MINUTES OF NAVIGATION WORKING GROUP FALL 2017 WORKSHOP 19-Nov-2017
David S. Berry / Chair

The CCSDS Fall 2017 Meetings were conducted at the Marriott Hotel in The Hague, Netherlands during the week of 06-Nov-2017 through 09-Nov-2017. ESA 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

Kyohei Akiyama (JAXA), Brigitte Behal (CNES), David Berry (NASA/JPL), Dale Force (NASA/GRC), Cheryl Gramling (NASA/GSFC), Julie Halverson (NASA/GSFC), Sandra Johnson (NASA/GRC), Ralph Kahle (DLR), Alain Lamy (CNES), Alexandru Mancas (ESA/ESOC), Dmitry Marareskul (FSA/Reshetnev Company), Francisco Martinez (ESA/ESOC/GMV), Mario Merri (ESA/ESOC), Dan Oltrogge (NASA (AGI, SDC, and ISO TC20/SC14)), Patrick Zimmerman (NASA/JSC).

TELECON PARTICIPANTS

Not applicable.

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/2017/Fall/navwg-agenda-201711.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/2017/Fall/navwg-action-items-201711.pdf . The 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. The list also includes a few items from prior meetings that had not yet been completed by the end of the Fall 2017 meetings.

New Action/Outstanding Action Items

##	Action Item	Actionee	Due Date (Original)	Due Date (Current)
85	Provide expanded "CDM Originator" SANA Registry information to David	As assigned, by Registry entry (see telecon minutes)	25-Aug-2017	15-Nov-2017
52	XML Section for ADM	David Berry	31-Dec-2016	30-Nov-2017

##	Action Item	Actionee	Due Date (Original)	Due Date (Current)
86	Migrate "CDM Originator" Registry to new SANA arrangement	David Berry	08-Sep-2017	30-Nov-2017
70	Produce Navigation D&C Green Book 3.5	Dale Force	07-Jul-2017	01-Dec-2017
71	Produce ODM P2.37	Dan Oltrogge	31-Aug-2017	01-Dec-2017
92	Produce RDM WB7	Alexandru Mancas	01-Dec-2017	01-Dec-2017
87	CDM corrigendum to replace "CDM Originator" Registry with new SANA arrangement	David Berry	15-Sep-2017	15-Dec-2017
22	Produce NDM/XML P1.1	David Berry	31-Jan-2016	31-Dec-2017
93	Produce TDM P1.0.6	David Berry	31-Dec-2017	31-Dec-2017
94	Confirm consistency of ADM Annex C and Green Book attitude material	Alain Lamy	31-Dec-2017	31-Dec-2017
95	SANA Registry: Orbit Central Bodies	Alexandru Mancas	31-Dec-2017	31-Dec-2017
8	Redistribute list of events previously prepared	Alain Lamy	31-Dec-2017	31-Dec-2017
96	Telecon with SANA Operator (Marc Blanchet) regarding representation of SANA Registries for Time Scales, Reference Frames, Element Sets	David Berry	31-Jan-2018	31-Jan-2018
97	Produce ADM P1.6	Alain Lamy	31-Jan-2018	31-Jan-2018
98	Produce Navigation Events Message initial draft	Alain Lamy	31-Jan-2018	31-Jan-2018
99	Complete SANA Registries for Time Scales, Reference Frames, Element Sets	Dan Oltrogge Julie Halverson	28-Feb-2018	28-Feb-2018
100	Produce Navigation D&C Green Book 3.6	Dale Force	01-Mar-2018	01-Mar-2018
1	Create prototype draft of material for Attitude Comprehensive Message	Julie Halverson	09-Apr-2018	09-Apr-2018
2	Draft Test Plan for TDM Doppler Counts	Cheryl Gramling	09-Apr-2018	09-Apr-2018
3	Draft Test Plan for TDM Phase Counts	Fran Martinez	09-Apr-2018	09-Apr-2018
4	Draft Test Plan for TDM Data Types	David Berry	09-Apr-2018	09-Apr-2018
5	Draft Test Plan for TDM MAG/RCS	Alexandru Mancas	09-Apr-2018	09-Apr-2018
6	Initial Thoughts on TDM V3	Cheryl Gramling	09-Apr-2018	09-Apr-2018
83	Navigation Data Messages KVN Structural Requirements	Dan, Alain, David, Julie	30-Sep-2017	09-Apr-2018
7	Request CESG Poll for Navigation D&C Green Book 3.6	David Berry	13-Apr-2018	13-Apr-2018

WORKSHOP PROCEEDINGS

DAY 1, MONDAY 06-NOV-2017

0815	0845	Registration
0845	1000	CCSDS Opening Plenary
1000	1110	MOIMS Opening Plenary
1110	1210	Admin: Agenda, Intro to Nav WG, Guidelines, Previous Action Items
1210	1310	Lunch
1310	1645	Orbit Data Messages V.3 (ODM)
1645	1730	Time Scales, Reference Systems, Element Set Definitions on SANA Registry

0845 1000 CCSDS Opening Plenary

The CCSDS Fall 2017 Meeting series started with a CCSDS Opening Plenary attended by all participating CCSDS members. Nestor Peccia chaired the meeting, and gave a few brief opening remarks. Afterwards Nestor introduced David Ross of the CCSDS Secretariat who 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; admonition to NOT make outgoing telephone calls from rooms; etc.). There were some important announcements made in this meeting, as follows:

