



CCSDS Navigation Working Group

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Purpose

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

Agenda

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

- 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 23 smaller groups called “Working Groups” (WG). Also, “Special Interest Groups” (SIG) & “Birds of a Feather Groups” (BOF) (but there are none now)
- Each WG, SIG or BOF is associated with an Area
- Nav 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

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 (iterative process)
- Recommendation documents go through several stages: Proposed (“White”), Draft (“Red”), Final (“Blue”), Revised Draft (“Pink”)
- White Books are internal to the Working Group
- When White Book matures, promotion to Red Book occurs
- Formal Agency Review process commences (2-3 months)
- When Agency Review is passed, prototyping is complete and test reports filed, promotion to Blue Book occurs
- ISO standards 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)
- “Green Books” are non-normative technical reports
- There are other colors in CCSDS spectrum (yellow, orange)

Navigation WG Participating Membership

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

Nav WG Documents (“Color Coded”)

- Current Work Items
 - [Attitude Data Messages \(ADM\)](#) (Version 2 in progress)
 - [Orbit Data Messages \(ODM\)](#) (Version 3 in progress)
 - [Tracking Data Message \(TDM\)](#) (Version 2 in progress)
 - [Navigation Data Messages/XML Spec](#) (Version 2 in progress)
 - [Navigation Data - Definitions & Conventions \(Ver 4 in progress\)](#)
 - [Navigation Data Messages Overview](#) (Version 2 in progress)
 - [Re-Entry Data Message \(RDM\)](#)
 - Navigation Events Message (NEM, White Book in progress)
- Completed Work Items
 - [Pointing Request Message \(PRM\)](#)
 - [Conjunction Data Message \(CDM\)](#) (5 Year Revision starting)
- “On Hold” Work Items
 - Several “Draft” Projects and future ideas (FDM, LDM)

Lead Editors

- Attitude Data Messages (ADM): Alain, Julie
- Conjunction Data Message (CDM): TBD
- Navigation Events Message: Alain, Fran
- Navigation Data - Definitions & Conventions: Cheryl
- Navigation Data Messages Overview: Patrick
- Navigation Data Messages – XML Spec (NDM/XML): David
- Orbit Data Messages (ODM): Dan
- Pointing Requests Message (PRM): Fran
- Re-Entry Data Message (RDM): Alexandru
- Tracking Data Message (TDM) Version 2: David
- Tracking Data Message (TDM) Version 3: Cheryl

Progress Since Spring 2018 Meetings

- ADM: Version P1.7 published
- Navigation Data – Definitions & Conventions Green Book: Version 3.5.5 published
- Navigation Data Messages Overview: Version G1.0.2 published
- ODM: Some former annexes moved to SANA
- RDM: Agency Review completed, RID disposition commenced, prototyping commenced
- TDM: Agency Review completed, prototyping plan nearly final
- CDM: "CDM Originator" registry obsoleted, 5Y decision "revise"
- NDM/XML: Rev B of schemas posted, Version P1.0.1 published
- NEM: Requirements update published
- SANA: Material for time systems, orbital element sets, and orbit centers are now candidate registries on SANA.
- UNOOSA: Material added to compendium of international standards addressing orbital debris and the mitigation thereof
- Action Items: 26 of 42 completed (62%... last time 57%), 14 outstanding (33%), 2 cancelled (5%)
- NOTE
 - Spring to Fall Duration (days, 2015-2018): 226, 190, 176, 185
 - Fall to Spring Duration (days, 2014-2018): 133, 143, 199, 151

Fall 2018 Meeting Objectives

- Continue discussion of ODM Pink Book
- Complete disposition of RDM RIDs, continue discussion of RDM Test Plan
- Complete disposition of TDM RIDs, continue discussion of TDM Test Plan
- Continue discussion of Green Book Version 4 (3.5.5) update
- Initiate proposal for CDM 5 Year Revisions project
- Continue discussion of NEM infrastructure, XML Boot Camp
- Continue discussion of ADM Pink Book, new ACM material
- Continue discussion of material on SANA, meet w/SANA Operator
- Continue discussion of Navigation Data Message Overview
- Continue discussion of NDM/XML Pink Book

1. David Berry
2. Frank Dreger
3. Cheryl Gramling
4. Julie Halverson
5. Ralph Kahle
6. Alain Lamy
7. Alexandru Mancas
8. Fran Martinez
9. Dan Oltrogge
10. Brian Swinburne
11. Patrick Zimmerman

