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MINUTES OF NAVIGATION WORKING GROUP FALL 2015 WORKSHOP 15-Nov-2015 David S. Berry / Chair

The CCSDS Fall 2015 Meetings were conducted at the Darmstadtium in Darmstadt, Hesse, Germany, during the week of 09-Nov-2015 through 12-Nov-2015. The European Space Agency (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

David Berry (NASA/JPL), Frank Dreger (ESA/ESOC), Jürgen Fertig (ESA/ESOC retired), Tim Flohrer (ESA/ESAC), Dale Force (NASA/GRC), Joseph Hashmall (NASA/GSFC/a.i. Solutions), Reinhard Kiehling (DLR), Alain Lamy (CNES), Alexandru Mancas (ESA/ESAC), Dmitry Marareskul (JSC Information Satellite Systems Reshetnev Company FSA), Francisco Martinez (ESA/ESOC/GMV), Dan Oltrogge (NASA (AGI, SDC, and ISO TC20/SC14)), Juan Carlos Raymond (NASA/GSFC), Karen Richon (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: <http://cwe.ccsds.org/moims/docs/MOIMS-NAV/Meeting%20Materials/2015/Fall/navwg-agenda-201511.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 <http://cwe.ccsds.org/moims/docs/MOIMS-NAV/Meeting%20Materials/2015/Fall/navwg-action-items-201511.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.

New Action/Outstanding Action Items

##	Action Item	Actionee	Due Date (Original)	Due Date (Current)
01	Re-distribute "Events" list	Alain Lamy	20-Nov-2015	20-Nov-2015
02	Review NHM WB13/14	All, (see detail assignments at end of AI List)	23-Nov-2015	23-Nov-2015
03	Produce TDM P1.0.3	David Berry	30-Nov-2015	30-Nov-2015

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##	Action Item	Actionee	Due Date (Original)	Due Date (Current)
04	Produce NHM WB15	Joe Hashmall	30-Nov-2015	30-Nov-2015
05	Produce PRM White Book 2.7 (response to CESG conditions)	Fran Martinez	30-Nov-2015	30-Nov-2015
06	Publish "Navigation Data Messages - Overview" Green Book	Tom Gannett (Secretariat)	15-Dec-2015	15-Dec-2015
07	Concept Paper for Fragmentation Data Message	Tim Flohrer / Alexandru Mancas	31-Dec-2015	31-Dec-2015
08	Concept Paper for Re-Entry Data Message	Tim Flohrer / Alexandru Mancas	31-Dec-2015	31-Dec-2015
09	Concept Paper for Launch Data Message	Dan Oltrogge	31-Dec-2015	31-Dec-2015
10	SMM White Book 5	Karen Richon	31-Dec-2015	31-Dec-2015
11	Produce CDM corrigendum for "N_BODY PERTURBATIONS" keyword	David Berry	13-Jan-2016	13-Jan-2016
12	Review SMM requirements for potential use in "OHM"	Dan Oltrogge	13-Jan-2016	13-Jan-2016
13	Find CMC documentation of XML requirement	David Berry	13-Jan-2016	13-Jan-2016
14	Enter Draft Projects for Future Ideas	David Berry	13-Jan-2016	13-Jan-2016
15	Commence PRM Agency Review	Tom Gannett (Secretariat)	15-Jan-2016	15-Jan-2016
16	Send Alain suggestions for "SPIN" block in the APM	All	15-Jan-2016	15-Jan-2016
17	CDM Corrigendum for element form default on schema (done as part of general change from 'elementFormDefault="unqualified"' to "qualified" for all NDM/XML schemas	David Berry	31-Jan-2016	31-Jan-2016
18	Produce NDM/XML P1.1	David Berry	31-Jan-2016	31-Jan-2016
19	Produce ODM P2.32	Dan Oltrogge	31-Jan-2016	31-Jan-2016
20	Produce ADM P1.2	Alain Lamy	31-Jan-2016	31-Jan-2016
21	Produce Green Book 3.1.1	Dale Force	15-Mar-2016	15-Mar-2016
22	Review SMWG "Events" draft	All	04-Apr-2016	04-Apr-2016
23	Next available number	N/A	31-Dec-2030	31-Dec-2030

Navigation Hardware Message White Book Review Assignments Version 13/14 (AI-02 Above)

Pages	Reviewer #1	Reviewer #2	Reviewer #3
Pages 1-1 thru 3-3	Frank Dreger	Tim Flohrer	Cheryl Gramling
Pages 4-1 thru 4-11	Dale Force	Patrick Zimmerman	Kyohei Akiyama
Pages 5-1 thru 6-2	David Berry	Fran Martinez	Reinhard Kiehling
Annex A-1 thru C-3	Dan Oltrogge	Juan Raymond	Dmitry Marareskul
Annex D-1 thru G-4	David Vallado	Alain Lamy	Karen Richon
Annex H-1 thru J-1	David Berry		

