



CCSDS Navigation Working Group

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04-Nov-2024

Purpose

- Introduce the CCSDS Navigation Working Group and its technical program to new members
- Highlight progress since prior meetings
- Set priorities for current meetings

- Are there any new attendees? If so, let's go around the room and introduce ourselves...

Agenda

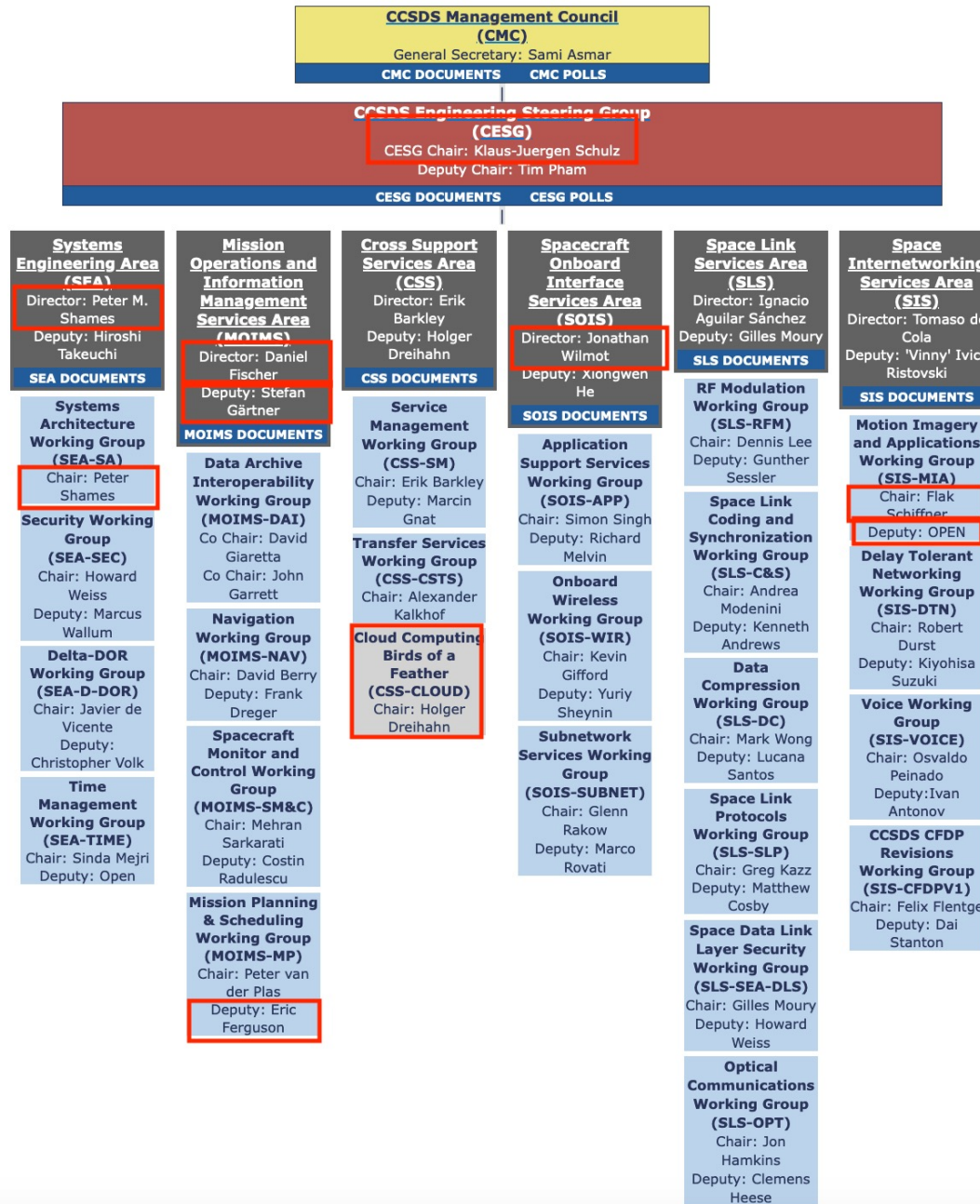
- CCSDS Overview
- Navigation Working Group Overview
- Navigation Working Group Documents
- Q&A

CCSDS & the Navigation Working Group

- CCSDS is an organization which acts as the “principal technical engine of ISO TC20/SC13”
- Develops international standards related to space data
- Organization chart at <https://cwe.ccsds.org/default.aspx>
- CCSDS consists of 6 general “Areas”
- Areas are partitioned into 24 smaller groups called “Working Groups” (WG, 24), “Birds of a Feather Groups” (BOF,0), or “Special Interest Groups” (SIG, 0) .
- Each WG, SIG or BOF is associated with an Area
- Navigation WG is part of CCSDS Mission Operations and Information Management Services Area (MOIMS)
- Charter is to produce CCSDS Recommendations related to the formatting and exchange of flight dynamics data