1. The CCSDS is planning the following upcoming meetings (with plans farther out fuzzier than those close in):

a) Spring 2018 hosted by NASA at The National Institute for Standards and Technology in Gaithersburg, Maryland, USA, 09-Apr-2018 to 13-Apr-2018
b) Fall 2018 hosted by DLR at Berlin, Germany, dates 15-Oct-2018 to 19-Oct-2018
c) Spring 2019 hosted by NASA at TBD, USA, dates TBD
d) Fall 2019 hosted by ESA/ESOC (Darmstadt?), Europe (4-day), dates TBD
e) Spring 2020 hosted by NASA at TBD, USA, dates TBD
f) Fall 2020 hosted by ESA, dates TBD

2. The "Boot Camp" session will be on Thursday from 0845-1200, Van Gogh room. 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 865.

4. The CCSDS now has 23 WGs, though the Telerobotics WG is essentially defunct. There have been no changes in Area Directors and Deputy Area Directors since the Spring 2017 Meetings.

5. The number of people registered for the meetings is 210.

6. There are 147 active CCSDS documents (88 normative, 59 informative). There are 83 approved projects in the CCSDS Framework, with 6 behind schedule, and 52 draft projects. There is only 1 project with no Prototype 2 commitment (the NHM).

7. Nestor also highlighted a number of activities in which the CESG has been engaged since the Spring 2017 San Antonio meetings.

8. IOAG/ICPA: many services have been requested by 2020, but are not currently represented by active projects. The SEA Area Director will resurrect the SEA BOF to discuss related work with Areas.

9. What are we missing in the CWE? Nestor highlighted a number of things on the wish list that require a high level of resources.

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.

1000 1110 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 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 high momentum, very active WG with an ambitious work plan. First service specifications have been published.
- 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.
- The number of telecons between Spring 2017 & Fall 2017 meetings, by WG, was presented. Mario also presented the results of a request for feedback on various topics from the WG Chairs.

In response to a question as to whether or not Mario foresees changes with Nestor's impending retirement, Mario responded simply, "Yes"; he did not elaborate further, though he did mention the 3 current candidates for CESG Chair: Wallace Tai/NASA (current Deputy Chair), Margherita di Giulio/ESA, Osvaldo Peinado/DLR. Mario also mentioned that Juan Miro (CMC member for ESA) is retiring at the end of the year.

There was brief discussion of the 5 days vs. 4 days meetings discussions... this is a cost issue almost exclusively.

Mario noted (as did Nestor in the CCSDS Plenary) that there is only one project for which there is no prototype 2 commitment (i.e., the NHM).

Mario closed his presentation by stating that we are in a period where there will be a lot of changes, and that we need to improve "the feeling" in the CCSDS, e.g., that we are space enthusiasts working together towards a common goal.

The MOIMS representative in the SEA System Architecture is Roger Thompson. The goal of the architecture effort is to increase consistency and coherency within MOIMS. The effort is defining the CCSDS Reference Architecture in several views using RASDS graphical conventions: Context, Functional, Information Model, Service, Data, Protocol (Communications), Deployment. Roger noted

that Peter Shames is very keen that it should be very clear as to what actually exists in the CCSDS, while Roger wants to show the Roadmap, including projects on the drawing board. Roger stated that the system architecture should eventually be hosted online to enable keeping it up to date. NOTE: This work is all done manually since RASDS has no modeling support.

In response to a question from David, Mario confirmed with Nestor that the report format for WG Chairs for Closing Plenary reports has not changed from the Spring 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 08-Nov-2017 at 2000 at a restaurant TBD.

1110 1210 Admin: Agenda, Intro to Nav WG, Guidelines, Prev Action Items

The Navigation WG meeting was started immediately after the close of the MOIMS Opening Plenary. In attendance this day were Kyohei Akiyama, David Berry, Dale Force, Cheryl Gramling, Julie Halverson, Ralph Kahle, Alain Lamy, Alexandru Mancas, Dmitry Mararеskul, Fran Martinez, Dan Oltrogge, Patrick Zimmerman.

After several minutes wrestling with the projection equipment and cables, 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 San Antonio. There were no updates to these Action Items since they had been updated at the 18-Oct-2017 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 Spring 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/2017/Fall/navwg-intro-201711.pdf . Review of the action items from San Antonio showed that as of the start of the meetings, 29 of 40 were completed (72.5%), 11 remained outstanding (27.5%), and 0 were cancelled (0%). Overall, the percentage of action items completed was quite good.

During this morning session there was some discussion of the work being done to transfer material currently in the normative annexes of our documents (e.g., tables of time systems, reference frames, element sets) into the SANA Registry. David explained that once the material is ready for listing in the SANA, we can work with the CCSDS Editor to incorporate corrigenda to the various documents as necessary. The corrigenda will remove the affected annexes, and the various portions of the document that refer to those annexes will be corrected to refer to information on the SANA Registry.

1310 1645 Orbit Data Messages V.3 (ODM)

We continued discussion of Dan's most recent draft of the Orbit Data Messages (draft P2.36). Dan displayed on the multiple pages of CRMs that he had received (on the order of 50 pages), focusing on those issues that were not relatively simple and thus required some discussion.

