SIST

SLOVENSKI STANDARD
oSIST prEN 17350:2019

01-julij-2019

SCM - Obrazec za časovno razporejanje in vodenje - Standardizirani format

SCM - Scheduling and Commanding Message - Standard

Raumfahrt - Überwachung der Weltraumlageerfassung - Planungs- und Kommando-Nachricht

SCM - Message de planification et de commande - Norme

Ta slovenski standard je istoveten z: prEN 17350

ICS:

49.140	Vesoljski sistemi in operacije	Space systems and operations

oSIST prEN 17350:2019 **en**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

DRAFT
prEN 17350

May 2019

ICS 49.140

English version

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This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/CLC/JTC 5.

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Recipients of this draft are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.Recipients of this draft are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

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Ref. No. prEN 17350:2019 E

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European foreword

This document (prEN 17350:2019) has been prepared by Technical Committee CEN/CLC/JTC 5 “Space”, the secretariat of which is held by DIN.

This document is currently submitted to the CEN Enquiry.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association.

0 Introduction

0.1 Document structure:

Clause 2 provides an overview of the SCM.

Clause 3 describes the scope and general nature of the SCM.

Clause 4 describes the general format of the SCM standard.

Clause 5 describes the detailed syntax of SCM communications.

Clause 6 provides additional information about headers.

Annex A (informative) provides SCM background.

Annex B (informative) provides SCM examples.

Annex C (informative) describes the survey strategy types and related parameter requirements.

Annex D (informative) informs about the handling of filter requests.

0.2 Verbal conventions:

The following conventions apply:

a) 'shall' implies a requirement;

b) 'should' implies a recommendation;

c) 'may' implies a permission; and

d) 'is', 'are', and 'will' denote factual statements.

1 Scope

1.1 Purpose:

The “Scheduling and Commanding Messages” (SCM) specifies a standard format for observing system commanding and scheduling. This document aims to ease the planning and operation processes and to reduce the effors from researchers that use several different observing systems and/or simulation software products.

The SCM establishes a common language for exchanging information on planning, scheduling, and executing observations of celestial objects. In the end this will:

a) Facilitate interoperability and enable consistent warning between data originators who supply celestial observations and the entities or researchers who use it; and

b) Facilitate the automation of observation processes.

1.2 Applicability:

The SCM is applicable to ground-based activities related to the planning, scheduling, and execution of the observations of celestial objects. It is used by planning software, scheduling software, telescope commanding software. It is applicable for optical telescopes.

2 Normative references

There are no normative references in this document.

3 Terms, definitions, symbols and abbreviations

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1.1
Observing System Command File
“observation plan”
data file which is used to control an observing system (OS), which contains absolute information on actions the OS is due to perform, e.g. absolute times and sky coordinates for observations, and which is read by an OS control computer that still processes part of their content (e.g. conversion of equatorial coordinates to telescope hardware coordinates, execution of pre-defined standard routines for calibration processes that are called by a single entry in the command file, etc.) and sends commands to the hardware drivers

3.1.2
Observing System Scheduler Input File
“scheduler request”
data file providing input to an observation scheduler.

Note 1 to entry: Opposed to Observing system command files, these files usually do not contain absolute information on when an OS is due to perform a certain action, but rather constraints that allow a scheduler to flexibly allocate the requested actions. The scheduler, on the other hand, can write command files which are subsequently passed on to an OS control computer.

3.1.3
Hardware Driver Input
commands that are produced by an OS control computer and are selectively sent to the according hardware drivers, e.g. the telescope mount drivers, dome drivers, etc.

3.1.4
Near-Earth Object
NEO
Solar System objects whose orbit brings them into close proximity with the Earth, which all have a perihelion distance < 1.3 astronomical units (the distance Sun - Earth, ~149.6x10^6 km), and which include near-Earth asteroids (NEAs), near-Earth comets, a number of solar-orbiting spacecraft, and meteoroids large enough to be tracked in space before striking the Earth

3.1.5
follow-up
<NEO field - identical to 'tracking' in the SST field> specific effort to obtain observations of an interesting object at times subsequent its discovery, with the goal of improving the knowledge of its orbit and the predictability of its future motion

Note 1 to entry: Follow-up telescopes are generally distinct from survey telescopes, and operate with a more close supervision of an observer, which selects the targets in need of follow-up. Survey telescopes may also observe known objects, thus providing follow-up observations, although these observations are often not the goal of the project.

Note 2 to entry: 'Tracking' is used in the SST field and identical to 'follow-up' in the NEO field.

