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Consultative Committee for Space Data Systems

**REPORT CONCERNING SPACE
DATA SYSTEM STANDARDS**

CCSDS PANEL 2 METHODOLOGY FOR DEVELOPMENT OF RECOMMENDATIONS

CCSDS 611.0-Y-1

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FOREWORD

This Report describes the methodology adopted by CCSDS Panel 2 for the development of Recommendations.

This document will serve as a guide for CCSDS Panel 2 members as they develop Recommendations in the area of Information Interchange and will provide insight into the techniques and approaches used by Panel 2 in its development activity.

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- National Space Program Office (NSPO)/Taipei.
- Swedish Space Corporation (SSC)/Sweden.
- United States Geological Survey (USGS)/USA.

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CONTENTS

1   INTRODUCTION

1.1   PURPOSE AND SCOPE

This document details the methodology adopted by CCSDS Panel 2 for the development of Recommendations. The methodology consists of the steps the Panel must take in order to achieve its aims.

It should provide guidance for the Panel's discussions about an overall plan of work. The division of that overall plan into work packages and the monitoring of progress in producing Recommendations is the province of the Management Plan and the Work Package Plans of the individual working groups [reference 3].

1.2   DOCUMENT STRUCTURE

Section 2 gives a brief overview of the requirements for the Recommendation methodology. Section 3 describes the methodology in some detail, covering the overall scope of work and prioritising of that work, which provides the motivation for the use of multiple models. The use of scenarios is stressed. The question of how to extract Requirements from scenarios in this context is also addressed in this section, as are considerations about testing, maintenance, and marketing.

1.3   REFERENCES

The following documents are referenced in this Report. At the time of publication, the editions indicated were valid. All documents are subject to revision, and users of this Report are encouraged to investigate the possibility of applying the most recent editions of the documents indicated below. The CCSDS Secretariat maintains a register of currently valid CCSDS Reports and Recommendations.

[1]   *Procedures Manual for the Consultative Committee for Space Data Systems*. CCSDS A00.0-Y-7. Yellow Book. Issue 7. Washington, D.C.: CCSDS, November 1996.

[2]   *CCSDS P2 SRAWG SADT- Activity View*. CCSDS 601.0-W-1. November 1994.

[3]   *Management Plan for Panel 2*. CCSDS-A20.M-Y-2.0, November 1994.

2 REQUIREMENTS FOR THE METHODOLOGY

There are four key requirements for the methodology:

– production of an explicit specification of the scope of work;

– division of this work into sensible pieces;

– setting the priorities for these pieces; and

– production of a consistent set of Recommendations, with the associated verification, validation and maintenance of requirements.

These are described in the following four sub-sections.

2.1 EXPLICIT SPECIFICATION OF THE SCOPE OF THE WORK

An explicit scope of P2 work must be agreed to within the Panel, with the CCSDS management Council, and to a degree, with other standards bodies. If the scope is not defined at the start, there are multiple dangers:

a) P2 Recommendations may attempt to cover problems addressed by other CCSDS Panels and external standards bodies.

b) The actual scope may slowly widen and increase the probability that later Recommendations will invalidate earlier ones.

In particular, the scope of each document produced, and its relationship to other existing or planned documents, must be clearly understood both by the Panel and the intended readers. This understanding will produce documents in a timely manner and assist potential users in selecting Recommendations that meet their needs.

2.2 DIVISION OF WORK

The amount of work performed within the scope of Panel 2 is very large and resources are limited. Therefore, in order to produce documents in a timely manner, the Panel must define limited work areas and assess priorities.

