MINUTES OF NAVIGATION WORKING GROUP SPRING 2018 WORKSHOP 22-May-2018
David S. Berry / Chair

The CCSDS Spring 2018 Meetings were conducted at the National Institute of Standards and Technology (NIST) in Gaithersburg, Maryland, USA during the week of 09-Apr-2018 through 13-Apr-2018. NASA hosted the meetings. This is a summary of the activities of the Navigation Working Group (WG) during the week. The Navigation WG is an element of the Mission Operations and Information Management Services (MOIMS) Area in the CCSDS organization.

ON-SITE PARTICIPANTS

Brigitte Behal (CNES), David Berry (NASA/JPL), Ling Chen (NSSC/CAS), Frank Dreger (ESA/ESOC), Cheryl Gramling (NASA/GSFC), Julie Halverson (NASA/GSFC), Alain Lamy (CNES), Hu Li (CAS), Alexandru Mancas (ESA/ESOC), Francisco Martinez (ESA/ESOC/GMV), Mario Merri (ESA/ESOC), Dan Oltrogge (NASA (AGI, SDC, ISO TC20/SC14)), Brian Swinburne (UKSA/Airbus), Patrick Zimmerman (NASA/JSC).

TELECON PARTICIPANTS

Dale Force (NASA/GRC).

AGENDA

The final agenda for the WG meetings is available on the Navigation WG CWE at: https://cwe.ccsds.org/moims/docs/MOIMS-NAV/Meeting%20Materials/2018/Spring/navwg-agenda-201804.pdf . In the meeting proceedings below, the detailed agenda for each meeting day is included in the minutes to provide context.

CURRENT ACTION ITEMS

The following action items were produced during the meetings. They are also available on the CWE at https://cwe.ccsds.org/moims/docs/MOIMS-NAV/Meeting%20Materials/2018/Spring/navwg-action-items-201804.pdf . The action items and due dates below reflect the status as of the end of the meetings; the list on the web page will be updated periodically between now and the next meeting series and will thus reflect relative completion progress and any new action items added after the face-to-face meetings. The list also includes a few items from prior meetings that had not yet been completed.

New Action/Outstanding Action Items

##	Action Item	Actionee	Due Date (Original)	Due Date (Current)
52	XML Section for ADM	David Berry	31-Dec-2016	24-Apr-2018
10	Request deletion of "CDM Originator" SANA Registry	David Berry	09-Apr-2018	24-Apr-2018
33	Update "NEM Requirements" document and send it by 04/27/2018.	Alain Lamy	27-Apr-2018	27-Apr-2018
38	Request updates to SANA infrastructure	David Berry	30-Apr-2018	30-Apr-2018

##	Action Item	Actionee	Due Date (Original)	Due Date (Current)
	on PRM Registry (Provisional => Assigned, Policy, Authority, etc.)			
3	Draft Test Plan Section for TDM Phase Counts	Fran Martinez	09-Apr-2018	01-May-2018
19	Review SANA Registry annex information (time, frames, etc.)	All	14-Mar-2018	01-May-2018
15	Finalize SANA Registries for Time Scales, Reference Frames, Element Sets, etc.	All	21-Mar-2018	08-May-2018
26	XML Section for ODM (update)	David Berry	08-May-2018	08-May-2018
29	Review the Time System material targeted for the SANA Registry and "make it perfect"	Frank, Fran, Cheryl	08-May-2018	08-May-2018
42	Re-type attitude material LATeX	Julie Halverson	08-May-2018	08-May-2018
25	Produce ODM P2.38	Dan Oltrogge	15-May-2018	15-May-2018
27	Fix errors in draft RDM XML schema to conform to the RDM draft (keyword change, number of segments => 1)	David Berry	15-May-2018	15-May-2018
32	Define schema that can be used with an XML editor to define events and parameters that go with it to validate the event description	Fran Martinez	15-May-2018	15-May-2018
36	Prioritize SANA Annex material	All	16-May-2018	16-May-2018
41	Produce Navigation Data Messages Overview draft #1	Patrick Zimmerman	16-May-2018	16-May-2018
37	Provide SANA Annex material to SANA Operator	David Berry	17-May-2018	17-May-2018
98	Produce Navigation Events Message initial draft	Alain Lamy	31-Jan-2018	21-May-2018
30	Provide content on international standards to UNCOPUOS/LTSSA WG	Dan, David	31-May-2018	31-May-2018
31	Look at implementation of epoch time system in abstract type, convey preference to Colin	Fran Martinez	31-May-2018	31-May-2018
39	Provide "Description" for each template on PRM Registry	Fran Martinez	31-May-2018	31-May-2018
100	Produce Navigation D&C Green Book 3.6	Dale Force	01-Mar-2018	13-Jun-2018
40	Provide "XML Boot Camp" session (dedicated telecon?)	Fran Martinez	20-Jun-2018	20-Jun-2018
28	Review Navigation D&C Green Book 3.6	All	27-Jun-2018	27-Jun-2018
7	Request CESG Poll for Navigation D&C Green Book 3.6	David Berry	13-Apr-2018	27-Jun-2018
35	Produce ACM Draft 3	Julie Halverson	30-Jun-2018	30-Jun-2018
22	Produce NDM/XML P1.1	David Berry	31-Jan-2016	15-Jul-2018

##	Action Item	Actionee	Due Date (Original)	Due Date (Current)
34	TDM Version 3 initial thoughts... send to Cheryl	All	01-Oct-2018	01-Oct-2018
83	Navigation Data Messages KVN Structural Requirements	Alain, Cheryl, Dan, David, Julie	30-Sep-2017	15-Oct-2018

WORKSHOP PROCEEDINGS

DAY 1, MONDAY 09-APR-2018

0800 0830 Registration
0830 1030 CCSDS Opening Plenary
1030 1130 MOIMS Opening Plenary
1130 1230 Admin: Agenda, Intro to NavWG, Guidelines, Prev Action Items
1230 1330 Lunch
1330 1510 Re-Entry Data Message + Prototyping Plan + Project Schedule
1510 1630 Deep Space Gateway / Lunar Orbit Platform Gateway Discussion
1630 1730 Orbit Data Messages V.3 + Prototyping Plan + Project Schedule

0830 1030 CCSDS Opening Plenary

The CCSDS Spring 2018 Meeting series started with a CCSDS Opening Plenary attended by all participating CCSDS members. Margherita di Giulio (new CESG Chair) chaired the meeting. We started with guest speakers:

- Dr. Kent Rochford, Associate Director for Laboratory Programs, NIST. Dr. Rochford welcomed everyone to NIST in his brief opening remarks.
- Phil Liebrecht, NASA SCaN's Assistant Deputy Associate Administrator followed with some remarks about the National Space Policy Council Directive 1: "Go to the Moon, as a stepping stone to Mars". He asserted that standards are critical this effort. He briefly covered upgrades in the NASA's Deep Space Network, Near Earth Network, and Space Network and stated that SCAN is looking for fully connected interoperable space assets that will enable "roaming around the globe" or even the Solar System. He spoke of a hybrid antenna design because optical communication is not the right answer for all data needs. A Laser Communications Relay Demonstration mission will launch in 2019. At NASA, they are calling this "The Decade of Light", a reference to the optical comm. There is a need for wideband forward links; the current ISS uplink at 25 Mb/sec is totally inadequate. He noted that the space communications market is small in general, but the combined activities of the world enlarge the market.
- Vincent Cerf, the "Father of the Internet", followed. He now works on global standards and will be on the NASA Advisory Council. He stated that it is important for the CCSDS to succeed. Lots of investment and lots of cooperation are required. Progress is really difficult in the absence of standards. His to do list includes deployment of the "Bundle Protocol" (BP), citing that the simple concepts of TCP/IP don't work in space (e.g., flow control). This realization led to the development of Delay/Disruption Tolerant Networking (a store-and-forward concept), which is now well beyond the theoretical phase. He noted that the ISS is a useful platform to evolve DTN concepts. An example communications path: McMurdo/Antarctica => TDRSS => ISS => TDRSS => ground (White Sands).