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Completed Action Items

##	Action Item	Actionee	Status	Completion Date
N/A	N/A	N/A	N/A	N/A

Cancelled Action Items

##	Action Item	Actionee	Reason
N/A	N/A	N/A	N/A

WORKSHOP PROCEEDINGS

DAY 1, MONDAY 09-NOV-2015

0800 0845 Registration
0845 1015 CCSDS Opening Plenary
1015 1130 MOIMS Opening Plenary
1130 1230 Admin: Intro to Navigation WG, Navigation WG Guidelines
1230 1330 Lunch
1330 1700 Navigation Hardware Messages (NHM)
1700 1730 Navigation Data Message Consistency Discussion

0845 1015 CCSDS Opening Plenary

The CCSDS Spring 2015 Meeting series started with a CCSDS Opening Plenary attended by all participating CCSDS members. Nestor Peccia chaired the meeting. We had a few opening remarks from Joan Miro of ESA/ESOC (workshop hosts). Miro's talk highlighted a number of missions and developments of ESA since the last time the CCSDS met at Darmstadt. In keeping with the charter of CCSDS, he also indicated that it is important to work together beyond agency boundaries to document in standards both that which has been done and also to define the future. Nick Tongson of the CCSDS Secretariat also spoke on the traditional set of various logistical matters and items of general interest (e.g., details of upcoming meetings, break times, lunch logistics, wireless access, social activities, 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 2016 hosted by NASA at Cleveland, Ohio, USA (04-Apr-2016 through 08-Apr-2016, 5 day meeting)
 - b) Fall 2016 hosted by ASI at Rome, Italy (31-Oct-2016 through 04-Nov-2016, 5 day meeting)
 - c) Spring 2017 hosted by NASA at TBD, USA
 - d) Fall 2017 hosted by ESA at TBD, Europe
 - e) Spring 2018 hosted by NASA at TBD, USA
 - f) Fall 2018 hosted by DLR at TBD, Germany
2. There will be two "Boot Camp" sessions for CCSDS book editors this week (Monday/Thursday PM).
3. The CCSDS now has 148 active publications, of which 92 are normative.

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4. The number of missions that have used CCSDS standards in some respect is now up to 767.
5. The CCSDS now has 21 WGs, 3 Birds of Feather (BOF, 2 of which are converting to WGs), and 1 Special Interest Group (SIG); this is approximately the number of entities reported at Pasadena Spring 2015.
6. There are 75 approved projects in the CWE Framework, and 65 "draft projects" (a new invention of the CESG).
7. The number of people registered for the meetings is quite high (234, with 65 from ESA and 65 from NASA).

During his presentation, Nestor highlighted a few things of importance to the Navigation WG, in particular, the fact that the PRM had not yet been approved for Agency Review, the "Navigation Data Messages Overview" Green Book is in CESG Poll, that many projects in the CCSDS Framework did not have a second prototype agency indicated (most of which are in MOIMS), and that the IETF RFC prepared by the XML Standards and Guidelines (SIG) had finally been approved (note that the first drafts of this were prepared in 2005!). The System Engineering Area's interest in developing stronger conventions for the SANA Registry (SANA Re-Engineering) was also highlighted.

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.

During the discussion, the CCSDS statistics report generated by the Secretariat came up. Later during the Navigation WG opening administration items, several WG members indicated interest in seeing the reports (document downloads primarily). David took an action item to forward the latest statistics to the group.

1015 1130 MOIMS Opening Plenary

The overall CCSDS Plenary was followed immediately by the MOIMS Opening Plenary meeting, which was chaired by Area Director Mario Merri. During the MOIMS Plenary, Mario presented a detailed description of his vision for the evolution of MOIMS. This presentation highlighted the status of each WG in the Area (DAI little momentum and cloudy future, Navigation very active with little interest in "Navigation Services", Telerobotics not very active, SM&C very active with definition of "MO Services", and the new Mission Planning & Scheduling just getting started with selecting leadership and contemplating a Green Book). The presentation was very much oriented towards service definitions as opposed to data formats; he specifically and prominently called out the "S" in "MOIMS". Mario described his vision as "standardization of a set of data/services interfaces for mission operations that is as much as possible complete, homogeneous, and spanning ground/space". There was a great deal of emphasis on service definitions available via open source software. This would seem to put the CCSDS into a somewhat different role than it has had in the past. In particular, for the Navigation WG, Mario's proposed evolution involved a combination of data messages standardization and a service oriented approach in selected cases, despite the fact that this direction has always been met with resistance from the Navigation WG. With regard to the division of labor/responsibility for services, Mario cited what he called "The London Agreement", which documented discussion/agreement that occurred at London between the leaders of the Cross Support Services Area (CSS), MOIMS, and the System Engineering Area (SEA). The London Agreement was endorsed by the CMC in November 2014. Schedule-wise, Mario confirmed the time of the MOIMS Closing Plenary (Thursday 12-Nov-2015 at 1600) and indicated that the MOIMS Area Dinner would be held on Tuesday 10-Nov-2015 at 2000 at the Rathskeller.

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1130 1230 Admin: Intro to Navigation WG, Navigation WG Guidelines

The Navigation WG meeting was started immediately after the close of the MOIMS Opening Plenary. In attendance this day were David Berry, Frank Dreger, Jürgen Fertig, Dale Force, Joseph Hashmall, Reinhard Kiehling, Alain Lamy, Alexandru Mancas, Dmitry Marareskul, Dan Oltrogge, Juan Carlos Raymond, Karen Richon, Patrick Zimmerman.

