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Space data and information transfer systems — Cross support service management — Simple schedule format specification

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CCSDS RECOMMENDED STANDARD FOR SIMPLE SCHEDULE FORMAT

1 INTRODUCTION

1.1 PURPOSE AND SCOPE

1.1.1 PURPOSE

This Simple Schedule Format Recommended Standard specifies a standard format for use in transferring scheduling information related to apertures at ground stations and/or relay satellites between space agencies and commercial or governmental spacecraft operators. Such exchanges are used in:

a) mission design, e.g., in investigating the feasibility of a mission with respect to its uplink/downlink requirements and the availability of suitable apertures;

b) mission planning, e.g., to ensure that there are sufficient aperture resources available to carry out the planned operations;

c) mission operations, e.g., to

1) inform the spacecraft operator of the actual allocation of apertures to their mission;

2) inform the spacecraft operator of any unused times of the apertures;

3) return the results of a query about apertures.

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1.1.2 SCOPE

The scope of this Recommended Standard is limited to the exchange of Simple Schedule information. The contents of the simple schedule format described here were derived from the analysis of the standard schedule formats used by a number of space agencies/parts of space agencies. This analysis led to the identification of a ‘core’ content that was (almost) universally present in all schedules analyzed. It was, however, also identified that there was a need to permit some extension to the core content to cover some use cases. Consequently an extension mechanism has been provided that can be used to add further information in the eventuality that the core content is insufficient for the required purpose.

Definition of the extended content for any specific case is outside the scope of this Recommended Standard and should be specified in an Interface Control Document (ICD) agreed upon among the involved parties.

While this Recommended Standard has been developed within the scope of the Space Communication Cross Support Service Management (SCCS SM) (references [E1] and [E2]) activity, it is intended that the Simple Schedule Format can be used to exchange schedule information where no other use of SCCS SM is made. In view of this, schedule data that is only of relevance when used in the scope of SCCS SM has been made optional. Thus there is no limiting dependency on Service Management in the Simple Schedule Format specification.

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Figure 1-1 puts the Simple Schedule Format Specification into context with the various standards that together form the Space Communication Cross Support Service Management.

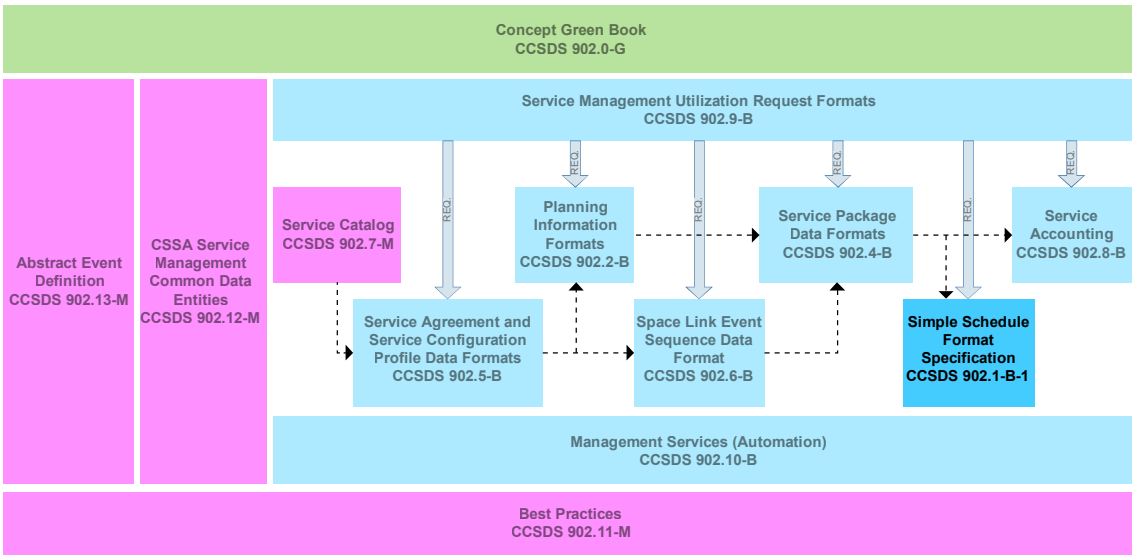


Figure 1-1: Simple Schedule Format in the Context of Space Communication Cross Support Service Management

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1.2 APPLICABILITY

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This Recommended Standard is applicable only to the schedule format and content, but not to its transmission. With respect to the transmission of the Simple Schedule between agencies and operators there are two scenarios:

a) The first involves exchange of the Simple Schedule within the context of SCCS SM.

b) The second involves exchange of the Simple Schedule outside the scope of SCCS SM. Here the mechanism by which the Simple Schedule is transmitted is outside of the scope of this document and should be specified in an ICD agreed by the parties involved.