There are also many Earth-based applications of DTN (e.g., US Navy deployments). The important take-away is the generic character of the BP. Another big issue is Digital Preservation. Retaining and being able to use the accumulated data of the Space Age, being able to go back and re-analyze collected data. Sometimes we find that we have failed to preserve the data. Media issues, hardware reader problems, software reader problems, and other issues can all defeat digital preservation efforts. The CCSDS DAI WG standards are an important step in the right direction, working to answer a critical question: what does it mean to operate an archive, to preserve data for the future? The CCSDS is all about "interoperability". We need archives that work together with each other. The interoperability framework for the OAIS facilitates collaborative and distributed mutual reinforcement among archives. We need to make use of data in the future!

Afterwards David Ross of the CCSDS Secretariat spoke on the traditional set of various logistical matters and items of general interest (e.g., wireless access, future meeting schedule, details of start/stop times, break times, lunch, security, etc.).

There were some important announcements made in this meeting, as follows:

1. The CCSDS is planning the following upcoming meetings:
a) Fall 2018 hosted by DLR at Berlin, Germany, dates 15-Oct-2018 to 19-Oct-2018
b) Spring 2019 hosted by NASA at TBD, USA, dates TBD
c) Fall 2019 hosted by ESA/ESOC at Darmstadt, Germany (4-day), dates 21-24 October
d) Spring 2020 hosted by NASA at TBD, USA, dates TBD
e) Fall 2020 hosted by CNES at TBD, France, dates TBD
f) Spring 2021 hosted by NASA at TBD, USA, dates TBD

2. The "Boot Camp" session will be on Friday from 0845-1200, Dining Room A. It was pointed out that those who are editing CCSDS documents must attend the Boot Camp (at least once).

3. The number of missions that have used CCSDS standards in some respect is now up to 1094 (the count is now calculated using the SANA Registry).

4. Margherita gave some updates from the perspective of the CESG:
- There have been many polls since November 2017 (Fall Meetings)
- The CSS has a new Deputy AD: CSS Colin Haddow
- James Afarin is now the CCSDS Liaison to the IOAG
- Yuxia Zhou is being voted as the SC13 Chair
- The Navigation Hardware Message (NHM) has been demoted to a Draft Project.
- There are 86 approved projects on the CWE (22 in MOIMS)
- New CESG work includes: a SOIS/SIS Strategic Plan and a CWE RID Tool in Excel format that has been prototyped

5. The number of people registered for the meetings is 185.

6. There are 150 active CCSDS documents (92 normative, 58 informative).

After these announcements and opening proceedings, the final portion of the General Plenary involved the Directors of the six CCSDS Areas presenting the detailed plans for the week for their respective areas.

1030 1130 MOIMS Opening Plenary

The overall CCSDS Plenary was followed immediately by the MOIMS Opening Plenary meeting, which was chaired by Area Director Mario Merri. Mario gave an overview of the status of the MOIMS working groups, as follows:

- DAI (Data Archive Ingest) has good momentum, very active WG with Long Term Data Preservation (LTDP) and archive architecture in discussion.

- Navigation has high momentum; it is a very active WG with a lot of ongoing work.

- SM&C (Spacecraft Monitor & Control): Focusing on Mission Operations (MO) services. A good momentum, very active WG with an ambitious work plan, slow implementation. Need to promote more usage with user community.

- MP&S (Mission Planning & Scheduling): High momentum. This is the youngest WG in MOIMS. A Green Book has been finished, and they are working on a Blue Book.

- Telerobotics: No momentum. The WG is basically on hold. The Blue Book project has been demoted to a draft project. Mario is reluctant to disband the WG because he sees its domain as part of the future of space exploration.

Mario tasked the 4 working groups with discussing a MOIMS Featured Topic: What is MOIMS' role in the Lunar Orbiter Platform Gateway (LOP-G) (formerly Deep Space Gateway), a new multi-Agency exploration project in planning. It represents the "Next Generation ISS", but will orbit the Moon. Mario suggested that the MOIMS WGs focus on the ground segment. All were asked to discuss in their respective WG meetings how MOIMS standards could be injected into the LOP-G and thereby be more influential. Can we do better than ISS in other CCSDS areas, in particular MOIMS (DAI, NAV, MP&S, SM&C, TEL)? WGs were asked to report their conclusions at the MOIMS closing plenary.

Mario closed his presentation by stating that we need to improve "the feeling" in the CCSDS, e.g., that we are space enthusiasts working together towards a common goal. In response to a question from David, it was confirmed that the report format for WG Chairs for Closing Plenary reports has not changed from the Fall 2017 Meetings. Mario concluded by requesting that WG Chairs keep Mario and Brigitte involved and let them know if there are any meetings they should attend. Mario announced that the MOIMS Dinner would be held on the evening of Wednesday 11-Apr-2018 at 1830.

1130 1230 Admin: Agenda, Intro to NavWG, Guidelines, Prev Action Items

The Navigation WG meeting was started immediately after the close of the MOIMS Opening Plenary. In attendance this day were David Berry, Frank Dreger, Cheryl Gramling, Julie Halverson, Alain Lamy, Alexandru Mancas, Francisco Martinez, Dan Oltrogge, Brian Swinburne, Patrick Zimmerman.

Given that we had a new member with us, we started by making introductions around the room. Then David reviewed the agenda for the week, presented the "Introduction to the Navigation WG" material, refreshed everyone on the Working Group Guidelines, and briefly looked at outstanding Action Items from The Hague. There were no updates to these Action Items since they had been updated at the recent 28-Mar-2018 telecon and also just prior to the meetings based on a few that were completed since that telecon. As is customary, the introductory presentation highlighted the progress since the Fall 2017 meetings and set the priorities for the meeting week. The presentation is also available on the CWE at

https://cwe.ccsds.org/moims/docs/MOIMS-NAV/Meeting%20Materials/2018/Spring/navwg-intro-201804.pdf . Review of the action items from The Hague showed that as of the start of the meetings, 28 of 42 were completed (57%), 14 remained outstanding (43%), and 0 were cancelled (0%). Overall, the percentage of action items completed was quite good considering that the time between the end of Fall Meetings and beginning of Spring Meetings was relatively short this time.

1330 1510 Re-Entry Data Message + Prototyping Plan + Project Schedule

Alexandru provided a nice presentation that covered the current status of the RDM, developments since the Fall 2017 Meeting, and his assessment of the current document schedule. David updated the formal RDM document plan on the CWE. The RDM is currently in the CESG Poll required to advance to Agency Review. The poll started 28-Mar-2018 and ends 23-Apr-2018 (a longer than usual poll given the CCSDS Technical Meetings and CESG Meeting in the middle). No votes on the poll had yet been received as of this meeting. Alexandru noted that the ESOC Space Debris Office Re-Entry Prediction System (RPS) already basically comprises a prototype of the RDM, but GSOC (Prototype #2) needs to develop the conversions to their RPS to conform to the RDM. Thus he would prefer not to start the RDM prototyping until the Agency Review has been completed and the RIDs from the Review have been applied. DLR can then proceed with their software modifications with greater confidence. Alexandru then walked the group through the RDM Prototyping Test Plan. He also noted that there are some necessary changes to the draft RDM/XML schema (one keyword has changed, also, the schema allows for unlimited segments but there should only be one). David has an action item to update the RDM draft schema.