One such item relates to the inclusion of an attitude time history in the OCM. Dan received comments from both Julie and David that this attitude material should be in a companion "Attitude Comprehensive Message" added to the ADM during the current revision process underway. David noted that he had asked Julie to work with Alain on such a message. Dan stated that he feels the approach of excluding the attitude information from the ODM and putting it in the ACM is a mistake, and that the Attitude Time History is necessary in the ODM/OCM in order to improve conjunction assessments that depend on the

combined orbit and attitude states. While this is a technically viable objective, David explained that we have some constraints within the CCSDS that make this a difficult approach to sell at this time. We are approved to work on revisions to the ODM, and revisions to the ADM, but we are not authorized to work on the future "Navigation Data Message" modular message that we foresee being the future. The folks in the CMC are very concerned about the human resources required to do CCSDS work, and right now we are not in a position to sell the future. We need to take a phased approach that focuses on getting the OCM (minus attitude) completed in the ODM, the ACM into the ADM, moves annexes from document annexes into SANA, and then we will have the foundation required to move into the "Navigation Data Message" modular message that we have been talking about. David also noted that the OCM prototyping will be significantly more complex if we add the attitude material at this time. As it is, we do not have approval to work on a project that combines the trajectory and attitude.

Ultimately Dan agreed that he would remove the attitude time history from the OCM; the simple attitude specification described via the Optimally-Enclosing Box (OEB) in the OCM Physical Characteristics section will remain. David indicated that Alain and Julie would probably welcome his input on the incorporation of the ACM into the ADM, so that it would be consistent with the intent of the OCM. Julie noted that she had already started working on a draft ACM that would be compatible/consistent with the OCM attitude time history and the evolving ADM revisions. For attitude needs when processing an OCM, Dan indicated that referring to an AEM would be an acceptable compromise.

During the course of the ODM discussions, the topic of keyword consistency arose couple of times (both within documents and between documents). In one such instance drawn the OCM metadata, there was discussion of keyword order and keyword names, all relating to the identification of the object. This led to the potential notion in the future NDM of an "identification block" in the Metadata section from which the message originator could choose at least one of the keywords, or any combination thereof, necessary to properly identify the object. In conjunction with this, Cheryl indicated that she would be interested in creating a keyword dictionary that could be consulted in instances like this. David shared with Cheryl that he had already started work in such a direction.

Alexandru raised the issue of whether it was desirable to depend upon a JPL Solar System Dynamics table of solar system bodies, suggesting maybe this should be a SANA Registry too. David indicated that this might not be such a great idea since there are so many celestial bodies and we would not be able to do a good job of this. Later, upon reconsideration, it does seem that the number of "plausible central bodies" that we would orbit is really a fairly small set for a fairly long time, so Alexandru accepted an action item to create such a SANA Registry.

During the discussion of the ODM, we revived at points a couple of the same topics regarding options that we discussed at San Antonio, to wit:

1. To potentially argue for re-confirmation of the ODM Version 2 essentially "as is", split the OCM out of the ODM into a new separate document. Additional groundwork towards the new approach must be performed before this action is taken.

2. Related to #1: to potentially argue for splitting the OCM off into a new (as yet unapproved) document, and combine it with the "Attitude Comprehensive Message" material (i.e., primarily that material related to attitude maneuvers as characterized in the SMMs residual requirements).

Neither of these approaches was seen as a direction we wanted to pursue at this time, so we will continue to pursue the ODM with the four message set (OPM, OMM, OEM, OCM).

Note: later in the meetings, it was suggested that the note from the RDM regarding informing the WG of

any user defined parameters utilized should be added to the OCM, so the group can consider areas that may have been missed in the OCM development.

1645 1730 Time Scales, Reference Systems, Element Set Defs on SANA Registry

For the last topic of the day, the material that Dan and Julie had prepared on Time Scales, Reference Systems, and Element Set Definitions was discussed. The objective of this effort is to migrate material from normative annexes in the various documents into SANA Registries that can represent a consistent set to be used for all of the Navigation WG standards. The material was not reviewed in detail, though both Fran Martinez and Alain Lamy had provided detailed comments on the material. Rather, we spent much of the time discussing how the material would be presented on the SANA web pages. Dan had inquired of the SANA Operator regarding what types of material could be presented on the SANA, and received a response from Marc Blanchet that "In general, any file format can be accommodated. However, roughly speaking, there will be no formatting or embedding: i.e. a file will appear as a link to click and the user will download the file. We may explore more, but currently we can offer that." The group discussed various ways that the equations and such could be represented on the web page, and PDF seems the most feasible approach, but there were questions as to what level of granularity could be achieved in terms of linking directly to a particular page in a PDF. Julie found some material that suggested such an approach is possible, but it will have to be investigated further. We set a target date for finalizing the material for the SANA, and Dan suggested having a teleconference with Marc Blanchet a month prior to that date in order to discuss the formatting options and such (see Action Items).

DAY 2, TUESDAY 07-NOV-2017

0845	0940	Re-Entry Data Message + project schedule
0940	1215	Nav: Definitions & Conventions Green Book + project schedule + Glossary Contents
1215	1315	Lunch
1315	1400	Standardization activities in CEN/CENELC (Sensor Data Message)
1400	1600	Tracking Data Message V2 (current draft) + project schedule
1600	1730	EVM: Change the name? (Navigation Events Message?) + project schedule

In attendance this day were Kyohei Akiyama, Brigitte Behal, David Berry, Dale Force, Cheryl Gramling, Julie Halverson, Ralph Kahle, Sandra Johnson, Alain Lamy, Alexandru Mancas, Dmitry Mararеskul, Fran Martinez, Patrick Zimmerman.

