

MINUTES OF NAVIGATION WORKING GROUP SPRING 2017 WORKSHOP 21-May-2017
David S. Berry / Chair

The CCSDS Spring 2017 Meetings were conducted at the Southwest Research Institute (SWRI) in San Antonio, Texas, USA during the week of 08-May-2017 through 12-May-2017. 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), Frank Dreger (ESA/ESOC), Dale Force (NASA/GRC), Cheryl Gramling (NASA/GSFC), Sandra Johnson (NASA/GRC), Ralph Kahle (DLR), Alain Lamy (CNES), Byoung Sun Lee (ETRI), 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)), Julie Halverson (NASA/GSFC), 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/Spring/navwg-agenda-spring-201705.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/Spring/navwg-action-items-201705.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 the Fall 2016 meetings that had not yet been completed by the end of the Spring 2017 meetings.

New Action/Outstanding Action Items

##	Action Item	Actionee	Due Date (Original)	Due Date (Current)
49	Prepare Review Assignments for ODM P2.36	David Berry	02-Dec-2016	19-May-2017
63	Facilitate scoring of the "General Case" PRM produced by Fran from an actual ROSETTA message	Frank Dreger	19-May-2017	19-May-2017

##	Action Item	Actionee	Due Date (Original)	Due Date (Current)
74	Send context for Green Book Long/Short intros to WG	Dale	19-May-2017	19-May-2017
61	XML Section for RDM	David Berry	15-Apr-2017	26-May-2017
39	Produce final PRM Prototyping Test Plan/Report	Fran Martinez	26-May-2017	26-May-2017
76	Produce final PRM update	Fran Martinez	26-May-2017	26-May-2017
53	XML Section for ODM	David Berry	31-Dec-2016	29-May-2017
64	Prepare Area Resolution request to Mario to have CESG Poll for the PRM	David Berry	29-May-2017	29-May-2017
62	Review TDM P1.0.4	All, as assigned	31-Mar-2017	31-May-2017
67	Request change to Time Codes document: ASCII Time Code A and B formats independent of the time scale.	David Berry	31-May-2017	31-May-2017
52	XML Section for ADM	David Berry	31-Dec-2016	31-May-2017
60	Produce TDM P1.0.5	David Berry	31-Mar-2017	31-May-2017
66	Confirm need for absolute magnitude for optical data in TDM	Alexandru Mancas	12-Jun-2017	12-Jun-2017
77	Review ADM P1.4	All, as assigned	15-Jun-2017	15-Jun-2017
82	Produce draft Attitude Representations SANA registry: "Navigation Data Message Attitude Representations"	Julie Halverson	16-Jun-2017	16-Jun-2017
55	Review ODM P2.36	All, as assigned	10-Jan-2017	16-Jun-2017
73	Review Green Book Long/Short intros	All	27-Jun-2017	27-Jun-2017
75	Decision: Green Book Long/short intro?	All	28-Jun-2017	28-Jun-2017
13	Determine agencies for "Prototype 2" for NHM, or discontinue project.	David Berry	30-Apr-2016	30-Jun-2017
84	"Events" schema for NDM/XML	Fran Martinez	30-Jun-2017	30-Jun-2017
22	Produce NDM/XML P1.1	David Berry	31-Jan-2016	30-Jun-2017
21	CDM Corrigendum for element form default on schema (to be done as part of general change from 'elementFormDefault="unqualified"' to "qualified" for all NDM/XML schemas)	David Berry	31-Jan-2016	30-Jun-2017
70	Produce Navigation D&C Green Book 3.5	Dale Force	07-Jul-2017	07-Jul-2017
65	Suggest refinements to the OD section of the ODM/OCM and present to the group	Cheryl Gramling, Dan Oltrogge	09-Jul-2017	09-Jul-2017
78	Produce draft Time Scales SANA registry: "Navigation Data Message Time Scales"	Dan Oltrogge	17-July-2017	17-July-2017
79	Produce draft Reference Frames SANA registry: "Navigation Data Message Reference Frames - Absolute"	Dan Oltrogge	17-July-2017	17-July-2017
80	Produce draft Reference Frames SANA registry: "Navigation Data Message	Dan Oltrogge	17-July-2017	17-July-2017

##	Action Item	Actionee	Due Date (Original)	Due Date (Current)
	Reference Frames - Relative"			
81	Produce draft Orbital Element Sets SANA registry: "Navigation Data Message Orbital Element Sets"	Dan Oltrogge	17-July-2017	17-July-2017
72	Produce ADM P1.5	Alain Lamy	31-Jul-2017	31-Jul-2017
71	Produce ODM P2.37	Dan Oltrogge	31-Aug-2017	31-Aug-2017
83	Navigation Data Messages Structural Requirements	Dan, Alain, David, Julie	30-Sep-2017	30-Sep-2017