1510 1630 Deep Space Gateway / Lunar Orbit Platform Gateway Discussion

Given that the RDM discussion had not taken as much time as had been scheduled, there was an opportunity to discuss the NavWG response to Mario's assignment from the MOIMS Plenary Meeting. The group brainstormed on the topic "What is the MOIMS role in the Lunar Orbiter Platform Gateway (LOP-G) (formerly Deep Space Gateway)" and derived the following material. David will report the material at the MOIMS Closing Plenary (see below).

- Principle: Don't have unique standards just for LOP-G/DSG... similar to concept with small satellites, i.e., use/adapt existing, or identify gaps and develop standards
- Question: Do we expect special requirements from LOP-G/DSG?
- Use Cases:
  - Potential need for more real time data exchange between entities (e.g., CSTS/Tracking Data Service, particularly for outbound missions to LOP-G/DSG (construction/re-supply); potential implication for MOIMS/SIS jointly developed messaging protocol
  - Support of navigation when DTN with multi-hops is in use (but there are several problematic aspects that have not to date been adequately addressed)
- Potential NavWG Standards Useful for LOP-G/DSG (all partners)
  - ODM - knowledge of position/velocity/accelerations of vehicle(s), proximity operations, contact acquisition data
  - ADM - approach and rendezvous up to docking, proximity operations
  - ODM/ADM in combination (or future message) to convey inertia matrix, center of gravity, etc.
  - CDM - general lunar environment conjunction assessment (existing & future lunar orbiters, potential future debris created in spacecraft ops)
  - ODM/ADM/CDM in combination to coordinate avoidance maneuvering
  - TDM - tracking of the LOP-G/DSG (with CSTS/Tracking Data Service), potential need to add optical image navigation observable
  - PRM - use case: pointing an onboard optical telescope (raster scan survey of local environment),

pre-EVA environment scanning.
- NEM - AOS, LOS, umbra, penumbra, RFI mitigation
- RDM - end of life studies/planning (future application)

1630 1730 Orbit Data Messages V.3 + Prototyping Plan + Project Schedule

Given that we were a little ahead of schedule, Dan commenced with Tuesday's opening topic, the ODM V.3, discussions of prototyping, and modifications to the project schedule. We started working through the CRM containing comments on ODM P2.36. Much of the discussion focused on a comment relating to the use of absolute and relative time in the OCM. There is some ambiguity with relative time in the OCM, but generally the relative time is meant to be with respect to the EPOCH_TZERO, not any other time. Fran pointed out that in the NEM we advocated for times relative to other events, so it is a bit different than what is being advocated for the ODM. Dan will make it clear that relative times in the OCM are all relative to the EPOCH_TZERO keyword, and no other time.

NOTE: During the discussion of schedule, Alexandru observed that the project schedules in the CWE Framework have dates in the "American" format (mm/dd/yyyy), however, many CCSDS WG members are more comfortable with a different format (dd/mm/yyyy). It was suggested that the project schedules use a standard format that is not ambiguous (e.g., dd-MMM-yyyy, where "MMM" is the letter abbreviation of the month, such as 13-Apr-2018). This will be suggested in the Closing Plenary report.

DAY 2, TUESDAY 09-APR-2018

0845 1200 Orbit Data Messages V.3 + Prototyping Plan + Project Schedule
1200 1300 Lunch
1300 1545 Navigation Events Message + Project Schedule
1545 1645 Joint Meeting w/CSSM on Navigation Events Message
1645 1730 Navigation Events Message + Project Schedule
1830 ???? NavWG "PRM Celebration" Dinner @ Old Town Pour House

In attendance this day were David Berry, Frank Dreger, Cheryl Gramling, Julie Halverson, Alain Lamy, Alexandru Mancas, Francisco Martinez, Dan Oltrogge, Brian Swinburne, Patrick Zimmerman. We also had visitors Ling Chen and Hu Li.

0845 1200 Orbit Data Messages V.3 + Prototyping Plan + Project Schedule

Dan continued working through CRM comments to the ODM P2.36 and a few comments already received on ODM P2.37. During this process, we continued detailed discussion of the use of time scales in the OCM. Frank, Fran, and Cheryl have assignment to review the Time System material targeted for the SANA Registry and "make it perfect" (per Dan). During this discussion Dan mentioned the ongoing activities of the UNCOPUOS Long Term Sustainability of Space Activities Working Group. He indicated the apparent lack of focus on, and even awareness of, international space standards within not only LTS but also across the UNCOPUOS organization. David stated that this had been something he had tried to impress upon the LTSSA when he was a member of one of the Expert Groups. They cited "standards" in one of their guidelines, but for some reason were reluctant to add the word "international" in front of "standards" (which was difficult to understand in the UNCOPUOS environment). Dan and David took an action item to provide content on international standards to the LTSSA Working Group. (Side note: Dan has just been officially selected as U.S. Head-of-Delegation to ISO/SC14/TC20... congratulations Dan!) As Dan went through the ODM CRM, it was found that there was still some attitude related material in the OCM; the group discussed and elected to remove attitude material from the

OCM, with the exception of the long-standing orientation (attitude rule) specification associated with the "Optimally-Enclosing Box" shape. Finally, we initiated very preliminary discussion on the ODM prototype testing plan, which in principle can be focused almost exclusively on the OCM given what are thought to be negligible changes in the OPM, OMM, OEM in that document. An XML test of the OPM, OMM, OEM may be necessary, but that is fairly straightforward. We imagined that AGI/SDC/ComSpOC would produce a full prototype, given their advocacy for and interest in the scope of the OCM. The second prototype will likely be partitioned across multiple other WG members to test portions of the OCM given that Dale Force's GRC funding for CCSDS work has been discontinued.

1300 1545 Navigation Events Message + Project Schedule

In preparation for a joint meeting with the CSS/Service Management (CSS/SM) WG, attendees discussed requirements for the NEM, which uses the XML event structure defined in conjunction with the CSS/SM. There is some question as to whether or not the structure is compatible with a KVN representation, but it's perhaps too early to definitively determine that. It was noted that some users of NavWG products prefer the XML format, some prefer the KVN, so it is probably better if we can accommodate both formats. We discussed some design objectives and requirements:

- Try to avoid an ICD (given CESG current direction)
- Use a pre-defined list of events (preferably on SANA)
- Leave the NEM open to customization by the user
- Keep the events as small as possible (restrict to only mandatory information)
- Keep the number of parameters to a minimum
- Define conventions for event attributes

There was some discussion as to whether or not event definitions should be limited to one spacecraft. Consensus was that allowing more than one spacecraft in an event would make the message more general (e.g., "ANGLE_BETWEEN <spacecraft1, spacecraft2> is X" was offered as an example two spacecraft event which would be useful for constellations, or formation flyers). Several extensibility options were discussed. Towards the end of the session, Frank proposed a concept that we didn't have time to discuss prior to the scheduled joint meeting with the CSS/SM WG, but we returned to it later. Specifically, Frank proposed defining the event schema, and use it to define a KVN instantiation.