CCSDS Organization Chart

CCSDS Technical Organization



Indicates change since Spring 2024

Standards Development Process (In Brief)

- A “Concept Paper” suggests a need for standardization
- A Working Group is chartered to develop Recommendation
- Working Group develops material (an iterative process)
- Recommendation documents go through stages:
 - Proposed=White, Draft=Red, Final=Blue, Revised Draft=Pink
- White Books are internal to the Working Group
- When a White Book matures, promotion to Red Book occurs
- Formal Agency Review process commences (2 months minimum)
- When Agency Review is passed, prototyping is complete, test reports filed, "Approval to Publish", promotion to Blue Book occurs
- ISO standard process entered at advanced stage (DIS/FDIS)
- Blue Books have 5 year review (reconfirm/retire/revise)
- Blue Books being revised enter a draft stage colored Pink
- Retired books are Silver historic, no longer normative, ("OK to use")
- Green Books are non-normative technical reports
- Other colors in CCSDS spectrum:
 - Yellow=Record, Orange=Experimental, Magenta=Best Practice

Navigation WG Participating Membership

- The CCSDS Navigation Working Group has had regular participation from the following space agency/organizations:
 - CNES
 - DLR
 - ESA
 - JAXA
 - NASA (JPL, GSFC, JSC)
 - UKSA
 - ISO TC20/SC14 (CCSDS “sister organization”)
 - CCSDS-related organizations that previously named representatives to the Nav WG, but have not recently participated: ASI, RFSA, ETRI
- Other agencies that participate in CCSDS, but have not been involved in Navigation WG: CSA, INPE, CNSA
- Commercial and/or military support is sponsored by an agency

Nav WG Documents (“Color Coded”)

- Current Work Items
 - [Conjunction Data Message \(CDM\)](#) (V.2 in progress)
 - Fragmentation Data Message (FDM) (White Book, just beginning)
 - Launch Data Message (LDM) (White Book, just beginning)
 - [Navigation Data Messages/XML V.3](#) (V.4 in progress)
 - Navigation Events Message (NEM) (White Book, just beginning)
 - [Tracking Data Message \(TDM\) V.2](#) (V.3 in progress)
- Completed Work Items
 - [Attitude Data Messages \(ADM\) V.2](#) (published Jan 2024)
 - [Navigation Data Definitions & Conventions V.4](#) (pub Nov 2019)
 - [Navigation Data Messages Overview V.3](#) (published Mar 2023)
 - [Orbit Data Messages \(ODM\) V.3](#) (published Apr 2023)
 - [Pointing Request Message \(PRM\)](#) (published Feb 2018)
 - [Re-Entry Data Message \(RDM\)](#) (published Oct 2019)
- New or “On Hold” Work Items
 - Navigation Composite Message (NCM) (approved 12-Jun-2024)

Lead & Co-Editors for Works In Progress

- Conjunction Data Message (CDM): Brian, Dan
- Fragmentation Data Message (FDM): Vitali
- Launch Data Message (LDM): Dan
- Navigation Composite Message (NCM): David
- Navigation Data: Definitions & Conventions (reformat): Julie
- Nav Data Msgs XML Spec (NDM/XML): David, Jose Miguel
- Navigation Events Message (NEM): Alain, Frank
- Tracking Data Message (TDM): Juan, Cheryl

Progress Since Spring 2024 Meetings

- CDM: Completed Agency Review, initiated Test Plan
- NDM/XML V.4: Completed CMC Agency Review poll, completed Agency Review, initiated application of RIDs
- NEM: Continued White Book progress
- PRM: Completed Reconfirmation process
- TDM: Completed internal WG review of version P-2.0.2
- SANA: Initiated reformatting of Nav Data & Definitions Green Book
- 4 Working Group telecons
- 13 of 37 Action Items completed (35.1%), 2 cancelled (5.4%), 22 remain open (59.5). Of the 22 open, 4 are dependent on other action items that are not yet complete.
- NOTE: Progress was good, but artificially low at least in part due to budget issues with the NASA Standards Program at JPL

Fall 2024 Meeting Objectives

- Current Items

- CDM: Continued discussion of Agency Review RIDs, Security Section & post Review comments, and Test Plan
- FDM: Continued discussion of White Book 1.0 material
- LDM: Continued discussion of White Book 1.0 material
- Nav Data - Defs & Conventions: Discussion of reformatting
- NCM: Initial discussion of issues and direction
- NDM/XML: Continued discussion of NDM/XML V.4, issues, & schedule
- NEM: Continued discussion of White Book 1.0 material
- RDM: 5 Year Review discussion
- SANA Registry: Discussion of current developments, upcoming registry changes
- TDM: Continued discussion of recent drafts and issues
- Joint Meetings with Delta-DOR & Time Mgmt WGs

- Future Items

- LunaNet... what Nav WG projects can contribute?