COMPLETED Action Items

##	Action Item	Actionee	Status	Completion Date
68	Resolution for EVM transition "Draft" project to "Active" project	David Berry	Complete	12-May-2017
69	Find out from Tom Gannett how CCSDS Glossary is populated... by Tom as he edits documents? or by direct submissions from WGs?	Dale Force	Complete	12-May-2017

WORKSHOP PROCEEDINGS

DAY 1, MONDAY 08-MAY-2017

0815 0845 Registration
0845 1015 CCSDS Opening Plenary
1015 1045 MOIMS Opening Plenary
1045 1200 Admin: Agenda, Intro to Nav WG, Guidelines, Prev Action Items
1200 1300 Lunch
1300 1550 Pointing Request Message Blue Book Approach (PRM)
1550 1645 Orbit Data Messages V.3 (ODM current draft)

0845 1015 CCSDS Opening Plenary

The CCSDS Spring 2017 Meeting series started with a CCSDS Opening Plenary attended by all participating CCSDS members. Nestor Peccia chaired the meeting. We had brief welcoming statements from Mike Epperly/SWRI (logistics, e.g., details of start/stop times, break times, lunch) and Michael McClellan (Director of SWRI, the workshop host). Dr. McClellan provided a brief history of SWRI and a nice overview of the broad and extensive science and technology program pursued by the institute. 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, 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) Fall 2017 hosted by ESA at The Hague, Netherlands (4-day), 06-Nov-2017 to 09-Nov-2017
- b) Spring 2018 hosted by NASA at Gaithersburg, Maryland, USA, 09-Apr-2018 to 13-Apr-2018
- c) Fall 2018 hosted by DLR at Berlin, Germany, dates 15-Oct-2018 to 19-Oct-2018
- d) Spring 2019 hosted by NASA at TBD, USA, dates TBD
- e) Fall 2019 hosted by ESA at TBD, Europe (4-day), dates TBD
- f) Spring 2020 hosted by NASA at TBD, USA, dates TBD

2. The "Boot Camp" session will be on Friday from 0845-1200. 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. The XML Standards and Guidelines Special Interest Group (SIG) has been closed due to lack of Agency resources.

5. The number of people registered for the meetings is 176.

6. There are 140 projects in the CCSDS Framework, with only 5 behind schedule. There are 86 approved projects and 54 draft projects. There is only 1 project with no Prototype 2 commitment (the NHM); the number was 12 two years ago.

7. There were 24 new publications in 2015, and 18 in 2016. There are 3 WG's which have had no publication since 01/01/2015 (note implications to CCSDS Nav WG... we are not in that set of 3, but could soon be if the PRM, TDM, and Green Book 4 are delayed much further).

8. Nestor also highlighted a number of activities in which the CESG has been engaged since the Fall 2016 Rome meetings.

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. One item of special note was the System Engineering Area's statement that the XML Standards and Guidelines SIG (Special Interest Group) has been closed due to lack of resources. Navigation WG has participated in this SIG since its creation in 2005.

1015 1045 MOIMS Opening Plenary

The overall CCSDS Plenary was followed immediately by the MOIMS Opening Plenary meeting, which was chaired by Area Director Mario Merri. He announced that the MOIMS Dinner would be held on the evening of Wednesday 10-May-2017 at 2000 at a restaurant TBD.

Mario gave an overview of the status of the MOIMS working groups, as follows:

- DAI (Data Archive Ingest) is picking up momentum. It needs more agencies to support it. They have ongoing 5 year revisions and are working on long term data preservation. A future architecture is in discussion.
- Navigation has high momentum; it is a very active WG with a lot of ongoing work.
- SM&C (Spacecraft Monitor & Control): Focusing in Mission Operations (MO) services. A high

momentum, very active WG with an ambitious work plan. The priority is to publish service specifications and promote standards with the potential 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: Has very low momentum. The WG is basically on hold. The Blue Book project has been demoted to a draft project.

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). There are no MOIMS projects showing as "Behind Schedule" in the CCSDS Project Framework.

The MOIMS representative in the SEA System Architecture is Roger Thompson. The goal is to increase consistency and coherence within MOIMS. The effort is defining the CCSDS Reference Architecture in 5 views: Functional, Service, Data, Protocol, Deployment.

WG Chairs were requested to please use the new report formats distributed by Nestor for their Closing Plenary reports.

Mario concluded by requesting that WG Chairs keep Mario and Brigitte involved and let them know if there are any meetings they should attend.

1045 1200 Admin: Agenda, Intro to Nav WG, Guidelines, Previous Action Items

The Navigation WG meeting was started immediately after the close of the MOIMS Opening Plenary. In attendance this day were Byoung Sun Lee, Patrick Zimmerman, Dale Force, Fran Martinez, Frank Dreger, Alain Lamy, David Berry, Alexandru Mancas, Cheryl Gramling, Julie Halverson, Dan Oltrogge, Dmitry Marareskul.