1.3 RATIONALE

1.3.1 GENERAL

The primary goal of CCSDS is to increase the level of interoperability among agencies. This Recommended Standard furthers that goal by establishing the means to exchange schedule information where most cross support activity occurs: between the tracking stations or ground data handling systems of various agencies and the mission-specific components of a mission ground system.

The use cases described in the following subsections were considered in deriving this Recommended Standard.

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1.3.2 USE CASES

1.3.2.1 Mission Design

During the design phase of a mission it is often desirable to be able to obtain some idea of aperture availability so that the feasibility of obtaining the required uplink and downlink bandwidth can be assessed. Typically, during the mission design phase, the information required relates to periods several years in the future. Currently there is no standardized way for obtaining this information from different agencies.

While this Recommended Standard does not address the mechanism by which the required schedule information can be requested (this possibly being covered in the negotiations involved in establishing the service agreement), it provides a standard format in which the possible availability of apertures can be returned.

1.3.2.2 Mission Planning

In the mission planning use case the provider agency provides the user agency with a schedule that gives the user agency the information it requires to plan its spacecraft operations with respect to the availability of uplink/downlink resources. The means by which the provider agency determines the availability for the user agency can be either:

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a) derived from a request from the user agency;

NOTE – The contents and format of such a request are outside the scope of this Recommended Standard (although this may be addressed elsewhere in the SCCS SM Recommended Standard at a later date).

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b) derived from what is specified in the service agreement between the agencies.

The planning process will typically go through a number of cycles, starting months before the actual activities are expected to take place and being finalized a few days before execution. During these planning cycles the status of the schedule can change with the initial exchanges being of a ‘provisional’ schedule that is likely to change. The final schedule provided is typically considered as ‘operational’ and can be expected to provide the actual schedule that will be executed, subject to unexpected events such as equipment failure or spacecraft emergencies.

1.3.2.3 Dissemination of Provider Cross Support Service System (CSSS)[1] Schedules

It is desirable that a standardized approach be available for disseminating Provider CSSS schedules, both between agencies and also within agencies. This Recommended Standard aims to provide that. There are, however, differences in policies between agencies with regard to the contents of distributed schedules. Some agencies provide complete schedules to

[1] A Provider Cross Support Service System is often colloquially referred to as a Network.

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all users, containing information regarding all spacecraft supported by the agency (and possibly unallocated time as well). At the other extreme, other agencies provide only details regarding a spacecraft's allocation to the operators of that mission.

In view of this, this Recommended Standard has been designed to be flexible enough to be able to cope with the different policies of the various agencies with respect to the information they wish to provide in disseminating their schedules.

1.3.2.4 Dissemination of Unallocated Time Schedules

Some agencies publish a list of unallocated time of the apertures in their network. This information can be used by missions to see if it is possible to request additional coverage by using resources during periods when they would otherwise be unused.

Although not addressing the method by which the usage of unallocated resources can be requested, this Recommended Standard can be used to publish a Provider CSSS unallocated time schedule. It can also be used to inform a mission of the result of a request to use an unallocated resource.

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1.3.2.5 Response to Schedule Query

The final use case of the Simple Schedule Format is to return schedule information resulting from a query about resource availability. While the contents and format of such a query are outside the scope of this Recommended Standard, the Simple Schedule Format provides a standard mechanism by which the information can be returned to the requestor. The ability to submit queries and the contents of these will depend on the capabilities and policies of the agency, but, for example, providing the agencies policy permits, it could be used by a mission to find unallocated aperture times which they could then request the use of.

