The Consultative Committee for Space Data Systems

# CCSDS OPERATING PLAN FOR STANDARDS DEVELOPMENT

**Draft Record**

**CCSDS A01.2-Y-4.1**

**Draft Yellow Book**

**March 2006**

# FOREWORD

The top level CCSDS administrative documents that control the operations of CCSDS, and their different purposes, are shown in figure 1.

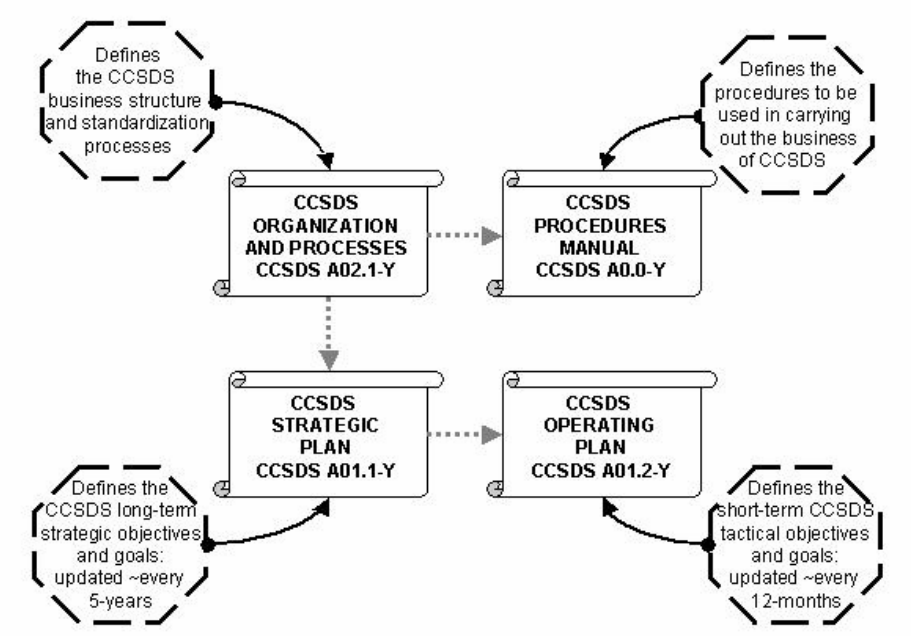


**Figure 1: CCSDS Controlling Documents**

This document (CCSDS A01.2-Y) is the CCSDS Operating Plan. It is formally updated approximately once per year to reflect the current program of work for CCSDS, and it covers roughly a future 24-month period.

The Operating Plan contains the charters of all of the CCSDS Working Groups that have been approved by the CCSDS Management Council. As Working Groups are added or retired, this document may be periodically revised.

At time of publication, the active Member and Observer Agencies of the CCSDS were:

Member Agencies

- Agenzia Spaziale Italiana (ASI)/Italy.
- British National Space Centre (BNSC)/United Kingdom.
- Canadian Space Agency (CSA)/Canada.
- Centre National d'Etudes Spatiales (CNES)/France.
- Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR)/Germany.
- European Space Agency (ESA)/Europe.
- Federal Space Agency (Roskosmos)/Russian Federation.
- Instituto Nacional de Pesquisas Espaciais (INPE)/Brazil.
- Japan Aerospace Exploration Agency (JAXA)/Japan.
- National Aeronautics and Space Administration (NASA)/USA.

Observer Agencies

- Austrian Space Agency (ASA)/Austria.
- Belgian Federal Science Policy Office (BFSPO)/Belgium.
- Central Research Institute of Machine Building (TsNIIMash)/Russian Federation.
- Centro Tecnico Aeroespacial (CTA)/Brazil.
- Chinese Academy of Space Technology (CAST)/China.
- Commonwealth Scientific and Industrial Research Organization (CSIRO)/Australia.
- Danish Space Research Institute (DSRI)/Denmark.
- European Organization for the Exploitation of Meteorological Satellites (EUMETSAT)/Europe.
- European Telecommunications Satellite Organization (EUTELSAT)/Europe.
- 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.
- MIKOMTEK: CSIR (CSIR)/Republic of South Africa.
- Ministry of Communications (MOC)/Israel.
- National Institute of Information and Communications Technology (NICT)/Japan.
- National Oceanic & Atmospheric Administration (NOAA)/USA.
- National Space Program Office (NSPO)/Taipei.
- Space and Upper Atmosphere Research Commission (SUPARCO)/Pakistan.
- Swedish Space Corporation (SSC)/Sweden.
- United States Geological Survey (USGS)/USA.

# DOCUMENT CONTROL

| Document | Title | Date | Status |
|---|---|---|---|
| CCSDS A01.2-Y-1 | CCSDS Operating Plan for Standards Development | December 1999 | Original Issue (superseded) |
| CCSDS A01.2-Y-2 | CCSDS Operating Plan for Standards Development | May 2004 | Issue 2 (superseded) |
| CCSDS A01.2-Y-3 | CCSDS Operating Plan for Standards Development | November 2004 | Issue 3 (superseded) |
| CCSDS A01.2-Y-4 | CCSDS Operating Plan for Standards Development | July 2005 | Current Issue:<br>– updates active Working Group (WG) and deletes dissolved WG charters;<br>– removes Birds of a Feather charters (relocated to on-line work areas) |
| CCSDS A01.2-Y-4.1 | CCSDS Operating Plan for Standards Development, Draft Record, Issue 4.1 | March 2006 | Current draft:<br>– adds Working Groups approved since issue 4;<br>– deletes dissolved Working Groups |

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# 1 SYSTEMS ENGINEERING AREA

## 1.1 SYSTEMS ARCHITECTURE WORKING GROUP

| | |
|---|---|
| **Title of Group** | **1.1 Systems Architecture Working Group** |
| **Chair** | **Takahiro Yamada/JAXA** |
| **Area Director** | **Peter Shames/NASA** |
| **Mailing List** | **sea-sa@mailman.ccsds.org** |

### 1.1.1 RATIONALE

The work done in the other Working Groups is focused upon services and protocols provided by specific components of space data systems. In order for these Working Groups to generate standards in such a way that every standard is consistent and coherent with any other standard generated by CCSDS, CCSDS requires a reference architecture that can be used as a common framework by all the Working Groups of CCSDS and also by engineers in the member Agencies who use CCSDS standards to build systems and to provide services. The reference architecture should encompass both informatics and telematics aspects of space data systems and cover all problem areas associated with space data systems (such as organizational, functional, operational and cross support issues).

### 1.1.2 GOALS

The goals of this Working Group are to:

1) Define a reference architecture that provides a framework for generation of space data systems standards and development of space data systems. This reference architecture should define a set of architectural views that encompass organizational, functional, informational, operational, security, communications, and cross support aspects.

2) Document the reference architecture identifying basic elements in each of the views mentioned above.

3) Develop a document that provides to the other Working Groups and BOFs, guidelines on how to apply the reference architecture.

4) Develop formal methods for representing space data systems architectures that will enable sharing of architectural information among engineers.

5) Develop tools that will facilitate design, modeling, and simulation of system architectural designs.

6) Provide a consistent set of views and terminology across all of the other Areas and Working Groups. Use existing CCSDS terms where they are clear and unambiguous. Resolve to develop a single agreed approach where there are ambiguous or conflicting uses of terms or definitions.

### 1.1.3 SCHEDULE AND DELIVERABLES

| **Date** | **Milestone** |
|---|---|
| 19 May 2003 | WG established. |
| October 2003 | Selection of candidate languages and tools. Prototyping (phase 1) of selected languages and tools starts<br>WG meeting. Coordination meetings with at least one other working group on use of Reference Architecture. |
| 30 November 2003 | Publish a revised version of the reference architecture document (Issue 0.8) that identifies basic elements in the architecture in a more concrete way. |
| January 2004 | Publish a revised version of the reference architecture document (Issue 0.9). |
| May 2004 | WG meeting. Reports of prototyping (phase 1). Coordination meetings with at least one other working group on use of Reference Architecture to develop or revise domain specific architecture. |
| November 2004 | WG meeting. Review the reference architecture document (Issue 0.10) and revise it as necessary. |
| April 2005 | WG meeting. Review the reference architecture document (Issue 0.11) and revise it as necessary. |
| August 2005 | Publish the reference architecture document as a Best Current Practice document and an accompanying Report as a Green Book. |
| *April 2006* | *Publish a document on formal methods for representing space data systems architectures.* |

### 1.1.4 RISK MANAGEMENT STRATEGY

#### 1.1.4.1 Technical Risks

Languages and tools that can be used in our work are still under development in other standards bodies and it may not be possible to select the best languages and tools at the time we need to make the selection.

#### 1.1.4.2 Management Risks

Unavailability of resources could delay achievement of milestones. Fallback option would be to reschedule the milestones.

Use of ambiguous or conflicting terms, definitions, and/or viewpoints in other WGs may result in impact on those WGs to resolve same.

## 1.2 SECURITY WORKING GROUP

| | |
|---|---|
| **Title of Group** | **1.2 Security Working Group** |
| **Chair** | **Howard Weiss/NASA** |
| **Area Director** | **Peter Shames/NASA** |
| **Mailing List** | **sea-sec@mailman.ccsds.org** |

### 1.2.1 RATIONALE

CCSDS develops communications and mission operation standards that support inter and intra agency operations and cross support. CCSDS standards include elements of flight and ground systems that are developed and operated by different agencies and organizations.

Over the years, ubiquitous network connectivity among principal investigators and mission operations has become the norm, which makes mission operations more dangerous than in the past when operations were carried out over closed, mission-only networks. The security risks to both spacecraft and ground systems have increased to the point where CCSDS must adopt existing or develop (as necessary) Information Security standards in order to protect both flight and ground mission critical resources and protect sensitive mission information.

As a result, a mission threat statement for CCSDS should be developed in order to allow mission planners to better understand the threats that they should plan to counter via security requirements. CCSDS also requires a Security Architecture as part of its overall System Architecture. CCSDS must promote secure interoperability for space missions. CCSDS also requires Information Security standards as part of, or as an accompaniment to its communications and mission operations standards.

### 1.2.2 GOALS

The goals of this Working Group are to:

1) provide advice and guidance on information security to all CCSDS activities;

2) identify data protection, information assurance, and information security issues across the full spectrum of CCSDS activities and provide solutions;

3) formulate courses of actions to incorporate security policies, security services, and security mechanisms into CCSDS work items across all Working Groups;

4) develop a security architecture;

5) develop and maintain an Information Security threat statement for CCSDS;

6) develop an information security guide for mission planners;

7) formulate a policy framework for developing trust agreements, rules for operational engagement, ensuring security compliance of legacy systems, and standard, secure interfaces between systems and across security domains;

8) adopt or develop (as necessary) interoperable security standards for CCSDS and CCSDS cross support infrastructure (e.g., authentication, encryption, integrity, key management, key distribution, etc.);

9) investigate and identify how to integrate the use of the Common Criteria (ISO 15408) into the development of mission security requirements;

10) develop reference implementations and perform interoperability testing;

11) revise and maintain current a Green Book to describe security guidelines for implementation;

12) hold working meetings with other Working Groups to develop agreed approaches and formulate the plans for integrating them into the work of these other Working Groups.

### 1.2.3 SCHEDULE AND DELIVERABLES

| **Date** | **Milestone** |
|---|---|
| 30 May 2003 | WG established. |
| January 2005 | Deliver revised Security Green Book. |
| February 2005 | Circulate Security Architecture White Book to working group for comments. Circulate Threat Document for final WG review. |
| April 2005 | Security WG meeting in Athens. Review final comments on Threat Document. Review Security Architecture White Book. |
| May 2005 | Publish completed Threat Document as a Green Book. Issue Security Architecture as Red-1. Develop an encryption standard trade study proposal. |
| July 2005 | Develop an authentication standard trade study proposal. |
| September 2005 | Review RIDS on Security Architecture Red-1 at Sec WG meeting. |
| October 2005 | Issue draft Policy Guidelines document based on NIST document. |
| December 2005 | Mission Planners Guideline—maybe based on tailored version of Common Criteria. |
| January 2006 | Issue encryption Red-1. |
| February 2006 | Issue authentication Red-1. |

## 1.2.4 RISK MANAGEMENT STRATEGY

### 1.2.4.1 Technical Risks

Security is still a different and often obtuse part of CCSDS' work and is often treated as an 'outsider'. It is not 'mainstream' CCSDS nor is it 'traditional' CCSDS. In the past, it has been met with resistance. This is changing and there is now general acceptance of the need for security services and interactions with other working groups are increasing. Working group resources have increased but are still not entirely adequate.

Given different policies in various countries toward import, export and use of security technology choosing an acceptable set for adoption may be somewhat problematic.

### 1.2.4.2 Management Risks

Unavailability of resources will delay achievement of milestones. Fallback option would be to reschedule the milestones.

Identification of specific security guidelines may result in additional work items being agreed upon with other working groups.

## 1.3 INFORMATION ARCHITECTURE WORKING GROUP

| | |
|---|---|
| **Title of Group** | **1.3 Information Architecture Working Group** |
| **Chair** | **Dan Crichton/NASA** |
| **Area Director** | **Peter Shames/NASA** |
| **Mailing List** | **sea-ia@mailman.ccsds.org** |

### 1.3.1 RATIONALE

In the absence of information system standards for interoperability and cross-support we have seen systems be developed that do not allow the exchange of information across ground and flight systems and across agency data systems.

The focus of this working group is to define a reference Space Information Architecture that encompasses the capture, management and exchange of data for both flight and ground environments across the operational mission lifecycle. The includes standard functional components for information management, definition of standard interfaces for information management, standards in information representation (data structuring and packaging mechanisms) and standard definitions of information processes (how the users and the systems interact).

This includes defining how existing standards fit into an overall reference architecture. The reference architecture should encompass informatics aspects of space data systems and cover all problem areas associated with space data systems (such as organizational, functional, operational and cross support issues). This working group has been delegated responsibility for elaborating the Information Architecture for the Information Viewpoint in the System Architecture being developed in the SAWG. The products of this working group will be integrated into the Reference Architecture for Space Data Systems (RASDS).

### 1.3.2 GOALS

The goals of this Working Group are to:

1) Define a reference end-to-end space information architecture for interoperability and cross support that encompasses both flight and ground data system operations and provides a common framework for use by standards and systems developers. The reference space information architecture includes:

   a) standard functional components for information management;

   b) definition of standard interfaces for information management;

c) standards in information representation;

d) standards in defining information processes.

2) Define and leverage common methods for representing information architectural views.