We started by making introductions around the room given that we had a few participants who have not participated for a while, and the group's composition has changed a bit in the past couple of years. Then David reviewed the agenda for the week, presented the "Introduction to the Navigation WG" material, went through the Working Group Guidelines, and briefly looked at previous Action Items from Rome. There were no updates to the Action Items since they had been updated at the 26-Apr-2017 telecon and also on Friday 05-May-2017 when several updated drafts were distributed. As is customary, the Introductory presentation highlighted the progress since the Fall 2016 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/Spring/navwg-intro-201705.pdf>. Review of the action items from Rome showed that as of the start of the meetings, 25 of 30 were completed (78%), 5 remained outstanding (16%), and 3 were cancelled (6%). Overall, the percentage of action items completed was quite good.

1300 1550 Pointing Request Message Blue Book Approach (PRM)

After lunch the WG initiated what David termed the "Blue Book Approach Plan" for the PRM. The primary element we worked on was a review of the PRM prototype test results as documented by Fran in the Test Plan/Report document. We first looked at Fran's results matrix, which highlighted each of the test cases, the WG members who had worked on them, and color coded the results. David requested that we also spend some time on the detailed test sheets filled out by Fran as the impartial Test Judge. In the

process, we evaluated each of the initial test assessments, adding clarifying text where necessary. For each test case, Fran completed his assessment given his role as the Test Judge, and then the WG as a whole evaluated the test cases. In each case we reviewed, an overall assessment of "Pass" was rendered. Sometimes it took a bit of discussion to arrive at the final conclusion given that some of the tests had ambiguous results. For example, in some cases there were XML errors due to the fact that the template had been re-typed from scratch rather than just being used as a file in which the values between tags needed to be replaced. There were also a few cases where it the test conductor had deleted tags from the template that were felt to be unnecessary; these represented a failure in some sense of the word, but these were more failures of instruction in how to use the template than outright errors. These led to the addition of clarifying text in the PRM document itself, for those who might use the templates without the background of having been in the WG that created the standard. There were also a couple of cases where the test conductor simply could not unravel the PRM language to understand what was being requested. In each of these cases, the other WG member who had worked on the test case filled in the template correctly. Therefore, these were not judged to be failures of the templates or of the PRM itself, and the tests received an overall assessment of "Pass". We could not complete the Test Plan/Report document however because there were still some outstanding items: one message submission and one message evaluation. (Note: later in the day the one outstanding message was submitted and evaluated successfully.) After reviewing the Test Plan/Report document, David showed in the "Organization and Processes of the CCSDS" document the other tasks that must be completed before we can publish the PRM. Specifically, David needs to provide to the Area Director the evidence that the Agency Review was conducted; that the RIDs received were dispositioned, and those dispositions shared with the reviewers; the PRM original MS Word document; and the Test Plan/Report. We are very close to completing the PRM.

1550 1645 Orbit Data Messages V.3

At the conclusion of the PRM discussion, there was still approximately one hour left in the work day, so we initiated discussion of Dan's most recent draft of the Orbit Data Messages (draft P2.36). Dan started to go through the CRMs prepared by Cheryl and David, focusing on a few items that had not been accepted and for which there was some need for discussion.

DAY 2, TUESDAY 09-MAY-2017

0815	1200	Orbit Data Messages V.3 (ODM P2.36 current draft)
1200	1300	Lunch
1300	1400	Orbit Data Messages V.3 (ODM P2.36 current draft)
1400	1545	Modular NFM Msg Format, "Attitude Comprehensive Msg", NHM Direction
1545	1645	Time Scales, Reference Systems, Element Set Defs, Object Defs on SANA Registry? LDM: should we start a formal project? Consistency

In attendance this day were David Berry, Frank Dreger, Dale Force, Cheryl Gramling, Julie Halverson, Sandra Johnson, Ralph Kahle, Alain Lamy, Byoung Sun Lee, Alexandru Mancas, Dmitry Marareskul, Fran Martinez, Dan Oltrogge, Patrick Zimmerman.

0815 1200 Orbit Data Messages V.3

We continued the ODM P2.36 discussion that had commenced the preceding day. We completed reviewing discussion items raised in the CRM for ODM P2.35 provided by David, and addressed most of the items raised in the CRM provided by Cheryl. During that discussion, we had occasion to discuss the

impact to an XML implementation of allowing comments anywhere in the OCM. David demonstrated the inability to validate an XML schema that (a) has multiple adjacent optional tags, and (b) allows optional comments everywhere; this same issue had arisen in the context of the NHM a couple of years ago. After this demonstration, the group discussed ways to accommodate both the desire to allow sufficient optional comments in an OCM while also allowing a large number of adjacent optional tags. Dan indicated he would consider placing unlimited comments at the beginning of the various sections of the OCM. David had previously been under the impression that we would not attempt an XML implementation of the OCM because of the desire to accommodate "comments everywhere", however, Dan indicated that he did not want to do things in the OCM that would preclude an XML implementation.

