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Space data and information transfer systems — Spacecraft onboard interface services — Message transfer service

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Published by BSI Standards Limited 2015

ISBN 978 0 580 87912 8

ICS 49.140

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This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 December 2015.

Amendments/corrigenda issued since publication

Date	Text affected

BS ISO 20213:2015

INTERNATIONAL STANDARD

ISO 20213

First edition
2015-08-15

Space data and information transfer systems — Spacecraft onboard interface services — Message transfer service

Systèmes de transfert des informations et données spatiales — Services d'interfaces à bord des véhicules spatiaux — Service de transfert de messages

Reference number
ISO 20213:2015(E)

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The Consultative Committee for Space Data Systems

Recommendation for Space Data System Practices

SPACECRAFT ONBOARD INTERFACE SERVICES—MESSAGE TRANSFER SERVICE

RECOMMENDED PRACTICE

CCSDS 875.0-M-1

MAGENTA BOOK

November 2012

AUTHORITY

Issue:	Recommended Practice, Issue 1
Date:	November 2012
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 documents is detailed in *Organization and Processes for the Consultative Committee for Space Data Systems* (CCSDS A02.1-Y-3), and the record of Agency participation in the authorization of this document can be obtained from the CCSDS Secretariat at the address below.

This document is published and maintained by:

CCSDS Secretariat
Space Communications and Navigation Office, 7L70
Space Operations Mission Directorate
NASA Headquarters
Washington, DC 20546-0001, USA

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FOREWORD

This document is a technical Recommended Practice 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 Message Transfer Service described herein is intended for missions that are cross-supported between Agencies of the CCSDS, in the framework of the Spacecraft Onboard Interface Services (SOIS) CCSDS area.

This Recommended Practice specifies services and service interfaces provided by the SOIS Message Transfer Service, which provides a standard service for mediating the transfer of discrete data, i.e., messages, between onboard software users in a (potentially) distributed onboard system regardless of the particular type of data link or protocol being used for communication.

Through the process of normal evolution, it is expected that expansion, deletion, or modification of this document may occur. This Recommended Practice is therefore subject to CCSDS document management and change control procedures, which are defined in the *Organization and Processes for the Consultative Committee for Space Data Systems* (CCSDS A02.1-Y-3). Current versions of CCSDS documents are maintained at the CCSDS Web site:

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DOCUMENT CONTROL

Document	Title	Date	Status
CCSDS 875.0-M-1	Spacecraft Onboard Interface Services—Message Transfer Service, Recommended Practice, Issue 1	November 2012	Original issue

CONTENTS

CONTENTS (continued)

1 INTRODUCTION

1.1 PURPOSE AND SCOPE OF THIS DOCUMENT

This document is one of a family of documents specifying the Spacecraft Onboard Interface Services (SOIS)-compliant services to be provided in support of onboard applications.

The purpose of this document is to define services and service interfaces provided by the SOIS Message Transfer Service. Its scope is to specify the service only and not to specify methods of providing the service, although use of the SOIS subnetwork services is assumed.

This document conforms to the principles set out in the SOIS Green Book (reference [C2]) and should not be applied without first consulting this reference.

1.2 APPLICABILITY

This document applies to any mission or equipment claiming to provide a SOIS-compatible Message Transfer Service.

1.3 RATIONALE

SOIS provides service interface specifications in order to promote interoperability and development reuse via peer-to-peer and vertical standardization.

1.4 DOCUMENT STRUCTURE

This document has six major sections and five annexes:

- this section, containing administrative information, definitions, and references;
- section 2, containing general concepts and assumptions;
- section 3, containing the Message Transfer Service specification;
- section 4, containing the protocol definition, i.e., interoperable protocol between service implementations, so as to allow interoperability between them;
- section 5, containing the Protocol Data Units (PDUs) associated with the protocol definition in section 4;
- section 6, containing the Management Information Base (MIB) for this service;
- annex A, comprising the Service Conformance Statement Proforma;
- annex B, discussing security considerations;
- annex C, containing a list of informative references;

– annex D, containing an example ANSI C Application Programming Interface for Message Transfer Service;

– annex E, containing an onboard software example of the use of Message Transfer Service, in particular with regard to the suggested interpretation of the adopted Asynchronous Message Service (AMS) primitives.

1.5 CONVENTIONS AND DEFINITIONS

1.5.1 DEFINITIONS

1.5.1.1 General

For the purpose of this document the following definitions apply.

1.5.1.2 Definitions from the Open Systems Interconnection Reference Model

This document is defined using the style established by the Open Systems Interconnection (OSI) Basic Reference Model (reference [C1]). This model provides a common framework for the development of standards in the field of systems interconnection.

The following terms used in this Recommended Practice are adapted from definitions given in reference [C1]:

layer: Subdivision of the architecture, constituted by subsystems of the same rank.

protocol data unit: Unit of data specified in a protocol and consisting of Protocol Control Information (PCI) and possibly user data.

service: Capability of a layer (a service provider) together with the layers beneath it, which is provided to the service users.

1.5.1.3 Terms Defined in this Recommended Practice

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

application: Component of the onboard software that makes use of the Message Transfer Service.

NOTE – Such components include flight software applications and higher-layer services.

message: Discrete unit of data with a defined length that is sent and received atomically between tasks using Message Transfer Service.