3) Address application layer information management issues including application protocols and data handling and ensure that they are dealt with in a clear and consistent way throughout the end-to-end system.

4) Work with the SEA System Architecture Working Group to provide the Information Architecture elements for the Reference Architecture for Space Data Systems (RASDS) and with the MOIMS Working Groups to develop the specific standard interfaces and protocols. Make recommendations to the other Working Groups and BOFs regarding architectural choices and options.

### 1.3.3 SCHEDULE AND DELIVERABLES

#### 1.3.3.1 Deliverables

1) Space Information Architecture Green Book detailing best current practices and core information architectural principles, including:

a) a set of functional information infrastructure components;

b) a set of information infrastructure interfaces for information management;

c) a set of information descriptors that are capable of representing data across the mission lifecycle;

d) a set of interfaces for cross support services, application program interfaces, and information management & access protocols.

2) Information Architecture and Grid Comparison Study White book outlining the alignment of information architectural principles and the current state of the practice in grid computing. Compare and contrast differences and similarities in approach, technical methodology, and data representation used in each community.

3) OWL-based ontology developed in Protégé to capture and describe Information Architecture concepts and principles.

4) Standards that support implementation of the information architecture including registries and repository standards for the software components based on industry best practice approaches. IAWG will support other groups in definition, implementation and prototyping of these standards and ensure that they fit against the architectural model.

### 1.3.3.2 Schedule

| Date | Milestone |
|---|---|
| 28 May 2003 | BOF chartered and active. |
| October 2003 | BOF meeting. Update on initial architecture and mapping of CCSDS standards. Coordination meeting w/ MOIMS. |
| November 2003 | BOF is chartered as a full WG. |
| December 2003 | Publish an initial version of the reference Information Architecture document that identifies basic elements in the architecture. Review with relevant experts & MOIMS. |
| February 2004 | Publish a revised version of the reference information architecture document. |
| March 2004 | Working meeting with IAWG and MOIMS. |
| April 2004 | IAWG meeting. Publish the final version of the reference information architecture document, its mapping to CCSDS existing standards efforts, and to a prototype implementation. |
| May 2004 | Working meeting with IAWG and MOIMS. Agree on IA terms of reference and on specific interfaces and protocols to be developed. |
| June 2004 | Draft of best current practices document on information architectures.<br>Protégé Ontology of IA concepts developed and sent out for review. |
| September 2004 | Information Architecture and Grid Comparison study white book published on CCSDS Web site. |
| October 2004 | IAWG meeting. Ensure integration with RASDS and MOIMS development plans. Final of best current practices document on information architecture. |
| April 2005 | IAWG meeting at CCSDS Spring Meetings in Athens, Greece. Joint registry working meeting between IA and IPR. |
| July 2005 | Technical Interchange Meeting between IA and MOIMS IPR. |
| September 2005 | Publish green book version of Information Architecture Reference document. |
| November 2005 | Registry White Paper based on requirements. Scenarios and best practices. |

| Date | Milestone |
|---|---|
| November 2005 | CCSDS XML Registry Prototype. |
| May 2006 | Initial XML Registry White Book. |
| August 2006 | Update to information models in IA Green Book. |
| November 2006 | Final XML Registry White Book. |
| August 2007 | Update to information models (data, software) in IA Green Book. |
| November 2007 | XML Registry Red Book. |
| May 2008 | XML Registry Blue Book. |

### 1.3.4 RISK MANAGEMENT STRATEGY

#### 1.3.4.1 Technical Risks

Languages and tools that can be used in our work are still under development in external standards bodies and it may not be possible to select the best languages and tools at the time we need to make the selection.

Standards for interfaces and protocols for distributed services are still under development in external standards bodies and it may be difficult to select a final set of approaches without some significant evaluation and prototyping efforts.

#### 1.3.4.2 Management Risks

Unavailability of resources could delay achievement of milestones. Fallback option would be to reschedule the milestones. There is an open issue between the IAWG and MOIMS / IPRWG as to the most appropriate distributed information architecture. This will have to be resolved before this work can be concluded. Agencies and projects that implement their own architectures and do not choose to coordinate or adopt any interoperable standards or reference architectures.

## 1.4 SPACE ASSIGNED NUMBERS AUTHORITY WORKING GROUP

| | |
|---|---|
| **Title of Group** | **1.4 Space Assigned Numbers Authority Working Group** |
| **Chair** | **Robert Bradford/NASA** |
| **Area Director** | **Peter Shames/NASA** |
| **Mailing List** | **sea-sana@mailman.ccsds.org** |

### 1.4.1 RATIONALE

CCSDS A02.1-Y-2. *Restructured Organization and Processes for the Consultative Committee for Space Data Systems*. Yellow Book. Issue 2. April 2004:

> **1.4.6 Space Assigned Numbers Authority (SANA)** The core registrar for the CMC's activities is the SANA. Many space mission protocols require that someone keep track of key protocol numbering assignments that were added after the protocol came out. Typical examples of the kinds of registries needed are for Spacecraft IDs, protocol version numbers, reserved APIDs and SFDU Control Authorities. The SANA provides this key configuration management service for CCSDS. The CCSDS Management Council (CMC) approves the organization that will act as the SANA. Its public interface is focused through web-based services provided by the Secretariat.

The purpose of the Space Assigned Numbers Authority (SANA) Working Group is to focus on generating the technical analysis and requirements for SANA.

A SANA registry will register information about protocols and standards, as they relate to spaceflight, that need updating or extension more frequently than is practical in a CCSDS standard or report.

There are four prioritized categories of work which need to be either investigated for registry requirements or assessed for possible adjustment. These categories start with the officially sanctioned CCSDS processes/technologies and extend to those process/technologies that are not covered. Category four will be addressed only as it relates to specific spaceflight related requirements either identified in categories one through three or required by new or impending technologies (generally identified but not assessed in any detail).

Category one (1) is current CCSDS registries, namely SCIDs and SFDU CA.

Category two (2) is the set of protocol identifiers, assigned numbers, port numbers and reserved APIDs that are currently documented within CCSDS approved documents and

SCPS protocol numbers including other current deployments like SLE service providers. This would include existing elements e.g. glossary, ground data systems and acronym lists.

Category three (3) is the list of current CCSDS working groups e.g. SM&C, XML schema and namespaces, and birds of a feather that may require registries and also includes current CCSDS developments.

Category four (4) is the catch all for all other activities which may possess a registries requirement, e.g. information models, reference software, but currently do not fall under CCSDS and/or do not currently operate under a registry.

### 1.4.2 GOALS

Provide the mechanisms, processes and documentation required for a CCSDS registry capability.

- Objective 1: Provide detailed requirements for a CCSDS registry.
- Objective 2: Coordinate and integrate current CCSDS registry processes and other operational information into a unified standardized framework.
- Objective 3: Propose a SANA advisory group and develop rules and processes to operate and support the SANA and identify the resources needed for the continuing operation, deployment, outreach, and evolution.

### 1.4.3 SCHEDULE AND DELIVERABLES

#### 1.4.3.1 Deliverables

1) Provide an assessment of categories 1 through 4 information sources for registry requirements in a SANA Green Book and present findings in an informal requirements review prior to further activities. The working group will document (possibly via a CCSDS White Paper/Report) the existing identifier spaces that CCSDS requires, according to the categories identified above, and to identify any special constraints imposed by those identifier spaces (e.g. that a particular registry exists and procedures for interaction with it are already defined).

2) Define processes to include a process that an organization can request assignment of numbers from the space(s) managed by CCSDS and a process that enables an organization to cause the CCSDS SANA to manage a particular identifier space within a SANA framework in a Magenta Book(s) also addressing security. In defining these processes, the working group will address transition issues that result from moving from existing processes to the new proposed SANA processes.

3) Define and document a statement of work for the ongoing operation of the SANA function. This statement of work will be delivered to the CCSDS Management Council (CMC) for their consideration in formulating a follow-on effort to actually

implement and operate the SANA function. The statement of work will identify specific tasks (processes and system development, etc.) that need to be accomplished to implement and operate the SANA function.

#### 1.4.3.2 Schedule

| Date | Milestone |
|---|---|
| Mar 2006 | SANA WG Charter approved |
| Aug 2006 | Requirements assessment complete |
| Oct 2006 | Green Book Requirements Review complete |
| Nov 2006 | Magenta Book complete |
| Dec 2006 | Statement of Work complete |
| Jan 2007 | Statement of Work, Green and Magenta Books approved |

### 1.4.4 RISK MANAGEMENT STRATEGY

#### 1.4.4.1 Technical Risks

Risks: No significant technical risk is involved. Technical risks are low since this is essentially process based.

Mitigation: None required

#### 1.4.4.2 Management Risks

Risks: Some management risk is involved including the usual politics and consensus building necessary for success.

- Issues of privacy, ownership
- Issues of security and access to aggregated information
- International resources for the WG and operations team

Mitigation: Work as required

# 2 MISSION OPERATIONS AND INFORMATION MANAGEMENT SERVICES AREA

## 2.1 DATA ARCHIVE INGEST WORKING GROUP

| | |
|---|---|
| **Title of Group** | **2.1 Data Archive Ingest Working Group** |
| **Chair** | **Don Sawyer/NASA** |
| **Area Director** | **Nestor Peccia/ESA** |
| **Mailing List** | **moims-dai@mailman.ccsds.org** |

### 2.1.1 RATIONALE

Agencies need to reduce the cost and increase the automation associated with acquiring, ingesting, managing, and disseminating data and metadata to, within, and from archives. Archives, including both mission archives, final archives and repositories performing long-term preservation, need appropriate metadata to accompany data objects to facilitate long term preservation. Currently submission requirements are usually totally ad hoc by mission, or by a given multi-mission archive or final archive. Producers of information for archives often seek guidance on how to submit such information. The OAIS reference model and the Producer-Archive Interface Methodology Abstract Standard set a context for all archives. Further, registry/repositories are of increasing importance as the holders of re-usable metadata in the exchange of information.

### 2.1.2 GOALS

**Goal 1**: Complete the ISO review of the CCSDS 'Producer-Archive Interface Methodology Abstract Standard' (PAIMAS) Blue Book:

1) review and respond to any comments;

2) update the PAIMAS book as appropriate to achieve ISO standardization.

**Goal 2**: Establish an extensible framework for a Submission Information Package (SIP). It will include mandatory and optional elements, with the ability to recognize categories of information and relationships:

1) define the main metadata categories and attributes;

2) define a way to create a dictionary of various classes of objects that will be considered (e.g., with the CCSDS Data Entity Dictionary Specification Language [DEDSL] standard), taking into account the general metadata identified above, and metadata specific to each given context;

3) define a method for creating a model of the instances of objects to be transferred during operations (from producer to archive);

4) map instances in the existing XML Structure and Construction Rules (XFDU) Package paper with the model and the dictionary;

5) develop two implementations of the SIP standard.

**Goal 3**: While this working group exists, support CCSDS archival requirements:

– monitor and report on Agency archival issues and implementations;

– perform the required 5-year CCSDS and ISO reviews on existing archive related standards, beginning with the 'Reference Model for an Open Archival Information System (OAIS)'.

### 2.1.3 SCHEDULE AND DELIVERABLES

#### 2.1.3.1 Goal 1: PAIMAS

| **Date** | **Milestone** |
|---|---|
| September 2003<br>Completed | Complete review comments on the Producer-Archive Interface Methodology Abstract Standard (PAIMAS) document and resolve as many RIDs as possible prior to the fall WG meeting. |
| May 2004<br>Completed | Submit revised PAIMAS Standard as a final CCSDS Standard. |
| September 2004<br>Completed | Submit CCSDS PAIMAS Standard for review as ISO Standard. |
| November 2005, assuming ISO comments received by 1 September 2005 | Complete review of ISO comments on PAIMAS and provide responses. |
| January 15 2006 | Assuming only editorial changes are needed, update the PAIMAS document appropriately for final ISO approval and request FDIS review be waived. |

#### 2.1.3.2 Goal 2: SIP

| Date | Milestone |
|---|---|
| 19 May 2004 Completed | SIP Goal accepted and active. |
| October 2004 Completed | Proposed metadata categories, optional and mandatory, with specific attributes for the SIP. |
| July 2005 | Revised draft SIP white book—high level view, and begin generating test cases. |
| December 2005 | Generate CCSDS SIP 'Proposed Standard' White Book and initiate review. |
| May 2006 | Generate CCSDS SIP 'Draft Standard' Red Book and initiate review. Begin two draft Agency implementations. |
| December 2006 | Generate CCSDS Recommended Standard Blue Book and two implementations (or a second round for a Draft Standard). |

#### 2.1.3.3 Goal 3: CCSDS Archival Requirements

| Date | Milestone |
|---|---|
| July 2005 | WG approved notice of need to review status of OAIS reference model is distributed by Agencies to solicit comments on the need for updates. |
| December 2006 | WG begins review of comments to determine extent, if any, of need for updates. |
| May 2006 | WG reaches recommended approach to any needed updates, recognizing January 2007 date for response to CCSDS on status. |
| TBD | Depends on results of previous step. |

### 2.1.4 RISK MANAGEMENT STRATEGY

#### 2.1.4.1 Technical Risks

Technical risks are low since there is already broad activity in this area and many years of experience of ad hoc non-standardized activities meeting the needs of individual archives.

The initial scoping is the Space agency archives and their Producers. It may also be expanded if reviewers outside the proposed scope find it relevant and useful. However, past reluctance of CCSDS and some CCSDS Member Agencies to support archive standardization activities have limited participation by outside parties. The lower level of

participation in CCSDS standardization activities may result in standards that are less well accepted outside the CCSDS community. It also introduces more possibilities for outside standards that may overtake or conflict with CCSDS activities. Working group members continue to network with their colleagues outside the CCSDS to mitigate as much of the risk as possible.

The SIP standard and implementations have some dependence on the development of the XFDU standard and implementations by the MOIMS-IPR Working Group. Management of XFDU development risk is left to be addressed by the MOIMS-IPR Working Group.

#### 2.1.4.2 Management Risks

Unavailability of resources could delay achievement of milestones. Fallback option would be to reschedule the milestones.

CCSDS CESG opposition to the PAIMAS standard resulted in at least a 6 month slippage in reaching the final CCSDS and ISO Standards. Approved CCSDS Operating Procedures that are informed by and reviewed by CCSDS Working Group participants would be useful for limiting this type of risk in the future.

Due to problems confirming PAIMAS, Lead Agencies did not initially allocate resources to the follow-on work (SIP Standard). This has resulted in about a 6 month slippage from the original estimate for most of the deliverables.

