INTERNATIONAL STANDARD

ISO 18440

Second edition
2016-11-15

Space data and information transfer systems — Space link extension — Internet protocol for transfer services

Systèmes de transfert des informations et données spatiales — Extension de liaisons spatiales — Protocole Internet pour services de transfert

Reference number
ISO 18440:2016(E)

© ISO 2016



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 18440 was prepared by the Consultative Committee for Space Data Systems (CCSDS) (as CCSDS 913.1-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 18440:2013), which has been technically revised.

© ISO 2016 – All rights reserved

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:

- 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.
- 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.
- 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.

© ISO 2016 – All rights reserved

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.

© ISO 2016 – All rights reserved

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 (BFSPO)/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.

© ISO 2016 – All rights reserved

DOCUMENT CONTROL

Document	Title	Date	Status
CCSDS 913.1-B-1	Space Link Extension—Internet Protocol for Transfer Services, Recommended Standard, Issue 1	September 2008	Original issue, superseded
CCSDS 913.1-B-2	Space Link Extension—Internet Protocol for Transfer Services, Recommended Standard, Issue 2	September 2015	Current issue: – changes the recommended algorithm for secure one-way hash function from SHA-1 to SHA-256; – updates references.

NOTE – Substantive changes from the previous issue are marked with change bars in the inside margin.

© ISO 2016 – All rights reserved

CONTENTS

Section Page

1 INTRODUCTION 1-1

1.1 PURPOSE 1-1
1.2 SCOPE 1-1
1.3 APPLICABILITY 1-2
1.4 RATIONALE 1-2
1.5 DOCUMENT STRUCTURE 1-2
1.6 DEFINITIONS, NOMENCLATURE, AND CONVENTIONS 1-4
1.7 REFERENCES 1-8

2 DESCRIPTION OF THE INTERNET SLE PROTOCOL 2-1

2.1 INTRODUCTION 2-1
2.2 ARCHITECTURAL MODEL 2-1
2.3 AUTHENTICATION LAYER 2-3
2.4 DATA ENCODING LAYER 2-4
2.5 TRANSPORT MAPPING LAYER 2-5
2.6 INTERFACES 2-11
2.7 SECURITY ASPECTS OF THE INTERNET SLE PROTOCOL 2-22

3 ISP1 MESSAGES AND PROCEDURES 3-1

3.1 AUTHENTICATION LAYER 3-1
3.2 DATA ENCODING LAYER 3-3
3.3 TRANSPORT MAPPING LAYER 3-4

4 TML STATE TABLE 4-1

4.1 INTRODUCTION 4-1
4.2 NOTATION 4-1
4.3 STATES 4-2
4.4 EVENTS 4-2
4.5 PREDICATES 4-4
4.6 ACTIONS 4-4
4.7 STATE TABLE 4-6

ANNEX A TML DIAGNOSTIC CODES (NORMATIVE) A-1
ANNEX B DIFFERENCES WITH EARLIER IMPLEMENTATIONS (INFORMATIVE) B-1
ANNEX C INDEX TO DEFINITIONS (INFORMATIVE) C-1
ANNEX D ACRONYMS (INFORMATIVE) D-1

© ISO 2016 – All rights reserved

ANNEX E INFORMATIVE REFERENCES (INFORMATIVE) **E-1**

© ISO 2016 – All rights reserved

CONTENTS (continued)

Figure Page

1-1 SLE Services and SLE API Documentation 1-3
2-1 ISP1 Architecture Model 2-2
3-1 ASN.1 Type for Generation of 'the Protected' 3-2
3-2 ASN.1 Type for the Credentials Parameter 3-3
3-3 Layout of a TML Message 3-4
3-4 Layout of a TML Context Message 3-5

Table

2-1 Primitives of the AL Interface 2-11
2-2 Parameters of the Primitive AL-SLE-PDU 2-11
2-3 Primitives of the DEL Interface 2-12
2-4 Parameters of the Primitive DEL-SLE-PDU 2-12
2-5 Primitives of the TML Data Transfer Interface 2-12
2-6 Parameters of the Primitive TML-SLE-PDU 2-13
2-7 Primitives of the TML Association Control Interface 2-13
2-8 Parameters of the Primitive TML-CONNECT 2-13
2-9 Parameters of the Primitive TML-PEER-ABORT 2-14
2-10 Parameters of the Primitive TML-PROTOCOL-ABORT 2-15
2-11 Primitives of the TML Listener Interface 2-15
2-12 Parameters of the Primitive TML-START-LISTEN 2-15
2-13 Parameters of the Primitive TML-STOP-LISTEN 2-16
2-14 Primitives Used for the TCP-Interface 2-19
2-15 Parameters of the Primitive TCP-PASSIVE-OPEN 2-19
2-16 Parameters of the Primitive TCP-CONNECT 2-20
2-17 Parameters of the Primitive TCP-DATA 2-21
3-1 TML Message Type Identifiers 3-5

