
**Mission operations — MAL space
packet transport binding and binary
encoding**

*Opérations de mission - transport de paquets de l'espace MAL reliés et
codage binaire*

Sample Document

get full document from standards.iteh.ai



Reference number
ISO 21082:2016(E)

© ISO 2016

Sample Document

get full document from standards.iteh.ai



COPYRIGHT PROTECTED DOCUMENT

© ISO 2016, Published in Switzerland

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
www.iso.org

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 21082 was prepared by the Consultative Committee for Space Data Systems (CCSDS) (as CCSDS 524.1-B-1, August 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*.

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.

CCSDS RECOMMENDED STANDARD FOR MISSION OPERATIONS—MAL SPACE PACKET
TRANSPORT BINDING AND BINARY ENCODING**FOREWORD**

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.

Sample Document

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 (BFSP0)/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 (SANSAT)/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.

CCSDS RECOMMENDED STANDARD FOR MISSION OPERATIONS—MAL SPACE PACKET
TRANSPORT BINDING AND BINARY ENCODING

DOCUMENT CONTROL

Document	Title	Date	Status
CCSDS 524.1-B-1	Mission Operations—MAL Space Packet Transport Binding and Binary Encoding, Recommended Standard, Issue 1	August 2015	Original issue

Sample Document

get full document from standards.iteh.ai

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 DEFINITIONS.....	1-2
1.7 NOMENCLATURE	1-3
1.8 BIT NUMBERING CONVENTION.....	1-3
1.9 REFERENCES	1-4
2 OVERVIEW.....	2-1
2.1 GENERAL.....	2-1
2.2 MO SERVICE FRAMEWORK OVER SPACE PACKET PROTOCOL.....	2-2
2.3 TYPICAL USE.....	2-5
2.4 MAL MESSAGE MAPPING.....	2-7
2.5 MAL TRANSPORT INTERFACE MAPPING	2-11
3 MAL MESSAGE MAPPING.....	3-1
3.1 OVERVIEW	3-1
3.2 URI FORMAT.....	3-5
3.3 MAL HEADER MAPPING	3-6
3.4 SPACE PACKET SPECIFIC FIELDS.....	3-12
3.5 MAL MESSAGE BODY MAPPING.....	3-14
4 MAL TRANSPORT INTERFACE MAPPING.....	4-1
4.1 OVERVIEW	4-1
4.2 SUPPORTEDQOS REQUEST.....	4-3
4.3 SUPPORTEDIP REQUEST.....	4-3
4.4 TRANSMIT REQUEST.....	4-3
4.5 TRANSMITMULTIPLE REQUEST	4-6
4.6 RECEIVE INDICATION.....	4-6
4.7 RECEIVEMULTIPLE INDICATION	4-7

CONTENTS (continued)

<u>Section</u>	<u>Page</u>
5 MAL DATA ENCODING.....	5-1
5.1 OVERVIEW	5-1
5.2 ELEMENT.....	5-2
5.3 ENUMERATION	5-3
5.4 COMPOSITE.....	5-4
5.5 LIST	5-4
5.6 NULLABLE ELEMENT	5-4
5.7 BLOB.....	5-5
5.8 BOOLEAN	5-5
5.9 DURATION.....	5-5
5.10 FLOAT.....	5-5
5.11 DOUBLE	5-6
5.12 IDENTIFIER	5-6
5.13 OCTET.....	5-6
5.14 UOCTET.....	5-6
5.15 SHORT	5-6
5.16 USHORT	5-6
5.17 INTEGER	5-6
5.18 UINTEGER	5-7
5.19 LONG	5-7
5.20 ULONG	5-7
5.21 STRING	5-7
5.22 TIME	5-8
5.23 FINETIME.....	5-8
5.24 URI	5-8
5.25 UNSIGNED N-BIT INTEGER	5-8
5.26 SIGNED N-BIT INTEGER.....	5-8
5.27 UNSIGNED VARINT	5-8
5.28 SIGNED VARINT.....	5-10
ANNEX A PROTOCOL IMPLEMENTATION CONFORMANCE	
STATEMENT PROFORMA (NORMATIVE).....	A-1
ANNEX B MAPPING CONFIGURATION PARAMETERS (NORMATIVE).....	B-1
ANNEX C QOS PROPERTIES (NORMATIVE)	C-1
ANNEX D SECURITY, SANA, AND PATENT CONSIDERATIONS	
(INFORMATIVE)	D-1
ANNEX E ENCODING EFFICIENCY (INFORMATIVE).....	E-1
ANNEX F ACRONYMS (INFORMATIVE).....	F-1
ANNEX G INFORMATIVE REFERENCES (INFORMATIVE)	G-1