CCSDS Secretariat procedural problems have resulted in an additional slippage of 6 months to reach the final ISO Standard. We will continue to monitor ISO progress ourselves as we have been doing to identify future problems. This monitoring resulted in raising the current issue and preventing even more slippage. We understand that the CCSDS Secretariat has implemented new CCSDS Resolution tracking procedures which will mitigate future problems.

## 2.2 NAVIGATION WORKING GROUP

| | |
|---|---|
| **Title of Group** | **2.2 Navigation Working Group** |
| **Chair** | **Felipe Flores-Amaya/NASA** |
| **Area Director** | **Nestor Peccia/ESA** |
| **Mailing List** | **moims-nav@mailman.ccsds.org** |

### 2.2.1 RATIONALE

The Navigation Working Group provides a discipline-oriented forum for detailed discussions and development of technical flight dynamics standards.

### 2.2.2 GOALS

1) Development of a Recommendation for the agency-to-agency exchange of a tracking data message (TDM). Deliverable: TDM Blue Book.

2) Development of a Recommendation for the agency-to-agency exchange of spacecraft attitude data messages (ADM). Deliverable: ADM Blue Book.

3) Development of XML specification corresponding to the ADM, ODM (orbit data messages) and TDM Recommendations. Deliverable: XML Blue Book.

4) Update NAV data green book with additional material for ADM, ODM and TDM Recommendations, as required. Deliverable: Updated Green Book.

5) Support SANA efforts pertaining to NAV-related requirements for a future, comprehensive object identification scheme. Deliverable: NAV feedback per request.

6) Support Time Services Architecture WG efforts pertaining to NAV-related requirements associated with timing issues being addressed by CCSDS. Deliverable: NAV feedback per request.

7) Support Navigation Services WG efforts pertaining to NAV-related requirements associated with orbit data transfer issues being addressed by CCSDS SLE management. Deliverable: NAV feedback per request.

8) Investigate requirements to support the ISO SC14 effort to develop a Common Data Format for Collision Avoidance. Deliverable: Plan of work.

### 2.2.3 SCHEDULE AND DELIVERABLES

| Date | Milestone |
|---|---|
| February 2005 | Working on documentation development. |
| March - April 2005 | Finalize TDM RB for CCSDS review. |
| May 2005 | Finalize ADM RB for CCSDS review. |
| May 2005 | Finalize XML RB for CCSDS review. |
| March - May 2005 | Release latest version of the navigation GB along with each CCSDS review. |
| Summer – Fall 2005 | Complete updates to all RBs, based on CCSDS review RIDs. |
| Winter 2005 | Release ADM, TDM and XML documents for another CCSDS review. |
| Spring 2006 | Finalize ADM, TDM, and XML documents and conduct related implementation tests. |
| Summer 2006 | Submit all documents for approval as official CCSDS Recommendations. |
| 2005 -2008 | Investigate requirements and interface with ISO SC14 to support development of a Common Data Format for Collision Avoidance. |

### 2.2.4 RISK MANAGEMENT STRATEGY

#### 2.2.4.1 Technical Risks

The problem and proposed solution are well understood, as they are derived from existing and tested navigation data support functions. Technical risk is minimal.

#### 2.2.4.2 Management Risks

Unavailability of resources could delay achievement of milestones. Fallback option would be to reschedule the milestones.

## 2.3 INFORMATION PACKAGING AND REGISTRY WORKING GROUP

| | |
|---|---|
| **Title of Group** | **2.3 Information Packaging and Registry Working Group** |
| **Chair** | **Louis Reich/NASA** |
| **Area Director** | **Nestor Peccia/ESA** |
| **Mailing List** | **moims-ipr@mailman.ccsds.org** |

### 2.3.1 RATIONALE

Agencies need to reduce the cost and increase automation among applications associated with the exchange of information applications and those facilities that produce, distribute, and store information. CCSDS has been a leader in developing data packaging techniques and their association with the registration of schemas/data definitions. CCSDS has produced several standards in this area that are in active use within agencies, and include those known as Standard Formatted Data Units, Parameter Value Language, Control Authority Procedures; and Control Authority Data Structures; however, the speed of technology change including the emergence of XML as a standard data description language, the vast increase in the size and interrelationships of space data, and the emergence of the Internet as a data delivery mechanism requires that vastly different versions of these documents be written. Also, the vast increases in space-hardened computer power and communications bandwidth allow techniques that previously were considered ground system only to be utilized in end-to-end space data systems. The large size and binary nature of space prevents the direct usage of commercial or international earth-based standards.

### 2.3.2 GOALS

The goals of this Working Group include:

1) Collect use cases from the space operations community and develop requirements for XML data packaging; Based on these requirements, develop a set of recommendations and best practices documents that specify an extensible framework for packaging data and metadata that can contain an object physically, or by reference (e.g., Universal Resource Locator (URL), Universal Resource Identifier (UR), or by Universal Resource Name (URN). This includes the ability to express appropriate relationships using XML and related techniques, and the implementation of the packaging format in an appropriate set of network and file protocols.

2) Oversee the deployment of at least two independent implementations of the packaging framework; conduct prototyping and interoperability tests in many areas of space data systems (refer to the Resource Requirements paragraph).

3) Based on the experience gained from the interoperability testing of the XML packaging software and use cases and requirements from various space data and operations groups, develop a set of registry/repository specifications that are extensible, addressing interfaces, data structures and information modeling. This registry/repository should leverage the more widely based registry work such as ebXML and UDDI while supporting any special space-based operations registry/repository requirements.

4) Transfer any XML tools and best practices developed for the XML Packaging and Registry/Repository tasks to the MOIMS Area Director for use in other CCSDS Working Groups.

5) Act as the responsible Working Group for any CCSDS Recommendations in the area of Information Understanding( Structures and Languages (formerly CCSDS Panel 2). This includes performing any CCSDS or ISO 5 year reviews of existing standards and monitoring any new activities by CCSDS member agencies in this area.

### 2.3.3 SCHEDULE AND DELIVERABLES

#### 2.3.3.1 GOALS 1 and 2

| **Date** | **Milestone** |
|---|---|
| 19 May 2003 | WG chartered and active. |
| 30 June 2003 | XFDU draft 'proposed' document (WB) with use cases/requirements available. |
| November 2004 Complete | Submit CCSDS XFDU 'Proposed Standard' (RB) and Reference Implementation for CESG Review. |
| September 2005 | Generate first draft of XML Packaging Best Practices Green Book. |
| December 2005 | Generate CCSDS Proposed Standard (Redbook V2), Best Practices Green Book and two interoperable reference implementations. |
| May 2006 | Generate CCSDS Recommended Standard and Best Practices Green Book based on Agency review comments and user feedback. |

#### 2.3.3.2 Goal 3

| Date | Milestone |
|---|---|
| April 2005<br>Complete | Joint FTF meeting with Systems Engineering, Information Architecture team to develop registry work plan in this area. |
| Dec 2005 | White Papers on the Scope, Use Cases and Requirements for Registries and Repositories in the Space Information and Operations domains. |
| 2006 -2007 | Develop Registry/Repository data structures, interfaces and procedure recommendations for the appropriate space operations and data domains. Develop enhancements for the XFDU packaging recommendations based on the planned Version 2 enhancements. |

### 2.3.4 RISK MANAGEMENT STRATEGY

#### 2.3.4.1 Technical Risks

The Packaging Recommendation functionality has been split between two planned releases of the XFDU Packaging Recommendation to allow early prototyping of required capabilities. This should allow lessons learned in the prototyping to influence the design of the more complex capabilities.

Also a wide variety of use cases and testing environments have been identified for the Interoperability Testbed for XFDUs:

1) NASA PDS;
2) NASA/EOSDIS Libraries;
3) NASA SLE implementations;
4) CNES SLE implementations;
5) CNES Archive Ingest SIP development;
6) ESA Data Distribution System;
7) ESA CAOS.

This range of environments should identify any efficiency or operability problems that must be solved either in the best practices document or by further implementations.

In the area of Registries and Repositories, overlapping membership, frequent discussions and a minimum of one FTF meeting with the Information Architecture BOF/WG in the Systems Engineering area to avoid significant duplication of effort or significant divergence of concepts. It is recommended that only one WG be tasked with the development of specifications in the area of Registries and repositories.

#### 2.3.4.2 Management Risks

Unavailability of resources could delay achievement of milestones. Fallback option would be to reschedule the milestones.

## 2.4 SPACECRAFT MONITORING AND CONTROL WORKING GROUP

| | |
|---|---|
| **Title of Group** | **2.4 Spacecraft Monitoring and Control Working Group** |
| **Chair** | **Mario Merri/ESA** |
| **Area Director** | **Nestor Peccia/ESA** |
| **Mailing List** | **moims-sc@mailman.ccsds.org** |

### 2.4.1 RATIONALE

The ability to standardize the interfaces for spacecraft monitoring and control (SM&C) will allow significant saving in the development of the flight components and the ground segment of future space missions. In fact, it will be possible to use standardized SM&C infrastructure systems, to seamlessly transfer data across systems, and to adopt commercial-off-the-shelf applications for monitoring and control. The high level goal of this standardization effort is to make economies by:

1) allowing interoperability with partner system and infrastructure;

2) reducing the risk of space missions by re-using systems and operational concepts, thus increasing their reliability;

3) facilitating the development of generic (infrastructure) on-board and on ground software that can be shared by multiple projects via simple re-configuration;

4) applying the SM&C approach and systems throughout all mission phases and to other M&C domains (e.g., ground stations, control centers, test facilities, etc.).

The scope of SM&C includes:

1) **Operational concept**: definition of an operational concept that covers a set of standard operations activities related to the monitoring and control of both ground and space segments.

2) **Core Set of Services**: definition of an extensible set of services to support the operational concept together with its information model and behaviors. This includes (non exhaustively) ground systems such as Automatic Command and Control, Data Archiving and Retrieval, Flight Dynamics, Mission Planning, Automation, and Performance Evaluation.

3) **Application-layer information**: definition of the standard information set to be exchanged for SM&C purposes.

### 2.4.2 GOALS

The goals of the working group are

1) To pave the way for the technical work that will be performed in the context of spacecraft monitoring and control. This will be done by defining the technology-independent framework to be used in future work. It is noted that this activity involves also the space segment and therefore requires close coordination with the SOIS. This will be done by initially producing a white book and to bring it to Green status.

2) To specify and produce the corresponding Reed Books for the following initial set of services:

   – SM&C Protocol;

   – SM&C Common Services;

   – SM&C Core Services.

3) To update the XTCE standard with the result of the public review together with the OMG.

4) To specify the other high level services identified in the Green Book.

### 2.4.3 SCHEDULE AND DELIVERABLES

#### 2.4.3.1 Goal 1 (GB)

| **Date** | **Milestone** |
|---|---|
| 5 Nov 03 | Telecon#03: status report. |
| 3 Dec 03 | Telecon#04: status report. |
| 5 Jan 04 | White Book, draft 0.1. |
| 28 Jan 04 | Telecon#05: Review. |
| 18 Feb 04 | White Book, draft 0.2. |
| 3 Mar 04 | Telecon#06: status report. |
| 28 May 04 | White Book, draft 0.5. |
| 4 Jun 04 | Telecon: agreement on WB draft 0.5. |
| 26 Aug 04 | Deadline for comments to WB after 3-month informal agency review. |
| 2 Sep 04 | Telecon: agreement on comment disposition. |
| 23 Sep 04 | Submission of WB to CCSDS as proposed GB. |
| 4 April 05 | Updated GB (integrating changes from CCSDS review) available. |

| | |
|---|---|
| 15 April 05 | Submission of GB to CCSDS for approval. |

#### 2.4.3.2 Goal 2 (High Priority (HP) RBs)

| **Date** | **Milestone** |
|---|---|
| 14 Jul 04 | Delivery of concept paper. |
| 21 Jul 04 | Telecon#11: agreement on concept paper. |
| 15 Oct 04 | Delivery of Common SM&C Protocol Service Draft 0.1 and the Core SM&C Application Services Draft 0.1. |
| 27 Oct 04 | Telecon#13: Discussion 2 RBs draft 0.1. |
| 14 Jan 05 | Delivery of SM&C Protocol Draft 0.2 and the Core SM&C Application Services Draft 0.2 and SM&C Common Services draft 0.1. |
| 26 Jan 05 | Telecon#14: discussion on 3 RBs drafts 0.2. |
| 16 Mar 05 | Telecon#15: discussion on general status. |
| 4 Apr 05 | New drafts of the RBs as follows:<br>– SM&C Protocol: update with received comments;<br>– SM&C Common Services: update with received comments and expand the service specification;<br>– SM&C Core Services: update with received comments and expand the service the information model. |
| 31 May 05 | Prototype Concept Paper available. |
| 6 Jun 05 | Availability of TN on feasibility of AMS for SM&C. |
| 15 Jun 05 | Telecon#16: discussion on 5 RBs + prototype approach + AMS. |
| 11 Jul 05 | Intermediate version of 3 RBs. |
| 20 Jul 05 | Telecon#17: discussion on 3 RBs. |
| 31 Aug 05 | Consolidated version of 3 RBs. |
| 01 Oct 05 | Start prototype work (estimated duration 6m). |
| 01 Jan 06 | Start of public review of 3 RBs. |
| Spring WS 2006 | Availability of the 3 BBs and Prototypes. |

#### 2.4.3.3 Goal 3 (XTCE Review)

| Date | Milestone |
|---|---|
| 15 Feb 05 | Submission of XTCE review data package to CCSDS Secretariat for initiation of the Public Review. |
| 11-15 Apr 05 | Disposition of XTCE RIDs. |
| 30 Aug 05 | Availability of new draft issue of XTCE (only specifications, no green book) incorporating agreed RIDs. |
| 01 Sep 05-31 Oct 05 | CCSDS Agency review. |
| 30 Apr 06 | Approved XTCE by OMG. |

#### 2.4.3.4 Goal 4 (Other SM&C Services)

| Date | Milestone |
|---|---|
| 4 Apr 05 | New drafts of the RBs as follows:<br>– SM&C Time Service;<br>– SM&C Remote Software Management Service. |
| 1 Sep 05 | Availability of revised versions of<br>– SM&C Time Service;<br>– SM&C Remote Software Management Service;<br>– SM&C Automation Service (NEW). |
| Spring 2006 | Availability of the consolidated RBs for<br>– SM&C Time Service;<br>– SM&C Remote Software Management Service;<br>– SM&C Automation Service. |
| Fall WS 2006 | Availability of the BBs for<br>– SM&C Time Service;<br>– SM&C Remote Software Management Service;<br>– SM&C Automation Service. |

### 2.4.4 RISK MANAGEMENT STRATEGY

#### 2.4.4.1 Technical Risks

None.