1.5.1.4 Definitions from the Asynchronous Message Transfer Recommended Standard

The following terms used in this Recommended Practice are adapted from definitions given in reference [1]:

Application AMS (AAMS): Protocol that conveys application data between AMS modules within a single continuum.

Meta-AMS (MAMS): Protocol that propagates configuration information that enables the exchange of AAMS PDUs within a single continuum.

Remote AMS (RAMS): Protocol the conveys application data between AMS modules in different continua.

Meta-AMS PDU (MPDU): PDUs used to effect configuration and discovery procedures.

1.6 NOMENCLATURE

1.6.1 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 INFORMATIVE TEXT

In the normative sections of this document (sections 3-6 and annex A), informative text is set off from the normative specifications either in notes or under one of the following subsection headings:

– Overview;

– Background;

– Rationale;

– Discussion.

1.7 REFERENCES

The following documents contain provisions which, through reference in this text, constitute provisions of this Recommended Practice. At the time of publication, the editions indicated were valid. All documents are subject to revision, and users of this Recommended Practice 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 documents.

[1] *Asynchronous Message Service*. Recommendation for Space Data System Standards, CCSDS 735.1-B-1. Blue Book. Issue 1. Washington, D.C.: CCSDS, September 2011.

[2] *Spacecraft Onboard Interface Services—Subnetwork Packet Service*. Recommendation for Space Data System Practices, CCSDS 851.0-M-1. Magenta Book. Issue 1. Washington, D.C.: CCSDS, December 2009.

NOTE – Informative references are contained in annex C.

2 OVERVIEW

2.1 FUNCTION

The Message Transfer Service is defined within the context of the overall SOIS architecture (see reference [C2]) as one of the services of the Application Support Layer, as illustrated in the figure 2-1.

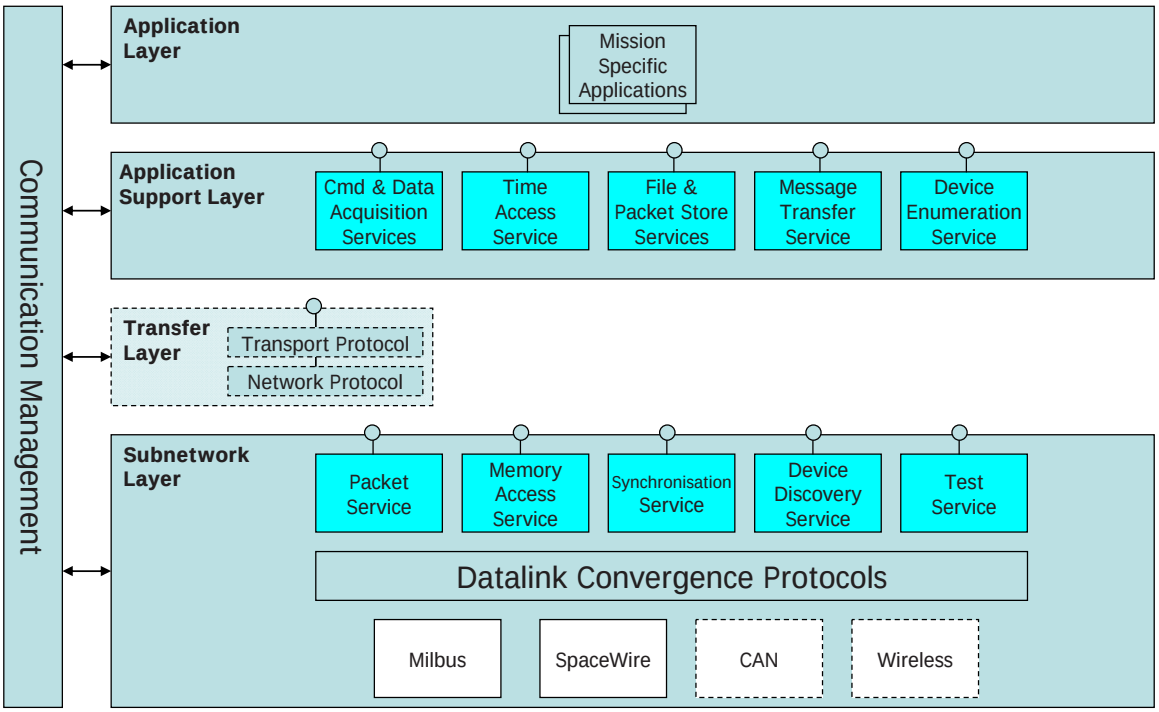

Figure 2-1: Message Transfer Service Context

The Message Transfer Service provides applications with a standard service for mediating the transfer of discrete data, i.e., messages, between onboard software users in a (potentially) distributed onboard system.

Four different models of message transfer exist:

– Send/receive. Messages may simply be sent to designated modules in an asynchronous manner.

– Synchronous query. Messages may be sent in an asynchronous manner, but allowing synchronization with the reception of the reply, i.e., suspending further activity until a reply is received.

– Publish/subscribe. Messages may be published anonymously to a time-varying community of self-selected subscribers. Messages may be published in an asynchronous manner.

– Announcement. Messages may be ‘announced’ to a set of modules selected by the message source. Messages may be ‘announced’ in an asynchronous manner.