© ISO 2016 – All rights reserved

1 INTRODUCTION

1.1 PURPOSE

The Space Link Extension (SLE) Reference Model (reference [1]) identifies a set of SLE Transfer Services that enable missions to send forward space link data units to a spacecraft and to receive return space link data units from a spacecraft. A subset of these services is specified by the SLE Transfer Service Recommended Standards (references [2], [3], [4], [5], and [6]). The SLE Transfer Service Recommended Standards specify

a) the operations necessary to provide the transfer service;

b) the parameter data associated with each operation;

c) the behaviors that result from the invocation of each operation; and

d) the relationship between, and the valid sequence of, the operations and resulting behaviors.

However, they deliberately do not specify the methods or technologies required for communications.

The purpose of this Recommended Standard is to define a protocol for transfer of SLE Protocol Data Units (PDUs) defined in the SLE Transfer Service Recommended Standards using the Internet protocols TCP (Transmission Control Protocol, reference [7]) and IP (Internet Protocol, reference [8]) for data transfer and the Abstract Syntax Notation One (ASN.1, references [9] and [10]) for data encoding. This protocol is referred to as the Internet SLE Protocol One (ISP1).

1.2 SCOPE

This Recommended Standard defines a protocol for transfer of SLE PDUs between an SLE user and an SLE provider system in terms of:

a) the procedures used to establish and release associations;

b) the messages exchanged on an established association;

c) the procedures used to monitor the status of data communication connections; and

d) the methods used to ensure that data are converted between different formats and representations on different platforms.

It does not specify:

a) individual designs, implementations, or products;

b) the configuration of the data communications infrastructure, including configuration of the TCP and IP protocols;

© ISO 2016 – All rights reserved

c) the means by which addresses (IP addresses and TCP port numbers) are agreed, assigned, and communicated.

This Recommended Standard responds to the requirements imposed by the Recommended Standards for SLE transfer services that were available when this Recommended Standard was released. The protocol specified in this Recommended Standard conforms to the requirements on data communication services set forth in those Recommended Standards.

1.3 APPLICABILITY

1.3.1 APPLICABILITY OF THIS RECOMMENDED STANDARD

This Recommended Standard provides a basis for the development of real systems that implement the Internet SLE Protocol. It is applicable for systems acting as an SLE service user or SLE service provider.

1.3.2 LIMITS OF APPLICABILITY

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

1.4 RATIONALE

The goal of this Recommended Standard is to create a standard for interoperability between the tracking stations and/or ground data handling systems of various agencies and the users of SLE transfer services based on the technologies TCP/IP and ASN.1.

1.5 DOCUMENT STRUCTURE

1.5.1 ORGANIZATION

This document is organized as follows:

a) section 1 presents the purpose, scope, applicability and rationale of this Recommended Standard and lists the definitions, conventions, and references used throughout the Recommended Standard;

b) section 2 describes the Internet SLE Protocol by means of an architectural model identifying individual protocol layers and the interfaces to higher layers;

c) section 3 specifies the messages exchanged via ISP1 and the procedures to be applied for connection establishment and release and for data transfer;

© ISO 2016 – All rights reserved

d) section 4 specifies the state table for the protocol;

e) annex A provides ISP1-specific diagnostic codes for the SLE PEER-ABORT operation;

f) annex B describes differences with earlier implementations of ISP1;

g) annex C lists all terms used in this document and identifies where they are defined;

h) annex D lists all acronyms used within this document;

i) annex E contains a list of informative reference documents.

1.5.2 SLE SERVICES DOCUMENTATION TREE

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

a) Part 1: SLE Services;

b) Part 2: Ground Domain Services;

c) Part 3: Ground Communications Services.