#### 2.4.4.2 Management Risks

Risk 1: Unavailability of resources to finalize started work and the relative prototypes.

Mitigation: Reduce individual agencies costs by distributing work across several agencies participating to the WG. Bring issue to CMC so as to raise awareness of contributing agencies. In the worst case, descope the work.

# 3 CROSS SUPPORT SERVICES AREA

## 3.1 CROSS SUPPORT CONCEPT AND REFERENCE MODEL WORKING GROUP

| | |
|---|---|
| **Title of Group** | **3.1 Cross Support Concept and Reference Model Working Group** |
| **Chair** | **Hugh Kelliher/BNSC** |
| **Area Director** | **Gerard Lapaian/CNES** |
| **Mailing List** | **css-crm@mailman.ccsds.org** |

### 3.1.1 RATIONALE

The successful use of Space Link Extension (SLE) services in mission operations has resulted in modifications to the SLE Transfer Services. Also, specification of SLE Service Management has progressed significantly since the SLE Reference Model Blue Book and SLE Concept Green Book were published. Feedback is now available from implementers suggesting changes to the SLE Reference Model; it has been more than five years since the SLE Reference Model was published and it should therefore be updated now.

### 3.1.2 GOALS

1) review suggested changes to the SLE Reference Model Blue Book and revise it as necessary;

2) revise the SLE Concept Green Book to make it consistent with the revised SLE Reference Model Blue Book and with the current concept for SLE Service Management.

### 3.1.3 SCHEDULE AND DELIVERABLES

| Date | Milestone |
|---|---|
| Spring 2004 | Space Link Extension — Cross Support Reference Model. Recommendation for Space Data Systems Standards, CCSDS 910.4-B-1. Pink Sheets Issue 1.1. (deliverable A) |
| Spring 2005 | Space Link Extension — Cross Support Reference Model. Recommendation for Space Data Systems Standards, CCSDS 910.4-B-1. Blue Book. Issue 2. (deliverable B) |
| Spring 2005 | Space Link Extension — Cross Support Concept Green Book, CCSDS 910.3-G-2. (deliverable C) |

### 3.1.4 RISK MANAGEMENT STRATEGY

#### 3.1.4.1 Technical Risks

The SLE Reference Model is being revised in line with changes to the SLE Transfer Services and SLE Service Management specifications. Since the latest versions of these specifications do not cover the complete range of SLE services addressed in the SLE Reference Model, there is risk that technical decisions may have been made at the detailed specification level that are inconsistent with the SLE Reference Model as a whole.

The SLE Reference Model and SLE Concept tie together the work on SLE Transfer Services and SLE Service Management. It is possible that there may be inconsistencies in the way the groups working in these two areas have approached the interface between data transfer and service management. This may have an impact on the SLE Reference Model.

These risks have been mitigated in the past by individuals within each of the other working groups assessing impacts on the SLE Reference Model, and by joint meetings of the groups at the spring and fall workshops. In the future, the risk will be mitigated by the fact that the members of the Cross Support Concept and Reference Model Working Group are drawn from the Cross Support Data Transfer Working Group and the Cross Support Service Management Working Group.

#### 3.1.4.2 Management Risks

The Cross Support Concept and Reference Model Working Group depends on individuals whose primary task is to support one of the other Cross Support working groups. Therefore, it is possible that the resources available to update the SLE Reference Model and SLE Concept may be unavailable due to the understandable priority of work in the other working groups.

SLE recommendations have been difficult to pitch at the right level for every type of reviewer: management, user and provider. The existing SLE Reference Model may need substantial modifications if it is to be accepted by agency reviewers. This would drive up the time and effort needed to complete the revision.

## 3.2 [DELETED: SLE DATA TRANSFER SERVICES WORKING GROUP—WORK COMPLETE, ABSORBED INTO CROSS SUPPORT TRANSFER SERVICES WG]

## 3.3 CROSS SUPPORT SERVICE MANAGEMENT WORKING GROUP

| | |
|---|---|
| **Title of Group** | **3.3 Cross Support Service Management Working Group** |
| **Chair** | **Erik Barkley/NASA** |
| **Area Director** | **Gerard Lapaian/CNES** |
| **Mailing List** | **smwg@mailman.ccsds.org** |

### 3.3.1 RATIONALE

The use of Space Link Extension services require the exchange of information that will allow a space flight mission to acquire those services from SLE service providers. The current ad hoc mechanisms for arranging, scheduling, control, and monitoring of SLE services are fragile and manually intensive. Production of the currently-specified suite of SLE services is coupled to the underlying radio frequency, modulation, coding, and link characteristics. There are no current standards for arranging, scheduling, control, and monitoring of TT&C services. The potential user base for a service management standard for arranging, scheduling, control, and monitoring of SLE and TT&C services is larger than the space Agencies that constitute the CCSDS membership.

### 3.3.2 GOALS

The goals of this Working Group include:

1) Develop a conceptual service management framework that identifies the categories of interactions between a spaceflight mission and a provider of TT&C and SLE services that are carried out for the purposes of arranging, scheduling, monitoring, and possibly controlling the provision of TT&C and SLE services.

2) Within the scope of the conceptual service management framework, develop a unified standard for the exchange of information by which a spacecraft mission requests SLE and TT&C services from a provider of such services, and ancillary information necessary to make such service requests realizable.

3) The service management standard is to have the following characteristics:

   a) it will support the request for provider services conforming to CCSDS RF, modulation, coding, space link, SLE transfer service, and orbit and trajectory data Recommendations;

   b) it can be implemented at multiple levels of automation, up to and including the fully automated exchange of all service management service request information between space flight mission and TT&C/SLE service provider;

c) it will be developed using widely-used, commercially-supported standard methodologies and technologies;

d) it will be organized in a way that will permit future addition of standard interchanges of other categories of information identified in the conceptual service management framework;

e) it will be possible to extend the standard to support the interoperable management of additional services, or refinements to the management of the baseline set of TT&C and SLE services;

f) it will be organized in a way that allows for incremental adoption, implementation in conjunction with existing ad-hoc mechanisms such that an incremental migration path from legacy ad-hoc methods to standardized service management can be accommodated.

### 3.3.3 SCHEDULE AND DELIVERABLES

| **Date** | **Milestone** |
|---|---|
| W-1., March 2006<br>G-1, May 2006 | Space Link Extension — Service Management — Concept of Operations Concept (CCSDS 910.14) (Green Book). |
| W-1, March 2005<br>R-1, September 2005<br>R-2, May 2006<br>B-1, September 2006 | Space Link Extension — Service Management — Service Management Service Specification (CCSDS 910.11) (Blue Book). |
| R-1, September 2006<br>M-1, December 2006 | Space Link Extension — Service Management — Technology Mapping Recommendations (CCSDS 910.?) (Magenta Book). |
| September 2004 | Inter-operable prototype demonstrations with respect to W-1 for 910.11 (CCSDS Record). |
| October 2005 | Inter-operable prototype demonstrations with respect to R-1 for 910.11 (CCSDS Record). |
| May 2006 | Inter-operable prototype demonstrations with respect to R-2 for 910.11 (CCSDS Record). |
| December 2006 | Retirement of SMWG. |

### 3.3.4 RISK MANAGEMENT STRATEGY

#### 3.3.4.1 Technical Risks

The risk that the technology needed to implement the standard will not be available (or too expensive) has been significantly reduced by the adoption of XML as the representation language. XML is the de facto standard data structure specification language, and there is a

large and growing number of commercial and free development tools and support by data system products such as DBMSs. The risk that specifications will be incorrect or not feasible for implementation is reduced by concurrent development of multiple prototypes. SLE Service Management prototypes are under way for the JPL Deep Space Network (DSN), in a service provider role, , the European Space Agency (ESA) in a service user role, and the US Air Force Satellite Control Network Interoperability Project in a service user role.. Plans are to have at least the service user prototypes interoperate with the service provider in support of Red Book validation and review.

#### 3.3.4.2 Management Risks

Lack of resources or reassignment of previously-committed personnel is a constant risk to all standards-making processes. The approach to mitigating this risk is to define the minimal set of capabilities that constitute a 'SLE Service Management Service Request' capability, and then adjust the deployment of available resources to ensure that those capabilities are addressed at a minimum. Of course, if the available resources fall below even that minimally-required level, a schedule slip may be required.

A CCSDS standard has two audiences: the eventual users of the systems that are built in conformance to the standard, and the implementers of those systems. If the standards are aimed exclusively at the eventual users, there is a risk that the standard will lack many of the low-level details required for true interoperability of independent implementations. If the standard attempts to address these myriad low-level details (which system implementers will need), there is the risk that the user reviewers will judge the result too complicated. The approach to mitigating these risks is to develop the standard via a two-tiered set of specifications: a 'service specification' of the functional and performance capabilities as viewed from the users' perspective; and an 'XML Schema specification' that defines the data representation and protocol for the interactions between the interoperating systems necessary to provide those functional and performance capabilities.

The service request standard is being developed as a consolidation and evolutionary refinement of best practices of SLE and TT&C service providers. As such, it will define 'standard' versions of capabilities that in many cases already exist in at least some of the CCSDS member agency networks. If the standard is interpreted to be an 'all or nothing' proposition, there is a risk that it will be judged as requiring unnecessary costs to replace those legacy capabilities, resulting in the rejection of the standard. The approach to mitigating this risk is to identify legacy capability interoperability points, and structure the specifications so that legacy capabilities can be used in place of their standardized counterparts. This will allow an SLE/TT&C service provider to substitute existing capabilities where they are functionally equivalent to the standard-based ones, allowing an evolutionary adoption of the standard. (Of course, use of such legacy capabilities will come at the loss of standardized interoperability in those functional areas, and this will be a trade-off that any service provider must make in deciding which legacy capabilities to retain vice replace with the standardized versions).

## 3.4 [DELETED: SLE NAVIGATION SERVICES BOF—ABSORBED INTO CROSS SUPPORT TRANSFER SERVICES WG]

## 3.5 [DELETED: SLE RETURN ALL DATA BOF—ABSORBED INTO CROSS SUPPORT TRANSFER SERVICES WG]

## 3.6 CROSS SUPPORT TRANSFER SERVICES WORKING GROUP

| | |
|---|---|
| **Title of Group** | **3.6 Cross Support Transfer Services Working Group** |
| **Chair** | **Yves Doat/ESA** |
| **Area Director** | **Gerard Lapaian/CNES** |
| **Mailing List** | **css-csts@mailman.ccsds.org** |

### 3.6.1 RATIONALE

The CCSDS has published recommendations for five Space Link Extension (SLE) Transfer Services. Each of these recommendations contains nearly identical specifications for association, operations, and communications management. Recently a number of new cross support services have been requested by member Agencies. Recommendations for these new services would repeat the redundant sections of the earlier recommendations if specified in the conventional manner. Figure 1 illustrates a conventionally specified transfer service.

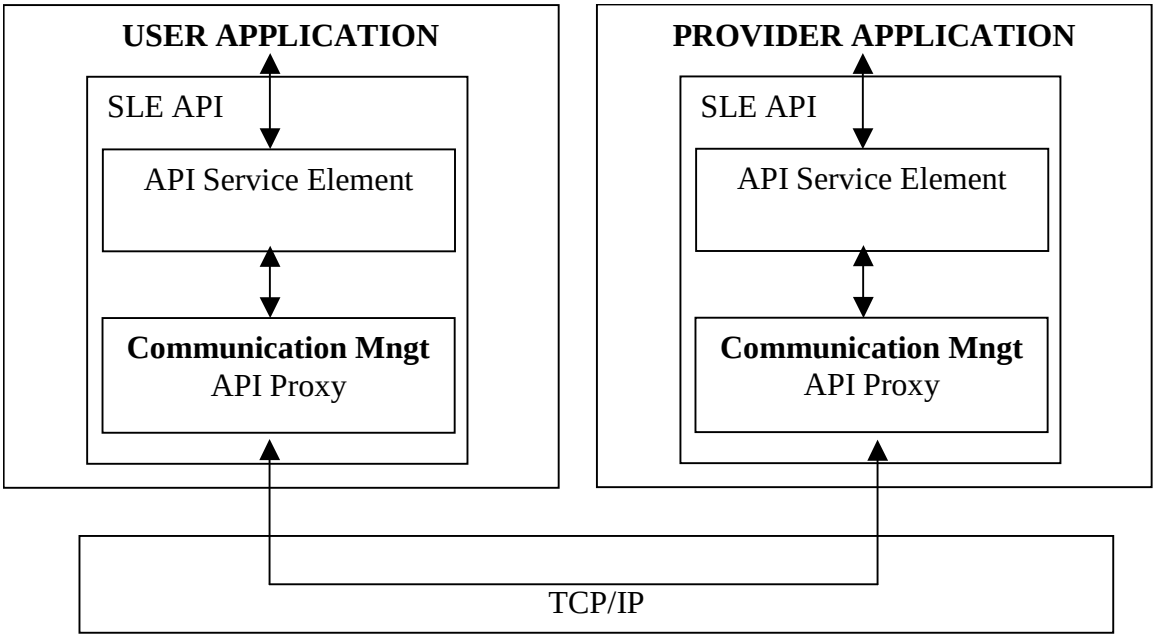


**Figure 3.6-1: Current Transfer Service Specification**

The monolithic nature of the current specification also has the more serious disadvantage that it requires changes to the abstract syntax notation specification for each new service. Although the specifications do not strictly require that the transfer syntax be directly derived form routines generated by an ASN.1 compiler, the practical result is the need to recompile the local-to-transfer syntax translation routines for each implementation of each new service definition.

A more efficient method would be to define a transfer service 'tool kit' that provides the common aspects of the association, operations, and communications capabilities. The toolkit transfers all common aspects using ASN.1 while the service specific data types are transferred in a syntax that is independent from the one used by the 'tool kit' for the common aspects. Figure 2 illustrates how such a specification might fit with multiple different data type specific interface specifications to provide services for any type of data.