Given that there were a few new attendees to the meetings in this meeting series (Frank Dreger, Dale Forces, Alexandru Mancas), we started the meeting by going around the room with introductions. Given Jürgen's retirement in June 2015, he was present to introduce the WG's new Deputy Chair, Frank Dreger. The "Introduction to the Navigation WG" presentation was presented in full for the benefit of new attendees (but the backup materials containing document details were not gone over in detail, rather, David sent the presentation slides to the group). This presentation highlighted the progress since the last meetings and set the priorities for the week.

Review of the action items from London showed that as of the start of the meetings, 23 of 33 were completed (70%), 7 remain outstanding (21%), and 3 were cancelled (9%). David noted that the duration since the end of the Pasadena meetings was 226 days, a somewhat greater period of time than between the end of Fall Meetings and the beginning of the Spring Meetings. This helps explain the higher percentage of action items completed at the time of Fall than in Spring. The remaining outstanding action items were not reviewed in detail, since they had been discussed on the WG telecon the preceding week; they will be carried forward into the new list of open action items added during the Fall Meetings (see above).

Another topic of discussion was the small document entitled "CCSDS Navigation Working Group Document Guidelines". This document had commenced at London, and was previously discussed on a telecon and via e-mail. Several updates had been made based on WG member reviews. The end result is a single page of "good citizen guidelines". In the course of discussing this, David noted that we had several documents for which a second prototyping entity has not been identified. Jürgen suggested that it might be appropriate to try to determine a second prototyping entity at the time of a Concept Paper; his logic was that if no one is interested in prototyping the standard, perhaps that could be grounds for not proceeding with the elaboration of the Concept.

1330 1700 Navigation Hardware Messages (NHM)

The WG discussed the items in the NHM Comment Resolution Matrix (CRM) that had been received on NHM White Book (WB) 12. In response to those suggestions, Joe had published an NHM WB 13 that contained the responses to most of the suggestions, and also an NHM WB 14 that dealt only with a suggested change in the order of sections so that KVN material and XML material are placed together. Joe had taken this two-draft approach in order to allow reviewers to focus on content changes (WB 13) as opposed to formatting changes (WB 14). The great bulk of the suggested changes had been made in the WB13/14, however, there were also a number in the CRM that required discussion with the group. The group worked through the list of these issues that required discussion. Joe initiated a WB 15 to capture the decisions and changes made in real time. The WG members were reminded that Joe's tenure in the WG is in jeopardy at this time due to contractual issues, so the time for commenting on NHM WB 13/14 is very abbreviated (target date 23-Nov-2015) and Joe's target for producing the NHM WB 15 is also in the very near term (target date 30-Nov-2015, when his funding nominally expires). David indicated that he had sent out review assignments for sections of the document. Patrick Zimmerman suggested that the detailed assignments should be included in the Action Items list so one could easily see their assignments; David indicated he would do this. One of the principal topics of discussion on the NHM revolved about the near necessity of using an ICD. Juan Carlos Raymond suggested that even in simple cases (e.g., a state "A"

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and a value "B"), one mission might choose to order them "A-B" and the next might choose "B-A"; this essentially guarantees a requirement for an ICD given the number of possible data types and combinations. Without an ICD, navigation teams will not know how to process the NHM data. Given recent conditions placed by the CESG on the PRM, it was acknowledged that the dependence on an ICD was a potential weak point with respect to moving the document forward. While Joe has championed the NHM, he has from the very beginning stated that he thought it might have a relatively low acceptance rate. The WG elected to proceed with the completion of the document; it is hoped that WB 15 can be the version submitted to the Secretariat for Red Book processing. We also had some discussions of consistency with respect to the use of "<timetag>" (as in the NHM/XML) and "<EPOCH>" (as in the TDM/XML). The verdict here was that the use of "<EPOCH>" in the TDM should probably have actually been "<timetag>" since "EPOCH" is not a keyword in the NHM. Thus "<timetag>" will continue to be used in the NHM Hardware Data Record.

1700 1730 Navigation Data Message Consistency Discussion

In the last half hour of the day, Karen suggested that we review the output of her message consistency study first discussed at London; our conclusion from the London meetings was that we should be as consistent as possible with prior works, and have a solid rationale for departing from consistency (these concepts are now captured in the "good citizen guidelines"). The group went through the list and discussed each item. We didn't quite finish the list, covering about 2/3 of the items. (Note: ultimately we ran out of time to complete discussion of the list, so the remaining topics will be covered in a telecon... periodic reminders of the need for consistency among our works do seem to be desirable.)

DAY 2, TUESDAY 10-NOV-2015

0845	1115	Pointing Requests Message (PRM)
1115	1245	Attitude Data Messages Version 2 (ADM)
1245	1345	Lunch
1345	1515	Attitude Data Messages Version 2 (ADM)
1515	1545	Events Message Joint Session Prep
1545	1700	Events Message Joint Session with Service Mgmt (Barkley)
1700	1900	CCSDS Reference Architecture (MOIMS/SOIS) Meeting
2000	????	Mario's MOIMS Area Dinner

In attendance this day were David Berry, Frank Dreger, Jürgen Fertig, Dale Force, Joseph Hashmall, Reinhard Kiehling, Alain Lamy, Alexandru Mancas, Dmitry Marareskul, Francisco Martinez, Dan Oltrogge, Juan Carlos Raymond, Karen Richon, Patrick Zimmerman.

