

**MINUTES OF NAVIGATION WORKING GROUP FALL 2014 WORKSHOP      10-Dec-2014**  
**David S. Berry / Chair**

The CCSDS Fall 2014 Meetings were conducted at the British Standards Institute (BSI) in London, England, during the week of 10-Nov-2014 through 14-Nov-2014. The United Kingdom Space Agency (UKSA) 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), Tom Gannett (CCSDS Secretariat), Joseph Hashmall (a.i. Solutions, Inc/GSFC), Alain Lamy (CNES), Ma Chaowei (BITTT), Dmitry Marareskul (RFSA), Luis Martin (ESA/ESAC), Dan Oltrogge (SDC and ISO TC20/SC14/WG3), Karen Richon (NASA/GSFC), Patrick Zimmerman (NASA/JSC).

(Unable to attend due to ROSETTA commitments were Jürgen Fertig (ESA/ESOC) and Francisco Martinez (GMV); Reinhard Kiehling (DLR) was unable to attend due to a long launch commitment.)

**TELECON PARTICIPANTS**

Juan Carlos Raymond (NASA/GSFC).

**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/2014/Fall/navwg-agenda-201411.pdf> . In the meeting proceedings below, the detailed agenda for each meeting day is included 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/2014/Fall/navwg-action-items-201411.pdf> .

**New Action/Outstanding Action Items**

<b>##</b>	<b>Action Item</b>	<b>Actionee</b>	<b>Due Date (Original)</b>	<b>Due Date (Current)</b>
21	Add ODM V3 Project to CWE Framework	David Berry	21-Nov-2014	21-Nov-2014
25	Redraw Joe's Green Book charts to reflect flowchart style.	Luis Martin	30-Nov-2014	30-Nov-2014
1	Add phase count examples to TDM	David Berry	30-Nov-2014	30-Nov-2014
2	Publish TDM P1.0.2	David Berry	30-Nov-2014	30-Nov-2014
4	Publish ADM Revision Recommendations	Alain Lamy	30-Nov-2014	30-Nov-2014

##	Action Item	Actionee	Due Date (Original)	Due Date (Current)
30	Confirm JAXA representation in WG	David Berry	05-Dec-2014	05-Dec-2014
26	Send ODM/ADM keyword consistency recommendations to Alain	Karen Richon	15-Dec-2014	15-Dec-2014
19	Determine FDF use of spacecraft parameters provided by JSC in OEM comments.	Karen Richon	15-Dec-2014	15-Dec-2014
5	XSLT converter for TDM	David Berry	15-Dec-2014	15-Dec-2014
20	Provide analysis of impact of proposed OEM changes	Dan Oltrogge	15-Dec-2014	15-Dec-2014
18	Recommended rules/guidelines for Navigation WG lead editors	David Berry	15-Dec-2014	15-Dec-2014
32	Extend consistency study to NHM, PRM	Karen Richon	31-Dec-2014	31-Dec-2014
6	Take a GRO maneuver example and factor into MPM logical block; correlate to requirements	Karen Richon	05-Jan-2015	05-Jan-2015
8	Review Green Book vol. 1 version 3.7 Section #n	As assigned	05-Jan-2015	05-Jan-2015
10	Review NHM White Book 10 Section #n	As assigned	05-Jan-2015	05-Jan-2015
27	Review Juan's ADM extensions for MMS	Alain Lamy	15-Jan-2015	15-Jan-2015
28	Consider technical corrigenda regarding "NUTATION*" keywords in ADM	Alain Lamy	15-Jan-2015	15-Jan-2015
12	Review TDM P1.0.2 Section #n	As assigned	15-Jan-2015	15-Jan-2015
29	Consider Russian frame conventions with respect to "X" axis	Alain Lamy	31-Jan-2015	31-Jan-2015
3	Design SMM Maneuver Planning logical block	Karen Richon	31-Jan-2015	31-Jan-2015
4	Publish ADM Pink Book 1.1	Alain Lamy	31-Jan-2015	31-Jan-2015
14	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-2015	31-Jan-2015
15	Publish PRM White Book 2.5	Fran Martinez	01-Feb-2015	01-Feb-2015
17	Produce write-ups discussing advantages and disadvantages to approaches to addressing duplication of data structures across NDMs	Joe Hashmall	02-Feb-2015	02-Feb-2015
23	Prepare NHM WB 11	Joe Hashmall	02-Feb-2015	02-Feb-2015
24	Prepare first draft outline of proposed navigation/orbital events and requirements	Alain Lamy	02-Feb-2015	02-Feb-2015
22	Prepare Green Book vol. 1 version 3.8	Juan Raymond	05-Feb-2015	05-Feb-2015
11	Review ADM Pink Book 1.1 Section #n	As assigned	01-Mar-2015	01-Mar-2015
16	Review PRM White Book 2.5 Section #n	TBD	01-Mar-2015	01-Mar-2015
7	Organize follow through to establish candidate SANA registries for NHM	David Berry	15-Mar-2015	15-Mar-2015
13	Resolve thorny issue: should "state" data structures from one NDM be duplicated in another NDM?	All (Spring Meeting Topic)	23-Mar-2015	23-Mar-2015
33	Next available number	N/A	31-Dec-2030	31-Dec-2030

## WORKSHOP PROCEEDINGS

### DAY 1, Monday 10-Nov-2014

0800	0845	Registration
0845	0945	CCSDS Opening Plenary
0945	1045	MOIMS Opening Plenary
1045	1120	Admin: Agenda, Intro to (Navigation WG, Prev Action Items
1120	1230	"Thorny Issues" Action Item Discussion/Resolution
1120	1230	Consistency Topic
1230	1330	Lunch
1330	1530	"Thorny Issues" Action Item Discussion/Resolution
1330	1530	Consistency Topic
1530	1730	Orbit Data Messages 5 Year Review (ODM)

