INTERNATIONAL STANDARD

ISO
21076

First edition
2016-07-01

Space data and information transfer systems — Space communications cross support — Architecture requirements document

Données spatiales et systèmes de transfert d'information - Support croisé des communications spatiales - Exigences d'architecture

iTeh STANDARD PREVIEW
(standards.iteh.ai)

COPYRIGHT PROTECTED DOCUMENT

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.

iTeh STANDARD PREVIEW
(standards.iteh.ai)

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 21076:2016
https://standards.iteh.ai/catalog/standards/sist/f861b026-fa861e435f-a696-
ISO 21076 was prepared by the Consultative Committee for Space Data Systems (CCSDS) (as CCSDS 901.1-M-1, May 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*.

CCSDS RECOMMENDED PRACTICE FOR SPACE COMMUNICATIONS CROSS SUPPORT—
ARCHITECTURE REQUIREMENTS DOCUMENT

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 **Recommendations** and are not in themselves considered binding on any Agency.

CCSDS Recommendations take two forms: **Recommended Standards** that are prescriptive and are the formal vehicles by which CCSDS Agencies create the standards that specify how elements of their space mission support infrastructure shall operate and interoperate with others; and **Recommended Practices** that are more descriptive in nature and are intended to provide general guidance about how to approach a particular problem associated with space mission support. This **Recommended Practice** is issued by, and represents the consensus of, the CCSDS members. Endorsement of this **Recommended Practice** is entirely voluntary and does not imply a commitment by any Agency or organization to implement its recommendations in a prescriptive sense.

No later than five years from its date of issuance, this **Recommended Practice** 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 Practice** is issued, existing CCSDS-related member Practices and implementations are not negated or deemed to be non-CCSDS compatible. It is the responsibility of each member to determine when such Practices or implementations are to be modified. Each member is, however, strongly encouraged to direct planning for its new Practices and implementations towards the later version of the Recommended Practice.

CCSDS RECOMMENDED PRACTICE FOR SPACE COMMUNICATIONS CROSS SUPPORT—
ARCHITECTURE REQUIREMENTS DOCUMENT

FOREWORD

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-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.

iTeh STANDARD PREVIEW
(standards.iteh.ai)

ISO 21076:2016
https://standards.iteh.ai/catalog/standards/sist/f861b026-a861-435f-a606-
8f262b4b6ada/iso-21076-2016

CCSDS RECOMMENDED PRACTICE FOR SPACE COMMUNICATIONS CROSS SUPPORT—
ARCHITECTURE REQUIREMENTS DOCUMENT

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.

CCSDS RECOMMENDED PRACTICE FOR SPACE COMMUNICATIONS CROSS SUPPORT—
ARCHITECTURE REQUIREMENTS DOCUMENT

DOCUMENT CONTROL

Document	Title	Date	Status
CCSDS 901.1-M-1	Space Communications Cross Support—Architecture Requirements Document, Recommended Practice, Issue 1	May 2015	Original issue

iTeh STANDARD PREVIEW
(standards.iteh.ai)

ISO 21076:2016
https://standards.iteh.ai/catalog/standards/sist/f861b026-a861-435f-a606-
8f262b4b6ada/iso-21076-2016

CONTENTS

CCSDS RECOMMENDED PRACTICE FOR SPACE COMMUNICATIONS CROSS SUPPORT—
ARCHITECTURE REQUIREMENTS DOCUMENT

CONTENTS (continued)

CONTENTS (continued)

CCSDS RECOMMENDED PRACTICE FOR SPACE COMMUNICATIONS CROSS SUPPORT—
ARCHITECTURE REQUIREMENTS DOCUMENT

CONTENTS (continued)

iTeh STANDARD PREVIEW
(standards.iteh.ai)

CCSDS RECOMMENDED PRACTICE FOR SPACE COMMUNICATIONS CROSS SUPPORT—
ARCHITECTURE REQUIREMENTS DOCUMENT

1   INTRODUCTION

1.1   PURPOSE

The purpose of this Recommended Practice is to define a set of requirements for CCSDS-recommended configurations for secure Space Communications Cross Support (SCCS) architectures. This architecture is to be used as a common framework when CCSDS Agencies 1) provide and use SCCS services, and 2) develop systems that provide interoperable SCCS services. These SCCS services include both elements on the ground and elements in space. These services cover both single-hop, space Data Link Layer services (Mission Operations Center [MOC]-to-spacecraft), and Solar System Internet (SSI), multi-hop, Network Layer services that involve data routing and internetworking using multiple space assets.