CONTENTS (continued)

<u>Figure</u>	<u>Page</u>
1-1 Bit Numbering Convention.....	1-3
1-2 Octet Convention	1-4
2-1 Mission Operations Services Concept Document Set	2-2
2-2 Overview of the MO Service Framework.....	2-3
2-3 MO Service Framework above Space Packet Protocol	2-5
2-4 Typical Deployment of the MAL Space Packet Transport Binding.....	2-6
2-5 MAL Message Mapping to Space Packet.....	2-9

Table

3-1 MAL Message Header Fields	3-1
3-2 Space Packet Primary Header Format	3-2
3-3 Space Packet Secondary Header Format	3-4
3-4 QoSlevel Field Encoding	3-8
3-5 Session Field Encoding.....	3-10
3-6 Interaction Type and Stage Mapping.....	3-11
4-1 MAL Transport Interface Primitives	4-2
4-2 Packet Interface Primitives	4-2
5-1 Unsigned Integer 7-Bit Groups.....	5-9
5-2 Signed Integer Bit Shifting	5-10
B-2 Mapping Configuration Parameters.....	B-2
C-2 QoS Properties	C-1
D-1 Mission Operations MAL Space Packet Transport Binding Version Number Initial Values.....	D-3
D-2 MAL Transport Binding URI Scheme Name Initial Values	D-3
E-2 Secondary Header Additional Overheads.....	E-1

1 INTRODUCTION

1.1 PURPOSE

This Recommended Standard defines the binding between the Mission Operations (MO) Message Abstraction Layer (MAL) specified in reference [2] and the Space Packet Protocol specified in reference [1]. This binding allows MO Services to use the Space Packet Protocol as messaging technology in all situations where this may be required.

1.2 SCOPE

The scope of this Recommended Standard is the specification of the binding in terms of technology mapping to the Space Packet Protocol of:

- a) MAL message;
- b) MAL Transport Interface.

The MAL Blue Book (reference [2]) specifies the MAL protocol in an abstract way, i.e., without defining the concrete protocol data units. The MAL Space Packet Transport Binding and Binary Encoding specifies:

- a) a complete and unambiguous mapping of the MAL message to the Space Packet;
- b) a complete and unambiguous mapping of the MAL transport interface to the Space Packet Protocol interface;
- c) a complete and unambiguous mapping of the MAL data types to fixed and variable length binary encoding formats.

This Recommended Standard does not specify:

- a) individual implementations or products;
- b) the implementation of entities or interfaces within real systems.

MO services defined in terms of MAL using the Space Packet Transport Binding as defined in this Recommended Standard are fully interoperable.

1.3 APPLICABILITY

This Recommended Standard specifies a technology mapping that enables different implementations of the MO service framework (see 2.2) to interoperate through the Space Packet Protocol.

1.4 RATIONALE

The goal of this Recommended Standard is to specify how to translate the abstract MAL message model in an unambiguous way into a concrete message exchange protocol, namely the Space Packet Protocol.

This Recommended Standard defines a binary encoding format for the MAL data types that may be re-used by a MAL binding to a messaging technology that is not the Space Packet Protocol.

1.5 DOCUMENT STRUCTURE

This Recommended Standard is organized as follows:

- a) section 1 provides purpose, scope, applicability, and rationale, and lists definitions, conventions, and references used throughout this Recommended Standard;
- b) section 2 presents an overview of the MAL Space Packet Transport Binding in relation with the MO service framework;
- c) section 3 specifies the mapping of the MAL message to the Space Packet;
- d) section 4 specifies the mapping of the MAL transport interface to the Space Packet Protocol interface;
- e) section 5 specifies a generic encoding format for the MAL data types.

1.6 DEFINITIONS

The following definitions are from the MO Reference Model (reference [8]).

Protocol: The set of rules and formats (semantic and syntactic) used to determine the communication behaviour of a Protocol Layer in the performance of the layer functions. The state machines that operate and the protocol data units that are exchanged specify a protocol.

Protocol Layer: The implementation of a specific Protocol. It provides a Protocol Service Access Point to layers above and uses the Protocol Service Access Point of the layer below.

Protocol Service Access Point (SAP): The point at which one layer's functions are provided to the layer above. A layer may provide protocol services to one or more higher layers and use the protocol services of one or more lower layers.

1.7 NOMENCLATURE

1.7.1 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.

1.7.2 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.

1.8 BIT NUMBERING CONVENTION

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 bit following 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’.