The CCSDS Fall 2014 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 the meeting organizer at UKSA, Matt Cosby. After the opening remarks, the meeting turned to 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 2015 hosted by NASA at Caltech/Pasadena (23-Mar-2015 through 27-Mar-2015, 5 day meeting)
  - b. Fall 2015 hosted by ESA at Darmstadt/Darmstadt (09-Nov-2015 through 13-Nov-2015, 4 day meeting)
  - c. Spring 2016 hosted by NASA at TBD, USA
  - d. Fall 2016 hosted by ASI at TBD, Italy
  - e. Spring 2017 hosted by NASA at TBD, USA
  - f. Fall 2017 hosted by ESA at TBD, Europe
  - g. Spring 2018 hosted by NASA at TBD, USA
2. There will be two "Boot Camp" sessions for CCSDS book editors this week (Monday/Friday PM).
3. Mike Kearney reported that the number of missions that have used CCSDS standards in some respect is now up to 718.
4. Mike also stated that there is a new Management Framework on the CWE. It includes lists of agency rapporteurs (i.e., the lead point of contact from each agency to any given WG). Some of the material (marked in green) is publicly available. There is also a new profile system in place that saves information collected during meeting registration for use in future meeting registrations.
5. All WGs were urged to ensure that applicable resources for their projects were entered in the CWE Framework, check consistencies, and update schedules in the Framework. The ICPA (IOAG/CCSDS Product Agreement) should also be checked. Mike noted that agency representatives to the CMC should be apprised of work that is being committed by their WG representatives.
6. The number of WGs, BOFs, and SIGs is down to about 27 from being over 30 not too long ago. A

few groups have completed their work and "gone out of business" (e.g., Next Generation Uplink and CFDP Over Encapsulation). NOTE: According to the CCSDS procedures, this is part of the natural process for a WG. The number of active projects in the CWE is 101 across the CCSDS.

7. The SANA Operator is developing an API for accessing registries on the SANA. Already AGI/STK has expressed interest in utilizing the registry of tracking resource locations direct from the SANA. Mike encouraged people to think of other useful applications.

8. "Team Spirit" T-shirts with CCSDS logos are available from the Land's End website.

9. Nestor reported that there will be two meetings this week to discuss overlaps in the CCSDS; these primarily involve the Spacecraft Monitor & Control WG from MOIMS, several WGs in Cross Support Services, and the System Engineering Area.

10. The CCSDS Yellow Book "Organization and Processes for the Consultative Committee for Space Data Systems" will be revised to contain an annex on the topic of "consensus".

11. All WGs were urged to review their charters, five year roadmaps, and project schedules.

12. The number of people registered for the meetings is quite high, nearly 200.

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. Items of note: SEA will host the XML SIG meeting on Friday, SEA is starting to revise the RASDS document (Reference Architecture for Space Data Systems), MOIMS is sponsoring a Mission Planning BOF on Friday, the CSS document "Space Communications Cross Support--Architecture Requirements" is in review.

The overall CCSDS Plenary was followed immediately by the MOIMS Opening Plenary meeting, which was chaired by Nestor Peccia. During the MOIMS Plenary, Nestor confirmed the upcoming week's program with each WG Chair. All WG Chairs were asked again to update their project schedules on the CWE Framework, fix their "behind schedule" projects, and fill out the resources information requirements. Nestor announced that the MOIMS Area Dinner would be held Wednesday 12-Nov-2014 at a nearby restaurant given that there is already a meeting scheduled for Thursday evening to discuss the overlaps in CCSDS. With respect to the issue of the overlaps, David stated that the Navigation WG has no particular preference regarding the definer of services (which seems to be the primary topic of the overlaps), but the WG does feel that the overlaps need to be resolved. Nestor indicated that if the CESG could not sort this out (primarily Nestor, Peter Shames, and Erik Barkley), they would escalate the issue to the CMC for resolution. Mario Merri noted that they had an agenda item on Wednesday regarding their "Navigation Services" specification presented by Ph.D. candidate Tiago Nogueira; David indicated that he had added it to the Navigation WG agenda and also wondered whether or not one half hour would be sufficient. Finally, it was announced that the MOIMS Closing Plenary would be held Friday at 1500 (this was later changed to Friday at 1345).

The Navigation WG meeting was started immediately after the close of the MOIMS Opening Plenary. In attendance this day were David Berry, Joseph Hashmall, Alain Lamy, Dmitry Marareskul, Luis Martin, Dan Oltrogge, Karen Richon, and Patrick Zimmerman.

David started the session by reviewing the agenda for the week. Given that there was a new attendee to the meetings in this meeting series (Dmitry), the "Introduction to the Navigation WG" presentation was presented in full. In addition to highlighting progress since the last meetings and setting the priorities for

the week, the CCSDS overview and detail on the standards in the WG's technical program were also presented. During the discussion of documents on hold, Alain suggested that even though the Event Messages document is on hold it might be possible to discuss some navigation related events given that there is work in progress at CNES that is in the process of defining such events as part of a larger definition of events related to control centers of the future. David indicated that there might be time on the agenda during the week, primarily due to the fact that the TDM discussions might not take the full allotted time.

Review of the action items from Noordwijkerhout showed that 15 remain outstanding (43%), 19 were completed (54%), and 1 was cancelled (3%). David expressed the opinion that we are still suffering from aftereffects of the CDM push, but the action item completion statistics are appreciably better than they were at the Spring Meetings in Noordwijkerhout. During the discussion on action items, there was some discussion of note. In particular, the question regarding incorporation of the GPS point solutions as a data type in the TDM was resolved with a decision to not add the data type; Joe Hashmall pointed out that the point solutions will be a data type covered by the Navigation Hardware Message. Karen indicated that she did not understand the action item on 'elementFormDefault="qualified"' that appears on the list; David illustrated the concept a bit later in the morning during a discussion of the NHM schema.

Next on the agenda was a discussion of a few topics classified as "thorny issues" given that they have been around for a while, and periodically pop up. David had initially proposed to address these issues via telecons, but by their nature they seemed to call for the "face-to-face" format.

First of these issues related to the question of "should we continue to restrict the messages to a single spacecraft, or allow many in an NDM?" (note: the CDM is an exception, with potentially two spacecraft by design). The group started discussion from the standpoint of trying to understand use cases where multiple spacecraft in an NDM might be advantageous. One scenario considered constellations in which one primary spacecraft was tracked and others were represented via a spacecraft-spacecraft relative frame. It was also noted that in all of the messages, the spacecraft is identified in metadata, not the header, so it was conceivable that different segments in the same message could contain data for different spacecraft. It was suggested that there would only be need for this if data from some spacecraft depended on the data from another spacecraft or if you need to guarantee the same global settings over a series of spacecraft. On the other hand, although this change might be advantageous in some cases in the future it could require substantial revision of the existing standards. After some discussion, Joe Hashmall suggested that we should not allow for multiple spacecraft in the same message until such time as a strong requirement emerges. There already exist two ways to achieve a similar goal in the existing message framework which were cited: (1) multiple complete navigation data messages each dealing with a single spacecraft could be packaged in a single file, and (2) multiple navigation data messages could be packaged in a single XML message using the <ndm></ndm> message construct (these are essentially the same method, one KVN and one XML). Given that there is currently no strong use case for multiple spacecraft in the same message (e.g., an OEM or TDM), and there are two easy workarounds within the current message framework, this issue was deemed resolved. It was suggested that the Green Book contain recommendations as to how to deal with multiple spacecraft. This topic took us up to the lunch break.