The individual work areas should be independent so that Recommendations in one area will not be effected when Recommendations are produced in a different area. This division of the P2 scope of work is shown in Figure 2-1.
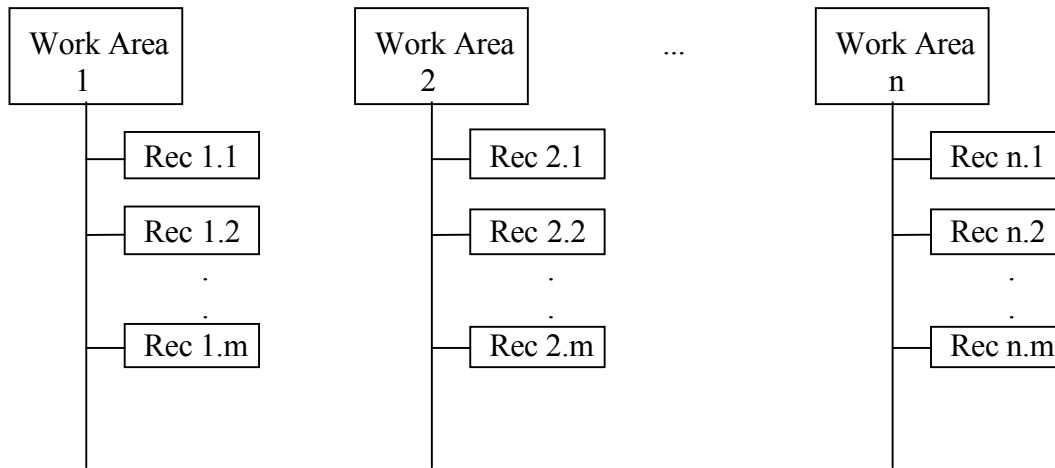
Figure 2-1: P2 Scope of Work Division

Even within each limited work area the amount of work needed will be large, possibly without clearly defined boundaries; therefore, priorities must be defined and the order in which the topics should be covered must be specified.

2.3   SETTING PRIORITIES

Priorities should decided using a criteria which will be reviewed as needed.

2.4   PRODUCTION OF RECOMMENDATIONS

A single Recommendation will not be sufficient; therefore, P2 will be producing a set, possibly tens, or several tens of Recommendations. These will be produced over a significant period of time. Newer Recommendations should not necessitate, or at worst minimise, changes in earlier ones. The Recommendations must also be consistent, in the sense that the Panel understands their relationships with those produced by other CCSDS Panels and relevant standards from other standards bodies.

For each individual Recommendation there will have to be some specific requirements that, when satisfied, will adequately address problem areas for an identified set of potential Recommendation users. The Recommendations produced must be validated against those requirements. In addition, there will be some planning needed for the marketing and practical use of the set of recommendations. Technological developments will undoubtedly occur and will require reviews of the analyses and possibly revisions or additions to the set of Recommendations.

3   DESCRIPTION OF THE METHODOLOGY

The methodology consists of several steps, some of which will be executed simultaneously with frequent cross-checks for consistency.

– The scope of P2 is addressed by the Mission Statement.

– One or more models must be defined to provide a level of coherence to the partitioning of the P2 scope.

– An understanding of the P2 activities must be developed within these models by defining and analysing scenarios that characterise various dimensions of the problem as defined in the Mission Statement.

– A high-level analysis provides the overall picture that helps to determine the appropriate divisions of the work, and also indicate priorities.

– Lower level scenarios and requirements for each individual Recommendation helps to define the precise contents of the individual document.

– The document must be tested against the requirements and validated after the drafting of a Recommendation. Supporting software is often essential to demonstrate practicality and provides potential users with a more concrete view of the services.

– A regular review of the Requirements and, therefore, the Recommendations must be made to assess changes in technology.

– Expertise and software tools, often developed in the testing and validation process, should be used to support the use of the Recommendations.

– Positive marketing efforts may be needed to encourage the use of the Recommendations by making it easier for potential users to see what is available and how it should be used.

3.1   SCOPE OF P2

In accordance with the requirements in Section 2 we state first the agreed overall "Mission" of the Panel. Then the subsequent steps are described in more detail.

3.1.1   MISSION STATEMENT

The mission of Panel 2 is to:

Provide Recommendations that can facilitate the development of an open, integrated, efficient and effective environment whereby any user can:

- –   determine the availability of, or request the creation of, or make known the location of;

- –   access or insert, when allowed;

- –   transfer;

- –   understand or describe;

- –   use;

- –   archive;

- –   data (and metadata).

This data has been, is being, or can be created at a different time and place by an entity (for example instrument, individual or organisation) from an environment that may be foreign to the user.

Provide supporting documents that aid the user in understanding and using the environment and aid the environment developer in implementing the desired capabilities that meet the objectives of the Recommendations.

The idea of helping to **automate** these processes - that is, to not need human intervention - clearly underlies this Mission statement. Even in those cases where full automation cannot realistically be achieved, it is, nevertheless, useful to provide enough support to facilitate any human intervention which may be required.

NOTE –   This Mission Statement has a very broad scope, potentially covering not only space-related data, but also data which has little directly to do with space activities, and it raises many difficult issues about understanding data.