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1.4 DOCUMENT STRUCTURE

This document is organized as follows:

a) Section 1 provides the purpose, scope, applicability, and rationale of this Recommended Standard and identifies the conventions and references used throughout the document. This section also describes how this document is organized. A brief description is provided for each section and annex so that the reader will have an idea of where information can be found in the document. It also identifies terminology that is used in this document but is defined elsewhere.

b) Section 2 provides a brief overview of the CCSDS-recommended Simple Schedule Format.

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c) Section 3 provides details about the structure and content of the Simple Schedule Format and specifies the normative files that define the XML schemas that govern the content of the XML instance documents that carry Simple Schedules.

d) Annex A provides the normative Implementation Conformance Statement (ICS) proforma.

e) Annex B discusses security, SANA, and patent considerations.

f) Annex C provides an informative listing of the normative XML schema that realizes the classes that comprise the Simple Schedule Format.

g) Annex D contains a list of abbreviations applicable to the Simple Schedule Format.

h) Annex E is a list of informative references.

1.5 DEFINITIONS

For the purposes of this document, the following definitions apply:

agency: A space agency.

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NOTE – The word ‘agencies’ may also be construed as meaning ‘satellite operators’ or ‘satellite service providers’.

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n/a: Not applicable.

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1.6 NOMENCLATURE

1.6.1 NORMATIVE TEXT

The following conventions apply for the normative specifications in this Recommended Standard:

a) the words ‘shall’ and ‘must’ imply a binding and verifiable specification;

b) the word ‘should’ implies an optional, but desirable, specification;

c) the word ‘may’ implies an optional specification;

d) the words ‘is’, ‘are’, and ‘will’ imply statements of fact.

NOTE – These conventions do not imply constraints on diction in text that is clearly informative in nature.

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1.6.2 INFORMATIVE TEXT

In the normative sections of this document, informative text is set off from the normative specifications either in notes or under one of the following subsection headings:

- Overview;
- Background;
- Rationale;
- Discussion.

1.7 CONVENTIONS—THE UNIFIED MODELING LANGUAGE

The Unified Modeling Language (UML) diagrams used in the specification (including class diagrams, package diagrams, sequence diagrams, and activity diagrams) follow the notation, semantics, and conventions imposed by the Version 2.4.1 UML specification of the Object Management Group (OMG) (reference [4]). An overview of UML diagramming conventions can be found in annex E of reference [1].

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Within the document use is made only of class diagrams. A UML class diagram describes the structure of a message, its parts, and how those parts interrelate. A UML class, represented in the diagram as a box, represents a data set. Class diagram conventions include composition, generalization, multiplicity, and constraints. Enumeration notation is also used but only when it is involved in a composition constraint.

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1.8 REFERENCES

The following publications contain provisions which, through reference in this text, constitute provisions of this document. At the time of publication, the editions indicated were valid. All publications are subject to revision, and users of this document are encouraged to investigate the possibility of applying the most recent editions of the publications indicated below. The CCSDS Secretariat maintains a register of currently valid CCSDS publications.

[1] *Space Communication Cross Support—Service Management—Service Specification*. Issue 1-S. Recommendation for Space Data System Standards (Historical), CCSDS 910.11-B-1-S. Washington, D.C.: CCSDS, (August 2009) June 2017.

[2] "CCSDS-910.11-B-1_XML_schemas." http://public.ccsds.org/publications/archive/CCSDS-910.11-B-1_XML_schemas.zip.

[3] *Time Code Formats*. Issue 4. Recommendation for Space Data System Standards (Blue Book), CCSDS 301.0-B-4. Washington, D.C.: CCSDS, November 2010.

[4] *Unified Modeling Language (UML)*. Version 2.4.1. Needham, Massachusetts: Object Management Group, August 2011.

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[5] *CCSDS SANA Registry Management Policy*. Issue 1. CCSDS Record (Yellow Book), CCSDS 313.1-Y-1. Washington, D.C.: CCSDS, May 2016.

[6] *Space Assigned Numbers Authority (SANA)—Role, Responsibilities, Policies, and Procedures*. Issue 2. CCSDS Record (Yellow Book), CCSDS 313.0-Y-2. Washington, D.C.: CCSDS, May 2016.