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

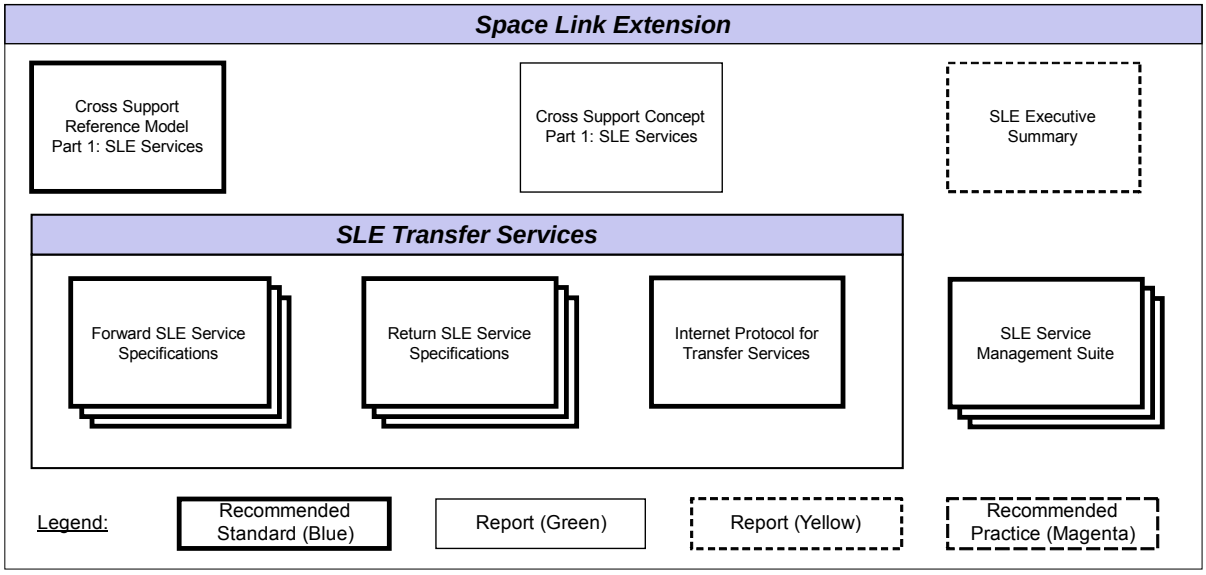


Figure 1-1: SLE Services and SLE API Documentation

a) *Cross Support Concept—Part 1: Space Link Extension Services* (reference [E1]), a Report introducing the concepts of cross support and the SLE services;

© ISO 2016 – All rights reserved

b) *Cross Support Reference Model—Part 1: Space Link Extension Services* (reference [1]), a Recommended Standard that defines the framework and terminology for the specification of SLE services;

c) *Forward SLE Service Specifications*, a set of Recommended Standards that will provide specification of all forward link SLE services;

d) *Return SLE Service Specifications*, a set of Recommended Standards that will provide specification of all return link SLE services;

e) *Internet Protocol for Transfer Services*, this Recommended Standard;

f) *SLE Service Management Specifications*, a set of Recommended Standards that establish the basis of SLE service management.

1.6 DEFINITIONS, NOMENCLATURE, AND CONVENTIONS

1.6.1 DEFINITIONS

1.6.1.1 Definitions from the SLE Reference Model

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

a) initiator;

b) operation;

c) responder;

d) service user (user);

e) service provider (provider);

f) SLE protocol data unit (SLE-PDU);

g) SLE transfer service instance (service instance).

1.6.1.2 Definitions from SLE Transfer Service Specifications

This Recommended Standard makes use of the following terms defined in references [2], [3], [4], [5], and [6]:

a) association;

b) communications service;

c) confirmed operation;

d) invocation;

© ISO 2016 – All rights reserved

e) parameter (of an operation);

f) port identifier;

g) return;

h) unconfirmed operation.

1.6.1.3 Definitions from TCP/IP

This Recommended Standard makes use of the following terms defined in references [7] and [8]:

a) Internet Protocol (IP);

b) IP address;

c) port (of TCP);

d) port number;

e) Transmission Control Protocol (TCP);

f) segment (of TCP);

g) socket.

1.6.1.4 Definitions from Abstract Syntax Notation One

This Recommended Standard makes use of the following terms defined in references [9] and [10]:

a) Abstract Syntax Notation One (ASN.1);

b) Basic Encoding Rules (BER);

c) Distinguished Encoding Rules (DER);

d) encoding rules (of ASN.1);

e) encoding;

f) module (of ASN.1).

1.6.1.5 Definitions from OSI Basic Reference Model

This Recommended Standard makes use of the following terms defined in reference [14]:

a) abstract syntax;

b) primitive;

© ISO 2016 – All rights reserved

c) (protocol) layer;

d) transfer syntax.

1.6.1.6 Additional Definitions

1.6.1.6.1 General

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

1.6.1.6.2 (SLE) Application

An application is a software entity in an SLE user system or an SLE provider system that makes use of the ISP1 protocol, as distinguished from the software implementing the protocol layers defined in this Recommended Standard. The application is considered to implement the 'higher layers' defined in the architectural model in section 2.

1.6.1.6.3 Local Application

The local application is the application implementing the higher layers interfacing with a given instance of an ISP1 implementation.