0845 0940 Re-Entry Data Message + project schedule

Alexandru provided a presentation on the status of the RDM; he has currently produced a White Book 6 based on comments received on the White Book 5 (there were not very many, and they were of relatively small magnitude). The document is overall in a fairly mature state, with no big technical comments. We worked through a few items in the CRMs he had received on WB4 and WB5 to address the discussion items. David indicated that he had been reviewing the RDM White Book 6 and there will be some additional minor changes. Alexandru will plan to produce a White Book 7 by the beginning of December based on any comments on White Book 6; it is intended that White Book 7 is the last RDM White Book. At that time we will prepare a resolution to the Area Director to commence the Agency Review. This corresponds reasonably well to the plan agreed upon at the San Antonio Spring Meetings, i.e., to have a Red Book before the end of 2017. Depending upon how rapidly the CCSDS Editor can perform his edits on the final White Book, it is possible that we could have a Red Book by the end of January. This would be highly desirable, because if we can get the Agency Review started by the end of January, it will conclude around the beginning of April and we will have RIDs to address at the Spring Meetings in

Gaithersburg. After discussing the technical matters, we reviewed the RDM schedule on the CCSDS Framework, and updated it with the above plan in mind (which is pretty optimistic... the biggest uncertainty is with the CCSDS Editor's queue, which grew quite long given a recent contract issue; the required CESG and CMC polls can also derail this plan). In any case, our objective is to have RIDs for disposition at the time of the Spring 2018 meetings. NOTE: On Thursday, after the Boot Camp, Alexandru brought up the issue that no document number has yet been assigned to the RDM. He said that he had discussed this with Tom Gannett during the Boot Camp and noted that he could consider 508.1 for the RDM given its close relationship with the CDM (508.0) and the fact that Tom is running out of numbers in the Navigation range (roughly 500-519). David took a note to send Tom Gannett a message regarding several "orphaned" Navigation WG document numbers (507 for SPM, 510 for NHM, 511 for SMM).

0940 1215 Nav: Definitions & Conventions Green Book + project schedule + Glossary Contents

NOTE: Dale's Standards Program Manager at GRC, Sandra Johnson, was present for this discussion.

Dale showed the various changes that had been made in the Green Book draft and went through the CRMs he had received on the previous draft. A few members of the WG indicated that they had sent CRMs to Dale, but he may not have recognized them as such and they apparently got lost in his flood of email. It was suggested that people use the acronym "CRM" in the subject line of the emails they send. This sounds like a good general guideline; the current guideline dealing with CRMs is amended to include the new guidance. Although going into the meetings it seemed that the Green Book was fairly ready for a CESG Poll to approve publication, as the session progressed it seemed that we would need another iteration of the document. Dale committed to producing the version 3.5 document by early December, and a version 3.6 a few weeks prior to the Spring 2018 Meetings. At that time a Resolution to get permission to publish seems possible. The version 3.5 will reflect the WG decision to use the "short intro" for the document. With respect to the problem of the vector equations getting garbled, Dale had sent a test document to David converted to *.docx format; in this document, some of the vector equations looked correct, but there were several equations that completely vanished from the test document. The best bet looks to be for Dale to continue with the *.doc version, and make the required PDFs on a Windows machine. During some discussions, Dale indicated that there were issues afoot with respect to NASA/Glenn's continued participation in the CCSDS project. He indicated that he had had approval to complete work in progress (i.e., the Navigation Data Definitions and Conventions Breen Book), but would not be able to start new work. The topic of reference frames came up... the Green Book describes a few commonly used reference frames, but the draft for the SANA Registry lists many, many more. Although detailed discussions of these could conceivably be in the Green Book, it may be better to describe the critical attributes of any reference frame in the Green Book, then describe a few very commonly used frames in the Green Book and refer readers to the SANA Registry for others. Finally, we also discussed the question as to what should be in the Glossary, without any firm decision. There are several possibilities:

1. Define terms inline in the document, and discontinue the Glossary in the document. Advantage: no worries about inconsistency between the main document and the Glossary. Disadvantage: one cannot get a quick overview of all the relevant terms defined in the document.

2. Define terms both inline and in the Glossary. (Cheryl noted a preference for this approach, i.e., the current approach.) Advantage: one can get a quick overview of the relevant terms in the document, in alphabetical order; enhances "lookup" capability. Disadvantage: Potential for inconsistency between the document and the Glossary exists.

3. Define terms inline in the document and in the CCSDS Glossary, and discontinue the Glossary in the

document. Advantage: Tom Gannett tends to independently add entries to the CCSDS Glossary. Disadvantage: This has the same disadvantages as #1 and #2. However, the disadvantage is worse because the CCSDS Glossary has hundreds of terms from all over the CCSDS domain; it is not segregated by document (though a document reference is provided in the CCSDS Glossary, it is at the document level, not at the paragraph level). Additionally, the potential for inconsistency between the Green Book and the CCSDS Glossary seems greater because it won't be easy to flip between two pages in the same document to check.

We will plan to decide this during a telecon (see tentative telecon agenda below).