1545 1645 Joint Meeting w/CSSM on Navigation Events Message

Per Erik Barkley's suggestion, the NavWG met with the CSS/SM WG to further discuss the concept of events. Erik described one of their standards in development, the "Planning Info Format" (PIF) which is close to Agency Review (target 10/2018). This standard will make use of events relating to (1) one or more apertures, for planning (e.g., rise, set, occultations, max elevation, RTLT) and (2) communications geometry. They have parameters that don't affect the abstract event definition. The PIF is not dealing with spacecraft to spacecraft events (though it is very conceivable that the NEM will). Per Fran, from a theoretical point of view, the abstract type defined by Colin Haddow is sufficient to meet NavWG needs. Some other aspects of PIF events are:

- PIF has small list of defined events but doesn't exclude development of others.
- CSS/SM will define parameters, the user can add additional events and additional parameters
- Events are predicted only (for planning purposes only), the PIF is not meant for "historical" purposes.
- Will not cover RFI planning; covers estimated data acquisition events
- All parameters are expressed as attributes of the element; tag names are the name of the event.
- UpperCamelCase event names used

- The PIF schema uses strong validation

It was indicated that the CSS/SM WG has already done some preliminary prototyping. Colin said he would send the UML and XML versions to Fran and will also send latest draft of the PIF. Mindjet is the software Erik used to visualize the relationships. Fran took an action item to look at the implementation of the epoch time system in the abstract type and convey the NavWG preference to Colin by the end of May.

1645 1730 Navigation Events Message + Project Schedule

After the joint meeting with CSS/SM, we continued NavWG discussion of the NEM. Frank reiterated his opinion that we should define a schema that can be used with an XML editor to define events and parameters that go with it to validate the event description. This was discussed at some length; Fran helped out significantly by showing us work he had quickly done during the afternoon along the lines of this concept using XML Spy to prototype Frank's idea. Seeing this in action was persuasive, even though it was a quick prototype. Fran has an action item to elaborate the work a bit and report at the next telecon. Alain took an action item to update the "NEM Requirements" document and send it to the WG. The NEM schedule on the CWE was reviewed; the WG agreed that it is still current and did not require adjustment. Other comments on events:

- Per Alain, we need the events list to be agreed
- Per Dan, we need a construct that can be rapidly expanded
- Per ????: we should have examples of common events
- It was noted that it will be difficult to avoid duplication of events in SANA or another events data base if we have a large number of them

1830 ???? NavWG "PRM Celebration" Dinner @ Old Town Pour House

The WG formally celebrated the publication of the PRM! First round of beers was on Fran, the intrepid Lead Editor for the standard. A new tradition is established. Alexandru is already making plans for the RDM celebration in Fall 2019, assuming trends hold.

DAY 3, WEDNESDAY 11-APR-2018

0845 1010 Tracking Data Message V2 + Prototyping Plan + Project Schedule
1010 1045 Tracking Data Message V3 Initial Thoughts
1045 1230 ADM Pink Book Updates+"Attitude Comprehensive Msg" + project sched
1230 1330 Lunch
1330 1530 ADM Pink Book Updates+"Attitude Comprehensive Msg" + project sched
1530 1645 Navigation Data: Defs & Conventions Green Book + Project Schedule
1645 1715 Deep Space Gateway / Lunar Orbit Platform Gateway Discussion
1715 1730 Free
1830 ???? Mario's MOIMS Area Dinner

In attendance this day were David Berry, Frank Dreger, Dale Force, Cheryl Gramling, Julie Halverson, Alain Lamy, Alexandru Mancas, Francisco Martinez, Dan Oltrogge, Brian Swinburne, Patrick Zimmerman. We also had visitors MOIMS Area Director Mario Merri and MOIMS Deputy Area Directory Brigitte Behal.

0845 1010 Tracking Data Message V2 + Prototyping Plan + Project Schedule

David presented the TDM Test Plan/Test Report version 1.2 test by test, and the WG edited as applicable, creating version 1.3 of the plan. Outlines of the testing for 5 of the 6 tests in the plan relating to new data types and new metadata keywords are now present. Fran has an action item to provide data for Test Case #3 (Phase Counts). During the discussion of Test Case #4 (Optical Magnitude), we had some discussion regarding apparent/absolute magnitude for the optical measurements. Alex and Tim Flohrer had discussed this topic in response to an action item from a prior meeting and decided that the absolute magnitude could be removed from the TDM (this removed the need for a metadata keyword as well). Dan raised a concern about removing the absolute magnitude (which is included in the OCM in the Space Object Physical Characteristics" section), but Alex argued that the absolute magnitude is something that cannot be measured and is therefore outside the TDM. David noted that the TDM does allow for observables that are calculated based on measurements, but Alex felt keeping the absolute magnitude in the TDM was not necessary. Finally, the CWE schedule for the TDM was adjusted to bring it into line with current expectations. David has an action item to send out the Test Plan version 1.3 to the WG.

1010 1050 Tracking Data Message V3 Initial Thoughts

In accordance with the plan for the TDM adopted at the Fall 2016 meetings in Rome, we will start a TDM Version 3 project immediately upon publication of the TDM Version 2. Cheryl went through an outline of initial thoughts for the TDM V3 which included discussion of new/improved precision and measurement types: optical imaging navigation, celestial nav (pseudo angles to celestial objects), cross-link measurements, and validity of angles for each participant. There was also additional material related to relay tracking motivated by NASA's Space Network (TDRSS). Given the "universal, modular message" we have been discussing, Cheryl's material also covered flexibility and thoughts on how the TDM V3 material might fit into the NDM/KVN concept. An action item was assigned to "All" to review these TDM V3 initial thoughts and send comments or additional ideas to Cheryl. Because the TDM Version 3 is not yet an official project, there was no CWE schedule to adjust. Around the time the TDM Version 2 is published, we will request a Resolution from Mario to open a new project for the TDM Version 3. This could be as soon as December 2018 given that the CWE schedule for CMC acceptance of the TDM is in November 2018.

1050 1230 ADM Pink Book Updates+"Attitude Comprehensive Msg" + project sched
1330 1530 ADM Pink Book Updates+"Attitude Comprehensive Msg" + project sched

Alain walked through the ADM P1.6 and he started the ADM P1.7 which incorporated real time changes to the document. We discussed the "Attitude Comprehensive Message" (ACM)also, but did not at this time make a formal commitment to include it in the ADM Version 2 (but see the notes from Friday morning's session). For the afternoon session, we were joined by Mario Merri and Brigitte Behal. In the afternoon we continued discussion of the ACM analogue to the Orbit Comprehensive Message (OCM) in the ODM, which will most likely be added to the Version 2 ADM as a third message type.