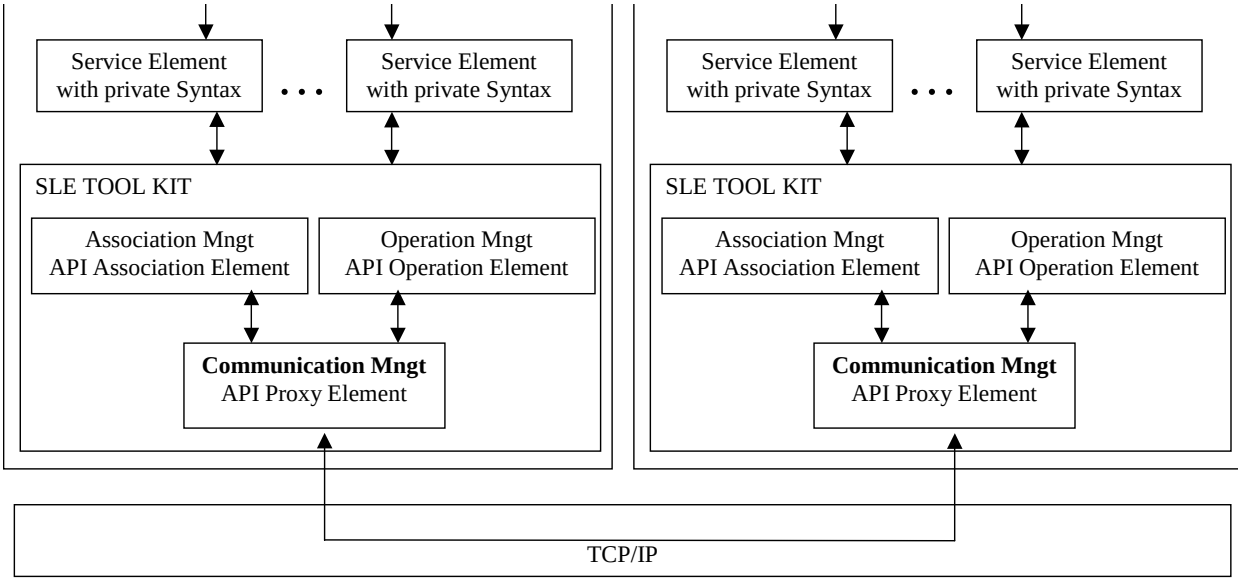


**Figure 3.6-2: Transfer Services Supporting Any Type of Data for New Transfer Specification**

The purpose of this Working Group is to develop the specification for a transfer service 'tool kit' capable of supporting new services implementing each their own syntax. This Working Group, to be known as the Cross Support Transfer Service, would provide association, operations, and communications management capabilities for new data transfer service. To demonstrate the use of this data type indifferent specification, this Working Group will develop recommendations for the SLE Tool Kit and the Guidelines describing the definition of new services. Once defined the SLE Tool Kit recommendation will be the basis for the definition of the Return Unframed Telemetry (RUFT) and Radiometric Data intended to be supported by the 'tool kit'.

Justification for RUFT selection: the CLTU service can be used as a transparent forward service. An equivalent return service has been requested by several agencies.

Justification for Radiometric service: the Radiometric service is considered a pure data transfer that would demonstrate the Toolkit approach for non–space link transfer.

Agencies listed other services that are not part of the current work activities. Some of them are listed here for completeness: Monitoring (and Control), Telemetry Catalogue, Off-line Telecommanding.

Once defined, the toolkit specifications will be the baseline for the implementation of a prototype capable of demonstrating their cross supporting data transfer capabilities.

In parallel with this activity, the Cross Support Transfer Service will ensure the maintenance of the existing SLE books: CLTU, FSP, RAF, R-CF and R-OCF. In particular the working group will develop the recommendation for the API Proxy: Mapping to TCP/IP and the best practices related to SLE.

### 3.6.2 GOALS

The goals of this Working Group include:

1) complete the Cross Support Transfer Service Specification of a Tool Kit and advance it to the CCSDS Recommendation state;

2) complete the Guidelines for the Definition of a new Service based on the Tool Kit;

3) implement a prototype demonstrating the interoperability of the proposed approach;

4) complete the production of Return Unframed Telemetry Specification and advance it to the CCSDS Recommendation state;

5) complete the production of the Radiometric Data Specification and advance it to the CCSDS Recommendation state;

6) complete the SLE API Proxy: Mapping to TCP/IP and advance it to the CCSDS Recommendation state;

7) complete the SLE API Best practices.

### 3.6.3 SCHEDULE AND DELIVERABLES

| **Date** | **Milestone** |
|---|---|
| Spring 2005 | Draft Recommendation:<br>SLE API Proxy: Mapping to TCP/IP CCSDS ???.1-R-1. |
| Spring 2005 | Draft Recommendation:<br>SLE API Best practices, CCSDS ???.1-R-1. |

| Date | Milestone |
|---|---|
| Spring 2006 | Draft Recommendation:<br>Cross Support Services—Cross Support Transfer Service Specification—Tool Kit, CCSDS ???.1-R-1. |
| Spring 2006 | Draft Recommendation:<br>Cross Support Services—Guidelines for new Service Definition, CCSDS ???.1-G-1. |
| Autumn 2006 | Prototype demonstration. |
| Autumn 2006 | Draft Recommendation:<br>Space Link Extension—Return Unframed Telemetry Interface Specification, CCSDS ???.1-R-1. |
| Autumn 2006 | Draft Recommendation:<br>Ground Domain—Return Radiometric Data Interface Specification, CCSDS ???.1-R-1. |

### 3.6.4 RISK MANAGEMENT STRATEGY

#### 3.6.4.1 Technical Risks

Because the Cross Support Transfer Service will be based upon existing successful implementations of conventional specifications there is little technical risk to this proposed capability.

#### 3.6.4.2 Management Risks

With the Cross Support transfer Service covering the bulk of the data transfer protocol there may be a temptation to use the service to transfer data types that are not sufficiently documented for cross-support purposes. No CCSDS standard cross-support service can exist unless and until a specification is produced for it.

Lack of resources or reassignment of resources is a constant risk to all standards-development processes.

Lack of sufficient budget to ensure that the Working Group members can participate in all meetings.

As alternatives videoconferences, teleconferences, and email will be utilized whenever possible to reduce costs.

# 4 SPACECRAFT ONBOARD INTERFACE SERVICES AREA

## 4.1 ONBOARD BUS AND LAN WORKING GROUP

| | |
|---|---|
| **Title of Group** | **4.1 Onboard Bus and LAN Working Group** |
| **Chair** | **Rick Schnurr/NASA** |
| **Area Director** | **Patrick Plancke/ESA** |
| **Mailing List** | **sois-obl@mailman.ccsds.org** |

### 4.1.1 RATIONALE

The Onboard Bus and LAN Working Group is concerned with the transfer of data over onboard buses and individual onboard LANs that constitute a single sub-network. The working group will define the data transfer services that must be provided by the sub-network, bearing in mind requirements on reliable delivery and security that may need to be met at the sub-network level. The working group will also define the service interface that is provided by the sub-network to higher layers of the communication stack.

The implementation of these sub-network services is highly dependent on the actual underlying physical connections that are used. The working group will investigate whether it is desirable to achieve interoperability at the electrical interface level as well as at the service interfaces, and may publish guidelines for achieving electrical interface compatibility for a limited set of popular onboard buses.

### 4.1.2 GOALS

The goals of this Working Group are to:

1) define a set of standard services that enable protocol multiplexing across a variety of real onboard buses and data links;

2) define standard interfaces to those services such that overlying entities are shielded from the details of the real underlying onboard buses and links;

3) specify the layer management parameters that may be used to control the operation of the data link and physical layers of the onboard communication stack;

4) define layer management procedures for the control of configurable parameters, the reporting of errors, and redundant link switching;

5) make representations to the other Working Groups and BOFs about the use of the onboard bus and LAN services in real systems—this will take the form of inter working group sessions during the area meetings, and a workshop to demonstrate the use of the services;

6) negotiate with other working groups and BOFs to determine what qualities of service need to be provided within the onboard data link and physical layers particularly, but not exclusively, in respect of reliable transfer of data and security—this will take the form of inter working group sessions during the area meetings;

7) identify the potential benefits of interoperability at the electrical interface level and make recommendations accordingly for popular onboard buses;

8) simulate and/or prototype the proposed services over a selection of popular onboard buses in order to verify functionality and to demonstrate the benefits of the proposed services, and to demonstrate the operation of other CCSDS protocols (such as CFDP) over the proposed service;

9) identify aspects of physical layer standardization that may be of interest to the CCSDS in the future—where potentially interesting activities are identified, they will be reported to the CESG in the form of 'technology watch' bulletins.

### 4.1.3 SCHEDULE AND DELIVERABLES

| **Date** | **Milestone** |
|---|---|
| 1 September 2005 | Red Book, Draft 1. |
| 1 June 2005 – 30 December 2005 | Simulation and prototyping. |
| 1 February 2006 | Red Book, Issue 1. |

### 4.1.4 RISK MANAGEMENT STRATEGY

#### 4.1.4.1 Technical Risks

The proposed sub-network services are typically not inherently provided by popular onboard bus specifications such as MIL-STD-1553B and ESA OBDH. Therefore, the primary concern here is the risk associated with the invention of an entirely new set of services. However, this risk can be minimized by keeping the requirements modest, i.e., by providing the minimum capability that is needed by overlying protocols and services.

Another risk is the feasibility of implementing the proposed services over a specific, real onboard bus. This risk is ameliorated by early simulation and prototyping, particularly on flight representative hardware. Finally, the capabilities of real underlying buses are vastly different, particularly in terms of reliable transfer and security, but also in terms of frame size and bandwidth. The risk here is that the service is over-specified for some underlying buses, while being underspecified for others. The risk management strategy in this case is to ensure that the service can be appropriately profiled to suite the given underlying bus while still providing a common service interface to the overlying services and protocols.

#### 4.1.4.2 Management Risks

The quality of the end product relies heavily on the commitment of Agencies to provide support for the simulation and prototyping work.

## 4.2 TIME CRITICAL ONBOARD NETWORK SERVICES WORKING GROUP

| | |
|---|---|
| **Title of Group** | **4.2 Time Critical Onboard Network Services Working Group** |
| **Chair** | **Steve Parkes/ESA** |
| **Area Director** | **Patrick Plancke/ESA** |
| **Mailing List** | **sois-tcons@mailman.ccsds.org** |

### 4.2.1 RATIONALE

The Time Critical Onboard Network Working Group addresses the problem of transfer of information across a spacecraft onboard network comprising one or more sub-networks where the sub-networks may be of different types (e.g., SpaceWire and Mil-Std-1553). It proposes to solve this problem using Transport and Network layers akin to TCP/IP or SCPS-TP/NP and a corresponding Network Management application. The Working Group will define a set of services that the Transport and Network layers and Network Management application are to provide. These services may be implemented in a number of different ways but will be interoperable if the service definition provided is followed. The Time Critical Onboard Network Working Group will liaise with the Time Critical Onboard Application Services and Time Critical Onboard LAN working groups to ensure that a coherent set of onboard communications protocols are specified and with the Space Link Services and Space Internetworking Services areas to ensure compatibility with other CCSDS standards.

### 4.2.2 GOALS

The goals of this Working Group are to:

1) Identify, define and document a set of network and transport layer services for spacecraft onboard communication which support time critical onboard applications and which permit interoperability and hence inter-agency cross support. Deliver draft Transport and Network layer red books defining the transport and network layer services.

2) Specify the layer management parameters that may be used to control the operation of the network and transport layers of the onboard communication stack. Deliver revised draft Transport and Network layer green books which include a description of the managed parameters.

3) Define layer management services for the control of configurable parameters and the reporting of errors. Deliver revised draft Transport and Network layer red books

which include the definition of the Transport and Network layer management services.

4) Prototype the proposed Time Critical Onboard Network services and demonstrate interoperability over at least two different underlying bus types.

5) Ensure that the proposed Transport and Network layer red books are coherent with the red books provided by other CCSDS working groups. In particular:

   a) make representations to the other Working Groups and BOFs about the use of the onboard network and transport layer services in real systems;

   b) consider the integration of the Time Critical Onboard Network services with the Time Critical Onboard Application Services and Time Critical Onboard LAN services;

   c) address the issue of onboard to off-board communication and develop recommendations for inter-operation between the onboard systems with other off-board systems, including the ground.

6) Consider integration and test issues and how the Time Critical Onboard Network services can support efficient and effective integration and test activities.

7) Deliver a revised final draft set of the Transport and Network layer Red Books for approval and issue by CCSDS.

### 4.2.3 SCHEDULE AND DELIVERABLES

| **Date** | **Milestone** |
|---|---|
| 1 September 2005 | TCONS service interface specification red book. |
| 1 August 2005<br>to 31st January 2006 | Prototyping and interoperability testing. |
| 1 February 2006 | Red Book, Issue 1. |

### 4.2.4 RISK MANAGEMENT STRATEGY

#### 4.2.4.1 Technical Risks

The lowest risk approach to providing an onboard network is to adopt an existing communication network standard, avoiding the ‘reinvention of the wheel’. The problem is that onboard communication has a number of requirements that are not met in existing standards like TCP/IP. These requirements that are not implemented in standard communications protocols are the main areas of risk to the planned onboard network and include:

1) Overhead – TCP/IP has a large overhead which means that small packets are inefficient, wasting communication bandwidth. This is why TCP/IP has a MTU of 1500 bytes: with that packet size the overhead becomes insignificant (<5%).

2) Performance – performance issues include communications bandwidth, latency, and determinism. Communications bandwidth is important in group applications but the ground-space technology gap may inhibit the use of the latest high performance ground network technology for spaceflight applications. Latency and determinism are important in some ground networks which may provide a useful basis for including these features in the onboard network.

3) Functionality – Onboard networking requires guaranteed, timely communication of chunks of information (messages) and it needs to provide or support fault tolerance. TCP/IP does not support guaranteed delivery of messages. It supports a guaranteed stream service (TCP) and non-guaranteed datagram delivery service (UDP). Little support for fault tolerance is available in existing ground based networks.

4) Compatibility – there is an implied requirement to be compatible with TCP/IP or SCPS-TP/NP to ease the onboard to off-board communication.

The risk management approach is to wherever possible use existing communication network standards. Where this is not possible concepts from more than one existing network standard will be combined. Where there are still deficiencies new approaches will be considered. From requirements detailed in the Transport and Network green books candidate, protocols will be considered and a set of services defined. Prototyping activities will be used to support the analysis, to evaluate the effectiveness of the defined services and to assess the feasibility of implementing protocols to fulfill the defined services. Results of various prototyping activities will be consolidated during the definition of the final Transport and Network Green Books.

