STRATEGIC PLAN

OF THE

CONSULTATIVE

COMMITTEE

FOR

SPACE DATA SYSTEMS

Strategic Plan
of the
Consultative Committee
for Space Data Systems

CCSDS A01.1-Y-2

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CCSDS CHARTER[1]

PREAMBLE

The major space agencies of the world recognize that there are benefits in using standard techniques for handling space data and that, by cooperatively developing these techniques, future data system interoperability will be enhanced. In order to assure that work towards standardization of space-related information technologies provides the maximum benefit for the interested agencies, both individually and collectively, an international Consultative Committee for Space Data Systems (CCSDS) is established as a forum for international cooperation in the development of data handling techniques supporting space research, including space science and applications, for exclusively peaceful purposes.

PURPOSES

The purposes of the CCSDS are as follows:

1) to provide a forum whereby interested agencies may exchange technical information relative to the development or application of standards for space-related information technologies;

2) to identify those common elements of space data systems which, if implemented in a standardized way, will result in significant enhancements in the operation of future cooperative space missions, or in the sharing of mission products;

3) to develop through consensus appropriate Recommendations that will guide the development of agency infrastructure so that interoperability is maximized;

4) to facilitate and promote the use of software and hardware developed under the CCSDS program by all participating agencies;

5) to promote the application of the Recommendations within the space mission community; and

6) to maintain cognizance of other international standardization activities that may have direct impact on the design or operation of space mission data systems.

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[1] The CCSDS Charter was originally approved in 1982. It was updated in May 1999.

Signature Page

(Insert signatures of all of Principal Delegates here)

Contents

Introduction

The Consultative Committee for Space Data Systems (CCSDS) was formed in 1982 by letter of agreement, signed by responsible officials of the participating national and international space agencies.

Since its formation in 1982, the CCSDS has developed and published almost fifty "Recommendations for Space Data System Standards", the majority of which have become full international standards and are currently in widespread use across the international space community.

The purposes of the CCSDS are contained in the Charter (above). Broadly, they are to provide a forum in which the CCSDS Agencies can discuss common space data communications problems and arrive through consensus at standard solutions to those problems, thereby increasing interoperability among agencies and decreasing costs.

This Strategic Plan has been approved by the CCSDS Member Agencies. It is intended that the Strategic Plan should be updated roughly every 5-years to redefine the organization's current objectives, domains for standardization and strategic goals. It also serves to reaffirm the cooperative agreements entered into by the founding agencies of the CCSDS.

A separate CCSDS Operating Plan, that provides the current CCSDS tactical program of work and organizational details, supplements this CCSDS Strategic Plan. The Operating Plan is established and maintained by the CCSDS Engineering Steering Group, and is nominally updated twice per year.

In 1990, Technical Committee 20 (TC 20) of the International Organization for Standardization (ISO) formed Subcommittee 13 (SC 13), Space Data and Information Transfer Systems. Recognizing CCSDS as a leading international authority in standards for space-related information technologies, ISO agreed that CCSDS has the primary responsibility for technical development of ISO TC 20/SC 13 standards.

CCSDS Target Missions

Standardization is widely recognized as a vehicle to stimulate the development of world markets. To help develop space as an international marketplace, CCSDS standards aim to support the data communications needs of a wide but not totally inclusive set of space missions. CCSDS target missions include spacecraft operating in Earth orbit, within the Earth-Moon system, in deep space and on and around other Solar System bodies. While no kind of mission – civil, military, commercial, robotic, piloted - is specifically excluded from the interests of CCSDS, it is recognized that some spacecraft provide specialized data handling services that are well supported by their user communities or by other standardization bodies. For example, commercial voice, data and video broadcasting satellites may use their own transponder data communications

protocols; commercial Earth observing satellites may use their own private data distribution protocols; yet they both may use CCSDS protocols to support their system monitor and control. CCSDS therefore aims to be inclusive and to seek the widest possible set of target missions.