3.1.6
range
radial distance between an observer and an object at a given instant of time, which is one of the direct observable that can be derived from a radar observation, by measuring the travelling time of a radio wave reflected from the object's surface, and which, since ground-based optical astrometry does not allow to directly determine radial distances, range measurements from radar are extremely powerful for orbital determination

3.1.7
survey
project operating telescopes designed to detect unknown moving objects in the sky, some of which will become new discoveries

Note 1 to entry: Surveys typically operate in a mostly automated way, and can detect and report measurements for thousands of objects every night.

3.1.8
sensor
<SST field> complete observation system, i.e. an optical telescope together with its camera, or a radar system.

<NEO field> detector, i.e. light-sensitive device in a camera (CCD or CMOS)

3.2 Symbols and abbreviations

Table 1 — Symbols

n.a.	not applicable

Table 2 — Abbreviations

ASCII	American Standard Code for Information Interchange
ASCOM	Astronomy Common Object Model
AstDyS	Asteroids Dynamic Site
CCSDS	Consultative Committee for Space Data Systems
CDM	Conjunction Data Message
ESA	European Space Agency
ESO	European Southern Observatory
FITS	Flexible Image Transport System
IAC	Instituto de Astrofísica de Canarias
INDI	Instrument-Neutral Distributed Interface
JSON	JavaScript Object Notation
NEO	Near-Earth Object
NEODyS	Near-Earth Objects Dynamic Site
OCA	Observatoire de la Côte d'Azur
OGS	Optical Ground Station
OS	Observing System
RTML	Remote Telescope Markup Language
RTS2	Remote Telescope System 2nd Version
SCM	Scheduling and Commanding Message
SSA	Space Situational Awareness
SST	Space Surveillance and Tracking
TBT	Test Bed Telescope
TDM	Tracking Data Message
TLE	Two-line element
UTC	Coordinated Universal Time
VLT	Very Large Telescope
XML	eXtensible Markup Language

The SCM generally uses units that are part of the International System of Units (SI), either base, derived, or non-SI units that are accepted for use within the SI. The following units are used in the SCM:

Table 3 — Unit conventions

deg:	decimal degrees
as:	seconds of arc (1/3 600 °)
m:	meter
mm:	millimetre
nm:	nanometer
s:	SI seconds
min:	minutes (60 SI seconds)

In order to simplify the standard and the interface to an observing system control computer or scheduler, only one notation per parameter is foreseen.

4 Overview — Context of the document

This document gathers the requirements described in the Proposal for a Telescope Commanding and Scheduling Data Standard [2].

The basic application scenarios of the standard are illustrated in Figures 1 and 2, once for the application as a scheduler input file and once for the application as an OS command file.

In the first case, the SCM file is created by a human operator or an automated planning tool and either directly submitted to an observation scheduler or retrieved by it from a database. The scheduler creates an observation schedule based on the targets and constraints provided in the SCM and sends corresponding commands to the OS control computer. In case of an OS network it is also possible that a central scheduler sends commands to several OSs. The scheduler can be located at the OS or work remotely. The scheduler needs to be reasonably "smart" to interpret the constraints in the SCM and to preferably calculate pointing coordinates from provided object ephemerides or retrieve information on objects from online sources.

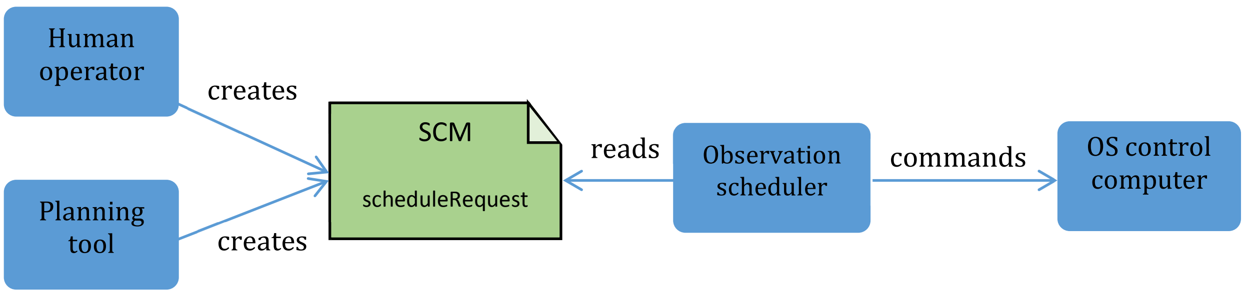

Figure 1 — Basic context of SCM used as a scheduler input file

It is well possible that the observation scheduler passes on the command to the OS control computer via another SCM, as illustrated in Figure 2. The OS control computer in this case is likely to be allocated somewhere close to the OS. It needs to be much less "smart" than the scheduler, assuming that in the typical case it will already be provided by a simple coordinates and timing information.