1300 1645 Orbit Data Messages V.3, Modular NFM Msg Format, "Attitude Comprehensive Msg", NHM Direction, Time Scales, Reference Systems, Element Set Defs, Object Defs on SANA Registry? LDM: should we start a formal project? Consistency

Note: The times for the Tuesday afternoon discussions are not very precise because the discussion was somewhat freewheeling and branched among several topics. Also, it was nearly impossible to capture much of the discussion, again because of the interwoven topics. So the times above encompass the entire post-lunch period without differentiation.

We finished up ODM discussion by reviewing the items in Cheryl's CRM for ODM P2.35. Once that discussion was completed, Dan showed some of the new material in the ODM P2.36. In particular, there was a new Attitude Time History section that duplicated many of the data items already in the ADM. David expressed that including this degree of duplicated keywords from the ADM into the ODM/OCM may not be appropriate, and that this material is what he envisioned appearing in what we have been tentatively calling the "Attitude Comprehensive Message", an analogue to the OCM. The discussion of the OCM Attitude Time History concept (not the detail) was the catalyst for rearranging the afternoon's agenda from the original plan to a very freewheeling discussion of a number of future direction oriented topics that have been brewing for some time. Because these future oriented items were already on the agenda for discussion during the Spring Meeting series (and in fact were the reason for opting to work on Friday morning), it was appropriate to entertain the momentum shift from the planned agenda to the future topics.

During this discussion, we briefly revisited the Launch Data Message (LDM) Concept Paper, but did not make a decision to proceed with further work at this time. However, Dan stated his opinion that much of the proposed LDM material would be overlapping with other Navigation WG standards. We also previewed material that Julie had prepared related to an alternative approach to the NHM that is more along the lines of the other current Navigation WG standards.

All of this rearrangement of existing direction is inspired by the issues related to consistency and overlap between the different messages produced by the Navigation Working Group.

As a result of these discussions, we arrived at a couple of potential conclusions:

1. To potentially argue for re-confirmation of the ODM Version 2. We discussed the idea of proposing a resolution to split the OCM out of the ODM into the new separate document, and reconfirm the ODM Version 2 as is, however, this was viewed as premature at this time. 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).

3. To potentially change direction of the NHM into a format that is much less reliant on an ICD, based on Julie's explorations.

4. To morph the OCM+ACM+NHM (+others?) into the conceptually proposed "universal, modular" navigation message that has risen in the past few meetings. (NOTE: We have not formally named this message, though it has been referred to by several provisional names including (a) Navigation Functional Message (aka Navigation Frankenstein Message), (b) Navigation Comprehensive Message, (c) "Container + sub-blocks", and (d) Navigation Data Message. Later in the meeting we gravitated somewhat towards option (d).

5. In the future, instead of saying "We need to add XYZ to the Metadata Section", we might say "We need to add XYZ to the 'Metadata Dictionary', i.e., a full set of metadata items that could be situationally selected by a message originator as dictated by the data in the message.

DAY 3, WEDNESDAY 10-MAY-2017

0815 0830 Navigation Hardware Message Direction/Decision (NHM)
0830 1100 Re-Entry Data Message (RDM)
1100 1200 Navigation Hardware Message Direction/Decision (NHM)
1200 1300 Lunch
1300 1415 Tracking Data Message P1.04
1415 1545 ADM Pink Book Updates + "Attitude Comprehensive Message"?
1545 1645 Joint Meeting with CSSM Regarding Events

In attendance this day were David Berry, Frank Dreger, Dale Force, Ralph Kahle, Alain Lamy, Byoung Sun Lee, Alexandru Mancas, Dmitry Marareskul, Fran Martinez, Dan Oltrogge, Julie Halverson, Patrick Zimmerman. For the morning session, we were joined by Mario Merri (MOIMS/AD) and Brigitte Behal (MOIMS/Deputy AD).

0815 0830 Navigation Hardware Message Direction/Decision (NHM)

David started the meeting by informing the group that Mario Merri and Brigitte Behal, the MOIMS Area Director and Deputy Area Director respectively, were planning to join us at 11:00 for the discussion regarding the NHM. The CCSDS/CESG policy of having a full complement of resources specified for projects (Lead Editor, Prototype 1, Prototype 2) was explained, along with the issue that the NHM is the only standard under development in the CCSDS that does not have a Prototype 2 Agency defined. David indicated that he finds this situation uncomfortable.