3.1.2 THE RELATIONSHIP OF P2 WORK TO THE OTHER CCSDS PANELS

The interrelationship between the work of Panel 2 and that of the other Panels of CCSDS is discussed within the remit of the CCSDS Technical Steering Group [reference 1].

Briefly stated, Panel 2 concentrates on the understanding and usage of data. These data are frequently characterised as being the mission primary science and engineering data. Panel 2 is not concerned with the problem of transferring data from point A to point B, such as from space to ground as addressed by some Panel 1 activities. Panel 2 assumes such transfer services can exist and can be used. It is also not directly concerned with the general system architectures addressing the operations and control of space mission data flows, as dealt with by Panel 3. However, to the extent that issues of data understanding, location, archiving, and usage, need to be addressed during these activities, there needs to be an awareness of the approaches taken by Panel 2 so as not to duplicate efforts and also to obtain the maximum consistency practical.

3.2 HIGH LEVEL MODELS

After defining the Mission Statement, the next step is to define one or more high-level models characterising aspects of the Panel 2 domain and the information interchange process. This provides the concepts and terminology to explicitly identify broad areas to be addressed. While it is desired that each of these areas be as independent as possible, limited resources restricts the areas from being addressed in parallel. Nevertheless, explicit identification of the areas being addressed will help maintain focus and the ability to identify what is inside and outside a given area. Each area will have multiple dimensions needed to characterise it. Some example 'dimensions' may include:

a) Identification of particular data flows between commonly recognised functional entities.

b) Breakout of layers above the OSI application layer where work is to be done.

c) Identification of aspects to be considered in an information representation model.

The Models are likely to include the following:

a) A Reference Model for Information Interchange.

b) (aspects of the) Overall CCSDS Interface Model.

c) A Process Model for Information Interchange.

d) A Reference Model for an Archive Information System.

3.3   HIGH LEVEL SCENARIOS AND REQUIREMENTS

A strict Top Down approach to analysing the Requirements has not proved viable and so a combined Top Down and Bottom Up approach has been adopted.

In logical terms one first gathers scenarios covering a wide variety of information interchange processes. These are then analysed under the guidance of a number of models, at times with an explicit emphasis on restricted aspects of the interchange process. The method for extracting requirements from these analyses is not well defined. Some techniques are described below. These requirements are to be at a high level; that is they do not feed directly into the Recommendations, but instead guide the overall design of the system of interrelated recommendations. The final step is to suggest a sequence of incremental sets of specific areas for Recommendations in order to provide adequate support in a timely manner.

At various stages, ideas for scenarios and possible requirements may arise, but not be immediately relevant. It is important that these unused scenarios and draft requirements are not lost.

As scenarios are specified and analysed, important questions arise, such as:

   a)   How are the scenarios selected?

   b)   How does one ensure that adequate details are provided in a suitable manner?

   c)   How are Requirements extracted from the scenarios?

Definitive answers are hard to provide, but the following sub-sections attempt to provide some guidance.

3.3.1   SCENARIO SELECTION

There are two guiding principles. The first is that the various models show important interfaces to be addressed. We should at least investigate, however informally, whether each interface may produce new types of scenarios. The second is that we will be concentrating initially on certain aspects of the Information Interchange process, guided by the Models.

3.3.2   SCENARIO DETAILS

Initial outline scenarios may be collected fairly simply; however, additional details must be gathered in order to progress further. The danger is that different scenario providers tend to give differing levels of detail. One would then expect to be guided by, for example, a Process Model to identify specific processes which need to be clarified. It may be that this is an ongoing, recursive, process, where at one level one can ignore details of a particular process, but that process may itself be the subject of further examination later. The Recursive SADT technique (reference [2]) may also be useful in providing a checklist of questions to be answered.

3.3.3 REQUIREMENTS EXTRACTION

The process of actually generating the Requirements is the most difficult area. There are a number of tools and techniques which may be applied in the area of software design; however, we are not simply designing a single software system. Moreover we are looking for areas that are worthy of Standardisation.

A typical approach involves the following stages:

a) given a specific scenario, try to draw out *generalisations* which are related to parts of the scenario;

b) from these, suggest *possible requirements;* and

c) classify these possibilities as being helpful towards *full automation* or towards *partial automation.*

One possible tool that has been described by CCSDS is the Recursive SADT method noted above.