1315 1400 Standardization activities in CEN/CENELC (Sensor Data Message)

In response to a request during a prior telecon, Alexandru went over the outline of a standard being produced by the CEN/CENELC (CEN = European Committee for Standardization, CENELEC = European Committee for Electrotechnical Standardization). The CEN/CENELC members are the European countries' national standardization bodies (e.g., DIN for Germany). While old, the CEN/CENELEC has a newer technical committee on Space (TC5) which has a working group on Space Situational Awareness Monitoring (WG2). They are working on a standard entitled the "Observing System Data Message" (OSDM) intended to convey information about a telescope/radar/SLR station. It is "CCSDS-styled" (same structure, same/similar keywords, etc.). Alex is the lead editor of the document. He will send the document to the group. SST Europe is planning on using the eventual standard. He doesn't anticipate high volume of messages.

1400 1600 Tracking Data Message V2 (current draft) + project schedule

David went through the recently produced TDM P1.0.5, noting the changes. The group pointed out several corrections/improvements that were necessary in the document; most of these were relatively minor changes. As a result, David will produce a TDM P1.0.6 update and will request that it be prepared for the Agency Review, in accordance with the TDM plan accepted at Rome. Alain inquired about a comprehensive TDM P1.0.6 => V1 comparison document; David responded that he had planned to make such a document for this meeting but ran out of time. Action items for planning prototype efforts were assigned. During telecons between the Fall and Spring Meetings we will begin working on the prototyping plan for the TDM Version 2. NOTE: During the MOIMS Closing Plenary, Mario suggested that David confirm with Tom Gannett whether the TDM Agency Review would be "Pink Sheets" or "Pink Book". From the standpoint of the WG, "Pink Sheets" is best because it does not open the entire book up for RIDs. The last time Tom reviewed the changes, he indicated that he thought it was in the "Pink Sheets" category, but that was a couple of years ago and there have been some changes since.

1600 1730 EVM: Change the name? (Navigation Events Message?) + project schedule

We formally kicked off the Events Message project in this session. Until very recently it has been a prospective "draft project". David and Alain related a bit of the history of the Events Message concept, and how it had evolved. Where at one time it seemed that an "event" construct would become one of the key underpinnings of the CCSDS architecture, it now seems to be left to individual working groups to figure out what events apply to them, and document them. Alain provided background on the starting material available to us that he has been accumulating (Concept paper; events structure; the list of events from CNES used by the "SIRIUS'" flight dynamics system (under development); and various examples sent by DLR, ESA, JAXA, NASA). The aim of the discussion was to focus on requirements for the message, as well as the schema that has been jointly developed with the Service Management Working Group. Alain led us through materials he had prepared on the Events Message (EVM). The group discussed a name change given the course of events from 2009 when the standard was proposed through

2017. A few alternatives were listed (Events Message, Orbital Events Message, Navigation Events Message). The group elected to change the name of the project to "Navigation Events Message" (NEM). There was some discussion as to whether or not the NEM should be XML only (we have a draft schema), or KVN too. It was also suggested that the list of events could be maintained on the SANA, which would make it easy to add, modify, or delete the descriptions of particular events. In this case the standards document would list the structure of an instantiation of the message, but not the text and parameters of individual messages. This would allow the message content to evolve in keeping with one of Alain's points, specifically, to not try to include all possible events but rather limit to some subset; practically speaking, this is all that is possible anyway, but it is good to be reminded of this at the outset. Alain suggested that there might be a need for some ancillary information or information that we don't want to repeat in each message, implying that there will probably be a need for an ICD for Events, though given recent CESG directions we should try to keep the need to a minimum. Alain indicated that he would resend the previously prepared list of events for the group to comment upon (add, modify, delete, etc.).

DAY 3, WEDNESDAY 08-NOV-2017

0845	1100	ADM Pink Book Updates + "Attitude Comprehensive Message"? + project schedule
1100	1200	Navigation Hardware Message (NHM) + project schedule
1200	1300	Lunch
1300	1330	Free (longer lunch)
1330	1400	Navigation Events Message schedule
1400	1420	Nav Data Messages Overview update (post-PRM/TDM) + project schedule
1420	1520	Navigation Data Messages XML Spec update + project schedule
1520	1645	Update project schedules for TDM, ADM, NDDC
1645	1730	Free

In attendance this day were Kyohei Akiyama, David Berry, Brigitte Behal, Dale Force, Cheryl Gramling, Julie Halverson, Ralph Kahle, Alain Lamy, Alexandru Mancas, Dmitry Marareskul, Fran Martinez, Mario Merri, Patrick Zimmerman.

0845 1100 ADM Pink Book Updates + "Attitude Comprehensive Message"? + project schedule

Because the updated P1.5 draft had been distributed a week prior to the Fall Meeting start, attendees had not yet had time to adequately review the material and formulate opinions. Alain led the group through the CRM that combined the comments he had received on the P1.4 draft, focusing on those changes that were not trivial and thus required some discussion. As we have often done, we again wrestled with the issue of consistency (a non-trivial issue). In this particular case, Julie pointed out that Annex C in the ADM and the Green Book attitude sections should be consistent (an Action Item was assigned to Alain to work this out). This did raise the question of the purpose of the Navigation Data - Definitions & Conventions Green Book; as we have been moving relevant explanatory material into informative annexes, the required content in the Green Book will likely be reduced. It is possible that at some point the Green Book itself can be obsoleted, with all the explanatory material allocated to informative annexes. Another consistency issue related to the topic of the SANA tables which we are planning to implement. In the original concept, the SANA tables would be used for a set of values that could be assigned to various keywords (primarily time systems and reference frames), but Julie indicated her understanding that keywords (e.g., "quaternion") would also be included in the SANA registries. This was based on the inclusion of element sets from the OCM in the SANA lists. The distinction was made that the element sets definitions are in fact values that are assigned to a keyword that indicate to a user how to decode a string of positional parameters in the OCM. The analog to this for the quaternion is in the AEM, where the position of the scalar component is indicated by the QUATERNION_TYPE metadata keyword which

has possible values "FIRST" and "LAST".