[7] *Cross Support Service Management—Common Data Entities*. Proposed Recommendation for Space Data System Practices, CCSDS 902.12. Forthcoming.

[8] *CCSDS Spacecraft Identification Field Code Assignment Control Procedures*. Issue 7. Recommendation for Space Data System Practices (Magenta Book), CCSDS 320.0-M-7. Washington, D.C.: CCSDS, November 2017.

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2 OVERVIEW

2.1 GENERAL

This section provides a high-level overview of the CCSDS-recommended Simple Schedule Format, which is designed to facilitate standardized exchanges of aperture schedule information between space agencies.

2.2 SIMPLE SCHEDULE

A Simple Schedule file is XML formatted. The format of the Simple Schedule file is suitable for automated interaction and/or (by means of a suitable XML viewer) human interaction.

Data in the Simple Schedule is either mandatory, in which case suitable values must be present, or optional, in which case values may be present or not. In addition it is possible to extend the contents of the Simple Schedule by defining additional parameters. The content of any additional parameters so defined is outside the scope of this document and should be documented in an ICD agreed upon by the involved parties.

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2.3 MAPPING TO W3C XML SCHEMA

This Recommended Standard includes the specification of a mapping to World Wide Web Consortium (W3C) extensible Markup Language (XML) schema. The normative mapping of this Recommended Standard to XML W3C schemas is a virtual annex to this Recommended Standard and is contained in a stand-alone set of schema files (reference [2]).

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NOTE – The XML schema has been elaborated on the basis of the mapping guidelines described in reference [E1].

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3 SIMPLE SCHEDULE

3.1 GENERAL

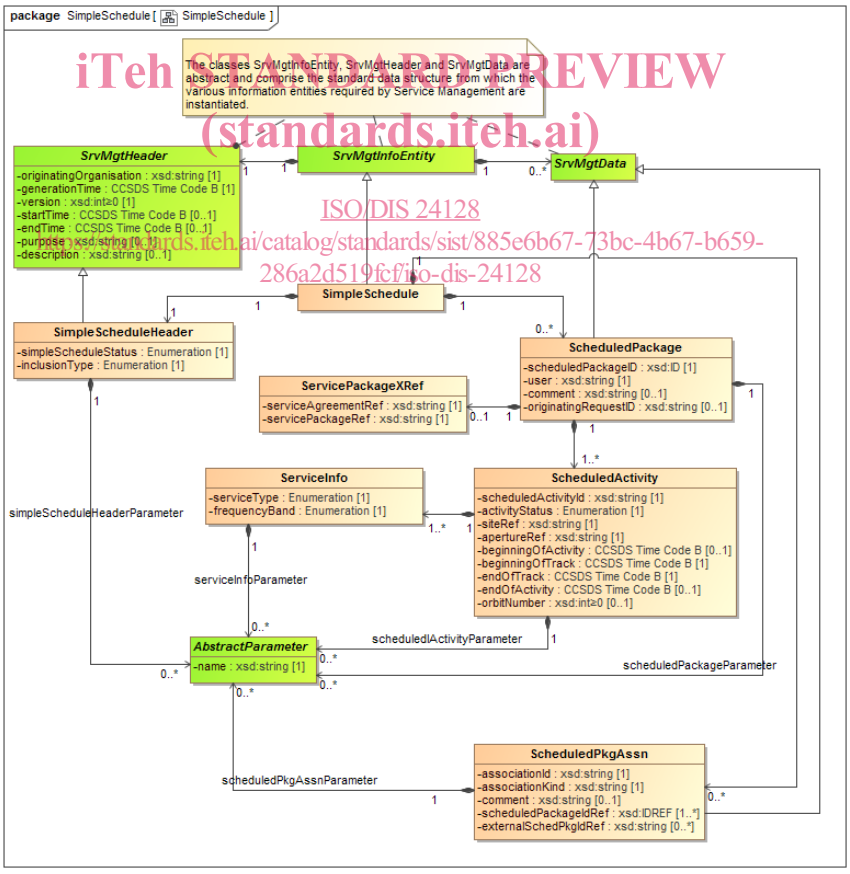
The Simple Schedule shall consist of digital data exchanged in the form of a file containing an XML instance document.

