model of Virtual Channel Demultiplexing Function	4-26
4-18 Abstract Model of Master Channel Reception Function	4-27
4-19 Abstract Model of Master Channel Demultiplexing Function	4-28
4-20 Abstract Model of All Frames Reception Function.....	4-28
6-1 Frame without SDLS Compared to Frame with SDLS.....	6-2

Table

2-1 Summary of Services Provided by TM Space Data Link Protocol.....	2-7
2-2 Summary of TM Services Supported by the Space Data Link Security Protocol.....	2-8
5-1 Managed Parameters for a Physical Channel.....	5-1
5-2 Managed Parameters for a Master Channel	5-2
5-3 Managed Parameters for a Virtual Channel	5-2
5-4 Managed Parameters for Packet Transfer	5-3
6-1 Additional Managed Parameters for a Virtual Channel when TM Space Data Link Protocol Supports SDLS	6-9

1 INTRODUCTION

1.1 PURPOSE

The purpose of this Recommended Standard is to specify the Telemetry (TM) Space Data Link Protocol. This protocol is a Data Link Layer protocol (see reference [1]) to be used over space-to-ground or space-to-space communications links by space missions.

1.2 SCOPE

This Recommended Standard defines the TM Space Data Link Protocol in terms of:

- a) the services provided to the users of this protocol;
- b) the protocol data units employed by the protocol; and
- c) the procedures performed by the protocol.

It does not specify:

- a) individual implementations or products;
- b) the implementation of service interfaces within real systems;
- c) the methods or technologies required to perform the procedures; or
- d) the management activities required to configure and control the protocol.

1.3 APPLICABILITY

This Recommended Standard applies to the creation of Agency standards and to future data communications over space links between CCSDS Agencies in cross-support situations. The Recommended Standard includes comprehensive specification of the services and protocol for inter-Agency cross support. It is neither a specification of, nor a design for, real systems that may be implemented for existing or future missions.

The Recommended Standard specified in this document is to be invoked through the normal standards programs of each CCSDS Agency and is applicable to those missions for which cross support based on capabilities described in this Recommended Standard is anticipated. Where mandatory capabilities are clearly indicated in sections of the Recommended Standard, they must be implemented when this document is used as a basis for cross support. Where options are allowed or implied, implementation of these options is subject to specific bilateral cross support agreements between the Agencies involved.

1.4 RATIONALE

The CCSDS believes it is important to document the rationale underlying the recommendations chosen, so that future evaluations of proposed changes or improvements will not lose sight of previous decisions.

1.5 DOCUMENT STRUCTURE

This document is divided into six numbered sections and two annexes:

- Section 1 presents the purpose, scope, applicability and rationale of this Recommended Standard and lists the conventions, definitions, and references used throughout the Recommended Standard.
- Section 2 provides an overview of the TM Space Data Link Protocol.
- Section 3 defines the services provided by the protocol entity.
- Section 4 specifies the protocol data units and procedures employed by the protocol entity.
- Section 5 specifies the managed parameters used by the protocol entity.
- Section 6 specifies the protocol entity with support for the Space Data Link Security Protocol.
- Annex A lists all acronyms used within this document.
- Annex B provides a list of informative references.

1.6 CONVENTIONS AND DEFINITIONS

1.6.1 DEFINITIONS

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

This Recommended Standard makes use of a number of terms defined in reference [1]. The use of those terms in this Recommended Standard is to be understood in a generic sense, i.e., in the sense that those terms are generally applicable to any of a variety of technologies that provide for the exchange of information between real systems. Those terms are:

- a) blocking;
- b) connection;
- c) Data Link Layer;
- d) entity;

- e) flow control;
- f) Network Layer;
- g) peer entities;
- h) Physical Layer;
- i) protocol control information;
- j) protocol data unit;
- k) real system;
- l) segmenting;
- m) service;
- n) Service Access Point (SAP);
- o) SAP address;
- p) service data unit.

1.6.1.2 Definitions from OSI Service Definition Conventions

This Recommended Standard makes use of a number of terms defined in reference [2]. The use of those terms in this Recommended Standard is to be understood in a generic sense, i.e., in the sense that those terms are generally applicable to any of a variety of technologies that provide for the exchange of information between real systems. Those terms are:

- a) confirmation;
- b) indication;
- c) primitive;
- d) request;
- e) response;
- f) service provider;
- g) service user.

1.6.1.3 Terms Defined in This Recommended Standard

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

aperiodic: not *periodic* (see below).

asynchronous: not *synchronous* (see below).

delimited: having a known (and finite) length; applies to data in the context of data handling.

Mission Phase: a period of a mission during which specified communications characteristics are fixed. The transition between two consecutive Mission Phases may cause an interruption of the communications services.

periodic: of or pertaining to a sequence of events in which each event occurs at a fixed time interval (within specified tolerance) after the previous event in the sequence.

Physical Channel: a stream of bits transferred over a space link in a single direction.

space link: a communications link between a spacecraft and its associated ground system or between two spacecraft. A space link consists of one or more Physical Channels in one or both directions.

synchronous: of or pertaining to a sequence of events occurring in a fixed time relationship (within specified tolerance) to another sequence of events. It should be noted that 'synchronous' does not necessarily imply 'periodic' or 'constant rate'.

(TM) Transfer Frame: The protocol data unit of the Telemetry (TM) Space Data Link Protocol.

1.6.2 NOMENCLATURE

1.6.2.1 Normative Text

The following conventions apply for the normative specifications in this Recommended Standard:

- 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.

NOTE – These conventions do not imply constraints on diction in text that is clearly informative in nature.

1.6.2.2 Informative Text

In the normative sections of this document, informative text is set off from the normative specifications either in notes or under one of the following subsection headings:

- Overview;
- Background;
- Rationale;
- Discussion.

1.6.3 CONVENTIONS

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).

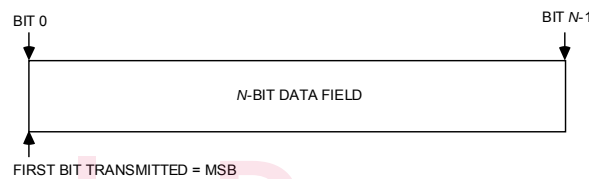


Figure 1-1: Bit Numbering Convention

In accordance with standard data-communications practice, data fields are often grouped into eight-bit ‘words’ which conform to the above convention. Throughout this Recommended Standard, such an eight-bit word is called an ‘octet’.

The numbering for octets within a data structure starts with zero. By CCSDS convention, all ‘spare’ bits shall be permanently set to ‘0’.