We continued discussion of the "Attitude Comprehensive Message" (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. As noted above in the discussion of the OCM, Julie has already been working on an ACM draft that would be consistent with the OCM Attitude Time History. We hope to have an ACM conceptual prototype at the Spring 2018 meetings, so it will no longer be "mythical". Alain noted that if we did not consider the ACM, he thought that the ADM revision was approaching Agency Review quality. This raises the possibility that a strategy similar to that of the TDM could be used here, e.g., publish the Version 2 ADM without the ACM and follow up with it later. The current strategy involves delaying the ADM update while the ACM is developed (see next telecon agenda below).

1100 1200 Navigation Hardware Message Direction/Decision (NHM)

The NHM continues to be the only project in the CCSDS that does not have a commitment for a second prototype. We have been discussing its fate since mid-2016 after the CESG policy change that no new projects would be approved without two commitments for protoypes. To set the context for discussion, David presented once again the two potential resolutions that were discussed at the Fall 2016 Meetings in Rome (one arguing to discontinue the NHM, the other arguing to continue with NHM development; see Fall 2016 Meeting minutes for the full text of the two resolutions). A new factor is that there is some indication that the Navigation WG may be receiving less NASA funding than it otherwise might because the NHM is not obviously within the sphere of interest of SCaN (Space Communications & Navigation), the NASA program which funds the CCSDS standards support. Accordingly, David proposed that the WG discontinue work on the Navigation Hardware Message. In light of the fact that there is still a perceived need to exchange such information (particularly for attitude determination), we discussed whether or not the SM&C "Parameters Service" for general telemetry could meet the need (a few years ago, SM&C made an effort to sell this idea to the Navigation WG, but we continued on the NHM path). In the end, a compromise position was reached; instead of deleting the project entirely, the Active project will be demoted to Draft Project. This means that we will not allocate any more resources to its development, but there is an option to do so in the future if the situation changes. A resolution to demote the Active project to Draft Project was added to the Navigation WG closing Plenary report.

1330 1400 Navigation Events Message Schedule

We updated the schedule on the CWE Framework for the NEM because it had never been fully specified, and we had not had time to do it during the previous day's discussion. This process involved selecting dates for first White Book production, last White Book prior to Agency Review, targeting an Agency Review to complete close to when we would be having face-to-face meetings for RID disposition, estimating prototyping durations, and the final publication of the standard. No issues were raised.

1400 1420 Nav Data Messages Overview Update (post-PRM/TDM) + Project Schedule

The schedule for updating the "Navigation Data Messages Overview" Green Book was discussed. Given that there is no official project in the Framework at this point, the schedule discussion was general in nature; no explicit dates were discussed. It is premature to update the document at this point because the basic plan is to wait until the "Navigation Data - Definitions & Conventions" Green Book is published, and then start a new project for the update of the other Green Book. The various changes required should be 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 (once the PRM is in fact published). A Resolution to the Area Director is anticipated in the next few months. The duration of the project is expected to be one work month or less.

1420 1520 Navigation Data Messages XML Spec Update + Project Schedule

David explained that there has not as yet been any draft Pink Book prepared for this update project, however, there has been a great deal of preparatory work has been done with schemas and XML sections for the various documents. Several bugs identified since the schemas were published were recently updated, a set of 'elementFormDefault="qualified"' schemas has been prepared, XML sections for the RDM and TDM have been prepared, an XML section for the ODM has been started (the OCM schema is still in development, so the section is not yet complete). An XML section for the ADM has not yet been prepared, but it is next on the list.

1520 1645 Update Project Schedules for TDM, ADM, NDDC

Using a method essentially identical to the preparation of the NEM schedule described above, we updated schedules for the TDM, ADM, and Navigation Data Definitions & Conventions Green Book, since these schedules had not been updated during the allocated discussion times (these updateds had been overlooked by the Chair). We did not address the ODM schedule during this session, though it needs an update, because Dan was not available to discuss the dates (he had to leave the meetings on Monday evening for other meeting commitments in France and the UK; we will discuss the document schedule in the December telecon).

DAY 4, THURSDAY 09-NOV-2017

0845	1100	Navigation Data Messages KVN + project schedule
1100	1215	Prep Closing Report, Action Items, Set Next Telecon
1215	1315	Lunch
1315	1530	Navigation WG Five Year Plan
1530	1530	End of Navigation WG Meeting
1530	1600	Free
1600	1730	MOIMS Closing Plenary

In attendance this day were Kyohei Akiyama, David Berry, Dale Force, Cheryl Gramling, Julie Halverson, Ralph Kahle, Alexandru Mancas, Dmitry Mararеskul, Fran Martinez, Patrick Zimmerman.

0845 1100 Navigation Data Messages KVN + project schedule

The final day of the meetings started with a look to the future and the proposed Navigation Data Messages KVN (which has also been referred to by various other names including "modular message", "building blocks", "Navigation Functional Message", "Navigation Frankenstein Message", etc.). There was no particular agenda for this discussion, rather, it was unstructured and more along the lines of a brainstorming session.