NOTE   –   The term 'agency' is used in CCSDS, but users of CCSDS cross support concepts include satellite operators and service providers, and the context of the cross support is not limited to a user/provider interface with an agency.

This Space Communications Cross Support—Architecture Requirements Document (SCCS-ARD) provides normative specifications and definitions; its companion Space Communications Cross Support—Architecture Description Document (SCCS-ADD) (reference [D5]) provides the descriptive information, explanatory materials, and other graphical representations that support the understanding of these requirements.

1.2   SCOPE

This document describes SCCS architecture in terms of the following:

– definitions of all key elements, on ground and in space, that are involved in space communications;

– definitions of concepts that characterize SCCS services;

– requirements on system elements and components that provide secure SCCS services;

– recommended protocol stack configurations for each element type; and

– recommended end-to-end system configurations to provide interoperable and cross-supportable space communications services.

This document does not specify:

– the details of how to implement systems that provide SCCS services;

– explicit technologies needed to implement SCCS services;

– application or mission operations protocols except for those used for data transfer;

- mission operations except for those involved in planning, scheduling, and executing space communications;

- spacecraft onboard cross support, except for space communication services.

This document contains references to other CCSDS technical engineering and architectural recommendations describing how systems doing space communication cross support should be engineered, deployed, organized, and operated to provide interoperable SCCS services. While this document does not specify detailed internal implementation approaches, which are a private matter, it does recommend specific protocols and protocol stacks, service interfaces, element behaviors, and end-to-end architectures.

Some of the standards that are referenced in this document, especially those relating to the SSI, are still in development. They are included here so the reader gets a clear understanding of how they fit into an overall architecture.

The protocol-related parts of this document make liberal reference to the layers defined in the Open Systems Interconnection (OSI) Basic Reference Model (reference [4]). Subsection 6.2 of the Architecture Description Document (ADD) (reference [D5]) contains a discussion of the OSI stack and the functions associated with each layer.

The technical scope of single-hop cross support is the provision of Data Link Layer (Layer 2) data communications services across the Solar System in support of space mission users, using the *interoperable infrastructure of one or more space agencies*. Services above the Data Link Layer, such as CCSDS File Delivery Protocol (CFDP), Cross-Support File Service (CXFS), or Delta-Differential One-way Range (DOR), may also be provided. All mission operations application in CCSDS-compliant, interoperable, single-hop deployments are expected to utilize these underlying space link and file communications layers.

The technical scope of the SSI is the provision of internetworked (Layer 3) data communications services across the Solar System in support of space mission users, using the *confederated and interoperable infrastructure of one or more space agencies* to achieve a level of service that individual agencies would otherwise be unlikely to achieve. All mission operations application in CCSDS-compliant, interoperable, SSI deployments are expected to utilize these underlying space internetworking communications layers.

The temporal scope of this document covers current, single-hop, secure interoperable cross support installations, future deployments of an interoperable and evolving space networking infrastructure, and the transition strategies to evolve from current deployments to a future SSI state. Included in this discussion are mission-driven considerations, such as use of hybrid science/routing missions, as well as identification of optional configurations that are considered acceptable because they are in line with the transition strategies defined in this document.

Any agency that wishes to participate as a peer in the SSI should implement interoperable services and interfaces at least up to the Network Layer, along with related support services, as described in this document and specified in the relevant CCSDS and Internet standards.

Agencies that are not yet ready to adopt the SSI themselves, but that wish to offer compliant ground station cross support services that can support SSI services, may also take advantage of this document for guidance on developing Data Link Layer services that will both meet their immediate needs and also interoperate with SSI-enabled missions.