1530 1645 Navigation Data: Defs & Conventions Green Book + Project Schedule

Dale was not able to travel to the meeting, so he joined the meeting via telecon. He reviewed the changes he had made in Version 3.5. He stressed the need to be able to find references, and has expended a fair amount of effort in ensuring public availability of the references. Work to go includes completing the reference cleanup and finding the source for Figure 4-6. Dale also stated that he planned to add a paragraph on xray/pulsar navigation. Cheryl and David expressed that they did not think this necessary given that there is no standard to support this technique and thus it did not really belong in the Green

Book at this time. This is particularly relevant given Dale's funding scenario. It was observed that the vector equations appeared mangled in the version Dale displayed on the Webex but looked correct in Cheryl's version on her Mac. This led to a discussion (led by Mario) of the situation with the MS Word Equation editor and the topic of proposing that the CCSDS Editor Tom Gannett update from *.doc to *.docx versions of MS Word (note that this change might not fix this particular problem). David stated his view that he doesn't think this is a WG responsibility; Dan voiced the counterview that Tom should update to *.docx and he thinks it's the WG responsibility to raise the issue. Mario will address the issue to the CESG/CMC as he feels appropriate. David inquired as to Dale's time availability given that his official funding has been cut; he has been allowed to complete work in progress but not start anything new. During this discussion he also confirmed that he would not be able to participate in the OCM prototyping as had been previously planned; this was not unexpected given the funding scenario. He also confirmed that he doesn't have much time to work on the Green Book updates and estimated that he could have Version 3.6 (final?) in a month or two. We hope to be able to advance a Resolution for approval to publish prior to the Fall 2018 Meetings. One minor change suggested was to add "RU" (range units) to the appendix on abbreviations.

1645 1715 Deep Space Gateway / Lunar Orbit Platform Gateway Discussion

Given that the Navigation Data - Definitions and Conventions discussion ended a bit early, and the fact that Mario and Brigitte were in attendance, the material developed by the WG in response to Mario's special assignment from the MOIMS Opening Plenary was previewed for them. The material previewed is shown in the MOIMS Closing Plenary Report material below.

1830 ???? Mario's MOIMS Area Dinner

At the end of the day, a few members of the Navigation WG went to Mario's MOIMS Area Dinner.

DAY 4, THURSDAY 12-APR-2018

0845 0900 Miscellaneous Admin
0900 0930 Update ADM project schedule (ACM formal third message)
0930 1000 Navigation Data Messages XML Spec update + Project Schedule
1000 1210 Annex Migration to SANA (Time Systems, Ref Frames, Element Sets)
1210 1230 Navigation Events Message (XML Schema Generator for Events)
1230 1330 Lunch
1330 1430 Navigation Events Message (XML Schema Generator for Events)
1430 1450 Nav Data Messages Overview update (post-PRM/TDM)+project schedule
1450 1510 Object Defs on SANA Registry? LDM and/or FDM:Start formal projects?
1510 1730 Navigation Data Messages KVN + Project Schedule

In attendance this day were David Berry, Frank Dreger, Cheryl Gramling, Julie Halverson, Alain Lamy, Alexandru Mancas, Francisco Martinez, Dan Oltrogge, Brian Swinburne, Patrick Zimmerman. We had guest Julien Bernard of the SANA Operator.

0845 0900 Miscellaneous Admin

S-l-o-w start this day... David arrived late and there was no discussion as people quietly attended to their email, etc.

0900_0930_Update ADM project schedule (ACM formal third message)

We discussed the Attitude Comprehensive Message, which we had discussed informally at The Hague, but had never officially added to the ADM update plan. Between the Fall and Spring meetings, Julie had made two drafts of an ACM to show what it could look like. At the conclusion of this discussion, the group formally decided to add the ACM to the ADM update, with Julie as lead editor for this new material. An action item was added to produce an updated version of the ACM to add to the ADM document. The ADM schedule was adjusted to account for the additional time required to add the ACM.

0930_1000_Navigation Data Messages XML Spec update + Project Schedule

David explained that the existing plan for the NDM/XML update has involved completing the updates to the ODM, ADM, and TDM, and then removing the applicable material from the NDM/XML document. However, this set of document updates may not be complete for some time. For this reason, an initial draft of the NDM/XML is slipping into the future too. David suggested that it may be possible to revise the NDM/XML document iteratively. In this plan, the NDM/XML Version 2 Blue Book would remove only the TDM material given that the TDM Version is potentially on track to be completed in early 2019. Then a Version 3 could be produced when the revised versions of the ODM and/or ADM are published. This proposal would increase administrative overhead due (resolution, polls, Secretariat, etc.), but according to Mario's thinking no prototyping would be necessary given that already tested material is being removed from the document. This tentative plan essentially arose during the discussion, and we ran out of time given that we had a guest arriving for the following meeting. The plan will be formally proposed and discussed during a telecon.

1000_1210_Annex Migration to SANA (Time Systems, Ref Frames, Element Sets)

We were joined by Julien Bernard of the SANA Operator (Viagenie) to discuss the proposed migration of material from Navigation WG normative annexes into SANA registries. Julien noted that the SANA team has already determined a way to support equations and files in the SANA Registry, as requested by the NavWG, and they are working on support of images (but it is not supported yet). The WG had a few questions for Julien. For example, we wondered how the conversion of material from provided drafts into registries is completed. David showed a couple of existing registries that were clearly not created by hand (e.g., the Delta-DOR X-Band Radio Sources registry has over 3600 entries of detailed numerical data with some fields having up to 10 significant digits). Julien suggested that if the NavWG material was provided in XML format, the Viagenie team has tools that will allow them to migrate it easily into the Registry formats. (The NavWG material will not be as demanding as the Delta-DOR registry, but it will be better if there is some automation.) The WG expressed interest in getting documentation on the required formats; Julien indicated that since there had been a major reorganization of the overall Registry structure relatively recently, he wasn't sure if the conversion documentation had been updated yet. The WG was interested in how long the queue is to get material into the SANA (since we are familiar with the length of the Secretariat queue, we also observe that there are many registries still marked as "Provisional" rather than "Assigned', and some obviously incomplete registries such as abbreviations for many of the entries in the "Organizations" registry). Julien expressed that the SANA team has a commitment to produce the material requested by the NavWG. We discussed a few cleanup items as well for the registry containing PRM templates, specifically, change the template statuses from "Provisional" to "Assigned, change the policy from "TBD" to, change the "Authority" from "TBD" to "CCSDS.MOIMS.NAV", and add a brief description to the "Description" column. David and Fran received action items for these changes. The NavWG is still finalizing the content to place on the SANA, but once it is finalized we will submit it to the SANA Operator. It is unclear how long it will take to migrate material to the SANA, but David noted that he has had good experience with the rapidity with which the SANA team can operate. Note that once all of our registries have been created, we will need to

have Corrigenda retroactively applied to the various documents (ODM, ADM, CDM, RDM) to remove the relevant annexes and refer to the SANA registries. As a topic unrelated to the migration of annex material to the SANA, David also noted that the NDM/XML schemas should be downloadable as a complete set; currently it is necessary to download the schemas one at a time, but several of them are included in the validation of any instantiation of a NavWG message in XML format.

1210_1230_Navigation Events Message (XML Schema Generator for Events)
1330_1430_Navigation Events Message (XML Schema Generator for Events)

During the short time available prior to lunchtime, the WG returned to the discussion of the NEM. Alain expressed the thought that we would need a clear division of labor/responsibility with the CSS/SM WG, "what we do" and "what they do" in order to better synchronize the effort. As a topic that arose during this discussion, Frank Dreger proposed the notion of an XML schema generator for events. After some fairly esoteric discussion on this topic, Alain and Cheryl queried as to the possibility of having an "XML Boot Camp" for the NavWG. It was agreed that this was a good idea, and Fran got the action item, though it is clear that such a Boot Camp will only scratch the surface. Frank's dynamic schema generator idea is a fairly advanced topic... but a Boot Camp will help. After lunch the discussion of the schema generator for events continued, with Fran showing a prototype that he had quickly developed. The prototype consisted of three basic components: an XML message that the user develops, an XML message that is used to develop the schema, and the schema that is used to validate an instance. It was a very impressive display of using an XML Editor to generate a schema and messages. Frank, Alain, and Fran will work together on elaborating the concept, which may become a core component of the NEM.