After lunch, the agenda called for the group to switch attention to the TDM revisions, however, David felt it important to continue the discussion of the longstanding issues, and also that the new TDM material to discuss may not take the entire allotted time. Thus the TDM discussion was deferred until later; we continued the discussion of "thorny issues".

The second "thorny issue" related to the question of "should 'state' data structures from one NDM be duplicated in another NDM?". Although this question specifically cites "state" data structures, one could generalize this to any data structure in the NDM set. After brief discussion, Joe Hashmall suggested that

there were three cases to be considered: (1) each message is created without taking into consideration other message structures, (2) each message reproduces relevant message structures that appear in other messages, (3) each message refers to relevant message structures that appear in other messages. He immediately suggested that (1) was non-viable (it seems counterintuitive for a standards development organization), and then suggested that write-ups be produced for each of the remaining two cases (i.e., essentially a trade study of the advantages/disadvantages of each approach). Joe volunteered to produce such a study. His thought is that with a write-up of the issue, each person could review it and then we could resolve the issue via telecons. Joe received the action item.

A final issue had been raised by Karen Richon shortly prior to the Fall Meetings as she was working on the SMM, specifically, consistency across the NDMs. She had produced an analysis of the keywords in all the currently approved books, i.e., the ADM, CDM, ODM, and TDM (as the NHM and PRM are not yet approved, they were not yet included). She had some interesting observations based on this study that showed that while we are largely consistent across the books, there are a few areas where inconsistencies have crept in. David also showed a detailed study that had been conducted in 2008 (post-TDM, ADM in final stages, ODM V2 still in development). This earlier study reached much the same conclusion, i.e., the Nav WG standards were largely consistent but a few areas were not. The group discussed this notion of consistency, acknowledging the famous Emerson quote "A foolish consistency is the hobgoblin of little minds, adored by little statesmen and philosophers and divines." The discussion of consistency branched briefly into a discussion of what constituted "foolishness". This avenue was not followed long given that Karen brought up statements by some users of NDMs who had noticed differences between the messages and had inquired as to why they existed. This was interpreted as a presumption on the part of users that the works of the Navigation WG should be self-consistent. Several ideas were suggested to address this presumption, for example: (a) when a new book is started, the source of verity could be the most recent approved book since it would contain the most recent consensus; alternatively, (b) the lead editor of the new book would have the responsibility to perform a study similar to Karen's and check for related keywords and concepts in all prior books. The group did acknowledge that a few large inconsistencies do exist, e.g., the "direct-to-XML" approach of the PRM, the dynamic keyword generation of the NHM, the relative metadata/data section in the CDM; sometimes it is the case that messages have less significant differences (sometimes slight) among representations. For example descriptions of the characters allowed differ slightly among the books even though they have the same intent. Joe raised the possibility that even something as mundane as the line length of NDMs might be called into question with the NHM in the case where an instrument produces a large number of measurements with many significant digits. The consistency discussion led to a proposal by Alain to produce a set of recommended rules/guidelines for lead editors of Navigation WG standards addressing topics such as the foregoing (keywords, values, etc.). In the end, we agreed that we should not be slaves to the notion of consistency; if there exists a strong case to be inconsistent (e.g., as there was in the case of the PRM, NHM, and CDM), then it would be allowed; otherwise, we should attempt to be consistent (but revising documents in order to make them consistent is not necessarily appropriate). Karen took an action item to extend her current study by adding the PRM and NHM keywords.

The discussion of the "thorny issues" took until mid-afternoon. By that time, both Luis Martin and Dan Oltrogge had arrived, and the full set of those with proposals for modifying the ODM was present. David reminded all that the fundamental decision of the review was to determine whether or not the standard should be reconfirmed without changes, or revised. We had already ruled out the option of retiring the standard. David reminded the group that a decision to reconfirm requires no further action from the WG and a decision to revise can require the potentially substantial work of modifying the document, performing the Agency Review, addressing RIDs, and prototyping).

Patrick Zimmerman presented his proposal for adding the spacecraft parameters that are present in the OPM to the OEM. The proposal is based on the fact that during development of a NASA/JSC and

NASA/GSFC OEM ICD, the two teams agreed there was benefit to including the parameters. He explained that these spacecraft parameters are required in the JSC operations ephemeris software (FreeFlyer). These spacecraft parameters were also seen as being desirable (but not necessarily mandatory) by the GSFC Flight Dynamics Facility (FDF) because they are used in some of their operations software. He showed how the spacecraft parameters were being provided via COMMENT statements added to the JSC OEM producer implementation. In discussion, Luis Martin noted that the same effect could be achieved by using the <ndm> XML construct to package an OPM with the spacecraft parameters and the OEM in the same message. Patrick was aware of this potential solution, but they had opted to use comments in the OEM rather than use a separate OPM. There was some discussion as to why some of the information was being requested by GSFC/FDF (e.g., the mass is not required for generation of tracking predicts, the presumed use of the OEM). Karen took an action item to follow up with FDF to learn why the information not needed for signal acquisition was being requested. Joe Hashmall summed up this discussion by suggesting that given the two workarounds being used by JSC, extension of the OEM might be convenient but not necessary as there are workarounds that allow the effect of this change to be accomplished without changes in the standard.

Dan Oltrogge then presented an exceptionally detailed analysis of features that could be modified in the three ODMs (OPM, OMM, OEM) to make them more useful. This analysis was largely from the standpoint of the applications of the Space Data Center, of which he is the Program Manager. For example, he suggested that the ODM would be more useful if we could:

- Add maneuver information to OEMs.
- Clarify use of orbit-relative frames to make them more evident
- Restore ability to use Julian dates in OPMs and OEMs
- Generalize OPM Keplerian elements
- Specify epoch when leap seconds were added
- Allow smaller (3x3) covariances
- Allow time in covariance as well as position and velocity (7x7) for near launch

There was some discussion of utilizing the "user defined parameters" feature of the ODM to accomplish some of these requests, however, it was noted that this concept is at bottom a "slippery slope" and something that should be sparingly used in a standard. One of the conclusions of Dan's presentation is that the OMM may not be very useful (an interesting statement given the history of the OMM). David briefly related some of the history of the ODMs, offering conjectures as to why the OPM has spacecraft parameters (i.e., they are used to propagate the state) whereas the OEM does not (because the ephemeris was propagated by the producer and it models all the required influences). In the initial use cases for the OEM, generation of tracking predicts for cross-support (pointing, frequency) was the primary purpose; use of the OEMs for conjunction assessment, an application which drives many of Dan's suggestions, was a less active area at the time the OEM was initially designed. Given more involved new use cases, it may make sense for the OEM to be extended in complementary ways. Joe Hashmall offered the thought that increasing the complexity of the OEM might deter some potential users who saw it as too complicated, or too powerful for their needs; however, Dan suggested that making added keywords non-obligatory permits potential users to ignore things too complicated for their use if they so desire.