Current WG Members

1. David Berry - Chair (NASA/JPL)
2. Frank Dreger - Deputy Chair (ESA/ESOC)
3. Vitali Braun (ESA)
4. Juan Crenshaw (NASA/GSFC)
5. Cheryl Gramling (NASA/GSFC)
6. Julie Halverson (NASA/GSFC)
7. Kiyoshi Hamada (JAXA)
8. Hideaki Hinagawa (JAXA) (Unable to attend Fall Meetings)
9. Ralph Kahle (DLR) (Virtual for Fall Meetings)
10. Alain Lamy (CNES)
11. Jose Miguel Lozano (ESA/GMV)
12. Dan Oltrogge (NASA/Comspoc, ISO TC20/SC14)
13. Dianne Poster (NASA/NIST)
14. Brian Swinburne (UKSA/Airbus)
15. Patrick Zimmerman (NASA/JSC)

Useful Web Sites/Contacts

- Web Sites
 - www.ccsds.org – general web site of the CCSDS
 - <http://cwe.ccsds.org/moims/default.aspx> , then choose the “MOIMS-NAV” tab on the far left menu
 - All draft documents available, archived drafts too
 - Select ‘Marketing Materials’ from the menu for various papers and presentations on the use of CCSDS Nav WG standards
- E-mail Address
 - moims-nav@mailman.ccsds.org (general communication)
 - moims-nav-exec@mailman.ccsds.org (WG internal)
 - **Do NOT use the one that has "bounces" in the name**

Q&A

- ???
- ???
- ???
- ???
- ???
- ???
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- ???
- ???
- ???



Backup Slides

04-Nov-2024

- Contains technical material related to the Navigation Working Group Recommendations
 - Non-normative document
 - Has a different development process (all internal WG)
 - Work started early in the history of the Navigation WG (pre-2000)
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- Current issue: 4.0 published 11/2019
 - Next Steps: "5.0" revision plus segmentation of material into SANA Registry pages

- Contains high level overview of and use cases for Navigation Working Group Recommendations
 - Originally intended to be “Volume 2 of existing Navigation Green Book”; Area Director suggested just having 2 different Green Books (a simpler approach)
 - Non-normative document
 - Has a different development process (all internal WG)
 - Initiated at Berlin meetings Spring 2011
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- Current Issue: 3.0 published 03/2023
 - Next Steps: None at this time

Attitude Data Messages (ADM)

- Three standard message formats for exchanging spacecraft attitude descriptions
- Attitude Parameter Message (APM) is an attitude state at epoch, must be propagated
- Attitude Ephemeris Message (AEM) specifies a series of attitude states at multiple epochs, allows modelling of any number of torques, must be interpolated
- Attitude Comprehensive Message (ACM), analogous to ODM's "OCM" added
- Work started ~2003, became Blue Book 05/2008 (ISO Standard 13541:2010), Blue Book V.2 01/2024
- Infusion Status: NASA, ESA, Orekit, others

- Current issue: [Blue Book V.2](#)
- Next Steps: Further infusion

Conjunction Data Message (CDM) (CDM)

- Standard message formats for transmission of conjunction assessment data that will warn spacecraft operators of pending close approaches between their spacecraft and another spacecraft or on-orbit debris
 - Also provides information for satellite operators to use to make decisions regarding whether and how to maneuver in order to avoid space collisions
 - Added to Charter/approved for development in Fall 2010
 - First White Book January 2011, became Blue Book June 2013 (record?), ISO/DIS 19389, **currently in revision**
 - Infusion Status: USSF 18th Space Command, NASA/CARA, SDC, CNES, NASA/JPL, others?
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- Current issue: **Blue Book 1.0**, **Pink Book 1.1**
 - Next Steps: Complete V.2 Test Plan, Testing, XML schemas, Publication

Navigation Events Message (NEM)

