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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:

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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

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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.