1430_1450_Nav Data Messages Overview update (post-PRM/TDM)+project schedule

The schedule for updating the "Navigation Data Messages Overview" Green Book was discussed. David had planned to add a schedule to the Framework during this meeting time, however, he found that there was already a schedule in the Framework from when this document update had been added as a Draft Project. The CMC Poll is now complete, so we can nominally start working on the project, though the results of the poll, which ended 04-Apr-2018, had not yet been officially announced (it was a unanimous "Adopt" vote). The various changes required are fairly straightforward; specific changes are to add the Navigation Events Message and the Re-Entry Data Message given that they have been added to the Project Framework since the document was published, subtract the Navigation Hardware Message and the Spacecraft Maneuver Message given that they have been removed from the Project Framework, and move the Pointing Request Message from the "In Development" section of the document to the "Published" section. One potentially tricky item will be to either (a) obtain the diagrams in the document from Tom Gannett, or (b) re-create them; option (a) is preferable. The effort level of the project is expected to be one work month or less. Patrick Zimmerman volunteered to be the Lead Editor for this document update. The project is already off to a great start. Patrick attended the CCSDS Editor's Boot Camp on Friday morning. David obtained the official Master draft of the document from the Secretariat. Subsequent to the meeting the Master was provided to Patrick and we received formal notification that the project was approved.

1450_1510_Object Defs on SANA Registry? LDM and/or FDM:Start formal projects?

In this brief discussion, it was noted that with the addition of the "orbit centers" material, we have made some movement towards putting object definitions on the SANA Registry. This could expand in the future, though probably not to a great extent. We also discussed the fact that we could never put "all" objects on a SANA Registry, e.g., many of the PRM test cases involved pointing at a star... the number of stars is so large that it would not be feasible for the NavWG to maintain a registry (not to mention that the celestial sphere is a continuum). Far better to use a definitive star catalog, e.g., the Gaia star catalog. The group also discussed whether or not a project for the FDM (Fragmentation Data Message) should be

started. Alexandru indicated that this was premature; prior to starting an FDM the RDM should be closer to completion and interest in prototyping should be gauged.

1510 1730 Navigation Data Messages KVN + Project Schedule

In this last discussion of the day, the WG worked towards defining what we would like to DO, not necessarily what we want to HAVE, with respect to a future message structure. It seemed clear that there was a desire to more tightly bind orbit data and attitude data given that the data groupings of the OCM and ACM seem like fundamental building blocks. This notion would more thoroughly eliminate the current segregation of orbit and attitude. Currently in the NDM/XML it is possible to have orbit data and attitude data in the same message, but they are still segregated given that the structural elements are still complete <odms> or <adms> (another way of expressing this is that the "atomic elements" at this time are at the full message level within the NDM/XML "container"). Dan proposed an idea that there be some metadata at the top that applied to all subgroups in the message (that could potentially be overridden?). This seemed similar to the notion of "global variables" and "local variables" that is present in many structured programming languages. Another idea (for a data section) was to allow complete freeform on the data row, with a first row comprised entirely of the keywords associated with the data in the following rows (similar to a CSV type implementation). During this discussion the question as to direction for the ODM and ADM again arose, i.e., ODM+OCM and ADM+ACM, or just re-issue ODM with minimal modification, and move as directly as possible to the "modular message" concept by combining the OCM and ACM into a new document (Navigation Comprehensive Message = NCM = OCM+ACM). We used a flipchart extensively during this discussion. Cheryl took the initiative to capture the salient content of the diagrams on the flip chart into a Powerpoint slide that summarized the discussion nicely and facilitated evaluation of the options. (Note that some of the options discussed moved in directions different than had been proposed and accepted during the week... an apparent but not real contradiction as we debate the best way to move forward.

DAY 5, FRIDAY 13-APR-2018

0845 0915 Conjunction Data Message 5 Year Review (reconfirm?,retire?,revise?)
0915 1015 Navigation Data Messages KVN + project schedule
1015 1230 Prep Closing Report, Action Items, Five Year Plan, Set Next Telecon
1230 1330 Lunch
1330 1530 MOIMS Closing Plenary
1530 1730 Free

In attendance this day were David Berry, Frank Dreger, Cheryl Gramling, Julie Halverson, Alain Lamy, Alexandru Mancas, Dan Oltrogge, Patrick Zimmerman (Fran and Brian had had to depart early for other commitments). We had guest Margherita di Giulio. Patrick also had attended the CCSDS Editor's Boot Camp session at the beginning of the day and arrived for the last hour or so.

0845 0915 Conjunction Data Message 5 Year Review (Reconfirm?,Retire?,Revise?)

The task of this brief discussion was to make a decision with respect to the 5 Year Review of the CDM, i.e., either to reconfirm, retire, or revise. Given that many organizations are currently using the CDM, the option to retire was quickly eliminated. The remaining options are to reconfirm without changes, or to revise the CDM. Dan reported that he had gotten a contact at JSpOC (Diana McKissick) who has provided some suggestions for revisions and is contacting the Air Force Space Command regarding further potential changes. There is also some question as to whether or not the Air Force will be able to provide resources to the CCSDS for any updates, unlike when the CDM was originally developed. Dan

reported that the analysis group at JSpOC is smaller than it was before; he said he would be surprised if they could support the effort directly. Dan indicated that he could potentially take on the CDM revisions if we vote to revise and the Air Force cannot allocate resources. Alexandru has some requests from ESA. Cheryl noted that NASA/CARA has a list of potential revisions as well. The WG will continue to make inquiries regarding potential modifications and will evaluate them during a telecon if the changes seem compelling, but we could wait until the Fall 2018 Meetings to make a decision. There is a potential for a resolution within the next 6 months for a new project to revise the CDM if the vote to reconfirm is negative. If there is a vote to revise we would need prototypers to be identified: ComSpOC, CARA, ESA/SDO, CNES, and USAF/JSpOC seem like potential prototypers.

0915 1015 Navigation Data Messages KVN + Project Schedule

Attendees continued discussion to fill out the matrix of options prepared by Cheryl that captured the discussion from the end of the day Thursday. There were still a few cells in the table that were empty but by the end of the discussion it had been fully populated. The discussion details are not captured in these minutes; it is represented in the Powerpoint that was sent out; it will be subject material for a future telecon. The options for achieving the composite message goal were:

Option 1: Complete ODM v3 with OCM; Complete ADM v2 with ACM; Request New NDM-KVN v1 with composite of OCM, ACM, and possibly other atomicized messages approximately 06/2020.

Option 2: Complete ODM v3 without OCM; Complete ADM v2 without ACM; *Now* request New NDM-KVN v1 with composite of OCM, ACM, and possibly other atomicized messages.

Option 3: Complete ODM v3 with OCM & ACM well-integrated to create a Nav Comprehensive Message within the ODM v3; No ACM in ADM. *Future* development of NDM-KVN v1 with NCM + atomicized other messages.