#### 4.2.4.2 Management Risks

The quality of the end product relies heavily on the commitment of Agencies to provide support for the simulation and prototyping work.

## 4.3 TIME CRITICAL ONBOARD APPLICATION SERVICES WORKING GROUP

| | |
|---|---|
| **Title of Group** | **4.3 Time Critical Onboard Application Services Working Group** |
| **Chair** | **Abhijit Sengupta/NASA** |
| **Area Director** | **Patrick Plancke/ESA** |
| **Mailing List** | **sois-tcoa@mailman.ccsds.org** |

### 4.3.1 RATIONALE

The Time Critical Onboard Application Services Working Group defines standard services that are provided to onboard software applications. These services isolate the flight software from the underlying hardware details and thereby increase the portability and reuse potential of the flight software. Furthermore, the service access points constitute cross support interfaces.

The standard services that are addressed by this working group are those that have been identified during previous CCSDS SOIF activities as being common requirements in all spacecraft missions, and providing the maximum benefit for flight software development. Furthermore, it is explicitly recognized that interoperability and cross support capabilities need to be provided throughout the project lifecycle, and particularly during application development, integration, and testing, not just during operations.

### 4.3.2 GOALS

The goals of this Working Group are to:

1) produce a document to describe the concepts of onboard time critical applications, showing the interfaces needed for inter agency cross support and interoperability, and showing clearly the relationship between the onboard application services and other CCSDS standards;

2) produce a specification for a spacecraft command and data acquisition service that enables onboard applications to read and write simple onboard devices, and define the service interface used to access that service (previously referred to as SOIF C&DA capability set 1);

3) produce a specification for a spacecraft command and data acquisition service that enables onboard applications to access pooled data from simple onboard devices, and define the service interface used to access that service (previously referred to as SOIF C&DA capability set 6);

4) produce a specification for a spacecraft command and data acquisition service that enables onboard applications to access virtualized onboard devices, and define the service interface used to access that service (previously referred to as SOIF C&DA capability set 5);

5) produce a specification for the onboard time access service that enables flight applications located on any node of the spacecraft to obtain the onboard time with bounded accuracy, and define the service interface used to access that service;

6) produce a specification for the onboard message transfer service that enables applications hosted onboard a spacecraft to communicate with each other using asynchronous ad hoc messaging, and define the service interface used to access that service;

7) produce a specification for the onboard file access service that enables flight applications located on any node of the spacecraft to read from and write to files within a (nominal) global filestore, and define the service interface used to access that service;

8) negotiate with other working groups and BOFs to determine what qualities of service need to be provided by the onboard application services;

9) make representations to the other Working Groups and BOFs about the use of the onboard application services in real systems.

**NOTE –** This will take the form of a workshop to which all interested working groups will be invited.

### 4.3.3 SCHEDULE AND DELIVERABLES

| **Date** | **Milestone** |
|---|---|
| 1 January 2004 | Concept document. |
| 1 May 2005 | Device Access Service Red Book. |
| 1 May 2005<br>1 September 2005 | Device Access Service prototyping. |
| 10 May 2005 | Time Access Service Red Book. |
| 10 May 2005<br>1 September 2005 | Time Access Service prototyping. |
| 1 September 2005 | Message Transfer Service Red Book. |
| 1 September 2005<br>1 April 2006 | Message Transfer Service prototyping. |
| 1 Sept 2005 | File Access Service Red Book. |

| Date | Milestone |
|---|---|
| 1 Sept 2005<br>1 April 2006 | File Access Service prototyping. |
| 1 April 2006 | Device Data Pooling Service Red Book. |
| 1 April 2006 | Device Data Pooling Service Red Book. |
| 1 April 2006<br>1 Sept 2006 | Device Virtualization Service prototyping. |
| 1 April 2006<br>1 Sept 2006 | Device Virtualization Service prototyping. |

### 4.3.4 RISK MANAGEMENT STRATEGY

#### 4.3.4.1 Technical Risks

The services that are to be defined by this working group have already been discussed extensively in previous SOIF activities, and a number of prototype and demonstration models have been developed. The lowest risk approach to developing these standards formally under CCSDS is to capitalize on these activities by taking them fully into account, and recruiting the personnel who have previously been involved into the new working group.

#### 4.3.4.2 Management Risks

The Working group addresses several topics, in particular Command and Data Acquisition and Message Transfer, which should require full availability of the members of the working group. To this one could be added the ‘plug and play applications services’ if the outcome of the corresponding BOF is positive. Maintaining the schedule may require continuous and possibly an increasing support of Agencies.

# 5 SPACE LINK SERVICES AREA

## 5.1 RF AND MODULATION WORKING GROUP

| | |
|---|---|
| **Title of Group** | **5.1 RF and Modulation Working Group** |
| **Chair** | **Enrico Vassallo/ESA** |
| **Area Director** | **Jean-Luc Gerner/ESA** |
| **Mailing List** | **sls-rfm@mailman.ccsds.org** |

### 5.1.1 RATIONALE

Agencies' new generations of space missions require telecommand and telemetry capabilities beyond current technologies to interconnect a spacecraft with its ground support system, or with another spacecraft. These new needs are for higher data rates, better link performances, more performing ranging systems, together with lower cost, mass and power and higher security.

This work will concentrate on updating the existing RF and Modulation Book to cope with these new needs; this includes in particular the updating of the recommendations addressing modulation techniques and the review and updating of the whole book to align it with any relevant decision taken at WRC 2003. The update work includes also the extraction of the physical layer out of CCSDS 211.0-B Prox-1 Protocol.

### 5.1.2 GOALS

The goals of this Working Group are to:

1) update the RF and Modulation Book CCSDS 401.0-B set of recommendations on modulation techniques;

2) update the RF and Modulation Book CCSDS 401.0-B to align it on decisions of ITU WRC 2003 and SFCG 23, 24 and 25;

3) extract the physical layer out of CCSDS 211.0-B Proximity-1 Protocol into a separate book.

### 5.1.3 SCHEDULE AND DELIVERABLES

| Date | Milestone |
|---|---|
| 15 June 2003 | Reviewed standalone Proximity-1 RF and Modulation Book. |
| June 2003 | Draft Proximity-1 RF and Modulation Book. |
| November 2003 | Compiled review of WRC 2003 output affecting CCSDS 401.0-B. |
| November 2004 | Proposed updates of CCSDS 401.0-B Recommended Standard on modulation.<br>Compiled review of SFCG-24 output affecting CCSDS 401.0-B. |
| November 2005 | Draft update of CCSDS 401.0-B Recommended Standard. |

### 5.1.4 RISK MANAGEMENT STRATEGY

#### 5.1.4.1 Technical Risks

No technical risks have been identified.

#### 5.1.4.2 Management Risks

Schedules are dependent upon Agency participation until November 2005.

## 5.2 SPACE LINK CODING AND SYNCHRONIZATION WORKING GROUP

| | |
|---|---|
| **Title of Group** | **5.2 Space Link Coding and Synchronization Working Group** |
| **Chair** | **Gian Paolo Calzolari/ESA** |
| **Area Director** | **Jean-Luc Gerner/ESA** |
| **Mailing List** | **sls-cc@mailman.ccsds.org** |

### 5.2.1 RATIONALE

Agencies' new generations of space missions require telecommand and telemetry capabilities beyond current technologies to interconnect a spacecraft with its ground support system, or with another spacecraft. These new needs are for higher data rates, better link performances, together with lower cost, mass and power and higher security.

The wide range of environment (space-Earth or space-space, near Earth congested bands and deep space link operations in extreme conditions of SNR, links dependent of atmospheric conditions in the new high frequency bands, optical links) requires coding systems with different levels of power efficiency and bandwidth efficiency, or different levels of link reliability or delivered data quality.

This work will concentrate on updating the existing set of Channel Coding Blue Books to incorporate recommended coding scheme for new bandwidth efficient codes with low complexity.

### 5.2.2 GOALS

The goals of this Working Group are to:

- support the development of a CCSDS Experimental (Orange) Book edited by NASA/GSFC and reporting valuable experience with Low Density Parity Check Codes (LDPCC);
- support the development of a CCSDS Experimental (Orange) Book edited by NASA/JPL and reporting valuable experience with Low Density Parity Check Codes (LDPCC);
- support the development of a CCSDS Experimental (Orange) Book edited by ESA/ESTEC and reporting valuable experience with Serially Concatenated Convolutional Codes (SCCC).

Because the Orange Book's funding and other associated resources are independently provided by the organization that initiates the work (i.e., NASA in this case), the Coding and Synchronization WG role is limited to the review(s) before publication.

### 5.2.3 SCHEDULE AND DELIVERABLES

| Date | Milestone |
|---|---|
| Fall 2005 | Review GSFC Orange Book on LDPCC.<br>Review JPL Orange Book on LDPCC.<br>Review first draft of SCCC Orange Book. |
| Spring 2006 | Final Review GSFC Orange Book on LDPCC.<br>Final Review JPL Orange Book on LDPCC.<br>Review second draft of SCCC Orange Book. |
| Fall 2006 | Issue GSFC Orange Book on LDPCC.<br>Issue JPL Orange Book on LDPCC.<br>Final Review of SCCC Orange Book. |
| Spring 2007 | Issue SCCC Orange Book. |

### 5.2.4 RISK MANAGEMENT STRATEGY

#### 5.2.4.1 Technical Risks

No technical risks have been identified.

#### 5.2.4.2 Management Risks

The schedule is very dependent upon Agency commitment of resources and the use of the same personnel working on concurrent CCSDS tasks.

## 5.3 DATA COMPRESSION WORKING GROUP

| | |
|---|---|
| **Title of Group** | **5.3 Data Compression Working Group** |
| **Chair** | **Pen-Shu Yeh/NASA** |
| **Area Director** | **Jean-Luc Gerner/ESA** |
| **Mailing List** | **sls-dc@mailman.ccsds.org** |

### 5.3.1 RATIONALE

There is a need for data reduction on-board spacecraft in order to make full use of limited on-board resources like data storage and downlink capacity. Images represent a vast amount of the data collected on-board spacecraft and that significant compression can be obtained on images while preserving acceptable image quality for the user.

Cooperative mission scenarios exist where cross-support is needed for the handling of the compressed telemetered data. Industry, principal investigators, instrument developers, etc., will welcome an international standard for image compression that would meet the unique requirements of space missions together with state of the art performances level. However, implementation constraints severely limit the complexity of on-board processing and that existing international standards do not meet the performance versus complexity requirements of space missions. CCSDS has developed a recommendation for lossless data compression only and that lossless compression is inherently very limited in terms of compression ratios achievable. Furthermore, this lossless algorithm is not specifically tailored to image data. Finally, the current CCSDS 121.0.B.1 Lossless Data Compression (May 97) needs to be reviewed for either update, reconfirmation or retirement.

### 5.3.2 GOALS

The goals of this Working Group are to:

1) specify an image compression algorithm fulfilling identified space mission requirements;

2) develop a subsequent recommendation together with the supporting information (performances, usage, reference software);

3) review CCSDS 121.0.B.1 Lossless Data Compression (May 97) for either update, reconfirmation or retirement.

### 5.3.3 SCHEDULE AND DELIVERABLES

| Data | Milestone |
|---|---|
| October 2005 | Image compression recommendation (Blue Book). |
| October 2005 | Image compression Green Book supporting above recommendation. |
| October 2005 | Open source reference software for the image compression recommendation, including reference data set. |
| July 2006 | Outcome of review of CCSDS 121.0.B.1 (either statement of reconfirmation or pink sheets or proposal for retirement). |

### 5.3.4 RISK MANAGEMENT

#### 5.3.4.1 Technical Risks

None.

#### 5.3.4.2 Management Risks

Resources.

## 5.4 SPACE LINK PROTOCOLS WORKING GROUP

| | |
|---|---|
| **Title of Group** | **5.4 Space Link Protocols Working Group** |
| **Chair** | **Greg Kazz/NASA** |
| **Area Director** | **Jean-Luc Gerner/ESA** |
| **Mailing List** | **sls-slp@mailman.ccsds.org** |

### 5.4.1 RATIONALE

This WG develops and adapts wherever possible link layer protocols for new mission environments (proximity communication, formation flying, optical communication, missions utilizing high rate telemetry and telecommand.

In line with the evolutions in the CCSDS link layer protocols which occurred in the recent years, e.g., development of the Proximity-1 Space Link Protocol, it has become necessary to update and complete the Green Books related to these link layer protocols.

It is important to note that this WG maintains a very close liaison with the related Channel Coding WG and RF & Modulation WG.

### 5.4.2 GOALS

1) Complete the Proximity-1 Green Book (involves the Prox-1 protocol suite: physical layer, coding and synchronization sublayer and the data link layers).

2) Update the Proximity-1 Space Data Link Protocol to conform to the restructured link layer recommendations (AOS, TC, TM Space Data Link Protocols). In particular, Proximity-1 will conform to the same service specifications where applicable with the other restructured link layer protocols.

### 5.4.3 SCHEDULE AND DELIVERABLES

| Date | Milestone |
|---|---|
| 1 August 2005 | Draft Pink Sheets on Restructured Prox-1 Space Data Link Layer due for WG review. |
| 15 August 2005 | Final Version of Proximity-1 Green Book for WG review available for comment. |
| 1 September 2005 | Comments on Draft Pink Sheets on Restructured Prox-1 Data Link summarized and reviewed by WG. |

| Date | Milestone |
|---|---|
| 16 September 2005 | Resolution on Restructured Prox-1 Pink Sheets at Fall 2005 Meeting. |
| 15 November 2005 | Publish the Proximity-1 Green Book. |

### 5.4.4 RISK MANAGEMENT STRATEGY

#### 5.4.4.1 Technical Risks

No technical risks have been identified.

#### 5.4.4.2 Management Risks

The schedule is somewhat dependent upon having the members of the Working Group provide a sufficient review of the pink sheets and the draft green book. Another risk involves getting technical editing assistance from the Document Editor on both the Green Book and the Pink Book.

## 5.5 TELECOMMAND CHANNEL CODING WORKING GROUP

| | |
|---|---|
| **Title of Group** | **5.5 Telecommand Channel Coding Working Group** |
| **Chair** | **Gian Paolo Calzolari/ESA** |
| **Area Director** | **Jean-Luc Gerner/ESA** |
| **Mailing List** | **sls-cc@mailman.ccsds.org** |

### 5.5.1 RATIONALE

Agencies new generations of space missions require  and telemetry capabilities beyond current technologies to interconnect a spacecraft with its ground support system, or with another spacecraft. These new needs are for higher data rates, better link performances, together with lower cost, mass and power and higher security.