0845 1115 Pointing Requests Message (PRM)

Fran Martinez led discussion of the PRM "pre-Agency Review" draft that had been updated to respond to the conditions levied by members of the CESG (Erik Barkley and Peter Shames). He led the group through the issues/suggestions from the CESG and we attempted to resolve them. In most cases this was possible. There was one notable exception, specifically, where the condition was that the namespace of the XML instantiation be explicitly stated in the example PRM. David noted that because of the way in which the NDM/XML master schema imports the namespace, it is impossible to satisfy the condition. This led to a discussion as to whether or not the PRM schemas would/should be incorporated into the NDM/XML schema. Fran indicated that each of the templates in Section 4 of the PRM would require its own schema, and it wouldn't make sense to put them all in the NDM/XML structure. The discussion then questioned whether the CMC's XML directive had only indicated use of the XML language or had

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specified the use of XML schema. David stated that he suspected the former (i.e., no specific mention of XML schema). This raised the question of what exactly was specified by the CMC. David indicated that he had looked through old minutes previously (some time ago) but could find no document from the CMC communicating the decision. David took an action item to try to find the statement from the CMC, as it affects the new OHM as well as the PRM. The group made a decision to NOT develop schemas for the PRM templates (there are none now), and only to register the templates in the SANA Registry. David took the action item to convey this decision to Barkley and Shames, which was accomplished at the morning coffee break; they were not particularly happy with this decision (the term "cop out" was used with reference to the decision), but it did not appear they would continue to block the Agency Review. Fran will need to clean up the PRM so that it can be presented to Barkley and Shames for their agreement that the conditions have been satisfied (e.g., re-arrange annexes so all the normative ones appear first, other minor changes), after which the CMC Poll for Agency Review can commence. (Note that we had originally hoped to have PRM RIDs to address at these Fall Meetings; we now hope to get the Agency Review started shortly after the beginning of the 2016 calendar year.) David indicated that he would add a Resolution to the Navigation WG Plenary Report asserting that we think the revisions satisfy the conditions placed by the CESG and that it is ready for the Agency Review.

1115 1245 Attitude Data Messages Version 2 (ADM)

1345 1515 Attitude Data Messages Version 2 (ADM)

Alain led us through discussion of the Attitude Data Messages (ADM) revisions incorporated in the ADM P1.1 that was distributed just prior to the meetings. Alain initiated a Pink Book P1.2 during the meeting in which the changes/decisions were recorded. One topic of discussion early on was the level of backward compatibility required (if we are backward compatible, then existing software could read an ADM version 2; if not, then existing software will require updates). Alain responded that this is one of the purposes of the version number keyword (CCSDS_*_VERS). Software must check this number to detect whether or not it is an acceptable version for the program processing the data. Alain explained that two of his goals are to (a) simplify the ADM and (b) make it unambiguous. In the allotted time we were able to complete a review of the Attitude Parameter Message (APM). Because the document had been distributed only shortly prior to the meetings, there was no opportunity for WG members to review the document and file CRMs, so we reviewed it in real time. At a few points in the discussion it was necessary to remind the WG that we are reviewing a document that has already been published for over 5 years, and we have no idea how it may be being used. We are not redesigning the APM from scratch; if there are errors we need to fix them, and if there are improvements to be made, we should make them. But we should not think we need to redesign things wholesale. This necessarily constrains the design space at least a little. There was one area where Alain indicated that he felt clarification was necessary, in particular, at minimum he would like to improve the descriptions associated with the SPIN* related keywords. He requested an action item for all to send him "the correct definition" (i.e., what they thought was correct) of the SPIN block keywords. An action item was added to the list, with a target date prior to the date of producing the next draft of the ADM. Note that since we did not get through the entire document, Alain suggested that we not make document review assignments for the ADM P1.1, rather, that we wait until after ADM P1.2 comes out since he feels there are many more things to address in the AEM portion of the document. Accordingly, no formal review assignments for the ADM P1.1 were made.

1515 1545 Events Message Joint Session Prep

1545 1700 Events Message Joint Session with Service Mgmt (Barkley)

In order to prepare for the joint meeting with the Service Management WG on the topic of "events", Alain Lamy led us briefly through the list of candidate events that could be under consideration for the Events Message (EVM). There was brief discussion, but given that the WG does not currently have a project in the Framework for the EVM, and no action items, there was not much to actually do other than be aware