Closing out the day, Luis Martin presented material that had previously been presented at Noordwijkerhout and extended in a few areas. This presentation included a proposal to rename some of the keywords in the OPM where an inconsistency had been created in the CDM (specifically, some changes as they are in the CDM such as addition of AREA\_PC, rename the OPM's DRAG\_AREA as AREA\_DRG, and rename the OPM's SOLAR\_RAD\_AREA as AREA\_SRP). Joe Hashmall suggested that one way to address this might be to allow "synonyms" in the OPM for these (and perhaps other)

terms. There is some precedent for the use of multiple terms, e.g., the user may currently choose TRUE\_ANOMALY or MEAN\_ANOMALY when using the Keplerian elements in an OPM. Admittedly these are not synonyms, but the user has a choice when constructing the message. Luis' proposal also included allowance of larger (9x9) covariances in the OPM, defined as in the CDM, and inclusion of the 9x9 state transition matrix that could be used to propagate the covariance matrix in the OPM/OEM.

Given the three proposals for modifying the ODM, the group ended the day with a charge to ponder the fact that the proposed changes would make certain data exchanges more convenient but would complicate the standard. Our task is to balance the wider usability of expanding the definition with the restrictions on usability due to added complexity. The ODM topic was scheduled to continue on Tuesday morning; given that both Patrick and Dan had to return to the US Tuesday afternoon for other meetings, the ODM discussion was scheduled to conclude upon their departure.

## **DAY 2, Tuesday 11-Nov-2014**

0845 1145 Orbit Data Messages 5 Year Review (ODM)  
1145 1230 Tracking Data Message Version 2  
1230 1330 Lunch  
1330 1615 Nav Green Book V.4 Topics  
1615 1715 TDM Topics with Tom Gannett

In attendance this day were David Berry, Tom Gannett, Joseph Hashmall, Alain Lamy, Dmitry Mararekul, Luis Martin, Dan Oltrogge, Juan Carlos Raymond (via telecon), Karen Richon, and Patrick Zimmerman.

We started the day with further discussion on the proposed changes to the Orbit Data Messages as part of the 5 Year Reconfirmation Review process. Over dinner the preceding night, Dan Oltrogge had indicated willingness to perform an analysis of the relative impacts of the various changes to the ODM he had proposed during his presentation Monday. An action item was duly assigned.

David sketched out the history of the ODM (as he knew it, from late 2003) and speculated that at the time the ODM was originally developed, the primary use case was interagency tracking between ESA and NASA. Although STRATCOM has performed space surveillance for a long time, there was probably only minor consideration given to the notion of using the ODMs in applications such as conjunction assessment. We've seen ample evidence that the use cases of satellite ephemerides have expanded to include at least conjunction assessment, so it makes sense to consider what might need to be added to the ODM in order to make it more useful for that application.

The group then launched into discussion on the relative merits of the covariance matrices and state transition matrices; this discussion covered the dimensions of the matrices (3x3, 6x6, 7x7, 9x9, ... arbitrary nxn), the epochs associated with the data, arrangement of the matrix entries ("standard" for the 3x3, 6x6, 7x7, but potentially arbitrary thereafter), and KVN keywords/XML tags associated with the matrices. During the course of this discussion, a number of interesting ideas were raised. For example, in order to limit impacts on existing users of the various ODMs, a "totally new message" was suggested. Joe Hashmall reminded all that an important part of our job is to balance the utility and complexity of the standards; if we add too many options to the standards, they may become too complex and potential users may resist using them.

During the discussion of changes to the ODM, and epochs associated with the various matrices, Dmitry Mararekul noted that Annex A of the ODM only lists GPS as a possible time system. He suggested that



the table should include the other Global Navigation Satellite System (GNSS) time systems that differ from the US GPS (e.g., GLONASS, BeiDou, Galileo). David noted that the Indian space agency had recently launched its own Indian Regional Navigation Satellite System (IRNSS) as well.

Just prior to Patrick's necessary departure to return to the US to support Orion's EFT-1 test simulation, David polled the attendees for their thoughts on the 5 Year Confirmation Review of the ODM based on both discussions at Noordwijkerhout and during the 2 days to date of the London meetings. Specifically, attendees were asked whether they favored "reconfirm" or "revise" as the direction. The decision to revise was unanimous.

In the immediate aftermath of the "revise" decision, there was continued discussion of ODM extensions, with several more interesting ideas raised. One idea in particular generated a lot of discussion. This was the notion of naming the elements of the covariance matrix by their row x column coordinates... this leads to a total liberation of the covariance matrix (and the addition of a metadata item that associates a given attribute with the corresponding row/column). Possible flavors: standard 3x3, 4x4, 6x6, 7x7, 9x9, 10x10 with USER\_DEFINED variables for extended dimensions beyond 10x10. The sigma level and dimensions of the covariance would likely need to be specified in the metadata. Dan Oltrogge mentioned that he had in the past produced an application that accomplished scaling of covariances.

Some questions also arose, e.g., "must the OEM ephemeris row have the same order as the covariance data?"; while there probably isn't a REQUIREMENT for this, we were reminded again about the need to balance utility, complexity, and impact to existing users. Based on such considerations, it seems advisable to retain the correspondence insofar as possible. The notion of an arbitrary ephemeris row was raised (E1=right ascension, E2=Zdot, E3=X, etc.). As rationale for this approach, Dan Oltrogge cited the fact that US military launches analyze scenarios using several element sets (e.g., spherical coordinate states, Cartesian coordinate states, associated covariances, etc.).

Joe reiterated his sense that things should be as simple as possible and as backward compatible as possible; we should seek to allow the standard applications, but make some unique applications possible. In this context, the notion of an entirely new message type was re-stated (e.g., an "OGM = Orbit General Message"), along with the notion that a user could assemble a totally unique message using a set of standardized "building blocks" (though it seems inevitable that even with this approach, someone somewhere could claim that something had been left out!).

Shortly thereafter, Dan had to leave to return to the US. Karen wanted to have a brief discussion on the SMM, in particular the potential overlaps with the OPM, so we looked at the SMM use cases Karen had prepared. Karen mentioned the first focus on the MPM (Maneuver Planning Message), and also expressed concern about the high degree of overlap with the OPM maneuver data items. There was no resolution to this discussion, but the topic was introduced.