1.6.1.6.4 Peer Application

The peer application is the application that communicates with the local application via the ISP1 protocol. The peer application is typically located on a remote network, but may also be located on the local network, or even on the same host as the local application.

1.6.1.6.5 Application Identifier

The application identifier is the authority identifier of the application by which the application is identified in the BIND invocation and the BIND return.

NOTE – For an initiating SLE application, the application identifier is the initiator-identifier, and for a responding SLE application, the application identifier is the responder-identifier.

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;

© ISO 2016 – All rights reserved

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

The Internet SLE Protocol is specified by a layered architecture model in which the interfaces between the layers are defined using abstract service primitives, roughly following the concepts in the OSI Basic Reference Model (reference [14]).

A service primitive is a signal optionally associated with a set of parameters that is generated by one layer and consumed by another (adjacent) layer. The direction in which the information is passed is defined by one of the following:

request	a primitive that is passed from the higher layer to the lower layer;
indication	a primitive that is passed from the lower layer to the higher layer;
response	a primitive generated by the higher layer in response to an indication of the same type;
confirmation	a primitive generated by the lower layer in response to a request of the same type.

For every service primitive, the following specifications are provided:

a) the name of the primitive;

b) the uses of the primitive (request, indication, response, confirmation);

c) the parameters associated with each of these uses.

© ISO 2016 – All rights reserved

In addition, the conditions under which the source emits a primitive and the tasks that the receiver shall perform are described.

In this Recommended Standard, primitive names are capitalized and are followed by the specific use in lowercase letters. The primitive name is prefixed by the identifier of the layer that defines the interface, e.g., 'TML-CONNECT-indication'. In the state table in section 4, the prefix is omitted in order to avoid clashes with the notation used in these tables.

1.7 REFERENCES

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

NOTE – A list of informative references is provided in annex E.

[1] *Cross Support Reference Model—Part 1: Space Link Extension Services*. Issue 2. Recommendation for Space Data System Standards (Blue Book), CCSDS 910.4-B-2. Washington, D.C.: CCSDS, October 2005.

[2] *Space Link Extension—Return All Frames Service Specification*. Issue 3. Recommendation for Space Data System Standards (Blue Book), CCSDS 911.1-B-3. Washington, D.C.: CCSDS, January 2010.

[3] *Space Link Extension—Return Channel Frames Service Specification*. Issue 2. Recommendation for Space Data System Standards (Blue Book), CCSDS 911.2-B-2. Washington, D.C.: CCSDS, January 2010.

[4] *Space Link Extension—Return Operational Control Fields Service Specification*. Issue 2. Recommendation for Space Data System Standards (Blue Book), CCSDS 911.5-B-2. Washington, D.C.: CCSDS, January 2010.

[5] *Space Link Extension—Forward CLTU Service Specification*. Issue 3. Recommendation for Space Data System Standards (Blue Book), CCSDS 912.1-B-3. Washington, D.C.: CCSDS, July 2010.

[6] *Space Link Extension—Forward Space Packet Service Specification*. Issue 2. Recommendation for Space Data System Standards (Blue Book), CCSDS 912.3-B-2. Washington, D.C.: CCSDS, July 2010.

[7] J. Postel. *Transmission Control Protocol*. STD 7. Reston, Virginia: ISOC, September 1981.

[8] J. Postel. *Internet Protocol*. STD 5. Reston, Virginia: ISOC, September 1981.

© ISO 2016 – All rights reserved

[9] *Information Technology—Abstract Syntax Notation One (ASN.1): Specification of Basic Notation*. 4th ed. International Standard, ISO/IEC 8824-1:2008. Geneva: ISO, 2008.

[10] *Information Technology—ASN.1 Encoding Rules: Specification of Basic Encoding Rules (BER), Canonical Encoding Rules (CER) and Distinguished Encoding Rules (DER)*. 4th ed. International Standard, ISO/IEC 8825-1:2008. Geneva: ISO, 2008.

[11] *Information Technology—Open Systems Interconnection—The Directory—Part 8: Public-Key and Attribute Certificate Frameworks*. 7th ed. International Standard, ISO/IEC 9594-8:2014. Geneva: ISO, 2014.

[12] *Secure Hash Standard (SHS)*. Federal Information Processing Standards Publication 180-4. Gaithersburg, Maryland: NIST, March 2012.

[13] *Time Code Formats*. Issue 4. Recommendation for Space Data System Standards (Blue Book), CCSDS 301.0-B-4. Washington, D.C.: CCSDS, November 2010.

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

© ISO 2016 – All rights reserved