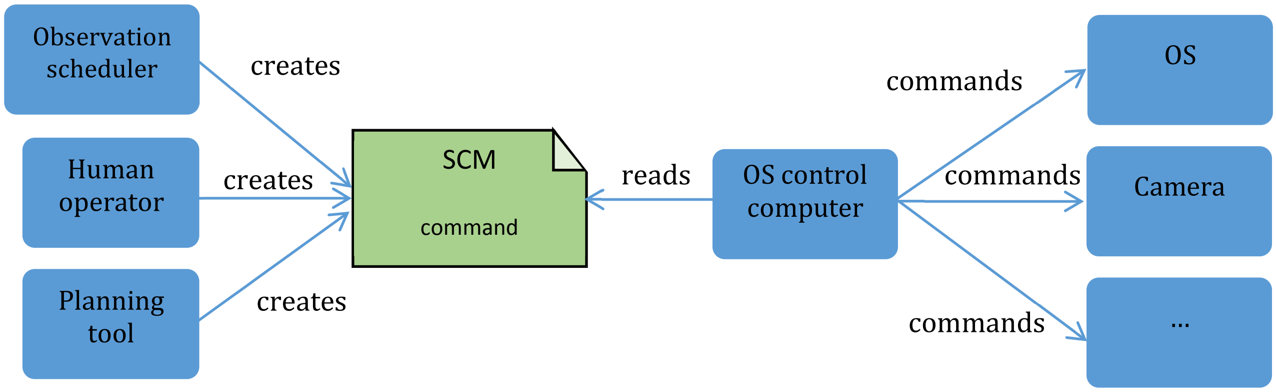

Figure 2 — Basic context of SCM used as OS command files

5 General nature of the standard — Documentation within the format

For individual images, the FITS (Flexible Image Transport System) standard allows the inclusion of a considerable amount of information in the machine- and human-readable image header. There is thus no need to duplicate this information in a separate file for observations of several images. The same applies to information on used hardware in robotic OS networks where observation requests are not submitted to individual OSs. The information on the OS used can also be written to the images' FITS headers, as done in the Las Cumbres Observatory Global Telescope Network, for example. In case of larger campaigns, however, it might be useful to have access to concise observation history in one file (i.e. which observations have really been carried out, actual observation conditions, ...). For the sake of clearness, it is preferable to have this information in a single file, not interrupted by command or other information.

To guarantee traceability from an image to the underlying command, the command message format foresees the option to request the command message ID (and potentially also its location) to be written into the image's FITS header.

6 SCM structure and content

6.1 General structure

6.1.1 General

An SCM file consists of at least one “observation block” which can be either a “command” or a “schedule request”. The “header” element contains basic parameters of the message itself. All actual commanding parameters for the OS are, in the basic case, included in a “command” element. In this element, the camera to be used is specified, the path and filename where the resulting image file shall be saved are detailed, information to be written into the image file’s FITS header can be passed on, and the physical observation parameters are transferred. Hereby, coordinates are defined in decimal degrees, exposure time in seconds. If more than one observation is desired, another “command” segment can be added at the end of the file. Overlapping information can be defined for all “commands” in a “commonData” segment.

The standard is described in an XML-based language. The logical layout of an XML document always follows a tree structure. The higher-level structure of an SCM is shown in Table 4.