Each message is sent in an asynchronous manner. The source user need not wait for the arrival of the message at the destination user(s) before continuing performance of its functions.

Each message is transferred with a SOIS Quality-of-Service (QoS) (such as service class, priority, and/or channel number) specified by the destination user(s) upon registration with the Message Transfer Service.

Although isolated from the details of the transfer mechanisms, the users must still know the format of data contained in the message, and the users remain responsible for correctly composing and interpreting those formats.

Source and destination users may dynamically be added to and removed from the system at any time.

The Message Transfer Service is defined as a restricted subset of the services provided by the CCSDS Asynchronous Message Service (reference [1]), as defined in 3.3. Although the services are defined to be independent of the underlying protocol, it is recommended that the protocol used by the Message Transfer Service be the subset of AMS protocol that is defined in sections 4 and 5. The subset has been defined with the following objectives:

– to provide sufficient functionality for onboard software applications;

– to operate within the environment of onboard software applications (i.e., support timeouts on service invocations and prioritization);

– to provide a mapping onto the SOIS subnetwork services.

From subsection 2.3 of reference [1], the following AMS interactions are deprecated to optional for Message Transfer Service:

– monitoring registrar health (other onboard mechanisms, e.g., centralized Fault Detection, Isolation, and Recovery [FDIR]), may be used to detect the failure of the registrar);

– configuration service fail-over (other onboard mechanisms, e.g., centralized FDIR, may be used to restart a failed configuration service on a redundant data system).

Finally, the following interactions, optional in AMS, are **not** used in Message Transfer Service:

– configuration resynchronization (sufficient control of the state of a spacecraft should be maintained to negate the need for a periodic resynchronization, with its inherent complexity);

– subject catalogue (not required by SOIS).

2.2 PURPOSE AND OPERATION OF THE MESSAGE TRANSFER SERVICE

The service provides a consistent, standard interface to onboard software; the interfaces are described by sets of primitives and related parameters.

From the user software perspective, use of the Message Transfer Service will result in onboard application software that is more portable, easier to develop, and can tolerate changes in the spacecraft hardware configuration.

From the spacecraft platform implementers' perspective, use of the Message Transfer Service will make it easier to control the access to shared hardware resources.

The Message Transfer Service is operated using service requests and service indications passed between the service user and the service provider.

3 MESSAGE TRANSFER SERVICE

3.1 PROVIDED SERVICE

3.1.1 GENERAL

3.1.1.1 The Message Transfer Service shall implement the following requirements:

a) The Message Transfer Service shall implement the capability to send a message to a designated destination service user in an asynchronous manner.

b) The Message Transfer Service shall implement the capability to receive a message sent to it from another service user.

c) The Message Transfer Service shall implement the capability to send a query message to and receive a reply message back from a designated destination service user in a synchronous manner.

d) The Message Transfer Service shall implement the capability to receive a query message from another service user and send back a reply message to a designated destination service user in a synchronous manner.

3.1.1.2 Optionally, the Message Transfer Service may implement the following requirements:

a) The Message Transfer Service may implement the capability to subscribe to receive messages published on a designated subject.

b) The Message Transfer Service may implement the capability to publish a message on a designated subject anonymously to a time-varying group of registered subscribers (destination users).

c) The Message Transfer Service may implement the capability to announce a message to a set of designated destination users.

3.2 EXPECTED SERVICE FROM UNDERLYING LAYERS

The minimum services expected from the underlying layers are:

a) deliver a discrete PDU to a Message Transfer Service instantiation;

b) support the SOIS Subnetwork Packet Service QoS (service class, priority, and/or channel number, reference [2], subsections 3.1.5, 3.1.7, and 3.1.6, respectively) specified by the destination Message Transfer Service instantiation and in accordance with the mapping between Message Transfer Service and Packet Service at the destination module;

c) provide a means for signalling the result of data transmission which may bespecific to the underlying data transport mechanism (at least Red=failure, Yellow=unknown or partial, Green=OK).

NOTE – In the annexes of this document are standardized mappings to particular SOIS subnetwork services. The list is not exhaustive and it is expected that additional mappings will be added in time. However, they all provide a concrete representation of the same abstract service provision that is defined in this section.

3.3 SERVICE PARAMETERS

3.3.1 GENERAL

The Message Transfer Service shall use the following parameters (being the full set of parameters of AMS, reference [1], subsection 3.1.2) but with a restricted definition as indicated):

a) *continuum ID*. Support for only a single, well-defined Continuum ID is compliant for Message Transfer Service.

b) *application name*. No restrictions.

c) *authority name*. No restrictions.

d) *unit ID*. No restrictions.

e) *role ID*. Support for the role RAMS, i.e., role ID '1', is not required.

f) *Meta-AMS Delivery Point (MADP) specification*. No restrictions.

NOTE – Use of the SOIS Subnetwork Packet Service is recommended for Message Transfer Service.

g) *module number*. No restrictions.

h) *subject ID*. No restrictions.

i) *delivery specification*. No restrictions.

NOTE – Use of the SOIS Subnetwork Packet Service is recommended for Message Transfer Service.

j) *service mode*. The service mode is restricted to 'Transmission order' sequence of delivery.

k) *priority*. No restrictions.

l) *flow label*. When it is necessary to define timeouts on delivery of messages, they should be implied by the flow label. The flow label shall be passed to the underlying transport service, and a mapping to a channel number and QoS parameters shall be made at that point.