0830 1100 Re-Entry Data Message (RDM)

Alexandru led the group through changes in the RDM Version 3 White Book. Some outstanding discussion items from the White Book Version 1 review were discussed. (Alexandru explained that there had been a Version 2 draft that had only been distributed internally at ESA, hence the apparent version numbering gap.) He noted that there were some issues with requiring certain information to be in a SANA Registry (e.g., OBJECT_OWNER, OBJECT_OPERATOR), because the registry might not be complete. However, David indicated that this issue can probably be dealt with by making these a "should" statement in the document rather than a "shall". In the future we will have to see how rapidly the SANA Operator can respond to requests for updates to the relevant registries. There was also a fair amount of technical discussion regarding the 1-sigma and 2-sigma confidence interval data items in the RDM, given that the

re-entry problem is inherently non-Gaussian. Different suggestions and alternatives were proposed for Alexandru's consideration. Alexandru indicated that he could have another draft of the RDM by end of June. We discussed the prospects for having a Red Book before the end of 2017; David indicated that this was a potentially realistic possibility, particularly given the fact that the RDM is perhaps the principal work item for Alexandru at this time (subtext: having resources enables faster progress!).

1100 1200 Navigation Hardware Message Direction/Decision (NHM)

At the appointed hour, Mario Merri and Brigitte Behal joined us for the discussion of the NHM. David indicated his intent that we would have a decision at these meetings as to a second prototyper or we would cancel the NHM. To set the context for discussion, the two potential resolutions (point/counterpoint) that were discussed at the Fall 2016 Meetings in Rome were again presented (see Fall 2016 Meeting minutes for the full text of the two resolutions). Mario suggested an informal poll of the meeting attendees as to their interest in the NHM; we went around the room and each attendee indicated their interest/need or lack thereof for the NHM. The result of this was that there was not sufficient interest outside NASA to prototype the NHM. We discussed again the possibility of an Orange Book option, but that is generally a last attempt to keep a project alive (there are only 4 Orange Books in the CCSDS publication list at this time). Their existence often indicates an inability to achieve consensus in a Working Group. Mario indicated that he would determine in discussion the following week in the CESG meeting whether or not an additional Orange Book would be acceptable to the CCSDS, given that Orange Books are very few in number. (NOTE: in subsequent communication after the CESG meeting, Mario indicated that "as promised I have raised the issue of using the Orange Book for the NHM. The CESG did not raise any objection. Based on that, please consider the publication of the NHM as an OB [Orange Book] as one of the viable options.")

In the end, essentially the same decision we made at Rome was again made, i.e., to provisionally "continue/keep" the NHM, even though we still do not have a second prototyping Agency identified. As another option, we have the new direction being explored by Julie, which has some promise of avoiding the Orange Book option (although an Orange Book is possible, it is not the preferred option).

1300 1415 Tracking Data Message P1.04

David started by reminding attendees of the "TDM Blue Book Approach Plan" for the TDM Version 2 that was proposed and accepted at Rome, specifically:

Basic Plan for TDM Version 2

1. Complete TDM Version 2 based on changes to date, as soon as possible.
2. Immediately upon publication of Version 2, open discussions for Version 3.

A full rationale for this Basic Plan was presented in the minutes of the Fall 2016 Meeting minutes, but the key point is that proposed revisions received starting in 2012 have not yet been made available to requestors, nearly 5 years later; this is largely attributable to the amount of energy devoted to the CDM development, the ripple effect that had on delaying other Navigation WG projects, and insufficient budgets.

After reviewing the Basic Plan, including the full rationale, David went through the P1.0.4 version of the TDM, showing again areas where changes had been made. There were a few comments made during the discussion that will be taken into account in the next (final?) draft of the document. Specifically, it was suggested to add units "Hz" on the DOPPLER_COUNT_BIAS; to add a discussion of the indexer "n" on the text discussion of the *_PHASE_CT_n keywords (currently missing); and to consider whether or not

the DOPPLER_COUNT_SCALE "shall be positive" (currently stated as "should be positive").

David also noted that he had had very little commentary on the TDM P1.0.4 draft that was distributed in January. Based on this, he proposed to move ahead with a request for an Agency Review once a few final loose ends are resolved. (NOTE: A resolution to this effect was NOT included in the Navigation WG Closing Plenary report, which was something of an oversight; it is anticipated that such a resolution will be requested in the relatively near future.)

1415 1545 ADM Pink Book Updates + "Attitude Comprehensive Message"?

We commenced discussion of Alain's Attitude Data Messages P1.4 document, but it was a bit rushed given that we had a meeting scheduled with the Service Management WG not long after. Also, because the updated drafts had been distributed the Friday prior to the Spring Meeting start, attendees had not yet had time to adequately review the material and formulate opinions. Thus Alain walked the group through the CRM that combined the comments he had received on the previous version, focusing on those changes that were not trivial and thus required some discussion. We also formally introduced the notion of the "Attitude Comprehensive Message" (ACM) analogue to Dan's Orbit Comprehensive Message (OCM) in the ODM. Possible options include adding a new message to the ADM document or combining the ACM and OCM together in the future Navigation Data Messages omnibus document. Due to the scheduled joint meeting with Service Management this portion of the ADM discussion was inconclusive; we returned to the topic on the following day.