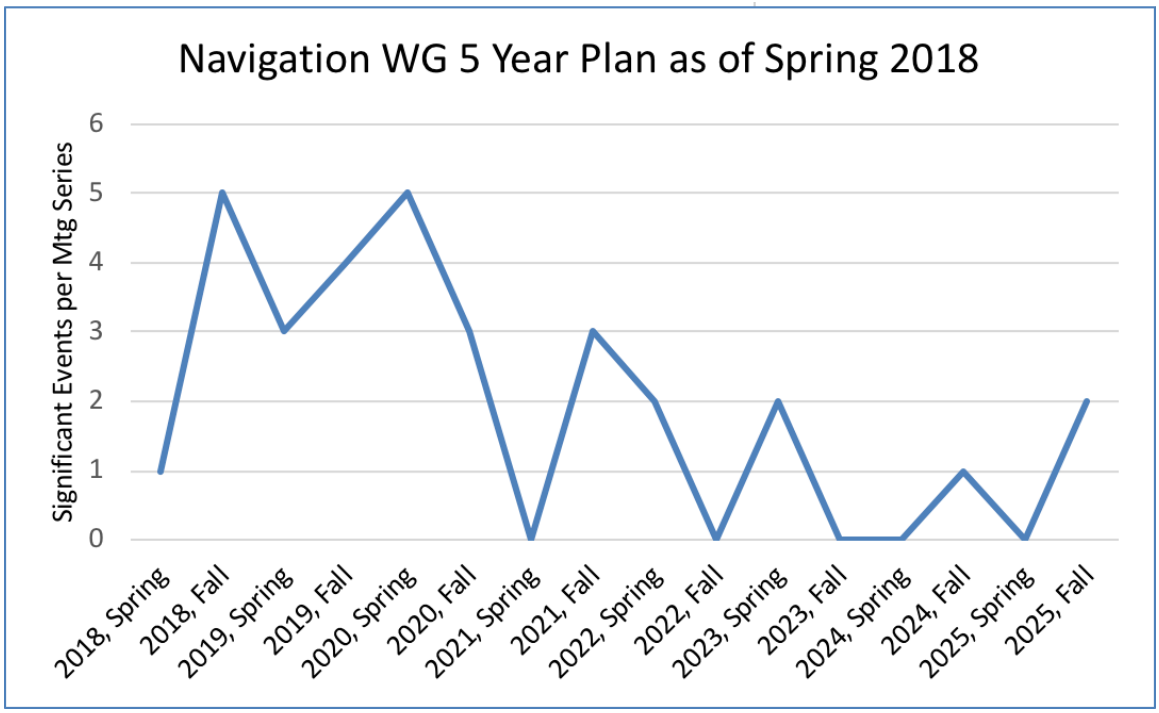
Option 4: Develop NDM XML with legacy structure of v2, new KVN of a ToBeDeveloped Nav Comprehensive Message and XML structure of composite NCM as v3, includes OCM/ACM/RDM/TDM/CDM. This concept yields ODM without OCM and ADM without ACM (similar to #2).

We are still building up to the point where the NDM/KVN can be proposed as a formal project. As yet it is still premature; a strong resources case will be necessary.

1015 1230 Prep Closing Report, Action Items, Five Year Plan, Set Next Telecon

David reviewed the Final Report with the remaining members of the WG (a few members had had to leave early due to travel plans). We were joined by CESG Chair Margherita di Giulio as we worked through the Final Report, making modifications as applicable. At a couple of points during the discussion Margherita posed some questions, mostly related to the allocation of resources (e.g., when there was an indication in the report of a possible resolution in the next 6 months for a CDM revision... these questions were not difficult to resolve, but they do point out the concern for resources that exists in the management layers of the CCSDS and indicate the strong case that will need to be made for the modular message concept when the time is right). David showed the list of potential action items that had arisen through the week; these had been augmented by the action items still open from Fall 2017. For some action items David had already assigned target dates if they came up in the course of earlier discussion; for other items we set target dates in this session. David showed a proposed plan of WG telecons between the Spring Meetings and Fall 2018 Meetings (to be found at the end of these minutes); in principle this plan was

adopted, though things like this are often subject to some changes. Finally, we worked through and updated the Working Group's 5 Year Plan. As we proceeded, David described his method for populating it. Several simplifications are utilized in order to keep the detail in the plan manageable. For example, there is a focus on the face-to-face meetings (restricted to April=Spring, October=Fall, other months are "rounded" to the closest meeting). There is a focus on 4 major events (initial white book, Red Book/Agency Review complete, Blue Book complete, 5 Year Review), so many of the items in the full schedule are ignored. A simple prioritization scheme is used (Blue Book=1, Red Book=2, White Book=3 or 4). We started by roughly synchronizing the plan with the schedules on the CWE Framework that had been updated through the week. After these basic changes were made, we reviewed the number of significant events in each time frame, and an attempt was made to "smooth out" the number of significant events in near term meetings. This was only partially successful, as can be viewed in the following plot of significant events per meeting... the near term appears to reflect significant optimism (which is not atypical). The full plan is on the CWE at https://cwe.ccsds.org/moims/docs/MOIMS-NAV/Meeting%20Materials/2018/Spring/navwg-5-year-plan-201804.pdf .



After completing all the closing matters, the Navigation WG meeting was concluded. Those still in attendance were thanked for a productive meeting week, we bid each other safe travels, and we started making plans for the next meetings in Berlin in October 2018.

All materials from the meetings (agenda, introductory presentation, action items, report, 5 year plan, and these minutes) are available on the CWE at the following link:

https://cwe.ccsds.org/moims/docs/Forms/AllItems.aspx?RootFolder=%2Fmoims%2Fdocs%2FMOIMS-NAV%2FMeeting%20Materials%2F2018%2FSpring&FolderCTID=0x012000C8EEDFBFAD59894AB84FF1AF9485D0AB&View={72CC1C3E-EFA9-498B-BEA5-C88E7DEE0C54}

Draft documents reviewed during the meetings are in their respective directories on the CCSDS CWE:

https://cwe.ccsds.org/moims/docs/Forms/AllItems.aspx?RootFolder=%2Fmoims%2Fdocs%2FMOIMS-NAV%2FDraft%20Documents&FolderCTID=0x012000C8EEDFBFAD59894AB84FF1AF9485D0AB&View={72CC1C3E-EFA9-498B-BEA5-C88E7DEE0C54}#InplviewHash72cc1c3e-efa9-498b-bea5-c88e7dee0c54=FolderCTID%3D0x012000C8EEDFBFAD59894AB84FF1AF9485D0AB-RootFolder%3D%252Fmoims%252Fdocs%252FMOIMS%252DNAV%252FDraft%2520Documents-SortField%3DLinkFilename-SortDir%3DAsc

1330 1530 MOIMS Closing Plenary

In attendance at this meeting were Mario Merri (MOIMS AD), Brigitte Behal (MOIMS DAD); David Berry and Frank Dreger (Nav); Dan Smith (SM&C); John Garrett (DAI); a representative from MPS given that Mehran Sarkarati was not able to gain access to the NIST campus; and a number of other members of the various working groups.

The reports of the Mission Planning & Scheduling (MPS), Digital Archive Ingest (DAI), Spacecraft Monitor & Control (SM&C), and Navigation WGs were presented; the Telerobotics WG did not meet during this meeting series so there was no report. David presented for Navigation; the report is shown immediately below. After the Plenary, the Technical Meeting week concluded.