NOTE – Use of the SOIS Subnetwork Packet Service is recommended for Message Transfer Service., in which case the flow label parameter shall be mapped onto SOIS Subnetwork Packet Service Quality-of-Service (QoS) parameters and channel number (reference [2], subsections 3.1.5, 3.1.6 and 3.1.7).

m) *context*. No restrictions.

n) *application data length*. The maximum value of the application data length may be restricted to significantly less than 65000 and still be compliant to Message Transfer Service.

o) *application data*. The maximum value of the application data may be restricted to a significantly shorter array than 65000 octets and still be compliant to Message Transfer Service.

p) *term*. A term with value -1, i.e., indefinite time, is disallowed for Message Transfer Service.

q) *fault expression*. No restrictions.

3.4 MESSAGE TRANSFER SERVICE PRIMITIVES

3.4.1 GENERAL

3.4.1.1 The Message Transfer Service interface shall implement the following primitives (being the full set of mandatory primitives of AMS, reference [1], subsections 3.1.10, 3.1.11, 3.1.12, 3.1.14, 3.1.16, 3.1.17):

– Send.request. No restrictions.

– Query.request. No restrictions.

– Reply.request. No restrictions.

– Message.indication. No restrictions.

– Reply.indication. No restrictions.

– Fault.indication. No restrictions.

3.4.1.2 Optionally, the Message Transfer Service may implement the following primitives (being the full set of optional primitives of AMS, reference [1], subsections 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.1.7, 3.1.8, 3.1.9, 3.1.13, 3.1.18, 3.1.19, 3.1.20, 3.1.21, 3.1.22, 3.1.23, 3.1.24) but with a restricted definition as indicated:

– Register.request. No restrictions.

– Unregister.request. No restrictions.

– Assert_invitation.request. Flow label parameter is elevated from optional in AMS to mandatory for Message Transfer Service.

NOTE – This elevation is so the receiver mandates the channel number and QoS parameters to use for sending on the related subject.

– Cancel_invitation.request. No restrictions.

– Assert_subscription.request. Flow label parameter is elevated from optional in AMS to mandatory for Message Transfer Service.

NOTE – This elevation is so the receiver mandates the channel number and QoS parameters to use for sending on the related subject.

– Cancel_subscription.request. No restrictions.

– Publish.request. Flow label parameter is not used in Message Transfer Service.

NOTE – This prohibition is to prevent the flow label in a subscription request from being overridden.

– Announce.request. Flow label parameter is not used in Message Transfer Service.

NOTE – This prohibition is to prevent the flow label in a subscription request from being overridden.

– Register.indication. No restrictions.

– Unregister.indication. No restrictions.

– Assert_invitation.indication. No restrictions.

– Cancel_invitation.indication. No restrictions.

– Assert_subscription.indication. No restrictions.

– Cancel_subscription.indication. No restrictions.

– Module_is_dead.indication. No restrictions.

3.4.1.3 The different message models identified in section 2 shall be supported by the service primitives as shown in table 3-1.

Table 3-1: Primitives Supported in Different Message Models

Primitive	Send / Rcv	Sync Q.	Pub / Sub	Ann.	Notes
Register.request	X	X	X	X	Register primitives are used for registering an application with Message Transfer
Register.indication	X	X	X	X	
Unregister.request	X	X	X	X	

Primitive	Send / Rcv	Sync Q.	Pub / Sub	Ann.	Notes
Unregister.indication	X	X	X	X	Service, including setting up the delivery point names, i.e., the underlying transport services and associated parameters.
Assert_invitation.request	X	X		X	Invitation primitives are used to indicate which private (non-published) message subjects, i.e., types, an application is interested in and the manner by which they are sent, i.e., 'an invitation to other applications to send messages on a certain subject and by a requested manner'.
Assert_invitation.indication	X	X		X	
Cancel_invitation.request	X	X		X	
Cancel_invitation.indication	X	X		X	
Assert_subscription.request			X		Subscription primitives are used for registering subscription-to-receive messages on certain subjects and the manner by which they are sent.
Assert_subscription.indication			X		
Cancel_subscription.request			X		
Cancel_subscription.indication			X		
Send.request	X				
Message.indication	X		X	X	The Message.indication primitive is used for delivering to the destination application messages sent using all message exchange models except for synchronous query.
Query.request		X			
Reply.request		X			
Reply.indication		X			
Publish.request			X		
Announce.request				X	
Fault.indication	X	X	X	X	Generic fault indication.
Module_is_dead.indication	X	X	X	X	Notification to application that registrar has declared it is no longer participating in AMS.

4 PROTOCOL SPECIFICATION

4.1 GENERAL

While multiple protocols may be used to support the Message Transfer Service, only one protocol, a subset of AMS defined in 4.2, is currently recommended by this standard.[1]

It is recommended that the subset of AMS protocols defined in 4.2 be supported by the SOIS Subnetwork Packet Service (reference [2]).

The priority parameter used on the MTS service interface refers to the priority at which the message is delivered to the user. Where a concept of priority is supported by the underlying transport service, this priority parameter shall be mapped onto the underlying transport service's priority.