After Dan left, David completed an action item from Spring 2014 by leading a discussion of the use and requirements of the now-normative Implementation Conformance Statement (ICS). The action item had originally been assigned to put a completed ICS in the TDM, however, this turned out to be not applicable; the ICS in the document Annex is supposed to be blank. The ICS that was shown as an example was filled out with respect to the NASA Deep Space Network implementation of the TDM. There are a number of use cases for the ICS, including packaging it with the Interface Control Document to characterize an implementation of the interface since it specifies which features of the standard are used in a particular instance.

After lunch, we conducted a telecon with Juan Carlos Raymond, lead editor of the Green Book version 4, who was in Maryland (with his brand new baby girl!). The goal of the telecon was to work through the

joint Comments Resolution Matrix (CRM) that had been prepared by Juan and address issues of a non-trivial nature that could not be immediately accepted. The CRM contained comments received from reviewers of the Green Book volume 1 versions 3.5 and 3.6. Juan indicated that the results of these discussions would be coming out in version 3.8 of the book. David requested that the version 3.8 not be immediately issued because the version 3.7 had only recently been issued and people have probably not had time to review it. David indicated that he would send Juan his comments on version 3.7. Also, sections of the document will be assigned to reviewers on the WG so it is likely that Juan will get several more comments. An action item was assigned to Juan to produce version 3.8 with a target in the first week of January 2015; this will give reviewers time to submit their comments to Juan and have them processed.

In addition to changes in the text that we discussed, Joe displayed some simple text and diagrams for the Green Book that he had prepared as an alternative to the complex process diagrams that currently exist. These were well received due to their integrated look and feel, in contrast to some of the material currently in the book (each of the 3 process diagrams for orbit determination, attitude determination, and conjunction assessment has a different look and feel given that they were done by 3 different people). Alain did suggest that the 3 proposed diagrams for the SMM be combined into a single diagram as is used for the other messages.

The telecon with Juan allowed us to make progress on the Green Book volume 1, but it only worked "OK"; it was better than nothing, but much less satisfactory than a face-to-face meeting. Under the current circumstances, however, we were fortunate to be able to conduct a telecon and the facilities were generally accommodating.

After the Green Book telecon, we discussed the pending TDM revisions with Tom Gannett, who had joined us in the room based on an invitation from David. We were concerned about whether or not we would have to have a Pink Book (which invites RIDs on unchanged material), or whether we could just do Pink Sheets to submit the revised material. This concern was based on a suggestion from Jürgen at Noordwijkerhout that if we can restrict the review to Pink Sheets we would avoid getting a lot of RIDs for previously agreed and settled material.

Tom explained his process, which involves him manually marking up document changes, and if the recorded changes become too cumbersome he will issue a Pink Book instead of Pink Sheets. However, even some large changes could be done as Pink Sheets rather than a Pink Book, e.g., if an entirely new informative annex is added. There is no standard recipe for this, but Tom has a great deal of experience with this and exercises good judgment.

David showed how in sections 1 and 2 he had substituted words/phrases like "could" or "might" for "may", "it is recommended that" for "should", and "it is required that" for "must" to avoid using the words "may", "should", and "must"/"shall" in non-normative document sections. David expressed a concern that this might push us over the "Pink Sheets/Pink Book" boundary. Tom indicated that we should not worry about the forbidden words "may", "should", "must"/"shall" in sections 1 and 2 because there is now language in the CCSDS Publications manual that makes it clear that usage in sections 1 and 2 is considered non-normative even if the forbidden words are used there. At the end of the day, Tom speculated that we were probably in the territory of just doing Pink Sheets and not a Pink Book for the Green Book modifications.

### **DAY 3, Wednesday 12-Nov-2014**

0845 1130 Navigation Hardware Messages (NHM)

1130 1230 Navigation Service Presentation w/SM&C  
1230 1330 Lunch  
1330 1545 Navigation Hardware Messages (NHM)  
1545 1615 Recap/Discussion of SM&C Session on Services  
1615 1730 Events Discussion (EVM)

In attendance this day were David Berry, Tom Gannett, Joseph Hashmall, Alain Lamy, Ma Chaowei, Dmitry Marareskul, Luis Martin, and Karen Richon.

This day was largely allocated to discussion of the NHM. Very early we embarked upon a reference frames discussion... again! (this time with respect to the NHM). This is becoming a new "thorny issue".

After a few minutes of reference frame discussions, Joe led the group through the NHM CRM (237 entries!). The focus of this discussion was items in Joe's combined CRM that he had color coded either yellow or red; items color coded green had already been accepted and incorporated into the NHM White Book 10.

One NHM topic that generated quite a bit of discussion was the use of "DEFINE" as a keyword in the metadata, but the use of "MNEMONIC" as the corresponding keyword in data section of the NHM XML schema. Although this discrepancy has existed for the past several drafts of the NHM, David suggested that the association between "DEFINE = keyword" in the metadata and the use of "<MNEMONIC></MNEMONIC>" in the NHM XML schema was not strong (there is no such issue in the KVN version of the NHM because the value associated with "DEFINE" is the keyword). After some discussion he suggested that the NHM XML schema be changed to use <keyword></keyword> in the NHM XML schema, where the data between the tags is the dynamic keyword. The group voiced no objection to this concept.

Before lunch we paused discussion of the NHM in order to participate in a joint meeting with the SM&C WG on the topic of "Navigation Services". The material was presented by Tiago Nogueira, Ph.D. student at the University of Würzburg in Germany; he is working on SM&C Mission Operations navigation services based on the Navigation WG's navigation data message formats. He showed how he used the NDM/XML schemas in conjunction with an auxiliary schema (ndmxml.mo.xsd) to establish a navigation services instance. The SM&C group is seeking to have the Navigation WG change its perspective on services given the high priority emphasis placed on navigation services by the IOAG/MOSCG/MOSSG. According to this group, navigation services were nearly the top priority; however, there was no actionable detail provided. It was also noted that there was some discussion of "events" in Tiago's presentation. This led to a brief discussion regarding the current status of the Navigation Events Message (currently called EVM); progress on this has been stalled for some time based on the "events" architecture having been elevated to the System Engineering Area in general and the Timeline Data Exchange BOF in particular. Subsequent to the meeting, Mike Kearney addressed an email to Peter Shames suggesting that "if Timeline is in trouble, then maybe we should make sure that the NAV guys know they have the flexibility to start on the event stuff if they choose to."