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of what types of things are in the list. At the appointed hour, several WG members went to the Service Management WG meeting room (David Berry, Frank Dreger, Dale Force, Alain Lamy, Fran Martinez, Juan Carlos Raymond, and Patrick Zimmerman). The remainder of the WG continued working on action items in the Navigation WG meeting room. In the joint meeting, Erik Barkley had one of the SMWG members (Colin Haddow) present the SMWG concept of an event. Note that there are at least 3 WGs interested in this concept: Navigation, Service Management, Mission Planning & Scheduling, and perhaps others. While there were some differences between the Navigation WG concept and the SMWG concept, there was also a high degree of similarity. Points of commonality included a simple structure, an event name, an event epoch (start time) and parameterization. Some points of difference included a duration (which Navigation WG has defined as zero), an orbit number, and an event identifier. Largely the points of difference seemed not too problematic, e.g., Navigation can use an event start time and an event stop time to allow calculation of a duration if necessary, and can ignore orbit number and event identifier. There was a fair amount of discussion as to why from the Navigation point of view the orbit number and event identifier were problematic; some of the reasons provided included questions such as do missions count orbits from 0 or 1? what orbital event is used to trigger incrementing the orbit number? if the time of an event changes based on an orbit determination, which is very likely, will the events database be able to link the identifiers properly in order to avoid duplicate events? The history of the Events Message concept was discussed, including the fact that it had been allocated to the System Engineering Area 3.5 years ago after the 2012 Spring Meetings, but the intended Timelines Data Exchange event specification never materialized. Given that the Navigation WG has no current project for the EVM, and has a significant workload already, and the SMWG has resources allocated to work on "events", the SMWG took an action item to prepare a first draft document that could be reviewed by the Navigation WG prior to the Cleveland meetings in Spring 2016.

1700 1900 CCSDS Reference Architecture (MOIMS/SOIS) Meeting

After the close of the regular Navigation WG meeting, David attended the CCSDS Reference Architecture Meeting chaired by Peter Shames. This material focused on folding the "Applications Layer" work of the MOIMS Area and SOIS Area into work that has already been done covering the other layers of the protocol stack. The meeting was well attended; the fairly large meeting room was nearly full. Peter went through material he had prepared that focused individually on MOIMS and SOIS. For the Navigation WG, the material consisted of the context diagram that showed the various functions of a space mission ground system with the flow of navigation data messages between the functions superimposed. Peter had assigned "service interface" points at various locations in the diagram in keeping with the final "S" in both MOIMS and SOIS (i.e., "services"). No action items were assigned to Navigation, at least not yet.

DAY 3, WEDNESDAY 11-NOV-2015

0845	1230	Orbit Data Messages (ODM) Pink Book
1230	1330	Lunch
1330	1730	Orbit Data Messages (ODM) Pink Book
1900	????	CCSDS Social Dinner @ Restaurant Sitte

In attendance this day were David Berry, Frank Dreger, Tim Flohrer, Dale Force, Joseph Hashmall, Reinhard Kiehling, Alain Lamy, Dmitry Marareskul, Francisco Martinez, Dan Oltrogge, Juan Carlos Raymond, Karen Richon, Patrick Zimmerman.

<u>0845</u>	<u>1230</u>	<u>Orbit Data Messages (ODM) Pink Book</u>
<u>1330</u>	<u>1730</u>	<u>Orbit Data Messages (ODM) Pink Book</u>

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The entire day was allocated to discussion of the ODM revisions, with almost total emphasis on the new Orbit Hybrid Message (OHM), led by Dan Oltrogge. Dan prefaced the discussion with a bit of background information as a level-set, and then proceeded in a fashion similar to that utilized the previous day with the NHM. In this case, Dan went over CRMs that had been filed with comments on the ODM P2.30 and P2.31 versions. Many of the comments and suggested changes to the ODM had been already implemented in P2.31, but there were a fairly large number of items that had been marked for discussion at the face-to-face meetings. Dan initiated a new draft ODM P2.32 in which to capture the results of decisions made during those discussions. Note that most of the discussion at this time is somewhat necessarily focused on the new message, the Orbit Hybrid Message (OHM), given that this is the source of the largest changes in the document. David indicated that before we can proceed to Agency Review for the ODM V.3, we will have to do a thorough review of the material from top to bottom, but for now it is acceptable to focus on Section 6 and 7, which contain the largest amount of new material. The group did spend some time discussing whether or not "Orbit Hybrid Message" was the best name for the new message. Dan noted that for consistency purposes, the name of the new message should start with "O" and end with "M", but the middle character (assuming a 3 character acronym) is the only one that needs to be decided. We discussed the suggestion of "Orbit Comprehensive Message", which fits the character of the new message, but re-uses an acronym used by the JSpOC for sending legacy conjunction analysis results to some customers (including NASA/GSFC and NASA/JSC). Karen Richon suggested that acronym overloading with someone else's acronym is virtually impossible to avoid, so we shouldn't trouble ourselves too much with that. We reviewed a few synonyms of "comprehensive", but nothing seemed to fully fit the requirement. We did not resolve the matter, but later in the day Dan did contact JSpOC to inquire about the status of their OCM. The response indicated that the JSpOC OCM will be phased out in the relatively near future, so "Orbit Comprehensive Message" is a potentially viable name. Several group members like the term "comprehensive" as a description for the new message; we will likely confirm a new name in the near future so "OHM" doesn't become permanently enshrined. Some other notable discussion on the OHM related to the use of OBJECT_NAME and OBJECT_ID keywords. Dan stated a preference to have the NORAD identifier for the OBJECT_ID, but the value assignment for that keyword in other ODM messages is recommended to be the international designator. The OHM proposal was to use the international designator for the OBJECT_NAME. After some discussion the group determined to add the international designator to the OHM metadata. Dan was a bit reluctant to do this given one of the OHM objectives to reduce overhead in the message, and argued that for some use cases NO identifying data is required (e.g., statistical debris/fragmentation studies). The counterargument stated that for most ODM use cases some spacecraft identifier is required. The group compromised by saying that all three identifiers would have keywords in the OHM (as appear in the CDM), but that only one of them would be required, at the preference of the message originator. Another OHM topic that received a lot of discussion was the use of defaults in several places in the message. The argument was advanced that having a default value in essence makes the associated keyword a requirement, and the programmers who create and consume the message must be absolutely sure to program the defaults. However, the counterargument appealed to the desire to reduce file size overhead. As a compromise, it was agreed that all the defaults in the message would be placed in a single, prominently described mandatory table for easy reference.