4.2 SUBSET OF AMS PROTOCOLS

The following restrictions on utilization of the AMS protocols (reference [1]) shall be applied to produce the subset required for the Message Transfer Service:

a) Sending of *I_am_running* MPDUs from Configuration Server to 'lower ranking' network locations is deprecated to optional.

b) The Configuration Server and all Registrars may be combined into a single communicating entity, thus avoiding the need for *announce_registrar* and *registrar_noted* MPDUs.

c) The Message Transfer Service shall use the AMS Module Registration option whereby the registrar retains information on the MAMS state of every module in the message space (subsection 4.2.5.5.3.2 of reference [1]).

NOTE – This requirement results from the resource constrained nature of the typical spacecraft upon which SOIS is deployed and is intended to minimize the number of messages exchanged during module registration.

d) Role '1' (RAMS gateway) is not required for the Message Transfer Service.

e) Resynchronization is not required for the Message Transfer Service. Therefore it is recommended that the resynchronization interval always be set to zero, and thus resynchronization need not be implemented.

f) The Remote AMS protocol is not required for the Message Transfer Service.

g) The RAMS Gateway is not required for the Message Transfer Service.

NOTE – The mapping of AMS onto an abstract underlying Transport Service is defined in subsection 4.1 of reference [1]. The recommended mapping of AMS onto the SOIS Subnetwork Packet Service is defined in D2 of this document.

[1] This list will be expanded should alternative protocols be defined for Message Transfer Service.

5 PROTOCOL DATA UNITS

5.1 OVERVIEW

This section defines the strict subset of the PDUs for AMS and Meta-AMS protocol (reference [1]) for use by the Message Transfer Service.

5.2 SUBSET OF PDUS FOR AMS AND META-AMS PROTOCOL

The following restrictions on utilization of the AMS and Meta-AMS protocols shall be applied to produce the subset required for Message Transfer Service:

a) A fixed maximum limit shall be imposed on the length of *strings*.

NOTE – This requirement results from the resource constrained nature of the typical spacecraft upon which SOIS is deployed.

b) A fixed maximum limit to the application data length of AMS messages shall be imposed.

NOTE – This requirement results from the resource constrained nature of the typical spacecraft upon which SOIS is deployed.

c) Support for the Remote AMS PDUs is not required for Message Transfer Service.

6 MANAGEMENT INFORMATION BASE

6.1 GENERAL

NOTE – The MIB for the Message Transfer Service is partially dependent upon the Service Interface and partially dependent upon the selected Protocol Specification.

If the subset of AMS protocol is selected as the Protocol Specification, then the subset of the MIB of AMS (reference [1]), as defined in the following subsections, shall apply (taking into account the subset of AMS protocol defined in this Recommended Practice).

6.2 SUBSET OF THE MIB OF AMS

6.2.1 AMS MODULE MIB

The MIB of each AMS module shall include the following:

a) the name and number of the local AMS continuum;

b) values for the N1, N2, and N3 timeout intervals and for N6, the limit on missing heartbeats;

c) the name of the Primary Transport Service;

d) the Primary Transport Service endpoint names of all network locations at which the configuration server for this continuum is authorized to operate, in descending order of preference;

e) the names of all transport services by which the module is able to transmit AMS messages;

f) the default MADP specification;

g) standard delivery preference rules, for translating between service modes and delivery point names and specifications;

Optionally, the MIB of each AMS module may include the following:

a) optionally, the AMS public encryption key characterizing the continuum, used by the configuration server;

b) optionally, the AMS public encryption keys characterizing one or more of the supported applications, used by the registrars of message space cells in which the module may register;

c) optionally, the AMS private encryption key characterizing one functional role within one supported application, used by the module in registering with that role’s name;

d) optionally, a list of all functional role names under which modules are authorized to register in any of the message spaces in which the module may register, together with the AMS public encryption key for the application module(s) that may register under each such name;

e) for each message space in which the module may register,

1) a list of all subjects, identified by both name and number, on which messages may be issued within this message space;

2) associated with each subject, for subject numbers greater than zero **only** ('application subjects'), subject catalogue information including:

i) optionally, a description of this message subject, discussing the semantics of messages issued on this subject;

ii) optionally, a detailed specification of the structure of the application data of messages on this subject;

iii) optionally, a specification of the manner in which a correctly assembled message is marshalled for network transmission in a platform-neutral manner and, on reception, un-marshalled into a format that is suitable for processing by the application;

iv) optionally, security information including:

a) a list of the functional role names of all modules that are authorized senders of messages on this subject;

b) a list of the functional role names of all modules that are authorized receivers of messages on this subject;

c) encryption parameters, including a symmetric encryption key, enabling encryption of messages on this subject.

6.2.2 AMS REGISTRAR MIB

The MIB of each AMS registrar shall include the following:

a) the name and number of the local AMS continuum;

b) values for the N1, N2, and N3 timeout intervals and for N6, the limit on missing heartbeats;

c) the name of the Primary Transport Service;

d) the Primary Transport Service endpoint names of all network locations at which the configuration server for this continuum is authorized to operate, in descending order of preference;

e) the period on which to autonomously re-advertise the configuration of the cell;

f) optionally, the AMS public encryption key characterizing the continuum, used by the configuration server;

g) optionally, the AMS public encryption key for the application characterizing the message space that contains the cell served by this registrar;

h) optionally, the AMS private encryption key for the application characterizing the message space that contains the cell served by this registrar;

i) a list of all functional role names under which modules are authorized to register in the cell served by this registrar. Associated with each role name is, optionally, the AMS public encryption key for the application module(s) that may register under that name.