3.4 DIVISION OF WORK AND SETTING PRIORITIES

Based on various models we would expect to be able to define a number of delimited areas for the development of a consistent set of Recommendations in each area. The important point is that by defining these areas in a larger overall context, each set should be consistent and facilitate increased functionality.

For example, consider data dictionaries. Ideally such dictionaries should allow users to begin to understand a particular data product - much as a language dictionary allows a tourist to read signs in a foreign country. Recommendations about data dictionaries may first define a general way of describing a general dictionary. This allows data dictionaries to be produced in a consistent way, but some functionality would likely be missing since several important questions could be omitted. For example, how would several dictionaries be used together? How can dictionary reuse be encouraged? These questions are ones which could be addressed in further Recommendations.

There are several possible criteria for determining the delimited areas. These must be discussed and decided upon.

One principle would be that adequate minimum end-to-end functionality must first be ensured within the overall scope of CCSDS. Further functionality would be added later, determined by the needs of CCSDS as a whole.

The priorities for Recommendation production will be based on several criteria. The most important of these is work that is expected to have a maximum positive impact on current systems. This means that the adoption of the Recommendation will lead to significantly increased services, or reduced costs, or both. It is recognised that not all Panel 2 participants may agree on a single highest priority; therefore, there may be several topics that are being

addressed at one time within the panel. This will also be affected by the resources available to the panel. There are several other criteria that need to be considered:

a) Related Recommendations of Panel 2 already completed. The utility of a given Recommendation may be significantly enhanced by completion of additional Recommendations that together provide a system with greatly increased services.

b) Work that makes a useful unit. The scope of a given Recommendation needs to be sufficient to provide real benefit by its use but not so broad as not to be achievable in an timely manner.

c) Related Recommendations of other CCSDS panels. As with related Panel 2 Recommendations, the Recommendations of another Panel, together with P2 Recommendations, may provide a system with greatly increased services.

d) Work being done by other standards bodies. It is imperative that Panel 2 be aware of work being done by other standards bodies so as not to duplicate effort. Also, P2 Recommendations should be compatible with such other work to the extent the Panel believes that the work will be useful to the type of systems Panel 2 is addressing in its overall scope.

The progress of the work must be managed and monitored in order to ensure it progresses smoothly and also provide visibility of progress to those outside the Panel.

3.5 DEFINITION OF LOWER LEVEL REQUIREMENTS

After deciding on a carefully defined, limited scope for a particular Recommendation, it is then necessary to go to an increasing level of detail using specific detailed scenarios to determine specific requirements for that document. In addition, such a detailed specific scenario may be generalised along the various dimensions of the scenario in order to call out a full scope of the needed functionality. Considerations about interoperability and compatibility with other Recommendations and standards, and also compatibility with current practice would be important.

3.6 VERIFICATION, VALIDATION AND CONFORMANCE

There are four separate issues with respect to conformance:

a) The extent to which the Recommendations satisfied the Requirements from which it was derived.

b) The conformance of an Agency's standards to the CCSDS Recommendations (Agency Conformance).

NOTE – The similarity of two Agencies' standards which allow cross-support between them (Cross-support conformance).In cases b) and c) there is the question as to who tests the conformance and who issues a "certification". These considerations should be taken CCSDS-wide.

c) The conformance of tools or products (for example software/hardware) produced by independent companies to the CCSDS recommendations (External Conformance).

3.7 MAINTENANCE

A minimum review cycle for specific Recommendations is specified in reference [1]. However other factors such as technological changes, which may necessitate revisions of the overall plan of work or the production of additional Recommendations, may arise.

3.8 TOOLS

In the course of developing Recommendation, Agencies and Panel members may develop new software tools for testing the usefulness and consistency of Recommendations or to demonstrate that usefulness. These tools may have wider usability which should be exploited.

The availability of software is a great incentive for users of the Recommendations as it allows a low cost entry method.

The combination of these two points underlines the importance of planning software tool development in such a way as to be of possible use to a very wide audience.

3.9 MARKETING

The attractiveness of Recommendations often depends upon their widespread use, irrespective of the technical advantages. It is therefore sensible, particularly for Panel 2, to try to actively encourage the use of its Recommendations.

The availability of the tools mentioned in the previous section is a major consideration in the marketing of the Recommendations. This is particularly relevant to Panel 2 recommendations because of their potential use to an audience which is not restricted to space related activities. Adequate guidance should also be given to, for example, project managers so that they can judge whether or not CCSDS Recommendations are suitable for their projects.