DAY 4, THURSDAY 12-NOV-2015

0845	1130	Spacecraft Maneuver Message (SMM) White Book
1130	1230	Joint Meeting with SM&C
1230	1330	Lunch
1330	1430	Future Topics (Time Systems & Reference Frames, Fragmentation Data Message, Re-Entry Data Message, Accelerations, Launch Handbook, etc.)

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1430 1445 Navigation Data Messages XML Specification 5 Year Review
1445 1600 Prep Closing Report, 5 Year Plan, Action Items, Set Next Telecon
1600 1600 End of Navigation WG Meeting
1600 1800 MOIMS Closing Plenary

In attendance this day were David Berry, Frank Dreger, Jürgen Fertig, Tim Flohrer, Dale Force, Joseph Hashmall, Reinhard Kiehling, Alain Lamy, Alexandru Mancas, Dmitry Marareskul, Dan Oltrogge, Juan Carlos Raymond, Karen Richon, Patrick Zimmerman.

0845 1130 Spacecraft Maneuver Message (SMM) White Book

The day started with discussion of the Spacecraft Maneuver Message (SMM). Karen started by going back to the SMM Concept Paper, then walked us through the latest draft of the SMM White Book. We discussed the potential levels of detail in an SMM, and discussed the strategy of starting with the MPM and publishing that, while working on the details in the MDM and MAM. During the discussion, we engaged in real time determination of the required data elements in the MPM. Having decided upon the data elements that were logically required in the MPM, without discussing keywords, we compared the set of data items against the requirements that had been previously developed for the SMM. It was apparent that the requirements annex in the SMM would need to be designed in a manner similar to that used in the ODM, specifically, a column for each document indicating whether or not the specific requirement was accepted for the given message. There are several requirements in the SMM requirements set that apply only to the MDM and MAM, but not the MPM (e.g., those requirements that imply more detailed information such as activity by individual thruster and other more detailed maneuver parameters).

1130 1230 Joint Meeting with SM&C

The group was not able to complete discussion of the MPM prior to the scheduled joint meeting with the Spacecraft Monitor & Control Group (SM&C). At the appointed time, several of the Navigation WG members went to the SM&C meeting room (David Berry, Frank Dreger, Alain Lamy, Juan Carlos Raymond, and Patrick Zimmerman), and the remainder of the Navigation WG continued to discuss the SMM.

In the joint session with the SM&C, there was mention of the Spring 2015 Meetings at Pasadena, where the SM&C group had discussed a potential Navigation Services Blue Book, "about but without the Navigation Working Group" in the words of the Chair Dan Smith. The Navigation WG delegation continued to assert the position that there was no perceived need for standardized navigation services and there was not a perceived practical use case; rather, the WG has focused on data formats for which there is an acknowledged need (it was noted that this was a significant challenge, even when services are not part of the picture). Dan Smith indicated that he thought there were several different types of working groups in the CCSDS, some which defined data formats, and some which defined services. He asserted that each of these types of working groups had a role in the CCSDS. There was discussion of a potential product distribution service that would accept file submissions into a repository for distribution to missions that had subscribed to the distribution service, e.g., TDMs placed into a repository and requested by a given mission. It seemed that such a service might meet some needs, however, there was speculation that such a static distribution process might not meet the needs of more dynamic efforts. However, there was no deep discussion of these topics. It was stated that the new MOIMS working group focusing on Mission Planning & Scheduling services is working at defining potential use cases for navigation services. Such use cases are important, because there is no desire to create services and then try to find a customer for them; it would be far better to have acknowledged use cases where a service definition is required before defining services.