6.2.3 AMS CONFIGURATION SERVER MIB

The MIB of each AMS configuration server shall include the following:

a) the name and number of the local AMS continuum;

b) values for the N1, N2, and N3 timeout intervals and for N6, the limit on missing heartbeats;

c) the name of the Primary Transport Service;

d) the Primary Transport Service endpoint names of all network locations at which the configuration server for this continuum is authorized to operate, in descending order of preference;

e) a list of all applications for which message spaces may be constructed; associated with each application name is, optionally, the AMS public encryption key for the application;

f) optionally, the AMS private encryption key characterizing the continuum, used by the configuration server.

ANNEX A

MESSAGE TRANSFER SERVICE PROTOCOL IMPLEMENTATION CONFORMANCE STATEMENT PROFORMA

(NORMATIVE)

A1 INTRODUCTION

This section provides the Protocol Implementation Conformance Statement (PICS) Requirements List (PRL) for implementation of the Message Transfer Service, CCSDS 875.0-M-1, November 2012. The PICS for an implementation is generated by completing the PRL in accordance with the instructions below. An implementation shall satisfy the mandatory conformance requirements of the base standards referenced in the PRL.

The PRL in this section is blank. An implementation's complete PRL is called a PICS. The PICS states which capabilities and options of the services have been implemented. The following can use the PICS:

– The service implementer, as a checklist to reduce the risk of failure to conform to the standard through oversight;

– The supplier and acquirer or potential acquirer of the implementation, as a detailed indication of the capabilities of the implementation, stated relative to the common basis for understanding provided by the standard PICS proforma;

– The user or potential user of the implementation, as a basis for initially checking the possibility of interoperability with another implementation;

– A service tester, as a basis for selecting appropriate tests against which to assess the claim for conformance of the implementation.

A2 NOTATION

The following are used in the PRL to indicate the status of features:

Status Symbols

M	mandatory
O	optional

Support Column Symbols

The support of every item as claimed by the implementer is stated by entering the appropriate answer (Y, N or N/A) in the Support column:

Y	Yes, supported by the implementation
N	No, not supported by the implementation
N/A	Not applicable

A3 REFERENCED BASE STANDARDS

The base standards references in the PRL are:

– Message Transfer Service – this document.

A4 GENERATION INFORMATION

IDENTIFICATION OF PICS

Ref	Question	Response
1	Date of Statement (DD/MM/YYYY)	
2	PICS serial number	
3	System Conformance statement cross-reference	

A5 IDENTIFICATION OF IMPLEMENTATION UNDER TEST (IUT)

Ref	Question	Response
1	Implementation name	
2	Implementation version	
3	Special configuration	
4	Other information	

A6 IDENTIFICATION

Ref	Question	Response
1	Supplier	
2	Contact Point for Queries	
3	Implementation name(s) and Versions	
4	Other information necessary for full identification, e.g. name(s) and version(s) for machines and/or operating systems: System Name(s)	

A7 SERVICE SUMMARY

Ref	Question	Response
1	Service Version	
2	Addenda implemented	
3	Amendments implemented	
4	Have any exceptions been required? (Note: a YES answer means that the implementation does not conform to the service. Non-supported mandatory capabilities are to be identified in the PICS, with an explanation of why the implementation is non-conforming.	Yes _____No

A8 INSTRUCTIONS FOR COMPLETING THE PRL

An implementer shows the extent of compliance to the protocol by completing the PRL; that is, compliance to all mandatory requirements and the options that are not supported are shown. The resulting completed PRL is called a PICS. In the Support column, each response shall be selected either from the indicated set of responses or it shall comprise one or more parameter values as requested. If a conditional requirement is inappropriate, N/A shall be used. If a mandatory requirement is not satisfied, exception information must be supplied by entering a reference X*i*, where *i* is a unique identifier, to an accompanying rationale for the non-compliance.

A9 GENERAL/MAJOR CAPABILITIES

Item	Service Feature	Reference (Magenta Book)	Status	Support
	SEND.request	3.4.1	M	
	QUERY.request	3.4.1	M	
	REPLY.request	3.4.1	M	
	MESSAGE.indication	3.4.1	M	
	REPLY.indication	3.4.1	M	
	FAULT.indication	3.4.1	M	
	PUBLISH.request	3.4.1	O	
	ANNOUNCE.request	3.4.1	O	
	REGISTER.request	3.4.1	O	
	REGISTER.indication	3.4.1	O	

Item	Service Feature	Reference (Magenta Book)	Status	Support
	UNREGISTER.request	3.4.1	O	
	UNREGISTER.indication	3.4.1	O	
	ASSERT_INVITATION.request	3.4.1	O	
	ASSERT_INVITATION.indication	3.4.1	O	
	CANCEL_INVITATION.request	3.4.1	O	
	CANCEL_INVITATION.indication	3.4.1	O	
	ASSERT_SUBSCRIPTION.request	3.4.1	O	
	ASSERT_SUBSCRIPTION.indication	3.4.1	O	
	CANCEL_SUBSCRIPTION.request	3.4.1	O	
	CANCEL_SUBSCRIPTION.indication	3.4.1	O	
	MODULE_IS_DEAD.indication	3.4.1	O	
	Maximum limit for the length of strings	5.2	M	
	Maximum limit to application data length of AMS messages	5.2	M	