As Alain was not able to attend this day due to travel plans, he had prepared some notes that David displayed to kick off the discussion. For example,

- Have at hand a collection of "data types" that could be used to build an entire message of any kind
- These data types are entities or structures as small as possible

- They may be already present (or not) in existing Navigation WG standards

Some of the other ideas (many of which were questions) that were raised during the discussion included:

- We need some way to convey the set of keywords. In this context, a "data dictionary" concept was proposed. The notion of keeping such a data dictionary in the SANA was suggested.
- What will be required in terms of prototyping?
- How do we structure the message so as to avoid "nonsense messages"?
- Will it be possible to develop an XML schema for this message? or is it even necessary?
- Do we envision a need for "user defined building blocks"? If we DON'T allow for them, we could limit the ability of the standard message to evolve. If we DO allow for them, it can be difficult to determine the point on the continuum where user defined parameters become untenable.
- What structural elements will be needed?
  - An "identification section" would seem to be mandatory: keywords like OBJECT_ID, *_NAME, INTERNATIONAL_DESIGNATOR, etc. from which a message originator would choose an applicable subset
  - Version identifier (perhaps to identify the applicable data dictionary?)
  - Some type of unique message ID (do we need a "universal" message_ID generator that all agencies could use?)
  - Spacecraft physical characteristics section (note that the OCM provides a good source of potential bigger blocks of the NDM KVN)
  - "None or all" type combination blocks (e.g., state vectors, covariance matrices)
  - Need "boundary markers" of some type to discriminate message subsets... (nonsense avoidance)... e.g., to restrict sphere of influence of a given reference frame setting.
- Do we need to have some type of ordering approach?
  - The message that is transferred from one agency to another agency may need to have some indication of the order.
  - Two ordering approaches... (1) overall, and (2) within a building block.

Alain's notes and other notes taken during the discussion have been added to a new CWE folder:

https://cwe.ccsds.org/moims/docs/Forms/AllItems.aspx?RootFolder=%2Fmoims%2Fdocs%2FMOIMS%2DNAV%2FDraft%20Documents%2FNavigation%20Data%20Messages%20KVN&FolderCTID=0x012000C8EEDFBFAD59894AB84FF1AF9485D0AB&View=%7B72CC1C3E%2DEFA9%2D498B%2DBEA5%2DC88E7DEE0C54%7D

We are still building up to the point where the NDM/KVN can be proposed as a formal project. As yet it is still too immature, though it is a fertile ground for the future.

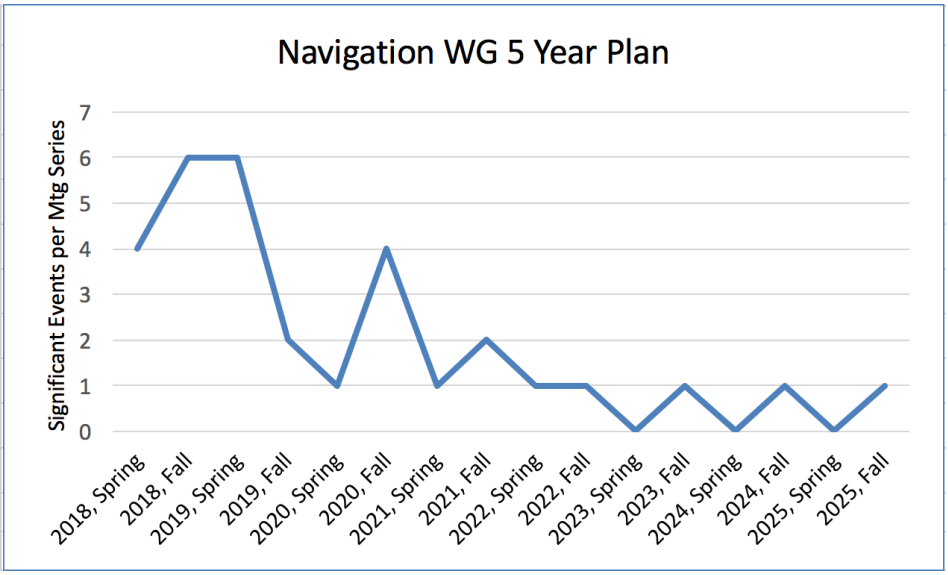
1100 1215 Prep Closing Report, Action Items, Set Next Telecon

Because three of the morning's attendees were leaving for the airport at lunch, the normal closing activities were moved into the late morning so they could participate. We completed the list of action items, target dates, and assignees (shown above in the minutes). We reviewed and completed the Working Group's report to the Area Director for the MOIMS Closing Plenary (shown below in the minutes). There was insufficient time to address the 5 Year Plan before lunch, so it was delayed until after lunch.

1315 1530 Navigation WG Five Year Plan

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 (restrict 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. Entries for the NHM were deleted given the decision to discontinue the effort. 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. The full plan is on the CWE at https://cwe.ccsds.org/moims/docs/MOIMS-NAV/Meeting%20Materials/2017/Fall/navwg-5-year-plan-201711.pdf .