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1330 1430 Future Topics

After lunch, the Navigation WG meeting resumed with a discussion of future topics. There were several, specifically:

- (a) Alexandru Mancas and Tim Flohrer led a discussion of two potential new messages, the Fragmentation Data Message to characterize fragmentation events, and the Re-Entry Data Message to characterize objects re-entering Earth's atmosphere. The desire is to have a CCSDS Navigation WG-compliant format. They have funding through 2016 for these efforts. Most of the data elements are optional, and each of them requires reference to an ODM in order to not duplicate data structures.
- (b) David Berry suggested that we produce normative Time Systems and Reference Frames document(s) to eliminate the requirement for a normative annex in each standard
- (c) David indicated that Frank Budnik of ESA/ESOC had suggested an Accelerations Message based on some material in the JPL/ESA Flight Dynamics ICD
- (d) Dan Oltrogge suggested a Launch Data Message

There was discussion of the fact that it is easy to come up with ideas, and that in fact one of the best ways to come up with good ideas is to generate lots of them and then throw out the not so good ideas. David stated that he has extreme reluctance to start new work when we have had such difficulty recently getting people to review the documents that are already part of our work program (e.g., ODM, TDM, PRM, NHM, etc.). It doesn't make sense to take on a lot of new work when we are having trouble getting resources to complete the work that is already on our approved project list. Nonetheless, David indicated that the first step is to produce a Concept Paper (as was noted on Monday in the "Introduction to Navigation WG" materials). Accordingly, several Concept Papers are in the action items from the meetings. David also took an action item to enter draft projects for the new ideas (though that might not be done until the group has reviewed and approved relevant Concept Papers). Another item that came up during discussion earlier in the week was a "Spacecraft Characteristics Message", but that was not discussed in any detail.

1430 1445 Navigation Data Messages XML Specification 5 Year Review

Once the discussion of Future Topics had concluded (with a few action items as noted above), David indicated that the group needed to formalize the decision of the Navigation Data Messages XML Specification 5 Year Review given that the document was initially approved in 2010. The group was reminded that the three possible outcomes of these reviews is reconfirm (standard still in effect with no changes required), retire (standard no longer relevant), or revise (standard still relevant, but changes required). David proposed that the decision could be made by process of elimination: (a) the standard cannot be reconfirmed given that it does not contain information covering the CDM, and (b) the standard cannot be retired given that there are active implementations using the CCSDS schemas. Given the elimination of reconfirmation and retirement, the only possible decision is revision; this is consistent with the direction of removing the XML material on the ODM, ADM, and TDM from the NDM/XML document and migrating it into the revised documents that are currently being prepared. This keeps us from having to issue two Blue Books each time one of these documents is revised. The NDM/XML Specification document will still have viability for describing the "combined instantiation" scenario, so it will still exist, but it will be a much slimmer document.

1445 1600 Prep Closing Report, 5 Year Plan, Action Items, Set Next Telecon

We reviewed and completed the group's report to the Area Director for the MOIMS Closing Plenary (shown below in the minutes). We completed the list of action items, target dates, and assignees (shown

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above in the minutes). Although the WG did not review the Charter, David indicated that he had reviewed the Charter the previous evening and felt there were no necessary changes. However, although we have not edited the Charter, it shows in the "Pending" state, which means some changes have occurred. David stated his hypothesis that the Secretariat had changed the Deputy Chair from Jurgen to Frank, and updated the e-mail address for the Deputy Chair, and that this had triggered the Charter transition to "Pending" state; the basis for this hypothesis is that we considered making this change at Pasadena, but did not make it, yet the Deputy Chair e-mail has been updated. The changes noted previously were inconsequential and under the circumstances did not warrant immediate revision, however, someone has taken it upon themselves to update the Deputy Chair e-mail address.

Document project schedules on the CWE Framework were not reviewed given the lack of time. However, David reported that 2 of them had been showing as being "Behind Schedule" in the Framework. The schedule for the "Navigation Data - Definitions and Conventions" project was updated so it is no longer "Behind Schedule", however, the schedule for the "Navigation Data Messages Overview" Green Book was not updated because the document is in the hands of the CESG. The Navigation WG 5 Year Plan was not reviewed since there was insufficient time given the 4 day schedule. Any changes will be reviewed during telecons.

1600 End of Navigation WG Meeting

Just prior to the start of the MOIMS Plenary, the Navigation WG meeting was concluded. The group was congratulated on a productive meeting week, adieus were bid, and we started making plans for the next meetings in Cleveland, Ohio, USA in April 2016. All materials from the meetings (agenda, introductory presentation, action items, report, and minutes) are available on the CWE at the following link:

<http://cwe.ccsds.org/moims/docs/Forms/AllItems.aspx?RootFolder=%2Fmoims%2Fdocs%2FMOIMS-NAV%2FMeeting%20Materials%2F2015%2FFall&View={8E605C3A-1DB4-4034-B479-91C6E2A03139}&>

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

<http://cwe.ccsds.org/moims/docs/Forms/AllItems.aspx?RootFolder=%2fmoims%2fdocs%2fMOIMS-NAV%2fDraft%20Documents&FolderCTID=&View={8E605C3A-1DB4-4034-B479-91C6E2A03139}>

1600 1800 MOIMS Closing Plenary

David Berry, Frank Dreger, and Dale Force attended Area Director Mario Merri's MOIMS Closing Plenary. Other attendance at the Plenary included: Nestor Peccia (ex-MOIMS Area Director (AD)), Mario Merri (MOIMS AD), Brigitte Behal (MOIMS Deputy AD), John Garrett (DAI WG Representative), David Mittman (Telerobotics WG Chair), Dan Smith (SM&C WG Chair), Mehran Sarkarati (MPS Chair), Steve Chien (MPS Deputy Chair), and several other members of the various MOMIS WGs.