The wide range of environment (space-Earth or space-space, near Earth congested bands and deep space link operations in extreme conditions of SNR, links dependent of atmospheric conditions in the new high frequency bands, optical links) requires coding systems with different levels of power efficiency and bandwidth efficiency, or different levels of link reliability or delivered data quality. A Telemetry Channel Coding Green Book is available to support designers' choices, while a similar book for Telecommand is not available.

This work will concentrate on the production of a Telecommand Channel Coding Green Book in support to existing Telecommand Blue Books.

### 5.5.2 GOALS

The goal of this Working Group is to develop a Telecommand Channel Coding Green Book.

### 5.5.3 SCHEDULE AND DELIVERABLES

| Date | Milestone |
|---|---|
| Nov 2004 | Draft Telecommand Channel Coding Green Book. |
| End of Jan 2005 | Revised draft Telecommand Channel Coding Green Book. |
| May 2005 | Issue draft Telecommand Channel Coding Green Book for Agency review. |
| Fall 2005 | Finalize Review and Issue Telecommand Channel Coding Green Book. |

### 5.5.4 RISK MANAGEMENT STRATEGY

#### 5.5.4.1 Technical Risks

Telecommand Channel Coding is stable and well-defined so no specific technical risks are identified. The Draft books have been prepared according to schedule and minor updates are expected before the Green Book can be issued.

#### 5.5.4.2 Management Risks

Manpower is available for the production of the drafts shown in the schedule above.

If adequate manpower is not allocated by reviewing Agencies, delays in comments may defer the finalization of the document.

## 5.6 RANGING WORKING GROUP

| | |
|---|---|
| **Title of Group** | **5.6 Ranging Working Group** |
| **Chair** | **Enrico Vassallo/ESA** |
| **Area Director** | **Jean-Luc Gerner/ESA** |
| **Mailing List** | **sls-rfm@mailman.ccsds.org** |

### 5.6.1 RATIONALE

Agencies new generations of space missions require telecommand and telemetry capabilities beyond current technologies to interconnect a spacecraft with its ground support system, or with another spacecraft. These new needs are for higher data rates, better link performances, more performing ranging systems, together with lower cost, mass and power and higher security. This work is dedicated to the development of recommendations for high performance ranging techniques to satisfy the needs of future agencies missions.

### 5.6.2 GOALS

The goals of this Working Group are to:

1) Review the requirements for navigation/ranging performance in future missions;

2) Review techniques available to meet the requirements (e.g., regenerative ranging, Delta-DOR, high frequency ranging);

3) Issue a draft recommendation for novel ranging techniques.

### 5.6.3 SCHEDULE AND DELIVERABLES

| Date | Milestone |
|---|---|
| June 2004 | Completion a review of requirements for navigation/ranging performance in future missions. |
| December 2004 | Review techniques available to meet the requirements (e.g., regenerative ranging, Delta-DOR, high frequency ranging, etc.). |
| July 2005 | Issue a proposed recommendation for novel ranging techniques, White Book, Issue 1. |
| July 2006 | Issue a proposed recommendation for novel ranging techniques, White Book, Issue 2. |
| July 2007 | Issue a draft recommendation for novel ranging techniques, Red Book. |

### 5.6.4 RISK MANAGEMENT STRATEGY

#### 5.6.4.1 Technical Risks

TBD.

#### 5.6.4.2 Management Risks

This work requires output from an activity of design and 'bread boarding' planned in ESA for completion in 2006; however, funding has not yet been consolidated.

## 5.7 PROXIMITY-1, BUILD 2 WORKING GROUP

| | |
|---|---|
| **Title of Group** | **5.7 Proximity-1, Build 2 Working Group** |
| **Chair** | **Greg Kazz/NASA** |
| **Area Director** | **Jean-Luc Gerner/ESA** |
| **Mailing List** | **sls-slp@mailman.ccsds.org** |

### 5.7.1 RATIONALE

Proximity-1 is a bi-directional protocol, for use in short distance (400,000 km), moderate signal strength environments and is primarily based upon the CCSDS Telecommand recommendation. The Proximity-1 (Prox-1) Space Link protocol recommendations consists of three CCSDS Blue Books: 1. Physical Layer; 2. Coding and Synchronization Sublayer; 3. Data Link Layer.

The initial development of Proximity-1 arose from the need for a standard approach for communication in the Mars environment, starting with the NASA/JPL Mars Odyssey project. Proximity-1 is envisioned to develop over a series of 'Builds', based upon user projects and programs within the space agencies that use it.

Proximity-1 Build-1 consisted of the Red Book versions of the protocol: Mars Odyssey (Red-1) and Mars Express and Beagle II (Red-2), and NASA/JPL MER I & II (Red-3). In Jan. 2003, Proximity-1 became a CCSDS Blue book. In April 2003, Proximity-1 was restructured (without technical change) into the 3 existing recommendations (Physical Layer, Coding and Synchronization Sublayer, Data Link Layer).

The work objective of this WG will be the completion of the Proximity-1 Space Link Protocol recommendations for 'Proximity-1 Build-2'. From a flight hardware and software point of view, this build will represent the recommendation from which the NASA/JPL ELECTRA project develops its Proximity-1 compliant NASA/JPL ELECTRA transceiver. This transceiver is envisioned to fly on international missions to Mars on orbiters as well as scaled down mass versions for surface use on, e.g., landers/rovers (ELECTRA-LITE).

### 5.7.2 GOALS

The goals of this Working Group are to:

1) ensure that current and future Mars missions are backward compatible with the existing long-term infrastructure at Mars (e.g., NASA Mars Odyssey, ESA Mars Express) with respect to frequency channel assignments, clarification of data rate

accuracies, values for transmit and receive mode fields, and clarification of time tag directionality made in the Red version of Proximity-1 documents;

2) review and correct (if necessary) the draft pink sheets distributed to the Space Link Protocol WG on 26 September 2003;

3) as a part of this review, determine and list any impacts of these draft pink sheets on existing or planned implementations of the Proximity-1 protocol recommendations;

4) as part of this review, determine and list any impacts of these pink sheets on the Draft Proximity-1 Green Book.

### 5.7.3 SCHEDULE AND DELIVERABLES

| **Date** | **Milestone** |
|---|---|
| June-July 2003 | Proximity-1 Build-2 BOF identified the problems that are now documented in the Prox-1 Physical Layer and Data Link Layer Draft Pink Sheets. |
| 26 September 2003 | Draft Pink Sheets to Prox-1 Physical layer and Data Link Layer released for review to SLS-Space Link Protocol WG (in anticipation of new formal WG being approved). |
| 8 October 2003 | New Prox-1 Build-2 WG Charter approved; WG opens. |
| 27-29 October 2003 | Detailed WG review and disposition of Prox-1 Physical Layer and Data Link Layer Draft Pink Sheets at the Fall 2003 CCSDS Meeting. |
| 29 October 2003 | SLS AD generate a resolution to the CESG to send the finalized pink sheets (Prox-1 Physical Layer + Data Link Layer) to the CMC for Agency review. |
| November 2003 – January 2004 | Formal Agency review of Prox-1 Build 2 Pink Sheets. |
| April 2005 | Consensus was not reached on Physical layer requirements on Proximity-1 data rate stability. Action items assigned to resolve value for the symbol to symbol variation requirement. |
| July 2005 | Results of action items due to this working group. Action item completed ahead of schedule by both NASA and BNSC as of May 26, 2005. |
| 30 June 2005 | Update data rate stability requirement based upon results from action item. Generate new pink sheets for Agency Review. |
| 29 August 2005 | Ensure all agencies are in agreement with the values of the parameters for this requirement. |

| Date | Milestone |
|---|---|
| 16 September 2005 | Generate Resolution to SLS AD requesting these pink sheets become part of Prox-1 Physical Layer Blue Book Version 3. |
| 28 October 2005 | Dissolve WG once CCSDS Secretariat takes action on publication of new blue book. |

### 5.7.4 RISK MANAGEMENT STRATEGY

#### 5.7.4.1 Technical Risks

No technical risks have been identified.

#### 5.7.4.2 Management Risks

The schedule is dependent upon Agencies' review of the updated Physical Layer pink sheets.

## 5.8 HIGH RATE UPLINK WORKING GROUP

| | |
|---|---|
| **Title of Group** | **5.8 High Rate Uplink Working Group** |
| **Chair** | **Greg Kazz/NASA** |
| **Area Director** | **Jean-Luc Gerner/ESA** |
| **Mailing List** | **sls-hru@mailman.ccsds.org** |

### 5.8.1 RATIONALE

There is renewed activity for further exploration of the moon. This includes both non-manned and manned missions. Furthermore, there is a need to transfer the communication technology developed for lunar missions to deep space whenever possible. In this endeavor, it is prudent for the CCSDS to develop the underlying requirements to enable higher rate uplinks beyond the current CCSDS capability. This WG will develop requirements for achieving increases in uplink data rate by taking an integrated approach in investigating bandwidth efficient modulation techniques, along with the appropriate channel coding methods coupled with the use of the most appropriate link layer protocols.

It is important to note that these higher data rates will be required for normal operations and it is essential to maintain backward compatibility with the present level 1 and

level 2 CCSDS recommendations for operations where lower rates can suffice and for emergency operations.

The rationale for this WG includes the following:

1) The current CCSDS recommendations can only accommodate telecommand rates up to 1 Mb/s.

2) The first Lunar missions requiring uplink data rates in excess of 1 Mb/s are planned for launch as early as 2011.

3) At least four years are required to budget, design, build, and test a new telecommand capability.

4) Uplink rates to 10 Mb/s will be required to support manned missions.

5) High rate downlink missions that use Acknowledged CFDP will increase the uplink data rate requirements. It is calculated that a 5 Mbps downlink could saturate a 4 kbps uplink with CFDP downlink responses (NAKs, FINISHs, EOF ACKs).

6) NASA is moving to replace its aging DSN antennas with Downlink Arrays which will support multiple spacecraft telemetry links within the same aperture. An array is

efficient for supporting telemetry but its utility for uplink is yet to be proven and will certainly be limited to supporting a single spacecraft leaving the remainder unsupported. Thus this process will require uplinks to be shared during their telemetry passes which obviously will result in significantly shorter command passes.

7) Today's spacecraft are storehouses for software which include software for Field Programmable Gate Arrays which are rapidly replacing unique hardware systems. Changes to flight software occasionally requires uplinks to deliver very large volumes of data.

### 5.8.2 GOALS

The High Rate Uplink WG will have the following objectives:

1) Develop the functional and performance requirements for a CCSDS telecommand standard accommodating data rates up to 10 Mb/s by the year 2007. This work involves integrating the requirements within the following functional areas: RF & Modulation, Coding & Synchronization, and Link Layer protocols.

2) Develop two high rate uplink application profiles with respect to these requirements: One application profile for cislunar and the second for deep space.

3) Ensure that the solutions proposed by this WG provide backward compatibility to the installed CCSDS customer base utilizing the current RF& Modulation, TC Sync and Channel Coding and TC Space Data Link Protocol.

### 5.8.3 SCHEDULE AND DELIVERABLES

| **Date** | **Milestone** |
|---|---|
| April 2005 | BOF chartered by SLS Area |
| Sept. 2005 | Concept Paper Released – Discussed at Fall 2005 Meeting |
| March 2006 | Draft HRU Requirements - Draft White Book created |
| June 2006 | Spring 2006 Joint CIS-Lunar/HRU Preliminary Design Review |
| Sept 2006 | Draft HRU Design – Red Book created |
| Oct. 2006 | Fall 2006 Joint CIS-Lunar/HRU Detailed Design Review |
| May 2007 | HRU Specifications – Preliminary Blue Book for Review |
| Oct. 2007 | Fall 2007 Joint CIS-Lunar/HRU Final Document Review |
| Dec. 2007 | Publish HRU Blue Book specifications |

### 5.8.4 RISK MANAGEMENT STRATEGY

#### 5.8.4.1 Technical Risks

[Undefined.]

#### 5.8.4.2 Management Risks

Schedule relies upon at least one other CCSDS Agency joining the effort and on the allocation of adequate Agency resources to the WG. This work involves coordination between SLS area and the SIS area Cislunar WG.

# 6 SPACE INTERNETWORKING SERVICES AREA

## 6.1 CFDP INTEROPERABILITY TESTING WORKING GROUP

| | |
|---|---|
| **Title of Group** | **6.1 CFDP Interoperability Testing Working Group** |
| **Chair** | **Richard Carper/NASA** |
| **Area Director** | **Robert Durst/NASA** |
| **Mailing List** | **sis-cit@mailman.ccsds.org** |

### 6.1.1 RATIONALE

In order to aid in the finalization of the protocol specification and to increase the confidence of potential users in the CCSDS CFDP, a series of interoperability tests was designed, documented, and executed among the several different CCSDS member Agencies' implementations of the Core Procedures of the CFDP. This approach was so successful in meeting those objectives that it has been determined to extend such testing to the Extended Procedures and the Store and Forward Overlay Procedures of the CFDP. This Working Group will fulfill that goal.

### 6.1.2 GOALS

1) Design, document, review, correct, and execute interoperability tests for the CFDP Extended Procedures, and the CFDP Store and Forward Overlay Procedures.

2) Make the resulting test documents ('Test Notebooks'), as well as a report on the results of the testing executed, available on an appropriate CCSDS-sponsored web site for review and use by potential protocol users.

3) Report any problems with the CFDP Extended Procedures identified in testing to the Space Internetworking Services Area for action on correcting the protocol and/or the Blue Book.

4) Report any problems with the CFDP Store and Forward Overlay Procedures identified in testing to the Space Internetworking Services Area for action on correcting the protocol and/or the Blue Book.