NOTE – Subsection 3.6 identifies the files that contain the normative Simple Schedule XML schemas. The naming conventions for the files containing the Simple Schedule XML instance documents are outside of the scope of this recommended standard.

3.2 SIMPLE SCHEDULE CONTENT/STRUCTURE

3.2.1 OVERVIEW

Figure 3-1 shows the UML Class diagram for the Simple Schedule. For clarity, *abstract* classes are highlighted in green.



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Figure 3-1: Simple Schedule Class Diagram

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The attributes of each class are described further in the following subsections and tables.

NOTES

1 In the following tables, data types specified as ‘xsd:nnn’ are XML schema types. Thus, for example, ‘xsd:string’ indicates that the type is an XML schema string.

2 In general the length of strings in this Recommended Standard is unbounded; i.e., no length is specified (in practice there is obviously the constraint of the maximum string length supported). However, in a number of cases, in the various SANA registries used, a length for string values in specified. For these cases the effective restriction on string length is the value specified in the SANA registry definition.

3.2.2 CLASS SimpleSchedule

3.2.2.1 The SimpleSchedule class is mandatory and shall constitute the Simple Schedule information entity.

NOTE – The SimpleSchedule class is a specialization of class SrvMgtInfoEntity described in reference [7], and the generic description of the parameters is given in there.

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3.2.2.2 The use of the parameters in the SrvMgtInfoEntity in the scope of the Simple Schedule shall be as specified in table 3-1.

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Table 3-1: Class SimpleSchedule Parameters

Parameter	Description	Data Type	Data Units
`Not applicable.`	(See reference [7], subsection 3.1.2)		

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3.2.3 CLASS SimpleScheduleHeader

3.2.3.1 The SimpleScheduleHeader class is mandatory and shall constitute the 'header' of the Simple Schedule.

NOTE – The SimpleScheduleHeader class is a specialization of class SrvMgtHeader described in reference [7], and the generic description of the parameters is given there.

3.2.3.2 Each instance of the SimpleScheduleHeader class may have zero or more instances of parameter classes derived from the abstract AbstractParameter class described in reference [7]. Usage of any additional parameters so specified is not within the scope of this document and should be specified in an ICD between by the relevant parties.

3.2.3.3 The SimpleScheduleHeader class, in addition to the parameters in the abstract SrvMgtHeader class, described in reference [7], shall contain parameters as specified in table 3-2.

3.2.3.4 The parameter `inclusionType` of the SimpleScheduleHeader shall be used to specify the type of inclusion rule that has been used to select the ScheduledPackages (see 3.2.4) that are contained in the schedule.

3.2.3.5 Two types of inclusion rules are supported and are discussed below; the following shall apply to both types:

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a) The start time of a ScheduledPackage (t_{ssp}) is defined to be the earliest `beginningOfActivity` or `beginningOfTrack` time of any ScheduledActivity (see 3.2.7) contained within that ScheduledPackage.

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b) The end time of a ScheduledPackage (t_{esp}) is defined to be the latest `endOfActivity` or `endOfTrack` time of any ScheduledActivity contained within that ScheduledPackage.

3.2.3.6 In the case of inclusion type OVERLAP_INCLUSION where the `startTime` and `endTime` specified in the SimpleScheduleHeader are respectively T_s and T_e, ScheduledPackages shall be included in the schedule where:

$$t_{esp} > T_s \text{ and } t_{ssp} < T_e$$

3.2.3.7 In the case of inclusion type START_INCLUSION, in the event that one or more ScheduledPackage are associated via a ScheduledPkgAssn (see 3.2.5), the start time of the associated ScheduledPackages (t_{sasp}) is defined to be the earliest ScheduledPackage time (t_{ssp}) of the associated ScheduledPackages; thus where the `startTime` and `endTime` specified in the SimpleScheduleHeader are respectively T_s and T_e, ScheduledPackages shall be included in the schedule where:

$t_{ssp} \geq T_s$ **and** $t_{ssp} < T_e$ (ScheduledPackage is not associated with other ScheduledPackages)

or

$t_{sasp} \geq T_s$ **and** $t_{sasp} < T_e$ (ScheduledPackage associated with other ScheduledPackages).

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