1545 1645 Joint Meeting with CSSM Regarding Events

Most of the members of the Navigation WG joined the Service Management WG for continued discussion on the nature and structure of "events". The class structure had evolved somewhat since we met at Rome given that the requirements specified by the Navigation WG had been incorporated. The discussion was led by Colin Haddow, who indicated that the joint time scale would be an enumerated type in an XML schema. There will also be some connection with a SANA registry, though it was not completely clear how the enumerated type would be implemented, and how it would be updated if the SANA registry changes. Fran had developed an XML schema to represent the event structure, so seems to be the most knowledgeable about the progress here. This joint meeting concluded our day.

DAY 4, THURSDAY 11-MAY-2017

0815 0930 EVM: Should we start a formal project?
0930 1115 Navigation Data: Definitions & Conventions Green Book
1115 1200 ADM Pink Book Updates + "Attitude Comprehensive Message"?
1200 1300 Lunch
1300 1510 ADM Pink Book Updates + "Attitude Comprehensive Message"?
1510 1600 Time Scales, Reference Systems, Element Set Defs, Object Defs on SANA Registry?
LDM: should we start a formal project? Consistency
1600 1630 Modular NFM Msg Format (Navigation Function Message)
1630 1645 Navigation Data Messages Overview update (post-PRM/TDM)

In attendance this day were David Berry, Frank Dreger, Dale Force, Ralph Kahle, Alain Lamy, Alexandru Mancas, Dmitry Marareskul, Fran Martinez, Dan Oltrogge, Julie Halverson, Patrick Zimmerman.

0815 0930 EVM: Should we start a formal project?

We started the day with a follow-on discussion related to the joint meeting of the previous afternoon, specifically, of the Events Message and the question as to whether or not we should promote the existing Draft Project to an Active Project. The group elected to propose a resolution to this effect (see "MOIMS Closing Plenary / Navigation Working Group Report" below). Alain will be responsible for leading the effort. Given that Fran indicated that this would likely be an XML implementation only, he will play a key role in getting the job done. CNES and ESA will perform the prototyping of the Events Message. Fran walked the group through the abstract type as discussed in the joint meeting of Wednesday afternoon, showing how the abstract type would be applied to the Navigation WG events. Primarily the task involves cataloging a list of events of interest to Navigation, determining the applicable parameters for those events, and developing/testing the applicable schema.

0930 1115 Navigation Data - Definitions & Conventions Green Book V.4

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. In general the changes were relatively few in number and minor as opposed to major, suggesting that the document may be nearing the point where we request publication of the update and thus completion of the project. One of the more voluminous comment sets in the CRM was related to the vector equations in several locations being garbled; Dale has been researching this issue but it is possible that it is a "Mac/PC" incompatibility phenomenon (which would be good because that would mean all the equations in the book don't need to be edited). There was a fair amount of discussion regarding changes to some of the physical constants reflected in the Green Book text; in general the group took the position that the source of these constants should be documented. One of the points that Dale wished to finalize was the introductory text in Section 2 of the Definitions & Conventions Green Book and the Navigation Data Messages Overview Green Book (he also referred to these as the "Long Intro" and "Short Intro"). Because the material had been distributed the Friday prior to the Spring Meeting start, attendees had not yet had time to adequately review the material and formulate opinions, so it was resolved to settle the matter during telecons in the coming months. Dale also had a question regarding terms in the Green Book glossary given that there is a CCSDS Glossary on the SANA Registry; he consulted with Tom Gannett on this matter and was informed that Tom appreciates getting specific listings of terms to add to the Glossary, but also will take this upon himself by processing the glossaries of documents that he edits. A few spot checks of terms in the Green Book glossary revealed that a number of terms were already in the CCSDS Glossary on the SANA Registry, reflecting Tom's prior efforts. Thus it may be possible to eliminate the glossary from the Green Book and simply point to the SANA Registry (<http://sanaregistry.org/r/glossary/glossary.html>); this registry is separated into separate sub-registries for "Terms" and "Abbreviations". Dale's research may be applicable to other Navigation WG documents as well, although this could be a matter for further discussion (e.g., is it better to have terms defined in the same book one is reading? or better to have a more comprehensive companion source document).

1115 1510 ADM Pink Book Updates + "Attitude Comprehensive Message"?

We continued the discussion of proposed changes in the ADM given that Alain's time on the agenda had been greatly shortened the previous day due to the discussion of future directions that had been accelerated from Thursday into Tuesday afternoon. A number of the ADM revision proposals represent relatively major changes from the current version of the ADM, which will likely necessitate software changes on the part of those parties that have implemented the ADM (APM and/or AEM). Some of the proposed changes are right in line with what we have been discussing for future changes, for example, having message originators select reference frames and time scales from a SANA registry. Other changes are potentially more problematic, for example, Alain noted a preference for eliminating the option to have

