INTERNATIONAL STANDARD

ISO 26900

Second edition

Space data and information transfer systems — Orbit data messages

Systèmes de transfert des informations et données spatiales — Messages pour données d'orbites

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by the Consultative Committee for Space Data Systems (CCSDS) (as CCSDS 502.0-B-3, Apil 2023) and drafted in accordance with its editorial rules. It was assigned to Technical Committee ISO/TC 20, *Aircraft and space vehicles,* Subcommittee SC 14, *Space systems and operations* and adopted under the "fast-track procedure".

This second edition cancels and replaces the first edition (ISO 26900:2012), which has been technically revised.

The main changes compared to the previous edition are as follows:

— Changes in the messages:

  — The OCM was added to provide better support for ISO Technical Committee 20, Subcommittee 14 objectives (see section 6).

  — MESSAGE_ID was added to the OPM, OMM, and OEM to provide better satisfaction of requirement P10 (identification and annotation of messages).

  — EPHEMERIS_TYPE was updated in the OMM to reflect currently used numbering scheme.

  — BSTAR and MEAN_MOTION_DDOT fields are paired with BTERM and AGOM parameters to support the SGP and SGP4 propagators as well as the new SGP4-XP propagator, respectively.

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— Changes in the document:

  — A new CCSDS repository for normative keyword values for navigation messages has been created at the SANA Registry, accessible on the Internet at: https://sanaregistry.org/r/navigation_standard_normative_annexes/. (See annex B for details on the affected keywords and links to the content.)

  — Several annexes were added. Some are required by CCSDS rule changes, and some are for the provision of supplementary material.

  — Examples for OPM, OMM, and OEM that formerly appeared in sections 3, 4, and 5, respectively, have been moved to an informative annex.

  — The 'Checklist ICD' that was added in ODM Version 2 has been discontinued. This Checklist ICD, intended to convey information that the OPM, OEM, and OMM did not address, such as third-body perturbations, solar pressure model, solid tides, ocean tides, Earth albedo, and polar motion, has now been replaced by the material that can be specified in the Orbit Comprehensive Message.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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1 INTRODUCTION

1.1 PURPOSE AND SCOPE

This Orbit Data Messages (ODM) Recommended Standard specifies four standard message formats for use in transferring spacecraft orbit information between space agencies and commercial or governmental spacecraft operators: The Orbit Parameter Message (OPM), the Orbit Mean-Elements Message (OMM), the Orbit Ephemeris Message (OEM), and the Orbit Comprehensive Message (OCM). Such exchanges are used for:

a) pre-flight planning for tracking or navigation support;

b) scheduling tracking support;

c) carrying out tracking operations (sometimes called metric predicts);

d) performing orbit comparisons;

e) carrying out navigation operations such as orbit propagation and orbit reconstruction;

f) assessing mutual physical and electromagnetic interference among satellites orbiting the same celestial body (primarily Earth, Moon, and Mars at present);

g) performing orbit conjunction (collision avoidance) studies; and

h) developing and executing collaborative maneuvers to mitigate interference or enhance mutual operations.

This Recommended Standard includes sets of requirements and criteria that the message formats have been designed to meet. For exchanges in which these requirements do not capture the needs of the participating agencies and satellite operators, another mechanism may be selected.

The ODM Recommended Standard is an international standard published under the auspices of CCSDS and International Standards Organization (ISO) Technical Committee 20, Subcommittee 13, developed jointly and in concert with the ISO TC20/SC14. As such, this CCSDS standard is also properly labeled as ISO 26900.

The recommended Orbit Data Message format is ASCII (reference [4]).

This ODM document describes both 'Keyword = Value Notation' (KVN) as well as Extensible Markup Language (XML) (reference [5]) formatted messages. Selection of KVN or XML format should be mutually agreed between message exchange partners.

NOTE – As currently specified, an OPM, OMM, or OEM file is to represent orbit data for a single spacecraft, and the OCM is to represent orbit data for either a single spacecraft or single parent spacecraft of a parent/child spacecraft deployment scenario. It is possible that the architecture may support multiple spacecraft per file; this could be considered in the future.

1.2 APPLICABILITY

The Orbit Data Message family of standardized orbit messages is applicable to all phases of the spacecraft and launch vehicle life cycle. The rationale behind the design of each orbit data message is described in annex E and may help the application engineer to select a suitable message. Definition of the orbit accuracy underlying a particular orbit message is outside of the scope of this Recommended Standard and should be mutually agreed upon between message exchange partners (or specified via COMMENT sections in the message itself). Applicability information specific to each orbit data message format appears in sections 3, 4, 5, and 6, as well as in annex subsections E2.4 and E2.5.

This Recommended Standard is applicable only to the message format and content, but not to its transmission. The transmission of the message between agencies and operators is outside the scope of this document and should be mutually agreed between message exchange partners.

Description of the message formats based on the use of XML is detailed in section 8.

1.3 RATIONALE

This update to version 2 of the Orbit Data Messages adds a fourth message type, the OCM, based on collaboration of the CCSDS Navigation Working Group and the ISO Technical Committee 20, Subcommittee 14, Working Group 3 (ISO TC20/SC14/WG3). A full list of the changes in this document is in annex J.