MOIMS CLOSING PLENARY / NAVIGATION WORKING GROUP REPORT

Achievements for this meeting cycle:
- Celebrated the recent publication of the Pointing Request Message
- Completed internal WG review of revisions to drafts of the Orbit Data Messages, Attitude Data Messages, Nav Data Definitions & Conventions
- Continued discussion of Navigation Events Message in preparation for first WB
- Initiated discussion of Prototyping Plans for the Re-Entry Data Message, Tracking Data Message, and Orbit Data Messages
- Initiated 5 Year Review of Conjunction Data Message (will reconfirm or revise)
- Continued new project Navigation Data Messages Overview Green Book V2
- Continued discussion of Navigation Data Messages future directions (XML & KVN)
- Completed discussion of MOIMS Area Director "Special Topic" related to the Deep Space Gateway / Lunar Orbit Platform Gateway
- Completed update of WG 5 Year Plan

Interaction with other WGs
- Joint meeting with CSS/SM Working Group on the topic of "events"
- Joint meeting with SANA Operator regarding plans to migrate material from document annexes to SANA (Time Systems, Ref Frames, Element Set Defs, Orbit Centers, ...)

Problems and Issues:
- It would be nice if an "Estimated Delay to Next Status" column could be added to the Document Editor Queue report; we can see that there are many docs in the queue, but how long is the expected backlog for a document in that queue?

Working Group Status:
- Active, "High Momentum"

Resolutions Agreed Upon This Meeting:
- Resolution 1: The Navigation WG thanks NASA and NIST for their excellent hosting of this CCSDS Meeting series.

Further Resolutions Anticipated in the Next 6 Months:

- Resolution 2: Request to perform CESG Poll to approve publication of the Navigation Data – Definitions and Conventions Green Book V4
- Resolution 3: Request to create new project for revision of CCSDS 508.0 Conjunction Data Message (outcome of 5 Year Review pending)

Document Status

Area and WG name	CCSDS Ref Nr	Document Title	Status / Comments	Start and / or Target Publication Date
MOIMS NAV	500.0	Navigation Data—Definitions and Conventions	Little progress (Lead Editor funding issue... May reassign).	Start date 09-Nov-2015 End date 15-Dec-2018
MOIMS NAV	500.2	Navigation Data Message Overview (Update)	Lead Editor assigned. Still shows as "Draft" project, but CMC Poll shows unanimous "Adopt" result	Start date 25-Apr-2018 End date 30-Nov-2018
MOIMS NAV	502.0	Orbit Data Message (ODM) 5 Year Review Revision	Good progress. Continued internal draft reviews. Initiated prototyping discussion.	Start date 16-Apr-2015 End date 30-Mar-2020
MOIMS NAV	503.0	Tracking Data Message (TDM) 5 Year Review Revision	Good progress. CESG Agency Review poll in progress. Initiated prototyping discussion.	Start date 09-Oct-2013 End date 15-Nov-2018
MOIMS NAV	504.0	Attitude Data Message (ADM) 5 Year Review Revision	Good progress. Continued internal draft reviews. Initiated prototyping discussion.	Start date 16-Apr-2015 End date 30-Apr-2020
MOIMS NAV	505.0	Navigation Data Messages XML Specification 5 Year Review Revision	Little progress.	Start date 13-Jul-2016 End date 01-Apr-2019
MOIMS NAV	508.1	Re-Entry Data Message	Excellent progress. CESG Agency Review poll in progress. Initiated prototyping discussion.	Start date 03-Jul-2016 End date 30-Sep-2019
MOIMS NAV	N/A	Navigation Events Message	Very good progress. Initial requirements work in progress. Productive discussion of many options. Had joint mtg w/SMWG	Start date 07-Nov-2017 End date 30-Nov-2019

Navigation WG Upcoming New Work Items

Area and WG Name	CCSDS Ref Nr	Document Title	Target Start / Publication Date	Resources Needed by Year	Total	EDITOR	PROTO1	PROTO2	Comments Rationale What if not started?
MOIMS NAV	508.0	Conjunction Data Message 5 Year Review Revision ???	??-???-2018	2018	?	?	?	?	The document will not reflect changes desired by key customers
				2019	?	?	?	?	
				2020	?	?	?	?	

NOTE: Pending outcome of Resolution 3 above, this new work item may not be necessary, though based on comments to date, "revision" seems likely.

MOIMS SPECIAL TOPIC: WHAT IS MOIMS ROLE IN THE LUNAR ORBITER PLATFORM GATEWAY (LOP-G)?

Discuss in WG how MOIMS could be injected in LOP-G (formerly Deep Space Gateway) and be more influential.

Navigation WG Report on "Special Topic"

Principle:
- Don't assume there is a need for unique standards just for LOP-G/DSG (similar to concept with small satellites).
- Use/adapt existing standards, or identify gaps and develop standards to fill them.

Question:
- Do we expect special requirements from LOP-G/DSG? Related concern: If DTN with multi-hops among multiple orbiting platforms, there are a number of technical issues that have not been adequately addressed. (Details available on request.)

Potential NavWG Standards Useful for LOP-G/DSG (All Partners)
- ODM - knowledge of position/velocity/accelerations of vehicle(s), prox ops, contact acquisition data
- ADM - knowledge of attitudes of vehicle(s), approach and rendezvous up to docking, proximity operations
- ODM/ADM in combination (or future message) to convey inertia matrix, center of gravity, etc., approach and rendezvous up to docking, proximity operations
- CDM - general lunar environment conjunction assessment (existing & future lunar orbiters, potential future debris created in spacecraft ops)
- ODM/ADM/CDM - in combination to coordinate avoidance maneuvering
- TDM - tracking of the LOP-G/DSG (with CSTS/Tracking Data Service), potential need to add optical image navigation observable
- PRM - use case: pointing an onboard optical telescope (raster scan survey of local environment), pre-EVA environment scanning.
- NEM - AOS, LOS, umbra, penumbra, RFI mitigation
- RDM - end of life studies/planning (future application)

Observations
- Pleasant meeting environment, nice campus
- Excellent parking availability and shuttle service
- Some facilities were excellent
  - Room size fit the number of attendees
  - Environmentals, electrical, WiFi access were generally excellent
  - Cafeteria offerings were extensive, reasonable, and good
- Some facilities presented minor challenges
  - Noise from nearby construction was a periodic irritant
  - Lights in room were somewhat bright and could not be dimmed
  - Projector image quality was a somewhat degraded for small text
  - Cafeteria closed at 15:00, but coffee break was suggested for 15:30

Suggestions for Improvement
- It was observed that the project schedules in the CWE Framework have dates in the "American" format (mm/dd/yyyy), however, many CCSDS WG members are more comfortable with an alternate format (dd/mm/yyyy). It is suggested that the project schedules use a format that is not ambiguous (e.g., dd-MMM-yyyy, where "MMM" is the letter abbreviation of the month 13-Apr-2018).
- Draft documents containing equations are inconsistently mangled due to issues with the equation editor. Is there a CCSDS recommendation for editing equations?

NEXT TELECON(S):

The WG established Wednesday 16-May-2018 @ 1300 UTC as a next telecon date. A meeting invitation will be sent. Tentative agenda:

1. Approve Spring Meeting Minutes
2. RDM Status
3. TDM Status
4. SANA Registry Status/Prioritize SANA Annex Material
5. Evaluate CDM Requests... Revise? or Reconfirm?
6. Confirm NDM/XML Version 2 plan (Version 2: TDM removed only; Version 3: ODM, ADM removed)
7. Action Item Update & Other Document Status

Additionally, a full schedule of monthly meetings until the Fall 2018 Meetings was proposed, as follows:

Proposed Telecon Schedule (all at 1300 UTC)
16-May-2018
20-Jun-2018
25-Jul-2018
05-Sep-2018
03-Oct-2018
Fall Meetings 15-Oct to 19-Oct