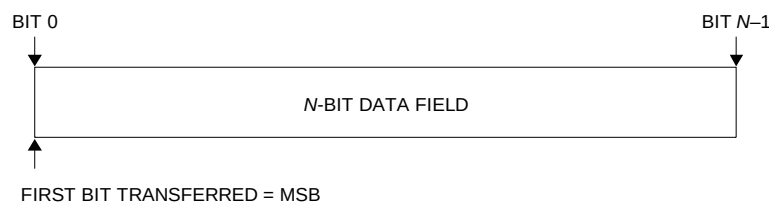


Figure 1-1: Bit Numbering Convention

In accordance with modern data communications practice, spacecraft data fields are often grouped into eight-bit ‘words’ which conform to the above convention. Throughout this Recommended Standard, the following nomenclature is used to describe this grouping:

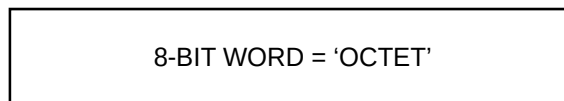


Figure 1-2: Octet Convention

By CCSDS convention, all ‘spare’ or ‘unused’ bits shall be permanently set to value ‘zero’.

1.9 REFERENCES

The following publications contain provisions which, through reference in this text, constitute provisions of this document. At the time of publication, the editions indicated were valid. All publications are subject to revision, and users of this document are encouraged to investigate the possibility of applying the most recent editions of the publications indicated below. The CCSDS Secretariat maintains a register of currently valid CCSDS publications.

- [1] *Space Packet Protocol*. Issue 1. Recommendation for Space Data System Standards (Blue Book), CCSDS 133.0-B-1. Washington, D.C.: CCSDS, September 2003.
- [2] *Mission Operations Message Abstraction Layer*. Issue 2. Recommendation for Space Data System Standards (Blue Book), CCSDS 521.0-B-2. Washington, D.C.: CCSDS, March 2013.
- [3] *IEEE Standard for Floating-Point Arithmetic*. 2nd ed. IEEE Std. 754-2008. New York: IEEE, 2008.
- [4] F. Yergeau. *UTF-8, a Transformation Format of ISO 10646*. STD 63. Reston, Virginia: ISOC, November 2003.
- [5] *Time Code Formats*. Issue 4. Recommendation for Space Data System Standards (Blue Book), CCSDS 301.0-B-4. Washington, D.C.: CCSDS, November 2010.
- [6] *Data Elements and Interchange Formats—Information Interchange—Representation of Dates and Times*. 3rd ed. International Standard, ISO 8601:2004. Geneva: ISO, 2004.
- [7] “Packet Version Number.” Space Assigned Numbers Authority. http://sanaregistry.org/r/packet_version_number/.
- [8] *Mission Operations Reference Model*. Issue 1. Recommendation for Space Data System Practices (Magenta Book), CCSDS 520.1-M-1. Washington, D.C.: CCSDS, July 2010.

2 OVERVIEW

2.1 GENERAL

This Recommended Standard allows MO services defined in terms of the MAL to interoperate across an end-to-end communication link using a normative binding of the MAL abstractions to the Space Packet Protocol for exchanging messages. This is of particular interest for MO services that are deployed across the space-ground link, for instance when the MO service provider is located onboard a spacecraft and the consumer on the ground. The messages that the provider and consumer exchange to implement the MO services are encoded in Space Packets and carried via the Space Packet Protocol, which acts as a Message Layer mapping. This can run directly over a space Data Link Layer or over a true Transport Layer such as TCP, UDP, or BP.

To achieve this, this Recommended Standard provides a technology mapping of the MAL transport interface, the MAL abstract message, and the MAL data types specification (reference [2]) to the Space Packet Protocol (reference [1]). This technology mapping requires the specification of a concrete encoding format that is compliant with the Space Packet Protocol and that maps MAL header fields to SPP primary and secondary header fields.

The MAL Blue Book (reference [2]) defines an abstract transport interface as a set of request and indication primitives. A technology mapping specifies how these primitives are provided according to the messaging technology.

In particular, a technology mapping translates the MAL message model into one or several specific PDUs in compliance with the protocol used by the messaging technology. Moreover, a technology mapping casts the MAL data types into a specific encoding format. In this binding specification a binary encoding is used. Other encodings, such as XML, are also possible.

Full interoperability of services is achieved only once a binding has been created to a specific messaging technology. Because all MO service specifications are defined in terms of MAL using a formal service description language, a technology mapping must be used to bind the abstract service specifications to a specific messaging technology. This document specifies the mapping of the MAL abstractions to the CCSDS SPP.

The diagram shown in figure 2-1 presents the set of standards documentation in support of the Mission Operations Services Concept. This book belongs to the technology mappings documentation.