ANNEX B

SECURITY CONSIDERATIONS

(INFORMATIVE)

B1 SECURITY BACKGROUND

The SOIS services are intended for use with protocols that operate solely within the confines of an onboard subnet. It is therefore assumed that SOIS services operate in an isolated environment which is protected from external threats. Any external communication is assumed to be protected by services associated with the relevant space-link protocols. The specification of such security services is outside the scope of this document.

B2 SECURITY CONCERNS

At the time of writing there are no identified security concerns. If confidentiality of data is required within a spacecraft it is assumed it is applied at the Application layer. For more information regarding the choice of service and where it can be implemented (see reference [C3]).

B3 POTENTIAL THREATS AND ATTACK SCENARIOS

Potential threats and attack scenarios typically derive from external communication and are therefore not the direct concern of the SOIS services, which make the assumption that the services operate within a safe and secure environment. It is assumed that all applications executing within the spacecraft have been thoroughly tested and cleared for use by the mission implementer. Confidentiality of applications can be provided by Application layer mechanisms or by specific implementation methods such as time and space partitioning. Such methods are outside the scope of SOIS.

B4 CONSEQUENCES OF NOT APPLYING SECURITY

The security services are outside the scope of this document and are expected to be applied at layers above or below those specified in this document. If confidentiality is not implemented, science data or other parameters transmitted within the spacecraft might be visible to other applications resident within the spacecraft, resulting in disclosure of sensitive or private information.

ANNEX C

INFORMATIVE REFERENCES

(INFORMATIVE)

[C1] *Information Technology—Open Systems Interconnection—Basic Reference Model: The Basic Model*. International Standard, ISO/IEC 7498-1:1994. 2nd ed. Geneva: ISO, 1994.

[C2] *Spacecraft Onboard Interface Services*. Report Concerning Space Data System Standards, CCSDS 850.0-G-1. Green Book. Issue 1. Washington, D.C.: CCSDS, June 2007.

[C3] *The Application of CCSDS Protocols to Secure Systems*. Report Concerning Space Data System Standards, CCSDS 350.0-G-2. Green Book. Issue 2. Washington, D.C.: CCSDS, January 2006.

NOTE – Normative references are listed in 1.7.

ANNEX D

RECOMMENDED USE OF THE SOIS SUBNETWORK PACKET SERVICE AS THE MESSAGE TRANSFER SERVICE UNDERLYING TRANSPORT SERVICE

(INFORMATIVE)

D1 OVERVIEW

This annex recommends how to use the SOIS Subnetwork Packet Service as the Message Transfer Service Underlying Transport Service.

The SOIS Packet Service itself is mapped onto different subnetwork types, e.g., SpaceWire and MIL-STD-1553B. However, the Message Transfer Service to SOIS Subnetwork Packet Service mapping shall be independent from the subnetwork type.

The Message Transfer Service Underlying Transport Service is dependent upon the selected Message Transfer Service Protocol Definition. The following subsections define the recommended use of the SOIS Subnetwork Packet Service (reference [2]) for each of the identified Message Transfer Service protocols.

D2 AMS AND MAMS PROTOCOL

The AMS and MAMS protocols (reference [1]) require that the Underlying Transport Service provide the following primitives:

- TRANSPORT.request (TDSU, Destination TS Address, Flow Label)
- TRANSPORT.indication (TDSU, Source TS Address, Flow Label)

where TDSU = Transport Service Data Unit, TS = Transport Service.

The mapping from these primitives to the primitives of the SOIS Subnetwork Packet Service is defined in the following table.

Table D-1: AMS Underlying Transport Service to SOIS Subnetwork Packet Service Mapping

AMS Underlying Transport Service Primitives	**SOIS Subnetwork Packet Service Primitives**	**Notes**
TRANSPORT.request - TDSU - Destination TS Address - Flow Label - Priority (optional)	PACKET_SEND.request - Data - PDSAP - Service Class, Priority, Channel	The PSSAP parameter of PACKET_SEND.request is not required by the AMS Underlying Transport Service.
TRANSPORT.indication - TDSU - Source TS Address - Flow Label	PACKET_RECEIVE.indication - Data - PSSAP - Service Class, Priority, Channel	The PDSAP parameter of PACKET_RECEIVE.indication is not required by the AMS Underlying Transport Service.
None	PACKET_FAILURE.indication	

For AMS and MAMS, the QoS provided by the Transport Service may vary, so long as it can be characterized within AMS in terms of the QoS parameters (*service mode*, *priority*, and *flow label*) discussed in 3.3. *Flow labels* as specified in the AMS service request are presented to the Transport Service as an additional QoS discriminator; consumption and interpretation of flow label values is a Transport Service implementation matter.