the scalar part of the quaternion notated as either first or last in an AEM ephemeris line (i.e., "QUATERNION_TYPE = FIRST" or "QUATERNION_TYPE = LAST"). Note that this change would not affect APMs. The justification for this change is that the amount of information necessary to describe a quaternion should be the same whatever the format used (XML or KVN). With respect to transformation direction, Alain asserted that there seems to be a consensus to eliminate these keywords (e.g., Q_DIR, SPIN_DIR, ANGVEL_DIR, EULER_DIR, etc.). Overall Alain indicated that from the beginning he has assumed no necessary compatibility between version 1 and 2 of the ADM, with Version 2 being seen as a new, redesigned version. David pointed out that this may be contrary to one of our guidelines to leave things as they are if they are not wrong, unclear, or a new requirement. Alain indicated that his aim is to simplify the content while also providing clearer descriptions in Version 2. There was some argument against taking several of these approaches, notably by Frank Dreger given that ESA is using APM/AEM structures in operations. However, Alain noted that the overall implementation of the AEM does not seem to be very wide, so the negative impact could be reduced. Several in the group countered by indicating that it is not possible for us to know exactly who is using CCSDS standards, and how they are being used. In the end there was no firm decision here. It is possible that the Agency Review of the ADM version 2 may produce some RIDs expressing further objections to the changes.

**1510 1630 Time Scales, Reference Systems, Element Set Defs, Object Defs on SANA Registry?
LDM: should we start a formal project? Consistency. Modular NFM Msg Format
(Navigation Function Message)**

We returned to the collection of future topics that are somewhat wrapped together. We seemed to converge on "Navigation Data Messages" as a formal name for the new direction. We already have the "Navigation Data Messages XML Specification" (which contains the "combined instantiation" characterized by the <ndm></ndm> tag pair) so it's not such a far leap. It was asserted that we would want KVN version also. After some discussion, Dan proposed the following prioritization for implementation of the various topics

1. SANA registry items (time scales, reference systems, maybe orbital element sets, attitude element sets)
2. Navigation Data Message Infrastructure/Superstructure (OCM blocks, ACM blocks, NHM blocks, PRM templates, RDM blocks, etc.)
3. Event Message
4. Launch Data Block

The result could be one parent "NDM" standard, with smaller specific reusable block oriented standards that "plug in". Obviously these concepts require further discussion and elaboration, but the resultant standard(s) could potentially be clearer, more consistent, and less duplicative. In support of the above prioritization, some action items were assigned for the time between the Spring and Fall Meetings series. In order to keep the future direction work from bogging down, we will need to engage relatively soon in the requisite discussions and elaborations. In support of this topic, David went through the paper that will be presented at the upcoming International Symposium on Space Flight Dynamics to highlight those directions and decisions expected during the Spring 2017 Meetings (see <https://cwe.ccsds.org/moims/docs/MOIMS-NAV/Marketing%20Materials/issfd26-paper-final-2017.pdf>). In general, we achieved or started upon most of the future topics described therein.

1630 1645 Navigation Data Messages Overview update (Post PRM/TDM/NDDC)

In the last few minutes of the day, David noted that we would need to do an update of the second

Navigation WG Green Book, the "Navigation Data Messages Overview", once the PRM and TDM updates are completed. At that time we can also remove the Spacecraft Maneuver Message from the document, and indicate that the Events Message has started. At this time, Dale is tentatively the point person for the update of the "Navigation Data Messages Overview" after the "Navigation Data - Definitions and Conventions" update is completed.

DAY 5, FRIDAY 12-MAY-2017

0815 1145 Prep Closing Report, Action Items, 5 Year Plan, Set Next Telecon
1145 1145 End of Navigation WG Meeting
1145 1300 Lunch
1300 1530 MOIMS Closing Plenary (attendance optional)

In attendance this day were David Berry, Frank Dreger, Dale Force, Alain Lamy, Dan Oltrogge, Julie Halverson, Patrick Zimmerman. The Lead Editor's Boot Camp was attended by Alexandru Mancas.

0815 1145 Prep Closing Report, Action Items, 5 Year Plan, Set Next Telecon

We completed the list of action items, target dates, and assignees (shown above in the minutes). We reviewed and completed the WG's report to the Area Director for the MOIMS Closing Plenary (shown below in the minutes). Given that several people were unable to participate in Friday morning's meeting, we postponed discussion of the 5 Year Plan, though the most recent iteration of the plan was shown and David described his method for populating it. We will address this plan in monthly telecons between now and the Fall 2017 meetings in The Hague, Netherlands.

Document project schedules on the CWE Framework were not reviewed during the meeting; however, in the CWE Management Framework they all show as "On Schedule". David noted that he reviews these schedules on a weekly basis. These project schedules form the basis for the consolidated Five Year Plan, which as noted above we will review in telecons.

1145 1145 End of Navigation WG Meeting

After completing all the closing matters, the Navigation WG meeting was concluded. All were thanked for a productive meeting week, we bid each other safe travels, and we started making plans for the next meetings in The Hague in November 2017.