1530 1530 End of Navigation WG Meeting
1530 1600 Free

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 Gaithersburg in April 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%2F2017%2FFall&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}

1600 1730 MOIMS Closing Plenary

In attendance at this meeting were Nestor Peccia (CESG Chair), Mario Merri (MOIMS AD), Brigitte Behal (MOIMS DAD); David Berry (Nav); David Giaretta and John Garrett (DAI); Mehran Sarkarati and Steve Chen (MPS); Dan Smith (SM&C); Roger Thompson (SM&C, MP&S), Sam Cooper (SM&C), 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.

Mario had two suggestions for the Navigation WG: (1) Check with Tom Gannett again regarding the type of review for the TDM... either Pink Sheets (desired) or Pink Book (entire book... not desired); and (2) check with James Afarin regarding any potential funding issues with the update of the Navigation Data Messages Overview Green Book.

After the Plenary, the Technical Meeting week concluded.

FRIDAY 10-NOV-2017

No meetings... this was a 4 day meeting series.

MOIMS CLOSING PLENARY / NAVIGATION WORKING GROUP REPORT

Achievements for this Meeting Cycle

- Completed internal WG review of revisions to drafts of the Orbit Data Messages, Attitude Data Messages, Tracking Data Message, Re-Entry Data Message, and Navigation Data Definitions and Conventions
- Initiated formal discussion of "Navigation Events Message" project
- Continued discussion of future directions for the Navigation Data Messages (XML and KVN)
- Continued plans to migrate substantial appropriate material to SANA from Annexes (Time Systems, Reference Frames, Element Set Defs)
- Completed discussion of the future of the Navigation Hardware Message =➢ Phase out and demote to "Draft Project"

Interaction with other WGs

- No joint meetings in this series...

Problems and Issues

- None

Working Group Status

- Active, "High Momentum"

Resolutions Agreed Upon this Meeting

- Resolution 1: The Navigation WG thanks ESA and The Hague Marriott for their excellent

hosting of this CCSDS Meeting series.

- Resolution 2: Request to move Navigation Hardware Message from Active Project to Draft Project

Further Resolutions Anticipated in the Next 6 Months:

- Resolution 3: Request to advance the Re-Entry Data Message White Book to Agency Review
- Resolution 4: Request to advance the Tracking Data Message Pink Sheets to Agency Review
- Resolution 5: Request to create new project for update of CCSDS 500.2 Navigation Data Messages Overview (+NEM, +RDM, -NHM, -SMM, move PRM In-progress=➤Published)

Planning (Only Approved Projects)

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	Acceptable progress	Start date End date	09-Nov-2015 15-Oct-2018
MOIMS NAV	502.0	Orbit Data Message (ODM) 5 Year Review Revision	Good progress	Start date End date	16-Apr-2015 31-Jul-2018
MOIMS NAV	503.0	Tracking Data Message (TDM) 5 Year Review Revision	Good progress	Start date End date	09-Oct-2013 15-Nov-2018
MOIMS NAV	504.0	Attitude Data Message (ADM) 5 Year Review Revision	Good progress	Start date End date	16-Apr-2015 30-Jul-2020
MOIMS NAV	505.0	Navigation Data Messages XML Specification Five Year Revisions	Acceptable progress on moving XML text into new books (RDM) and books being revised (TDM, ODM, ADM)	Start date End date	13-Jul-2016 01-Apr-2019
MOIMS NAV	509.0	Pointing Requests Message	In CCSDS Technical Editor queue, soon to enter CESG Poll.	Start date End date	06-May-2010 15-Feb-2018
MOIMS NAV	510.0	Navigation Hardware Message	Project cancelled, demoted to "Draft Project"	N/A	
MOIMS NAV	N/A	Re-Entry Data Message	Excellent progress, nearly ready for Agency Review	Start date End date	03-Jul-2016 15-Oct-2018
MOIMS-NAV	N/A	Navigation Events Message	Just getting started. Initial requirements work in progress.	Start date End date	07-Nov-2017 30-Nov-2019

Nav WG Resource Issues for Approved Projects

- None at this time

Navigation WG Upcoming New Work Items

Area and WG name	CCSDS Ref Nr	Document Title	Target Start / Publication Date	Resources Needed (total, Editor, Proto 1, Proto 2)					Comments Rationale What if not started?
					TOTAL	EDITOR	PROTO1	PROTO2	
MOIMS NAV	500.2-G-1	Navigation Data Message Overview	??-???-2018	2017	0	0	0	0	The document will not reflect new message types added, and message types subtracted from the work program
				2018	1	1	0	0	
				2019	0	0	0	0	

Navigation WG Additional Viewgraph 1

PRO

- Very pleasant meeting environment
- Meeting facilities were excellent in general (room size, environmentals, electrical, WiFi, coffee, water, cookies)

Suggestions for Improvement

- Projector image was a bit small given the size of the room; it was often hard to read the screen from the back of the room
- It would be great if provisions for lunch time meeting room security could be pre-arranged and announced at the Opening Plenary
- The Marriott lunch option was fairly expensive, and the purported "variety of restaurants in the vicinity of The Hague Marriott", while true, was to some extent misleading. "Vicinity" is a relative word, and many of the closest restaurants were not open at lunch time.

NEXT TELECON:

The WG established Wednesday 13-Dec-2017 @ 1300 UTC as a next telecon date. A meeting invitation will be sent. Tentative agenda:

- Approve Fall Meeting Minutes
- ACM/ADM Strategy (similar to TDM strategy? delay ADM update for ACM?)
- ODM Schedule (from CWE, requires update)
- Green Book Glossary approach
- Action Item update
- Document status