1.3   APPLICABILITY

1.3.1   APPLICABILITY OF THIS RECOMMENDED PRACTICE

This Recommended Practice provides a set of reference architecture requirements for the development of CCSDS compatible agency systems for space communications. This Recommended Practice is applicable to all space communication systems that are involved in cross support.

The SCCS systems that are addressed in this Recommended Practice explicitly include ground stations and related systems that provide cross support services, user mission control and mission operations ground systems, and a variety of spacecraft systems. In all cases the applicability is to both single space link (ABA) and internetworked (SSI) systems. The term 'spacecraft systems' includes free-flying spacecraft, landers, rovers, and even balloons and other 'platforms' that are users of space communication services. It also includes spacecraft that are themselves providers of space communication services.

1.3.2   LIMIT OF APPLICABILITY

This Recommended Practice is not a design for real SCCS systems that may be implemented for communication with existing or future missions. It provides detailed, but broadly stated, requirements that may be tailored or adapted for use in constructing such systems.

Future CCSDS requirements (e.g., service interfaces, protocols, or data formats) that are planned, but still under development, are included for completeness so that the directions of CCSDS are clear; these are marked '[Future]' to avoid ambiguity. Any requirements that are considered optional are marked '[Opt]'. The [Opt] requirements are things like security, which may or may not be implemented by any given system. All other core standards, those that are expected to be used by the bulk of missions and implemented by the bulk of service providers, are defined as mandatory, with 'shall' rather than 'should' language. Any specific system deployment may treat these as 'shall' if they are required for that use.

Any requirements marked '[Future]' should not be relied upon in the design of current real SCCS systems. This Recommended Practice will be updated periodically. When updates of this document are published, any requirements now marked '[Future]' whose conditions are met will be reviewed and evaluated for inclusion as full requirements. Many of these future specifications are completely applicable to either ABA or SSI deployments.

CCSDS RECOMMENDED PRACTICE FOR SPACE COMMUNICATIONS CROSS SUPPORT—
ARCHITECTURE REQUIREMENTS DOCUMENT

1.4   RATIONALE

CCSDS has developed a body of space communications recommendations that specify protocols and related services for specific types of functionality that are usually defined at a single layer of the OSI stack, or define how to format and exchange a specific type of information. In order to build end-to-end space communications systems that will interoperate, systems designers need to understand how to select, configure, and deploy different kinds of system elements that implement a complete stack of protocols in each element and how these are assembled to deliver end-to-end services. Single-hop communications configurations often require cross support, where one space agency develops the spacecraft and the corresponding MOC, and another agency provides the ground communications assets. This is the typical cross support configuration used today. Multi-hop communications configurations may require that space assets developed by one agency offer cross support to space elements developed by another agency, with both being supported by ground communications assets from yet another agency.

Since cross support among agencies has become the norm, and since future agency collaborative missions require elements developed by different agencies, at different times, to interoperate as a network, agreed-upon interoperable standards and architectures must be adopted in an end-to-end sense. As the only international body that defines standards to link space communication service providers with space missions, CCSDS is defining this recommended standard architecture for SCCS services, so that interoperable cross support between agencies can be defined and operated more efficiently and effectively for single-hop and multi-hop mission configurations.

Similar to existing ABA architectures, it is fundamental to the SSI concept that all full participants in the confederation must expose standard and agreed-upon cross support services at the Network Layer of the OSI communications stack, while observing common network management strategies and governance mechanisms. Agencies that provide only single-hop Data Link Layer services may still participate in the SSI if they provide compliant services at that layer.

1.5   DOCUMENT STRUCTURE

This document consists of several sections plus annexes.

– Section 1 presents the purpose, scope, and rationale of this document and lists the definitions, conventions, and references used throughout the document.

– Section 2 provides context and an overview of the SCCS architecture.

– Section 3 provides a brief overview of ABA and SSI technical architecture and some guidance on how to use the document.

– Section 4 defines top-level service requirements of ABA and SSI configurations from user and provider perspectives.