The *service mode* is a selected *delivery point name*. The format for delivery point names that use the SOIS Subnetwork Packet Service is as follows:

<transport_service_name>=<endpoint_name>

The <transport_service_name> is ‘sois_ps’. The selection of the subnetwork type is resolved inside the transfer layer where spacecraft global network address is translated into subnetwork type and subnetwork address.

The <endpoint_name> is

‘<local_endpoint_identifier>:<destination_address>’

where:

<local_endpoint_identifier> = identifier of the endpoint at the destination data system in decimal;

<destination_address> = global network address (within the spacecraft) in decimal;

For example:

sois_ps=0:531

would be the SOIS Packet Service endpoint name for messages for the local endpoint 0 at the network node at address 531. The network node address 531 (0x0213 in hexadecimal) would then be translated for example into SpaceWire subnetwork (0x02) with logical address 0x13.

Finally, the *flow label* is mapped onto the SOIS Subnetwork Packet Service's service classes (together with channel number) as follows:

0 = Best Effort service class

1 = Assured service class

2 = Reserved service class

3 = Guaranteed service class

The priority parameter on the MTS service interface is mapped onto the SOIS Subnetwork Packet Service's priority parameter, so that the user requested priority is respected by the underlying transport service.

ANNEX E

ONBOARD SOFTWARE EXAMPLE OF THE USE OF MESSAGE TRANSFER SERVICE

(INFORMATIVE)

This annex provides a real-world mission example use of the parameters used in the Message Transfer Service service interface (derived from AMS) so as to provide guidance as to how they should be used for onboard software.

Message Transfer Service Parameter	Mission Examples	Comments
Continuum	Spacecraft (SC), Ground (GRND)	More than likely determined by the properties of the available communications mediums.
Application	CDHS, SYSCON, AOCS, EXPCON	Identifier of individual applications, e.g., CDHS = Command and Data Handling Software application, SYSCON = System Controller application, AOCS = Attitude and Orbit Control Software application, and EXPCON = Experiment Control application.
Authority	Test, RealTime, Replay	An owner of one or more ventures. Likely not to be encountered onboard a spacecraft.
Unit	EXP1 (containing Battery Manager, Thermal Sensors), EXP2 (containing Experiment Controller, Telemetry Manager)	Organizational collection of modules, importantly may also span Continua but typically analogous to subsystem.
Role	Experiment Controller, System Controller, Battery Manager, Thermal Sensor	A role is performed by a set of Application modules, i.e., a categorization.

Message Transfer Service Parameter	Mission Examples	Comments
MADP specification	SOIS Subnetwork Packet Service	Transport service endpoint specification characterizing the manner in which a module is prepared to receive Meta-AMS messages.
Module	EXP1-Controller, EXP2-Controller	A component of an Application that performs a single Role, but can subscribe to multiple subjects.
Subject	AOCS Housekeeping Telemetry	Parameter indicating the general nature of the application data in a message.
Delivery specification	SOIS Subnetwork Packet Service	Parameter characterizing the manner in which a module is prepared to receive Application-AMS and Meta-AMS messages.
Service mode	Sequence: transmission order. Diligence: SOIS Subnetwork Packet Service Class (whenever used as transport service).	Parameter indicating the service mode governing issuance of messages on a given subject.
Priority	Mapping to SOIS Subnetwork Packet Service Priority (whenever used as transport service).	Parameter indicating the relative urgency of messages issued on a given subject.
Flow label	SOIS Subnetwork Packet Service Channel (whenever used as transport service).	Parameter identifying the message stream or ‘flow’ to which messages on a given subject contribute.
Context	TC seq. counter for the couple [TC, TM Ack].	Unique numeric identifier to associate message and reply.
Application data length	TM max size, i.e., 4 kbytes.	Parameter indicating the length (in octets) of the application data parameter.
Application data	AOCS commands content.	Parameter being an array comprising the application data in a message.

Message Transfer Service Parameter	Mission Examples	Comments
Term	CDHS tasks deadlines.	Parameter indicating the length of time following message transmission within which a reply message should be received.
Fault expression	Failure metadata of PACKET_FAILURE.indication whenever SOIS Subnetwork Packet Service is used as transport service.	Parameter indicating the nature of an operational fault encountered by AMS.
SAP	AOCS Application Process ID.	Parameter indicating the AMS at which the service primitive is enacted.

ANNEX F

ABBREVIATIONS AND ACRONYMS

(INFORMATIVE)

AAMS	Application AMS
Ack	Acknowledgement
AMS	Asynchronous Message Service
AOCS	Attitude and Orbit Control Software (application)
CDHS	Command and Data Handling Software (application)
EXPCON	Experiment Control (application)
FDIR	Fault Detection, Isolation, and Recovery
GRND	Ground
MADP	Meta-AMS Delivery Point
MAMS	Meta-AMS
MIB	Management Information Base
MPDU	Meta-AMS PDU
MTS	Message Transfer Service
OSI	Open Systems Interconnection
PCI	Protocol Control Information
PDSAP	Packet Destination SAP Address
PDU	Protocol Data Unit
PSSAP	Packet Source SAP Address
QoS	Quality of Service
RAMS	Remote AMS

SAP	Service access point
SC	Spacecraft
SOIS	Spacecraft Onboard Interface Services
SYSCON	System Controller (application)
TC	Telecommand
TDSU	Transport Service Data Unit
TM	Telemetry
TS	Transport Service

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