### 6.1.3 SCHEDULE AND DELIVERABLES

Progress in testing has been slow, primarily due to the lack of face-to-face opportunities for testing. We were unable to conduct face-to-face testing in Athens due to JPL restrictions on foreign travel. Therefore it has been necessary to stretch out the testing schedule (per the

Risk Management Strategy) to allow face-to-face testing to take place at and after the CCSDS Fall meetings in Atlanta, at which the key testing participants will be present. This should allow completion of the testing and the dissolution of the Working Group.

| **Date** | **Milestone** |
|---|---|
| 1 June 2003 | WG established. |
| 1 February 2004 | Draft Testing Notebooks distributed for review by WG. |
| 23 August 2004 | Initial interoperability testing ('shakedown testing') begins. |
| 15 May 2005 | First test series (SFO) begins. |
| 29 October 2005 | First test series complete. |
| 15 June 2005 | Second test series (Extended Procedures) begins. |
| 29 October 2005 | Second test series complete. |
| 30 December 2005 | Test Execution Report and final Test Notebooks available. |
| 1 February 2006 | WG dissolved. |

### 6.1.4 RISK MANAGEMENT STRATEGY

#### 6.1.4.1 Technical Risks

The task of the WG is well understood and the WG members participated in the Core Procedures testing and are experienced in the work. There is very little technical risk. Schedule risk is as always dependent on a) commitment of resources, and b) interference in the WG members work by higher priority work in their home Agencies. The resources have been committed by NASA and ESA. Interference by higher priority work does not at this time seem a problem. Fallback options are a) extension of the schedule, and/or b) rearrangement of testing participants.

#### 6.1.4.2 Management Risks

*Security Issues:* There are no security issues within the domain of this WG.

## 6.2 [DELETED: UNACKNOWLEDGED CFDP EXTENSIONS WORKING GROUP]

## 6.3 CCSDS PACKET PROTOCOL WORKING GROUP

| | |
|---|---|
| **Title of Group** | **6.3 CCSDS Packet Protocol Working Group** |
| **Chair** | **Dai Stanton/BNSC** |
| **Area Director** | **Robert Durst/NASA** |
| **Mailing List** | **sis-spp@mailman.ccsds.org** |

### 6.3.1 RATIONALE

The CCSDS Packet Protocol has been drafted as part of the CCSDS Subnetwork and network restructuring activity. It defines the Network layer role of the CCSDS Packet. The purpose of this activity is to produce pink sheets relating to a correction to the Packet addressing context.

### 6.3.2 GOALS AND DELIVERABLES

Review and, if necessary revise, the CCSDS Packet Protocol and recommend its adoption as a CCSDS standard. Develop Space Packet Protocol Green Book?

### 6.3.3 SCHEDULE

| Date | Milestone |
|---|---|
| 17 Nov 2003 | Draft Pink Sheets for SIS review |
| 24 Nov 2003 | Pink Sheets for Agency Review |
| 8 December 2003 | RID Closure |
| 15 December 2003 | WG dissolved |
| | Or not. . . . |
| | |
| | |

### 6.3.4 RISK MANAGEMENT STRATEGY

#### 6.3.4.1 Technical Risks

Agency review results in extensive or substantial RIDs. Unlikely because only one RID was achieved on the whole recommendation and the Pink Sheet modification is simple, well understood and in line with current practice.

#### 6.3.4.2 Management Risks

Required resources are very low (less than half a man day for each of the two participating resources), resulting in low risk.

## 6.4 CISLUNAR SPACE INTERNETWORKING WORKING GROUP

| | |
|---|---|
| **Title of Group** | **6.4 Cislunar Space Internetworking Working Group** |
| **Chair** | **Keith Scott/NASA** |
| **Area Director** | **Robert Durst/NASA** |
| **Mailing List** | **sis-csi@mailman.ccsds.org** |

### 6.4.1 RATIONALE

The discovery of water ice at the Moon's poles and evidence of a history of water on Mars has prompted increased interest in executing an expanded program of human and robotic exploration missions to the Moon and Mars. A unified data communications architecture and protocol suite is needed to support these new missions, with Lunar infrastructure being forward-compatible to Mars; this will increase opportunities for cross-support and reduce costs.

### 6.4.2 GOALS

The Cislunar Space Internetworking WG is chartered to perform the following work by 1 April 2007:

1) Create a top-level architecture and operations concept (CCSDS Green Book) for communicating effectively over the whole range of cislunar distances. The architecture will address the projected needs of new lunar exploration programs and their mapping into (and interoperation with) similar capabilities that will be needed on and around Mars.

2) Review current and emerging CCSDS standards and recommend any updates required to keep them current and to support cislunar communication (Pink Sheets).

3) Examine the spectrum of new Internet development activities that are proceeding within Internet standardization groups, such as the Internet Engineering Task Force (IETF), and identify where they may be applicable to the operations concept developed above. Candidate activities include:

    a) the Stream Control Transmission Protocol (SCTP);

    b) the Datagram Congestion Control Protocol (DCCP);

    c) Voice Over IP (VOIP);

    d) Disruption Tolerant Networking (DTN);

    e) LEMONADE enhancements to Internet email to support diverse service environments;

f) Internet over Digital Broadcast Video Networks.

4) Recommend standards for cislunar communications (CCSDS Red/Orange Books as appropriate) with the proviso that these standards should, whenever possible, be extensible to larger communications distances such as Earth-Mars.

### 6.4.3 SCHEDULE AND DELIVERABLES

| Date | Milestone |
|---|---|
| 15 November 2004 | Draft Green Book describing cislunar communications architecture, operations concept, and protocol suite requirements. This Green Book considers both cislunar and Mars in-situ communications environments.<br>Survey document describing candidate protocols. |
| 1 April 2005 | Draft2 Green Book.<br>Draft review of existing CCSDS Standards with proposed plan for updating them. |
| 1 November 2005 | Draft3 Green Book.<br>Report on first round of proposed updates to existing CCSDS protocols. Includes pink sheets or recommendation on reaffirmation without changes for SCPS-NP, SCPS-SP, SCPS-TP, and SCPS-FP. These will require agency review.<br>Down-selection from protocol survey list to core set for further investigation/performance analysis.<br>Begin extensive analysis of candidate protocols. The first step will be to identify existing test reports / testbeds related to or implementing the protocols. |
| 1 April 2006 | Finalized Green Book describing operations concept and protocol requirements.<br>Report on protocol analysis / prototyping efforts. |
| 30 November 2006 | Draft 1, Red/Orange Book(s) for recommended protocols; Includes any additional recommendations for updating CCSDS protocols. Already identified is the need for at least one Red/Orange book on implementation details of the Green Book Architecture. |
| 1 April 2007 | Red/Orange Book(s) Issue 1 for recommended protocols. Includes newly adopted/developed protocols and updates to CCSDS protocols. These books will be ready for agency review. |

### 6.4.4 RISK MANAGEMENT STRATEGY

#### 6.4.4.1 Technical Risks

The risk management approach is to wherever possible use existing architectures and standards. Where this is not possible, new architectures will be defined, and efforts will be made to influence existing standards to include features needed by the WG. If existing standards cannot be modified, revisions/updates to existing standards will be considered. Here concepts from one or more existing network standards may be combined, and new protocol specifications will be required. Where there are still deficiencies, completely new approaches will be considered for standardization.

The initial set of candidate protocols will be selected taking into account the requirements detailed in the architecture and operations concept Green Book. This set of protocols will be reduced as necessary, and simulation and/or prototyping activities will be used to evaluate the effectiveness of the reduced set of protocols and the feasibility of deploying them. Results of various prototyping activities will be consolidated during the definition of the final Orange/Red Books.

This task is very synergistic with current work in NASA (Exploration Program) and ESA (Aurora Program). Whenever programmatically possible and technically reasonable, this working group will leverage ongoing work and result from these and other member agencies' work programs. Participation by members from agencies interested in a return to human space flight to the moon is strongly desired.

#### 6.4.4.2 Management Risks

The quality of the end product relies heavily on the commitment of Government Agencies to provide support for the architecture study and protocol evaluations.

The schedule listed in section C of this document assumes that the working group can be formed quickly following the Spring 2004 CCSDS meetings. Delay in forming the working group will slip the entire schedule.

## 6.5 ASYNCHRONOUS MESSAGE SERVICE

| | |
|---|---|
| **Title of Group** | **6.5 Asynchronous Message Service** |
| **Chair** | **Scott Burleigh/NASA** |
| **Area Director** | **Robert Durst/NASA** |
| **Mailing List** | **sis-ams@mailman.ccsds.org** |

### 6.5.1 RATIONALE

The CCSDS File Delivery Protocol (CFDP) provides file transfer functionality that can offer significant benefits for spacecraft operations. Not all spacecraft communication requirements necessarily fit the file transfer model, however. In particular, continuous, event-driven asynchronous message exchange may also be useful for communications with and among spacecraft. Examples include:

- streaming engineering (housekeeping) data;
- real-time commanding;
- continuous collaborative operation among robotic craft.

NASA's proposed new Command, Control, Communications, and Information (C3I) architecture for the Crew Exploration Vehicle and other Constellation program elements is based on an asynchronous message exchange framework.

At the same time, large-scale, efficient, robust asynchronous message exchange can be difficult to implement. Among the challenges:

- A successful large-scale message system must tolerate heterogeneity in deployment platforms, security regimes, communication environments, QOS requirements, performance requirements, and levels of cost tolerance.
- In order to support continuous mission-critical operation, a message system must tolerate unplanned changes in application topology. This tolerance of change entails autonomous discovery of communication endpoints and automatic reconfiguration, to minimize operations cost and risk.
- Distributed systems based on asynchronous message exchange are typically less labor-intensive to configure, upgrade, and operate if message transmission conforms to the peer-to-peer 'publish/subscribe' (or 'push') model rather than the 'client/server' model. But publish/subscribe communication is made possible only by extensive underlying automation.

Consequently most existing asynchronous message exchange systems are proprietary, licensed products rather than open international standards. Moreover, no such system is designed for mission-critical operation on deep space robots.

We believe that an open CCSDS standard for large-scale, publish/subscribe-based asynchronous message exchange would be a useful alternative.

### 6.5.2 GOALS AND DELIVERABLES

AMS-WG is a Standards Track Working Group. The Working Group will:

> Develop a Recommended Standard for an Asynchronous Message Service, based on the Concept Paper submitted with this Charter, that satisfies the requirements identified by the AMS BOF group.

Per standard CCSDS procedure, development of this Recommended Standard will entail demonstration of two interoperable implementations of the protocol and service.

### 6.5.3 SCHEDULE

| **Date** | **Milestone** |
|---|---|
| 22 July 2005 | Formation of working group. |
| 19 December 2005 | Publication of Proposed Standard (‘white book’). |
| 19 June 2006 | Publication of Draft Standard (‘red book’). |
| 25 September 2006 | Demonstration of two interoperable implementations. |
| 2 October 2006 | Start of final Agency review. |
| 8 January 2007 | Publication of Recommended Standard (‘blue book’). |
| 22 January 2007 | Dissolve working group. |

### 6.5.4 RISK MANAGEMENT STRATEGY

#### 6.5.4.1 Technical Risks

The service concept is derived from a design, developed at JPL in the mid-1990s, which has proved efficient and stable in a number of deployments over the past decade; JPL’s initial implementation of AMS will be adapted from that established code base. Technical risk therefore appears to be minimal.

#### 6.5.4.2 Management Risks

Unavailability of resources could delay achievement of milestones. Fallback option would be to reschedule the milestones.

## 6.6 IP OVER CCSDS SPACE LINKS WORKING GROUP

| | |
|---|---|
| **Title of Group** | **6.6 IP Over CCSDS Space Links Working Group** |
| **Chair** | **Greg Kazz/NASA** |
| **Area Director** | **Robert Durst/NASA** |
| **Mailing List** | **sis-ipo@mailman.ccsds.org** |

### 6.6.1 RATIONALE

It is generally recognized that IP datagram transfers will become more prevalent for both on-board applications as well as off-board for transfer through a network of in-space CCSDS data links.

Although the CCSDS space link protocols can support IP datagram transfer, there is a lack of a clear specification for how to accomplish this. -. Currently, each of the four CCSDS space data link protocols - AOS, TC, TM, Proximity-1 - includes a short section (devoid of any context information) that defines how to carry IP datagrams over that link.

It is the purpose of this WG to clearly define a CCSDS recommended practices document (Magenta Book) for how IP will be carried over CCSDS links, including IP datagrams encapsulated into serial streams (e.g., Bridged Ethernet frames). The recommended practice is envisioned to encompass three major areas: IP over CCSDS links service concept, PDU formats, and transfer service primitives.

This Working Group Charter establishes the detailed steps, personnel, and schedule needed to transform the 'IP over CCSDS Links BOF' White Paper into a formal CCSDS specification that will become the agreed international mechanism for interoperably transferring IP datagrams over CCSDS space links, to ensure cross-support amongst space Agencies requiring this capability.

Figure 6.6-1 shows the sending and receiving side interfaces between the Network (IP) and Link Layers which define the scope of this WG.

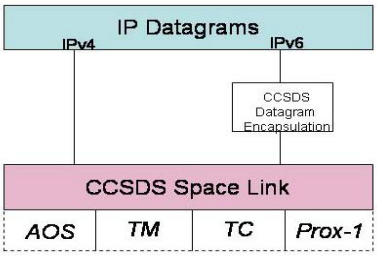


**Figure 6.6-1: Context: How IP Interfaces with the CCSDS Link Layer**

### 6.6.2 GOALS AND DELIVERABLES

The IP over CCSDS Space Links WG will have the following objectives:

1) Describe the recommended method(s) of transferring IPv4 and IPv6 datagrams over the four underlying internationally standardized CCSDS link layer protocols:
   - TM Space Data Link Protocol
   - TC Space Data Link Protocol
   - AOS Space Data Link Protocol
   - Proximity-1 Space Data Link Protocol
2) Describe the standard CCSDS options for carrying IP datagrams within those CCSDS frames, including the mode where those IP datagrams are encapsulated within a specific HDLC serial bit stream for interfacing with a COTS router.
3) Utilize the "IP over CCSDS Links BOF" Concept Paper (http://public.ccsds.org/sites/cwe/sis-ipo/default.aspx) as the framework for the content of the CCSDS IP over CCSDS Recommended Practice specification.

### 6.6.3 SCHEDULE

| **Date** | **Milestone** |
|---|---|
| June 2005 | BOF chartered by SIS Area |
| Aug. 2005 | BOF Concept Paper produced |
| Sept. 2005 | BOF meets in Atlanta to discuss BOF Concept Paper |
| Oct. 2005 | WG Chartered,<br>BOF Concept Paper Updated as Draft Magenta Book Version 1 |
| May 2006 | Draft Magenta Book Version 2 |
| Sept. 2006 | Magenta Book Version 1 |

### 6.6.4 RISK MANAGEMENT STRATEGY

#### 6.6.4.1 Technical Risks

[Undefined.]

#### 6.6.4.2 Management Risks

Schedule relies upon the assistance of BNSC and on the allocation of adequate Agency resources to the WG. This work involves coordination between SLS area SLS-SLP WG and the SIS area Cislunar WG.

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