Table 4 — Higher-level structure of an SCM

```
<SCM>
  - Header
  - MetaData
      - Project
      - Contact
      - Linked SCM
      - Wait Constraint
  - Common Data
      - Camera
      - Device
      - Spectrograph
      - Image Data
      - Target
      - Surey Strategy
      - Exposure
      - Observation
      - Macros
  - Command
      - MetaData
      - Camera
          - Detector
          - Chips
          - Chip
          - Windowing
          - Binning
       - Device
          - Device
       - Spectrograph
          - Detector
          - Device
          - Grating
          - FilterWheel
          - Slit
          - xyPosition
          - Coordinates
       - ImageData
           - FitsHeader
       - Target
           - Coordinates
           - Ephemerides
           - OrbitalElements
           - RaDecList
           - TargetBrightness
           - TrackRate
       - CalibrationObservation
       - Exposure
           - Dithering
       - Shutter
       - Observation
  - ScheduleRequest
       - MetaData
           - LinkedBlock
       - Camera
          - Detector
          - Chips
          - Chip
          - Windowing
```

```
            - Binning
         - Device
            - Device
         - Spectrograph
            - Detector
            - Device
            - Grating
            - FilterWheel
            - Slit
            - xyPosition
            - Coordinates
         - ImageData
            - FitsHeader
         - Target
            - Coordinates
            - Ephemerides
            - OrbitalElements
            - RaDecList
            - TargetBrightness
            - TrackRate
         - SurveyStrategy
         - Constraints
             - AirmassConstraint
             - DateTimeConstraint
             - EclipticConstraint
             - ExposureConstraint
             - FieldOfViewConstraint
             - GalacticPlaneConstraint
             - InformationGainConstraint
                 - Interval
             - MoonConstraint
             - NightConstraint
             - SunConstraint
             - WaitConstraint
             - Other Constraints
         - CalibrationObservation
         - Exposure
             - Dithering
         - Shutter
         - Observation
```


6.1.2 XML document header

The header carries information on the format of the document, but also information necessary to check the validity of the XML document (through the comparison with an XML grammar). It also lists the document's unique identification code.

As Figure 3 shows, the third part of the document header appears in the form of attributes of the root element (shown as red dots in the tree diagram). As the ASCII code of the header below shows, these are written directly into the opening tag of the root element. The content of the attributes is added on the right side in XML Notepad, or in the form *attribute="content"* in ASCII format.

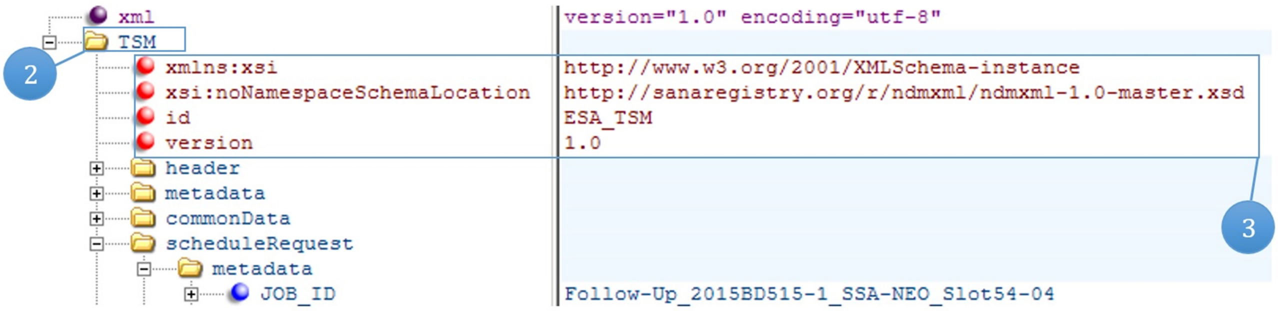

Figure 3 — XML document declaration and root element attributes

1	XML declaration. Defines the XML version and the character encoding.
2	Root element of the document (i.e. defining: “this is an SCM document”)
3	Root element attributes. Each has the following functions: xmlns:xsi - defines the namespace used in the document. The URL does actually point to the website, but is the name of the namespace. xsi:noNameSpaceSchemaLocation - Defines the location of the XML schema (the grammar to be used for validation) for elements that do not belong to any namespace (basically all elements in an SCM) id - Identification code for the document code. Shall always be “ESA_SCM”. version - Identifies the version of the SCM data format that is used throughout the document.

Header in ASCII code:

```
<?xml version=”1.0” encoding=”utf-8”?>
 <SCM  xsi:noNameSpaceSchemaLocation="  http://sanaregistry.org/r/ndmxml/ndmxml-
     1.0-master.xsd" id="CEN_SCM" version="1.0">
```

6.1.3 Segment

Higher-level XML element that might contain child elements or other segments. For instance, the segment “Header” only contains elements (COMMENT, CREATION_DATE, ...) while segment “commonData” containts other segments (camera, device, ...) which, in turn, contains elements. See Clause 7 for the description of each segment.

6.1.4 Observation Block

Smallest unit of an observation request/command. Are included in a Scheduling and Commanding Message, with each Observation Block being represented by one XML element (with child elements). Observation blocks are treated as impartible and are the smallest unit to which the status “succeeded”/”not succeeded” can be assigned.

6.1.5 Command

Single observation block used to command an action from an OS. Represented by an XML element called “command” (with child elements).