Proceedings of the Plenary included presentations of the DAI WG (John Garrett), the SM&C WG (Dan Smith), the MPS WG (Mehran Sarkarati), the Telerobotics WG (David Mittman), and the Navigation WG (David Berry). For the Navigation WG, the report shown below was presented. There were no particular issues. After the various MOIMS WG chairs presented their reports, the meeting week was concluded.

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DAY 5, FRIDAY 13-NOV-2015

There was no meeting of the Navigation WG this day, as this was a 4 day meeting series.

MOIMS CLOSING PLENARY / NAVIGATION WORKING GROUP REPORT

- **Documentation Status**
 - Navigation Hardware Message (NHM)
 - Completed comprehensive discussion of comments/issues arising from internal review of NHM White Book 12
 - Initiated NHM White Book version 15 with meeting discussions
 - Attitude Data Messages (ADM)
 - Initiated review of ADM P1.1 containing 5 Year Revisions to the ADM; completed discussion of APM
 - Pointing Requests Message (PRM)
 - Completed comprehensive discussion of conditions placed on starting Agency Review by the CESG
 - Believe the book is ready now for Agency Review
 - Initiation of CMC Red Book Poll anticipated before year end
 - Events Message (EVM)
 - Continued discussion of orbital events potentially pertinent to a Navigation Events Message; discussed with Service Mgmt WG
 - Orbit Data Messages (ODM)
 - Completed review of WG member comments on ODM P2.30 and P2.31
 - Initiated ODM Pink Book P2.32 based on meeting discussions
 - Spacecraft Maneuver Messages (SMM)
 - Completed discussion of fundamental data requirements for the Maneuver Planning Message (MPM) (SMM WB4)
 - Navigation Data Messages / XML Specification
 - Completed 5 Year Review discussion; “REVISE” decision (neither retirement nor reconfirmation is viable)
 - Tracking Data Message (TDM)
 - No discussion, agenda too full given 4 day meeting.
 - Navigation Data – Definitions & Conventions Green Book
 - No discussion, agenda too full given 4 day meeting
- **Cross-Area Meetings & Technical Issues**
 - ISO TC20/SC14 representative was present all week
 - Completed joint meeting with SM WG on Events Message topics
 - Completed participation in SEA Reference Architecture meeting
 - Completed joint meeting with SM&C WG on Navigation Services
- **Administration**
 - Two WG members completed the CCSDS Editor’s Boot Camp (this constituted the entire Monday class)
 - Completed discussion of Navigation WG “Good Citizen Guidelines”
 - Continued discussion of Navigation Data Message Consistency
 - WG Charter: Reviewed charter, no changes made (but in pending status).
 - Document Schedules: Updated schedule for Nav GB V.4
 - Project Resources in Framework: No changes

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- Navigation Working Group 5 Year Plan: No time given 4 day mtg
- Attendance: Representatives from CNES, DLR, ESA, NASA, ISO TC20/SC14, RFSA; from 12 to 15 participants each day
- **Issues**
 - We have many books in progress; consequently it is difficult to get detailed commentary on the new drafts. We are still recovering from the 2.5 year long “laser focus” on the CDM that caused significant delays to occur in other work.
 - Could not support XSG SIG or SANA Steering Group... cannot attend during 4 day meetings due to full agenda.
 - Recent and pending losses of 3 long term WG members will cause a loss of continuity and rhythm
- **Overall Assessment**
 - Made satisfactory progress catching up on items delayed by intensive work on CDM (ADM, NHM, ODM, PRM, EVM, SMM)
 - No progress on TDM, Green Book
- **Requested Feedback Items**
 - None
- **Unsolicited Feedback Items**
 - Facilities:
 - Location was excellent... Darmstadtium is an excellent facility
 - Opening Plenary activities (CCSDS and MOIMS) took about an hour longer than usual... we should strive to keep this short, especially during 4 day meetings
 - Meeting room was spacious and well equipped. It was nice to have a room key for security reasons
 - It was nice to have a meeting room in which we could open the windows if we liked! (sometimes got a bit warm)
 - Meeting room materials (access to power, projection capability, light control) were excellent
 - Wireless connectivity was very good... no reported problems
 - Provision of refreshments (coffee, tea, water, lunches, etc.) was good
- **RESOLUTIONS Issued**
 - Resolution 1:
 - The Navigation WG believes that the conditions placed on the PRM Agency Review by the CESG have been resolved, and request that the CMC Poll begin as soon as possible, followed by the Agency Review.
 - Resolution 2:
 - The Navigation WG requests approval to add to the Framework a project to update the Navigation Data Messages XML Specification (5 Year Revisions) .
 - Resolution 3:
 - The Navigation WG expresses appreciation to the staff of ESA/ESOC and the staff of the Darmstadtium for their excellent support of these meetings.

NAVIGATION STANDARDS 5 YEAR PLAN

Given that this was a 4 day meeting series, there was insufficient time to update the 5 Year Plan. We will

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address this plan in monthly telecons starting in January 2016.

NEXT TELECON:

The WG established Wednesday 13-Jan-2016 @ 1300 UTC as a next telecon date. A meeting invitation will be sent. The tentative agenda is TBD, but will likely include status updates on the documents in work, action item status, and possibly some 5 Year Plan revisions.