1.4 DOCUMENT STRUCTURE

Section 2 provides a brief overview of the CCSDS-recommended Orbit Data Message types, the OPM, OMM, OEM, and OCM.

Section 3 provides details about the structure and content of the OPM.

Section 4 provides details about the structure and content of the OMM.

Section 5 provides details about the structure and content of the OEM.

Section 6 provides details about the structure and content of the OCM.

Section 7 discusses the syntax considerations of the set of Orbit Data Messages (OPM, OMM, OEM, and OCM).

Section 8 provides details on the XML instantiations of the OPM, OMM, OEM, and OCM.

Following the principal content of the document, there are several annexes, both normative and informative, to guide the ODM user.

1.5 CONVENTIONS AND DEFINITIONS

1.5.1 NOTATION

1.5.1.1 Unit Notations

The following conventions for unit notations apply throughout this Recommended Standard, with message-specific guidance provided in 7.7. Units are drawn from the International System of Units (SI); units are either SI base units, SI derived units, or units outside the SI that are accepted for use with the SI (reference [1]). Except as noted, the units used within this document are as follows:

– d: days, 86400 SI seconds;

– kg: kilograms;

– km: kilometers;

– m: meters;

– n/a: (units are not applicable);

– %: percent;

– s: SI seconds;

– SFU: Solar Flux Units, equivalent to 10^{-22} W/(m**2*Hz);

– W: watts.

1.5.1.2 General

The following notational conventions are used in this document:

a) multiplication of units is denoted with a single asterisk '*' (e.g., 'kg*s');

b) exponents of units are denoted with a double asterisk '**' (e.g., m^2 = m**2);

c) square roots of units are denoted by the same exponent notation of a double asterisk '**' (e.g., $\sqrt{km}$ = km**0.5);

d) division of units is denoted with a single forward slash '/' (e.g., m/s);

e) the usual order of operations ordering applies (e.g., exponents before multiplication).

1.5.2 NOMENCLATURE

1.5.2.1 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.

1.5.2.2 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.

1.5.3 DEFINITIONS

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

a) the word 'agencies' may also be construed as meaning 'satellite operators' or 'satellite service providers';

b) the word 'participant' denotes an entity that can acquire or broadcast navigation messages and/or radio frequencies, for example, a spacecraft, a tracking station, a tracking instrument, or an agency/operator;

c) the notation 'n/a' signifies 'not applicable';

d) depending on context, the term 'ODM' may be used to refer to this document or may be used to refer collectively to the OPM, OMM, OEM, and OCM messages;

e) an 'observation' is a unique measurement set of a satellite's state from a single sensor configuration at a single time (e.g., azimuth from a single sensor at a single time);

f) a 'sensor track' is a set of observations within a specified number of minutes for the same object, observed by the same sensor configuration, where each observation is within a specified number of minutes (which is dependent on the orbit regime of the object) of the other observations in the track (e.g., a set of 10 two-way transponder range measurements from the same sensor using the same transponder on the satellite), and where the number of minutes could alternately be defined as the time between start and stop of the measurement 'session' or signal modulation that enables metric tracking.

1.6 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] *The International System of Units (SI)*. 8th ed., 2006; updated in 2014. Sèvres, France: BIPM, 2006.

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

[3] "Online Index of Objects Launched into Outer Space." United Nations Office for Outer Space Affairs (UNOOSA). https://www.unoosa.org/oosa/osoindex/.

[4] *Information Technology—8-Bit Single-Byte Coded Graphic Character Sets—Part 1: Latin Alphabet No. 1*. International Standard, ISO/IEC 8859-1:1998. Geneva: ISO, 1998.

[5] *XML Specification for Navigation Data Messages*. Issue 3. Recommendation for Space Data System Standards (Blue Book), CCSDS 505.0-B-3. Washington, D.C.: CCSDS, May 2023.

[6] Paul V. Biron and Ashok Malhotra, eds. *XML Schema Part 2: Datatypes*. 2nd ed. W3C Recommendation.

[7] *IEEE Standard for Floating-Point Arithmetic*. 3rd ed. IEEE Std 754-2019. New York: IEEE, 2019.

[8] Henry S. Thompson, et al., eds. *XML Schema Part 1: Structures*. 2nd ed. W3C Recommendation.

[9] *Tracking Data Message*. Issue 2. Recommendation for Space Data System Standards (Blue Book), CCSDS 503.0-B-2. Washington, D.C.: CCSDS, June 2020.

[10] *Attitude Data Messages*. Issue 1. Recommendation for Space Data System Standards (Blue Book), CCSDS 504.0-B-1. Washington, D.C.: CCSDS, May 2008.

[11] "CCSDS Navigation Standards Normative Annexes." Space Assigned Numbers Authority. https://sanaregistry.org/r/navigation_standard_normative_annexes.

[12] *Re-entry Data Message*. Issue 1. Recommendation for (Blue Book), CCSDS 508.1-B-1. Washington, D.C.: CCSDS, November 2019.

[13] *Pointing Request Message*. Issue 1. Recommendation for (Blue Book), CCSDS 509.0-B-1. Washington, D.C.: CCSDS, February 2018.

[14] *Conjunction Data Message*. Issue 1. Recommendation for Space Data System Standards (Blue Book), CCSDS 508.0-B-1. Washington, D.C.: CCSDS, June 2013.

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