CCSDS Objective

The objective of the CCSDS is to lead the world-wide standardization activities that promote the international interoperability of space mission information systems, thus enabling these space systems to be integrated with their terrestrial data communications and processing counterparts.

Rationale: CCSDS provides the means whereby space agencies can reach voluntary consensus on standardized solutions to common problems associated with the design of interoperable space mission information systems. The fruits of that consensus are made available across the space community in the form of new international standards, along with hardware and software that facilitate their adoption. Standardization and interoperability are mechanisms that enhance the international exploration of space by increasing the use and value of the information gathered, while simultaneously realizing significant savings in cost and development time for all participants.

CCSDS Goals

The goals of the CCSDS are:

♦ By 2020: to progressively propagate the set of CCSDS space mission information interchange standards (which currently support the needs of approximately 40% of all spacecraft in the vicinity of Earth and deep space) so that they support - either in whole or in part - the mission of 90% of all spacecraft that are launched.

♦ By 2010: to ensure that CCSDS space mission information interchange standards support - either in whole or in part – the mission of 100% of all spacecraft that leave Earth orbit for the purposes of scientific exploration.

♦ On a yearly basis: to extend the CCSDS body of standards with sufficient lead-time to keep pace with the new requirements of international missions to be flown in the coming decades, including:

- Space and ground based cross support among an increasingly interdependent set of multi-agency missions.
- Constellations of spacecraft in the vicinity of Earth and the Moon.
- Constellations of spacecraft in deep space.
- Orbiting and in-situ landed vehicles deployed around and on other Solar System bodies.

♦ On a yearly basis: to use this aggregate body of standards to stimulate a 5% annual buildup of an internationally interoperable and re-usable space data communications and navigation infrastructure throughout the Solar System, in support of robotic and eventual human exploration.

CCSDS Operating Strategy

The CCSDS executes its business in accordance with document CCSDS A02.1-Y-2 "RESTRUCTURED CCSDS ORGANIZATION AND PROCESSES". Within the terms of that document, the CCSDS provides the environment and infrastructure whereby:

➢ The international space community - space agencies and their commercial partners - can openly discuss common problems associated with implementing space mission information systems so as to identify where standard solutions will be beneficial.

➢ Technical experts within the community can adopt, adapt, or develop the necessary standards. The resources needed for these activities are provided primarily by the participating agencies at levels commensurate with their individual requirements. Where mutual interests exist, the CCSDS will develop technical alliances with other organizations as appropriate.

➢ The community can formally review and comment on those standards as their development progresses.

➢ The CCSDS Agencies can approve the publication of standards when their review is complete and consensus is achieved.

➢ The standards are made available for adoption and use across the community.

In providing these functions, the CCSDS is committed to:

➢ Adopting or adapting current widely supported standards where advantageous.

➢ Developing new standards for critical space-related information technologies where current standards are considered to be inadequate.

➢ Allowing the agencies (at their individual discretion) to open the standardization process, on a voluntary basis, to all interested parties across their government, private sector, and academic space communities;

➢ Using experimentation and demonstration as integral components of standards development;

➢ Encouraging partnerships between space agencies and the commercial sector to produce off-the-shelf hardware and software so that the standards can be used to build space mission information systems that are scaleable, fast to integrate, low in cost, and interoperable among different users.

CCSDS Domains for Standardization

At the top level, the work of CCSDS is logically partitioned into three abstract "domains" that enclose the principal technical disciplines of the organization:

SPACE INFORMATICS DOMAIN: the Informatics domain embraces the web of applications, distributed across the spacecraft and their ground support systems, that are used to actually fly missions (mission planning; navigation; mission control; scientific data processing; etc.). Typically, the Informatics domain is concerned primarily with the semantic interpretation of information rather than how it is physically moved from place to place. The Informatics domain is the rough "space analog" of the diverse and complex set of applications that form the terrestrial World Wide Web.