After lunch the discussion of NHM comments resumed. Several of the additions from the Noordwijkerhout meetings were re-visited in this discussion. In particular, the CALCURVE and FRAME keywords have some difficulties that appear to complicate matters more than clarifying them. For example, the way units might be defined in conjunction with a calibration curve is problematic, and in discussion it seemed that depending on the desired units, there might be a need for more than one CALCURVE for a given dynamic keyword. The definition of FRAMEs in the message has also become problematic; the BODY, SENSOR, EXTERNAL choices for the FRAME keyword are not specific enough to be useful, and thus an ICD is required. Joe pointed out that in his experience, such matters are

usually handled in auxiliary documentation (such as an ICD or other mission document). Based on this discussion there was a decision to remove both the CALCURVE and FRAME keywords from the DEFINE set (which also somewhat eliminates the concept of a define set altogether, or renders it degenerate).

The topic of blanks within NHM text values and quotation marks (or apostrophes) within NHM strings also received a fair amount of discussion. David stated that requiring quotation marks to bound text values would lead to inconsistencies with other Navigation WG standards; however, Joe clarified that this requirement was restricted to the data section of the NHM. Joe gave as an example the text ("not converged") that he had encountered in telemetry data that would be problematic given the measurement counts in the NHM. Without quotation marks (or some other delimiter) the phrase "not converged" would be interpreted as two values when it is really only one. The group agreed that allowing text values in the data section to be bounded by quotation marks made sense under the circumstances.

Quotes/apostrophes within character strings turned out to be another matter... the group decided that this would not be supported, and that the standard would specifically state this was not allowed; either the quote/apostrophe would have to be removed or substituted. This was because of the various machinations that must be introduced to be able to accommodate a quote/apostrophe within a text string bounded by quotes (shades of assembly language programming!).

We also discussed the fact that some components of the dynamic keywords have a defined length of three characters, others seem to allow either three or four, and some state that the length is arbitrary; Joe explained the rationale for these differences.

The results of all these discussions will be combined with comments received on NHM White Book version 10 to produce version 11. Sections of the NHM version 10 will be assigned to reviewers on the WG.

Once the NHM discussion was complete, a few miscellaneous topics were addressed.

We returned briefly to the topic of services and discussed the results of the joint meeting with SM&C that had been held earlier in the day. In general it was agreed that the definition and provision of standardized services was something of a political issue in the CCSDS; it may be best to stick with defining exchange formats, remain "service agnostic", and not make a choice between SM&C and CSS.

Alain led a brief "events" discussion, sharing material compiled as part of the development of what he described as "a next generation of control centers" at CNES. He had requested an opportunity to discuss this material even before Mike Kearney made his comments after the SM&C meeting regarding our ability to discuss "events"; that license made Alain's topic even more timely. We concluded that we could proceed with the definition of orbital events. Alain explained that an "event" has zero duration. An extended phenomenon such as a planetary occultation is not an "event"; rather, it is defined by two discrete events, specifically, the "occultation begin" event and the "occultation end" event. An event is thus necessarily always in the past or the future, never "in progress".

After some discussion, we resolved that the WG can work on requirements for orbital events, and be freed from thinking about the format or "keywords". David suggested that this notion is similar to one advanced by Alain at Noordwijk in 2009, specifically, that Navigation WG standards might be expressed only in terms of the required content, and not specify the specific presentation format (KVN, XML, something else, etc.). The notion here is that favored formats have changed, but technical content seems to change more slowly.

For the final topic of the day, Luis showed a different rendering of Joe's simple diagram for the Green Book (the CDM use case was presented). It had the look and feel of a flow chart. The group felt this was a good way to represent the processes and Luis received an action item to re-draw the rest of Joe's material in the flowchart style. The presentation of the CDM use case led to a question by Ma Chaowei and brief discussion of procedural issues related to the CDM, after which the day's meeting concluded.

#### **DAY 4, Thursday 13-Nov-2014**

0845	1145	Attitude Data Messages Version 2 (ADM)
1145	1230	Spacecraft Maneuver Message (SMM) White Book/Use Cases
1230	1330	Lunch
1330	1530	Spacecraft Maneuver Message (SMM) White Book/Use Cases
1530	1800	Review Document Schedules, Update 5 Year Plan
1530	1800	Set Action Items, Prep Closing Report, Set Next Telecon
1800	1800	End of Navigation WG Meeting

In attendance this day were David Berry, Tom Gannett, Joseph Hashmall, Alain Lamy, Dmitry Marareskul, Luis Martin, Karen Richon.

The day started with a discussion of the Attitude Data Messages revisions planned by Alain. Alain also noted some differences (a departure from convention) with respect to the rotation constructs in the XML implementations of APM/AEM, and also cited the existence of some ambiguities that he hopes to remove. David explained that the XML rotation constructs had been a matter of some difficulty that had been resolved by Francisco Martinez; he expressed that a preference to not change this unless there is something technically wrong with it.

In terms of the ADM revision, Alain proposed some changes to the document that he characterized as "more drastic", for example: reduction in the number of keywords (\*\_FRAME\_A, \*\_FRAME\_B, \*\_DIR were specifically cited); addition of a requirement for a reference frame; establishment of a single convention for the format of the quaternion (instead of the current two); addition of a block for the angular velocity; writing the standard in terms of either an active rotation or a passive frame translation but not both; and other changes. A principal driver for many/most of the proposed changes is removal of ambiguities in the current implementation; Alain noted that the requirements related to Euler angles and derivatives of Euler angles was particularly unclear in the current document and XML schema and that angular velocity vector is ambiguously defined as far as the direction of rotation. David and Karen suggested that it would be advisable for Alain to consult with John van Eepoel (NASA/GSFC) and Jacques Foliard (CNES, retired) regarding the proposed changes given that they were the principal developers of the document. Joe Hashmall noted that he had been assigned to the Navigation WG in order to work with John VanEepoel on the ADM, so he had some context for helping to resolve these issues.

Joe inquired regarding the degree of backward compatibility that would be supported in the ADM revisions (format and contents). While this will be a design point for the ADM Version 2, we have in general determined that we cannot be slaves to the past. The major changes to the ADM may be not backwards compatible but will make the message less ambiguous. Alain suggested that this may not be much of an issue based on his assessment that there is not much current use of the ADM. Joe reminded us that Jürgen had stated that the ADM is used in the Data Distribution System at ESA, that Juan is implementing the ADM for MMS, and Karen is planning to use the ADM for JWST. In counterpoint to Alain's statement, David added that at GSAW a couple of years ago he learned about a prototype implementation of the CDM that he knew nothing about! (The book had not yet even been published.)

The Lesson: We don't always know who is using our standards! so we should be judicious in our introduction of changes.