All materials from the meetings (agenda, introductory presentation, action items, report, 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%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}>

1300 1530 MOIMS Closing Plenary

In attendance at this meeting were Brigitte Behal (ESA, MOIMS), Mario Merri (CNES, MOIMS), David Berry (Nav), John Garrett (DAI), Mehran Sarkarati (MPS), Dan Smith (SM&C), and a number of other members of the various working groups.

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

MOIMS CLOSING PLENARY / NAVIGATION WORKING GROUP REPORT

Navigation WG Executive Summary

Achievements for this meeting cycle:

- Completed review of Pointing Request Message Test Plan & Report
- Completed internal WG review of revisions to drafts of the Orbit Data Messages, Attitude Data Messages, Tracking Data Message, and Navigation Data Definitions and Conventions
- Completed internal review of latest draft of Re-Entry Data Message
- Continued discussion of the future of the Navigation Hardware Message
- Completed decision to convert "Events Message" Draft Project to Active
- Initiated discussion of future directions for the Navigation Data Messages (XML and KVN)
- Initiated plans to migrate substantial appropriate material from Annexes to SANA

Interaction with other WGs

- Completed productive Joint Meeting with CSSM on the definition of "Event"

Problems and Issues:

- We continue to lack a second prototype commitment for the Navigation H/W Message; we continue to explore options (e.g., Orange Book?)

Working Group Status:

- Active, "High Momentum", OK

Resolutions agreed upon this meeting

- Resolution 1: Request to convert the Navigation Events Message from Draft Project to Approved project. (CNES/ESA)
- Resolution 2: The Navigation WG thanks NASA and SWRI for their excellent hosting of this CCSDS Meeting series.

Further Resolutions anticipated in the next 6 months:

- Resolution 1: Request to convert the Pointing Requests Message Red Book to Blue Book.
- Resolution 2: Request to advance the Re-Entry Data Message White Book to Agency Review

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 02-Sep-2015 End date 31-Oct-2017
MOIMS NAV	502.0	Orbit Data Message (ODM) 5 Year Review Revision	Good progress	Start date 14-Nov-2014 End date 31-Jul-2018
MOIMS NAV	503.0	Tracking Data Message (TDM) 5 Year Review Revision	Acceptable progress	Start date 09-Oct-2013 End date 15-Nov-2017
MOIMS NAV	504.0	Attitude Data Message (ADM) 5 Year Review Revision	Acceptable progress	Start date 16-Apr-2015 End date 31-Jul-2018
MOIMS NAV	505.0	Navigation Data Messages XML Specification Five Year Revisions	Progress delayed by other priorities, however, we are now poised for future effort	Start date 13-Jul-2016 End date 01-Apr-2019
MOIMS NAV	509.0	Pointing Requests Message	Good progress. Prototyping effort nearly complete.	Start date 06-May-2010 End date 15-Aug-2017
MOIMS NAV	510.0	Navigation Hardware Message	Some progress, still lacks prototype #2, considering Orange Book.	Start date 29-Sep-2010 End date 30-Apr-2018
MOIMS NAV	N/A	Re-Entry Data Message	Good progress	Start date 27-Jun-2016 End date 31-Aug-2018

Nav WG Resource Issues for Approved Projects

Area and WG name	CCSDS Ref Nr	Document Title	Target Publication Date	Missing Resources	Comments
MOIMS NAV	510	Navigation Hardware Message (Blue Book Track)	30-May-2018	Prototype #2	The "Target Publication Date" is the date in the CCSDS Framework, however, this book has been on hold for about one year. Possible options being

Area and WG name	CCSDS Ref Nr	Document Title	Target Publication Date	Missing Resources	Comments
					considered for going forward: 1. Capturing the desired technical content in a different manner 2. Orange Book (there does not appear to be much interest outside NASA in the Navigation WG) 3. Cancellation

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?
MOIMS NAV	N/A	Navigation Events Message	01-Sep-17	2017	6	6	0	0	The current need for standardized event descriptions will remain unfilled
				2018	6	6	0	0	
				2019	18	6	6	6	

Navigation WG Additional Viewgraphs

PRO

- Meeting facilities were excellent (room size, environmental, electrical, WiFi, coffee, cookies, cafeteria, etc.)
- Very pleasant campus
- We appreciate SWRI scheduling good weather
- Cool that the San Antonio Spurs won while we were in town!

CON

- CCSDS Plenary Meetings are now taking quite a bit longer than they formerly did... this detracts valuable time from WG activities.
 - It is the consensus of the Navigation WG that the detailed plans of every Area Director be distributed as backup material, rather than presenting them during the Plenary.

MAILING LIST

- Feedback on CCSDS mailing lists had been requested. Navigation WG already has 2 lists... one for WG members, one for all.

NEXT TELECON:

The WG established Wednesday 28-Jun-2017 @ 1300 UTC as a next telecon date. A meeting invitation will be sent. The tentative agenda will focus on (1) PRM Prototype Testing Status / PRM Blue Book Approach Plan, and (2) Action Items Review & Document Status. We may also take a look at a draft of an updated 5 Year Plan.