- 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
 - 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 traffic)
 - moims-nav-exec@mailman.ccsds.org (WG internal)

Q&A

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Backup Slides

- Contains technical material related to the Navigation Working Group Recommendations
- Non-normative document
- Has a different development process (all internal to the working group, with CESG approval)
- Work started early in the history of the Navigation WG (pre-2000)
- Most recent edition (3.0) was published 05/2010
- Green Book 4.0 project in progress; current issue is draft 3.5.5
- Next steps: Complete version 4.0 update

- Contains high level overview of and use cases for Navigation Working Group Recommendations
- Originally intended to be “Volume 2 of existing Navigation Green Book”; AD suggested just having 2 different Green Books (a simpler approach)
- Non-normative document
- Has a different development process (all internal to the WG, with CESG approval)
- Initiated at Berlin meetings Spring 2011
- Published 12/2015
- Green Book 2.0 project in progress; current issue is draft 1.0.2
- Next steps: Complete Version 2.0 update

- Two 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
- Work started ~2003, became Blue Book 05/2008 (ISO Standard 13541:2010), currently being revised as result of 5 Year Review, "Attitude Comprehensive Message" to be added
- Current issue is Pink Book 1.7
- Infusion Status: in daily use at NASA/GSFC, ESA
- Next Steps: Complete version 2 revisions (including "ACM"), initiate Agency Review

Conjunction Data Message (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, to provide 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
- Deliverable: Blue Book and schema based on the “Conjunction Assessment Message” Concept Paper
- First White Book January 2011, became Blue Book June 2013 (CCSDS record?), ISO/DIS 19389
- Infusion Status: JSpOC, NASA/CARA, SDC, CNES, others?
- Next Steps: 5 Year Revisions starting post-Fall 2018

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
- Deliverable: 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)
- Next steps: First White Book, XML infrastructure

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, ODM, and TDM
- Compatible with ODM 1.0, ODM 2.0, ADM 1.0, ADM P1.0.6, CDM 1.0, TDM 1.0
- Draft schema compatible with RDM R1
- Work started 05/2004, became Blue Book 12/2010 (ISO Standard 17107:2011), **currently being revised as result of 5 Year Review**
- Was first “approved” registry in the SANA Registry
- Other Desirable Work: Agency infusion
- Next Steps: Version 2 revisions (“qualified” vs. “unqualified” schemas, namespace revision, oemType changes, consolidation of "common" schemas)

Orbit Data Messages (ODM) (ODM)

- Four standard message formats for exchanging orbit descriptions
- Orbit Parameter Message (OPM) is a state vector
 - Position/velocity at epoch; must propagate
- Orbit Ephemeris Message (OEM) is an ephemeris
 - Position/velocity at multiple epochs; must interpolate
- Orbit Mean Elements Message (OMM) is an orbit state
 - Mean Keplerian elements; must propagate
- **Orbit Comprehensive Message (OCM)** is a comprehensive message designed to contain much more detailed info
- Work started ???, became CCSDS Blue Book V.1 09/2004 (ISO Standard # 22644 01/2006), CCSDS Blue Book V.2 11/2009 (ISO Standard #26900:2012), **currently in revision**
- Current issue is Pink Book 2.37
- Infusion Status: Orbit Data Messages are used in daily ops
- Next Steps: Complete Version 3 revisions, Agency Review

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 a pointing of a spacecraft instrument or of an onboard-antenna, within the future attitude sequence of the specified spacecraft
- PRM identifies spacecraft, onboard instrument, various constraints and rates, applicable epochs, and other descriptive metadata
- Proposed at Berlin Fall 2008, Concept Paper Fall 2009
- Added to Charter Fall 2009, and approved for development in Spring 2010
- First White Book Spring 2011, Blue Book 02/2018
- Next steps: Agency infusion

Re-Entry Data Message (RDM) (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 January 2016
- Approved for development/added to Charter in June 2016
- Deliverable: Blue Book and schema based on the “Re-Entry Data Message” Concept Paper
- First White Book August 2016, final version is WB7, Agency Review complete July 2018
- Next Steps: Conduct prototyping, publish.

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
 - 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, **currently being revised as result of 5 Year Review**
- Infusion Status: in progress or complete at ESA, NASA/JPL, JHU/APL, ISRO, DLR
- Current issue is Red Book 2, Agency Review complete
- Next Steps: Disposition RIDs from Agency Review, complete prototype testing, publish document, initiate TDM version 3 project.