Alain's material focused on the APM; he had not yet prepared material on "the new AEM" for this meeting. David suggested that proposed AEM changes could be a telecon topic between now and the Spring 2015 meetings. Alain will prepare a first version of an updated ADM in early 2015 in preparation for the Spring 2015 meetings.

Before lunch Karen started discussion of the SMM by reviewing the use cases she had sent out. The use cases identify mandatory and optional components of the message from a data standpoint.

We continued discussion of the multiple "flavors" of SMM, e.g., the first flavor could be a desired maneuver objective, the second flavor could be a more detailed design of how to achieve the objective, and the third flavor could be a reconstruction that would allow comparison to the design. Joe suggested that these flavors could be implemented as an "incremental" message that got progressively longer and more detailed: the Maneuver Planning Message (MPM) for the first increment, Maneuver Design Message (MDM) for the second, and Maneuver Analysis Message (MAM) for the third. At each juncture, the message file is just augmented (e.g., the MPM comes first, then the MDM = MPM + detailed design, then the MAM = MDM + actual performance). We did not immediately resolve definitively whether or not the SMM standard is composed of three separate messages (MPM, MDM, MAM) or one incremental SMM (MPM section, MDM section, MAM section). If we decide on the latter, Karen suggested that the organization be reversed, i.e., MAM segment, MDM segment, MPM segment; the rationale is that at each stage the most current phase is at the top of the message. It was also suggested that the full history of the maneuver might be included in a single file with the history of various MDM segments and MPM segments as follows:

Incremental (with history)

CCSDS\_SMM\_VERS

    MAM segment (1)

    MDM segment(s) (1...m with version number or message ID)

    MPM segment(s) (1...n with version number or message ID)

Karen suggested that each maneuver should be named, but no convention described because different missions name their maneuvers in different fashions depending on mission characteristics; there really can be no standardization of this.

There were also several discussions regarding potential overlaps of the SMM/MPM with the OPM and/or APM, and whether or not this overlap dictates reducing the scope of the SMM (at one point Karen asked "Is the MPM just the OPM/APM in disguise?").

Discussion before lunch focused primarily on the MPM. After lunch, we continued with use cases for the Maneuver Design Message. This is a much more detailed message than the Maneuver Planning Message.

There was a hypothesis that many components of the SMM may not be read by computers, in which case it was proposed that an XML implementation may not be particularly useful given that it is primarily for computer ingestion and not easily read by humans. Joe suggested that we shouldn't design something that requires a person to type numbers into a simulator, for example; there is some sense that maneuver messages may be more of a person-to-person communication as opposed to a computer-to-computer communication. It was stated that we are required to create XML for each of our standards; David stated that it is generally not too difficult to create the XML version once all the required data items are defined and we can also provide an XSLT transform for the SMM as we did with the CDM for those that want to

read a KVN message.

Karen started to go over the material in the MDM use case, which necessarily has much more complexity. There were many preliminary discussions as to what exactly should be part of the exchange (e.g., should the MDM contain uncertainties and ranges over which certain parameters might vary?). These are obviously discussions that could take quite a while, and many document iterations, so the concept of a reduced scope initial SMM re-emerged.

In support of the reduced scope initial SMM, David described a few places where he has noted this as a possible direction in conjunction with a Space Situational Awareness scenario. The first of these was in the context of the United Nations COPUOS Long Term Sustainability of Space Activities Working Group where he presented the case that the TDM, ODM, and CDM could be used in succession to track an object, exchange its trajectory, and use that in conjunction assessments; the logical extension of this is to exchange maneuver information with another party which operates a satellite with which there is a perceived conjunction. The second was a panel discussion at GSAW a couple of years ago where he presented similar material. The third occasion was a SpaceOps 2014 paper similar to the GSAW panel discussion.

David noted that an argument for focusing at first only on the MPM is that it should be relatively simple compared to the MDM/MAM. In general, standards development once commenced can take substantial time. For example, the ODM Version 2 took four years to develop, and it was strongly based on an already created ODM Version 1. The CDM was a record in CCSDS terms at two and a half years. The TDM took four years. To develop a comprehensive SMM would likely take at least four years, perhaps even five given the complexity and variety of maneuver options. It will take five years for the entire SMM if we create the MPM as SMM V1 and also continue to discuss the MDM/MAM, or five years if we do them all at once. The difference is that for about three years missions should be able to make use of the MPM. The group consensus was to develop a Version 1 Blue Book covering only the MPM, and address the MDM and MAM in an SMM Version 2. This also buys time to definitively address the question as to whether the MPM, MDM, and MAM messages are independent or incremental (they can still be defined in the same standard document, regardless). Ultimately we reached a conclusion that the initial version of the SMM will only deal with the maneuver planning aspects of the overall maneuver exchange. Karen Richon will draft a White Book with these contents; the overview portion of the document will state the SMM development plan described above. Karen plans to use as many CCSDS Navigation WG standards as possible in the JWST mission, and though a fully realized SMM would be helpful, it may not be completed by the time of the JWST launch in 2018 and Karen stated that she thought the reduced scope MPM would suffice. Karen did have a few SMM questions, specifically:

- (a) Can the SMM/MPM keyword order be 'arbitrary'?
- (b) Can the units be either km and km/s, or m and m/s, as best applicable?
- (c) Does it make sense to have people review the existing SMM White Book 4 given the decision to restrict Version 1 of the SMM to the MPM?.

To these questions, David stated for (a) yes, the keyword order can be 'arbitrary', but it must address some basic reasonable constraints (e.g., the positions of META\_START and META\_STOP cannot be arbitrary; we would not want to produce a state vector for analysis that includes the elements in the order YZX; etc.). Also, a recommended order could be provided for keywords where order doesn't matter. For (b), he stated that yes the units can be mixed as suggested based on the precedent set with the CDM, where km and km/s are used for the state vector but m and m/s are used for the relative position and relative velocity; however, allowing multiple units in this fashion requires that they must be displayed in the message. Finally, for (c) he took an action item to rescind the SMM White Book 4 review assignments based on the change in direction.

At the conclusion of the SMM discussions, David led the group through the various closing activities. We reviewed all the document project schedules on the CWE Framework with the intent of updating them, but ran into a technical difficulty with the ADM schedule (it wouldn't save). In order to save time (and not knowing the extent of the technical problem), we addressed the critical point in the development of a standard; specifically, the date at which the last draft prior to Agency Review is distributed to the WG. From this, the full schedule was later successfully elaborated; all active document schedules with the exception of the ADM revision were updated. Most of the updates involved extending target dates, a condition caused largely due to delays introduced during our CDM "laser focus" stage. CCSDS Tech Support was notified of the problem and it appears that resolving the issue is something they were already working to correct. Based on the work to modify document schedules described above, the Navigation WG 5 Year Plan was updated post-meeting; it is available below near the end of the minutes. The one item related to the WG 5 Year Plan that was discussed with the WG were some ideas for future work that had previously appeared as "New Standards Development Project #1" and "New Standards Development Project #2" (Nestor had implicitly requested that these prospective projects be better defined). One new project, the Spacecraft Re-Entry Message (SREM) was suggested by Luis Martin; the second was to resuscitate the Spacecraft Perturbation Message (SPM) now that the domain of the NHM and SMM has been better defined.