SPACE TELEMATICS DOMAIN: the Telematics domain embraces the communications protocols by which these space applications exchange information. Typically, the Telematics domain is concerned primarily with how data units are moved from place to place rather than how they are converted into user information within the applications. The Telematics domain is the "space analog" of the communications networks by which the Web applications exchange information over the terrestrial Internet. It is assumed that nearly all ground communications are Internet-based, with more specialized protocols being employed when crossing into space regions.

SPACE SYSTEMS DOMAIN: the Systems domain encompasses the high level functions that cut across both of the other domains, e.g., the global architecture of how space mission information systems are constructed and how information is represented, and cross-cutting issues such as security.

Note that the Domains are simply logical partitions that differentiate work occurring in three diverse engineering disciplines; they therefore indicate the broad range of human skills that Agencies are expected to furnish when supplying staff to the standardization effort; CCSDS potentially has a very wide scope. Within each of those discipline Domains, CCSDS *Areas* provide the framework for developing actual standards.

CCSDS Areas for Standardization

The CCSDS *Areas* represent the first level of major physical work breakdown within the CCSDS. Although they are intended to be relatively stable entities, Areas may be added or deleted in response to a changing space mission environment. Each Area contains narrowly chartered Working Groups that concentrate on the production of specific standards within the theme of that parent Area.

As shown in Figure 1, six technical Areas of standardization form the current structure of CCSDS.
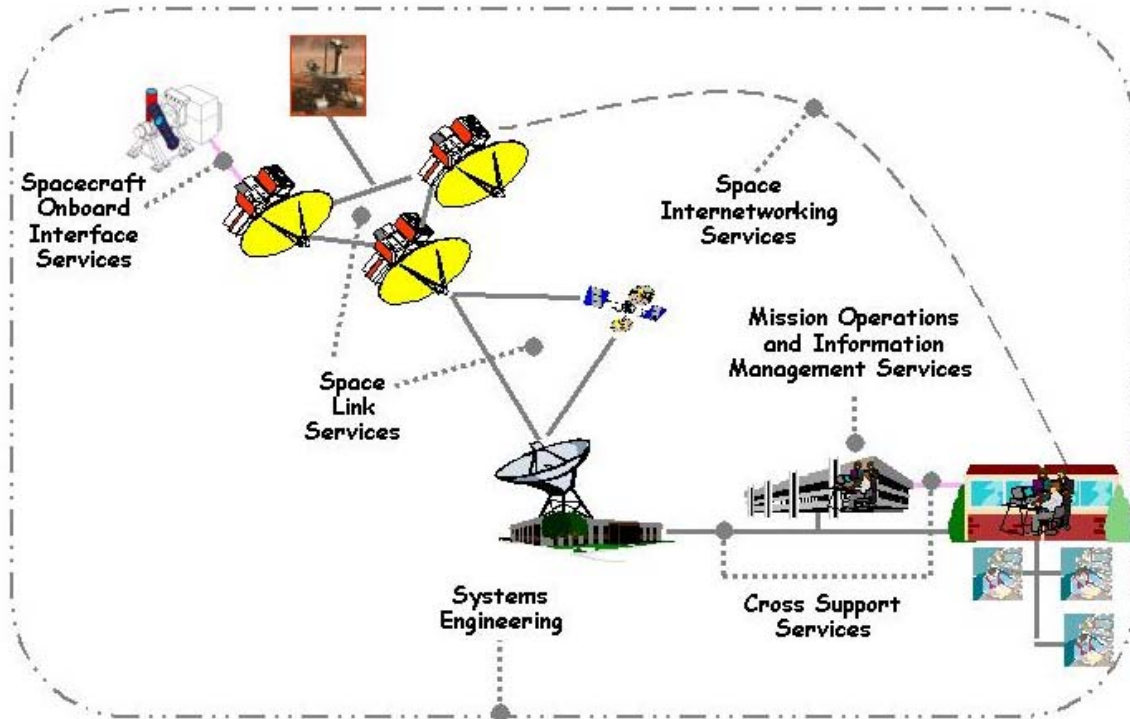
Figure 1: CCSDS Technical Areas of Standardization

CCSDS Area Objectives and Goals

1. SYSTEMS ENGINEERING AREA

The objective of the Systems Engineering Area (SEA) is to address system-wide architectural and engineering aspects that are so pervasive that they span both the Informatics and Telematics Domains.