- Standard message formats for exchanging information regarding predicted orbital events
 - Orbital events describe when and possibly how some situations occur (generally related to a satellite) and constitute a major data type used in operations centers
 - Proposed at Colorado Springs Spring 2009, Concept Paper Fall 2010, added to Nav WG Charter Spring 2011
 - Work item in Charter approved December 2011
 - Project approved August 2017, delayed by ADM update
 - Deliverables: Blue Book based on the “Events Message” Concept Paper, SANA Registry of Events
 - NOTE: Interest in this document by CSS/SM WG and CCSDS System Engineering Area (SEA)
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- Current issue: N/A
 - Next Steps: Complete White Book 1.0 draft, WG review

Navigation Data Messages/XML Spec (NDM/XML) (NDM/XML)

- Directive to put Navigation WG Recommendations into XML format came from CMC ~2002
- Describes an integrated XML schema set for encoding the ADM, CDM, ODM, RDM, and TDM
- Compatible w/ ODM 3.0; ADM & TDM 2.0; CDM & RDM 1.0
- Work started 05/2004, became Blue Book 12/2010 (ISO Standard 17107:2011), V.2 published 05/2021, V.3 published May 2023, **currently in revision**
- Fun Fact: was first “approved” registry in SANA Registry
- Other Desirable Work: Agency infusion
- Current issue: **Blue Book 3.0**, **Pink Book 3.0.1** (removes instructions for ADM/XML and ADM schemas, i.e., **ADM doc NDM/XML are out of phase**)
- Next Steps: Process Agency Review RIDs, testing, publish. V.4 could be "The Last Version"

Orbit Data Messages (ODM)

- Four standard message formats for exchanging orbit descriptions
 - Orbit Parameter Message (OPM) is a state vector
 - Position/velocity at epoch; must propagate
 - Orbit Mean Elements Message (OMM) is an orbit state
 - Mean Keplerian elements; must propagate
 - Orbit Ephemeris Message (OEM) is an ephemeris
 - Position/velocity at multiple epochs; must interpolate
 - Orbit Comprehensive Message (OCM) is a comprehensive message designed to contain much more detailed orbit info
 - Work started ???, became Blue Book V.1 09/2004 (ISO Standard # 22644 01/2006), Blue Book V.2 11/2009 (ISO Standard #26900:2012), Blue Book V.3 05/2023
 - Infusion Status: OEM, OMM, OPM widely used in ops
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- Current issue: [Blue Book 3.0](#)
 - Next Steps: Promote adoption of OCM

Pointing Request Message (PRM)

- Standard message formats for transmission of pointing requests in formal language
- Reduces “common language” pointing request errors
- The requested pointing could be pointing of a spacecraft instrument or of an onboard-antenna, within the future attitude sequence of the specified spacecraft
- PRM identifies S/C, onboard instrument, various constraints and rates, applicable epochs, other metadata
- Proposed at Berlin Fall 2008, Concept Paper Fall 2009
- Added to Charter Fall 2009, approved for development in Spring 2010
- First White Book Spring 2011, Blue Book 02/2018
- Agency infusion: ESA, also being used by MOIMS/MP WG

- Current issue: [Blue Book 1.0](#), reconfirmed 05/2024
- Next Steps: None

Re-Entry Data Message (RDM)

- The Re-entry Data Message (RDM) specifies a standard message format to be used in the exchange of spacecraft (re-)entry information between Space Surveillance and Tracking (SST) data providers, satellite owners/operators and other parties.
 - These messages can be used to inform spacecraft owners/operators of predicted re-entries or warn civil protection agencies about potential ground impacts.
 - Concept Paper 01/2016
 - Approved for development/added to Charter 06/2016
 - First White Book 08/2016, Blue Book 11/2019
 - Agency infusion: ESA, DLR
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- Current issue: [Blue Book 1.0](#) published 11/2019
 - Next Steps: 5 Year review Fall 2024

Tracking Data Message (TDM) (TDM)

- Standard message format for exchanging tracking data
- TDM supports widely used tracking data types:
 - Radiometrics: Doppler, range, angle, Delta-DOR, phase, optical
 - Ancillary information (e.g., meteorological, media delays, clock bias/drift)
- Work started 10/2003, became Blue Book 11/2007, Corrigenda published 09/2010, ISO 13526:2010, Blue Book 2 published 06/2020, **currently in revision (new reqts)**
- Infusion Status: in progress or complete at ESA, DLR, NASA/JPL, JHU/APL, ISRO, others
- Current issue: **Blue Book V.2, Pink Book V.2.0.2**

- Next Steps: Distribution and internal review of P-2.0.3 draft