The strategic goals of the SE Area are:

a. By 2005: to define an overall architecture and representational methodology for space mission communications, operations, and cross-support.
b. By 2006: to define a reference information architecture, information infrastructure services and interfaces, and frameworks for handling operational data flows and supporting multi-agency federated data systems.
c. By 2006: to define an updated Space Assigned Numbers Authority (SANA), using Information Architecture elements, to enable both a centralized reference point and distributed federated elements own by participating agencies.
d. By 2007: to define a security architecture, and to define framework, infrastructure mechanisms and techniques to protect system elements and information as it flows through the end-to-end space mission system.
e. By 2008: to define an overall time services architecture for time correlation, synchronization, and distribution, for end-to-end mission operations operations and cross-support throughout the mission lifecycle.

2. MISSION OPERATIONS AND INFORMATION MANAGEMENT SERVICES AREA

The objective of the Mission Operations and Information Management Services (MOIMS) Area is to address all of the flight execution phase <u>applications</u> that are required to operate the spacecraft and its ground system in response to mission objectives, and their associated detailed information management standards and processes. The focus of this Area is primarily on the "mission operations" functions that occur on a timescale driven by the flight path of the space vehicle. In many cases a dedicated community conducts these mission operations, while "mission utilization" occurs on a timescale that is convenient for users and is often conducted by a separate community. The MOIMS Area ensures that application standards exist which facilitate the smooth transition of space mission information between the "mission operations" systems and the "mission utilization" systems

The strategic goals of the MOIMS Area are:

a   By 2006: to develop and deploy the standards that specify an extensible framework for packaging data and metadata.

b   By 2008: to develop and deploy the standards for the submission and ingest of digital data sources and digital metadata to the Archive, for the identification of digital data within the Archive and for the search and retrieval of digital data and metadata.

c   By 2008: to develop and deploy the standards for the exchange of Navigation information (e.g. position, velocity and attitude) by establishing content and format for tracking, attitude, trajectory and ancillary data (e.g. gravity models, spacecraft orientation).

d   By 2008: to deploy and develop a suite of standard spacecraft Monitor and Control (M&C) services that are exposed for cross support interfaces between M&C and other mission components

3. CROSS SUPPORT SERVICES AREA

While the MOIMS Area focuses on the internal details of the application processes that are needed to execute a space mission, the Cross Support Services (CSS) Area addresses how those applications are made available by one organization to another for the purpose of "Cross Support". The objective of the CSS Area is therefore to define what services are required at various cross-support interface points, and how those services are exposed, scheduled and used by organizations that want to confederate their infrastructure in order to execute a mission.

The strategic goals of the CSS Area are:

a   By 2005: to complete an update of Cross Support Reference Model (CCSDS Recommended Standard) and associated Cross Support Concept and Rationale (CCSDS Informational).

b   By 2005: to complete specifications for the core set of SLE Transfer Services necessary for cross support (CCSDS Recommended Standards).

c   By 2005: to develop specifications for the exchange of SLE Service Management configuration and scheduling information necessary for cross support (CCSDS Recommended Standard).

d   By 2005: to define the requirements for transfer of Ground station tracking, navigation, monitor, and other data associated with cross support operations (CCSDS Proposed Standard).

e   By 2005: to define an approach for simplifying the specification of SLE Transfer Services (e.g., a 'generic' service).

f   By 2006: to develop specifications for a complete set of SLE Management Services, including expanded capabilities required for cross support of complex missions (CCSDS Recommended Standard).

g   By 2008: to develop Specifications for an expanded set of SLE Transfer Services, including transfer of Ground Station data (see "d", above) (CCSDS Recommended Standard).

4. SPACECRAFT ONBOARD INTERFACE SERVICES AREA

The objective of the Spacecraft Onboard Interface Services (SOIS) Area is to address all of the onboard communications networks and protocols <u>within</u> a single spacecraft, and their time critical data handling interfaces and applications.

The strategic goals of the SOIS Area are:

a   By 2006: to define a SOIS reference architecture for onboard systems, using methodologies developed by CCSDS Systems Engineering Area.

b   By 2006: to define and deploy standards for onboard data link layer services that can be implemented over a variety of onboard data buses and data links and thus provide uniform communication capabilities for time critical data transfers.

c   By 2007: to define and deploy standards for basic, generic onboard services provided to flight application software for spacecraft time distribution, command and data acquisition, file transfer, and messaging.

d   By 2007 to define and deploy standards for onboard network and transport layer services that enable time critical data transfer over multiple, possibly heterogeneous onboard sub-networks.

e   By 2008: to seamlessly extend CCSDS space link and space Internet services into the spacecraft by developing and deploying standardized onboard data communication services.

5. SPACE LINK SERVICES AREA

The objective of the Space Link Services (SLS) Area is to address all of the point-to-point communications links and protocols that interconnect a spacecraft with its ground support system, or with another spacecraft.

The strategic goals of the SLS Area are:

a   By 2007: to create a CCSDS Draft Standard that identifies a set of novel ranging techniques geared to significantly improve orbit determination of deep space spacecraft.

b   By 2008: to create a CCSDS Draft Standard containing the specification of a second generation short-haul Proximity-1 Protocol to support the missions to Mars in 2015 and beyond, in preparation for possible human missions.

c   By 2008: to create a CCSDS Proposed Standard that defines the characteristics (compression, protocols, coding, modulation) required for very high rate long-haul space-to-Earth data transmission (at rates of several 100s Mbps).

d   By 2009: to create a CCSDS Proposed Standard that defines the set of measures (to be implemented on point-to-point space link protocols, at all sublayers) that support user-selectable levels of data protection and security.

e   By 2010: to create a CCSDS Proposed Standard that defines the short-haul radio links and protocols for Mars in-situ communication and navigation infrastructure, in line with identified Agency requirements.

f   By 2010: to create a CCSDS Proposed Standard that defines the basic standards required for space-to-Earth long-haul optical links.

6. SPACE INTERNETWORKING SERVICES AREA

The objective of the Space Internetworking Services (SIS) Area is to address all of the routine communications services and protocols supporting end-to-end communications between applications, particularly where these communications may span multiple heterogeneous technologies. Areas addressed by SIS include application-to-application communication onboard a single multi-technology spacecraft, communications among multiple spacecraft, and communications between space-based applications and their counterparts on Earth and/or other planetary bodies.

The strategic goals of the SIS Area are:

a   On a yearly basis: to actively promote the use of Internet standards for data transport, routing, and auxiliary functions in environments where end-to-end paths exist and are relatively stable. This includes the use of TCP (including options defined by CCSDS and/or IETF) when round trip times are low (~<2s), and possible use of UDP for unidirectional paths and/or high delays.

b   By 2009: to support over 80% of deep space missions with CFDP.

c   By 2014: to support over 70% of routine communications between Earth-based and lunar entities and over 20% of near-earth missions with SIS recommendations for application, transport, and network services (including the standard Internet suite).

d   By 2020: to support routine Interplanetary Internet operations among at least 20 entities communicating over interplanetary distances by means of Delay-Tolerant Networking protocols.

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