Following the adjustment of document schedules, we addressed a number action items that had been generated during the meetings, and prepared the closing report that will be presented at the MOIMS Closing Plenary on Friday afternoon. The action items from the meeting were prepared, assigned, and dated; they appear at the beginning of these minutes. The draft material prepared by David was reviewed with the attendees and finalized, insofar as that was possible to accomplish given that Friday's events have not yet occurred; the report appears below near the end of the minutes.

As a final act of business, the "Next Telecon" was set (see below for scheduling info). The Navigation WG Meeting then formally ended at 1800 (we ran about one half hour late in order to complete all the closing activities). The group was congratulated on a productive meeting week, adieus were bid, and we started making plans for the next meetings in Pasadena, California, USA in March 2015.

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%2F2014%2FFall&View={8E605C3A-1DB4-4034-B479-91C6E2A03139}&>

#### **DAY 5, Friday 14-Nov-2014**

There was no meeting of the Navigation WG this day, as we had completed our Navigation WG program work the prior evening.

The XML Standards and Guidelines (XSG) Special Interest Group (SIG) was held in the morning. David attended given the large number of XML schemas produced by the group and the CMC directive to produce XML implementations our standards. In attendance were Mike Kearney (NASA), Peter Shames (NASA), David Berry (NASA), Tom Gannett (CCSDS Secretariat), Wallace Tai (NASA), Lorenzo Marchetti (ESA), Andrew Hurd (ESA), and Marc Blanchet (SANA Operator, via telecon).

The first part of the meeting was allocated to the SANA Steering Group. Although the Navigation WG



currently has materials registered with the SANA, and has plans to register more materials with SANA, this meeting was focused on management issues of the SANA so there was not much to contribute. A great deal of the time was allocated to discussion of the Spacecraft ID registry, which doesn't (presently) affect the Navigation WG.

After the SANA Steering Group meeting was complete, Peter started the XSG SIG portion of the meeting by stating that the purpose of the SIG was to focus the efforts of the CCSDS with respect to XML schemas. We went briefly through the IETF (Internet Engineering Task Force) RFC (Request for Comments) document that had been prepared to request the CCSDS URN namespace and a namespace policy for maintaining it (a Yellow Book draft). Drafts of these two documents have been in progress for the past nine (!) years and are now suitable for moving forward. The RFC will be presented to the IETF IESG (Internet Engineering Steering Group) IANA (Internet Assigned Numbers Authority) for consideration. If the namespace is not awarded, the URN policy document will need to be modified accordingly because it assumes that the "urn:ccsds" URN will be allocated to the CCSDS; while this seems a good assumption, it is not official until reviewed and awarded by IETF/IESG/IANA. The CCSDS SANA will be responsible for updating the RFC if not acted upon by the IETF/IESG/IANA within six months. Once approved, it becomes permanent and doesn't need to be renewed anymore. The assignment of the URN and the CCSDS URN Policy Yellow Book impact the Navigation WG because the URN appears in our standards documents, all the schemas, etc. The policy directs the way in which we assemble our namespace and maintain it (though the old namespace we've been using will be "grandfathered" for the time being).

The discussion of the policy document was fairly non-controversial. It is a Yellow Book normative on CCSDS; it doesn't require Agency Review, but must be approved by the CESG and CMC. NOTE: In addition to CCSDS related schemas, the Policy allows agencies to keep agency specific schemas on the SANA Registry for convenience (I'm not sure what the CESG/CMC will say about this provision, and I'm not necessarily sure it makes sense as a policy matter).

Peter stated his intention that the XSG SIG will go out of business once the namespace RFC is approved and the URN Policy Yellow Book is published, however, in order to provide a group of experts for future consideration of XML issues in the CCSDS he will establish an "XML Expert Group" mailing list... anyone with ownership of XML schemas would be part of the group. A WG in SEA will be established to continue the work on XML guidelines for the CCSDS (it was later stated that the XML guidelines work will be part of the charter of the System Architecture WG (SAWG)).

We also discussed a few other topics, e.g., how to manage meeting mechanics of the XSG SIG given that all the participants have other WG, Area, and/or CESG/CMC assignments (in fact, several of the presumed participants were not able to attend even though this was a five day meeting series).

The remainder of the meeting consisted of a presentation containing proposed XML guidelines drafted by Peter. He indicated that this material had been presented at the SEA meetings earlier in the week.

Peter reported that he had performed a survey of all the XML based data formats in CCSDS: DEDSL DTD, ndmxml, SM Service Package, SM&C schemas (including XTCE), and SOIS XTEDS. He observed that there is quite a range of things done in different styles. He suggested that what we need to do for XML guidelines is to see if there is a set of common guidelines that will make things hang together better, but admitted that there is not a lot of guidance here. He did find some guidance documents, in particular, Google XML Document Format Style Guide (2008), ESA Design & Style Guide for XML Data and Schema (2005), XML Schema Best Practices, from XML-DEV, compiled by University of Cambridge (2001). These guidelines vary in content, but are helpful in terms of providing assistance. Peter extracted some common elements and showed them in his presentation.

Peter also wants to work on the CCSDS Glossary and revise it. We spent some time talking about an SEA project to resurrect the CCSDS Glossary, how that ties to the XML schemas, and in particular how it ties to the underlying documents. Some terms are defined differently in multiple places. A lot of times we have multiple definitions (sometimes three or four, e.g., the term "service"). Usually one of the multiple definitions seems fairly fundamental that can be used as a root, with some specializations.

Tom Gannett suggested that every WG should spend some time at each meeting working on definitions for the Glossary, which is now kept as a SANA registry. He did admit that the capabilities of SANA are somewhat clumsy at present (e.g., there is no way to filter and sort all the terms defined by a given WG). There are also some policy directives that should be issued, e.g., "Don't add definitions willy nilly"; this implies some approval authority. Peter proposed a requirement on WGs that if they are going to define a term, they must go to the Glossary/Ontology to see if it's already defined. He also wants to add other fields to the Glossary (e.g., provenance info, sources, derivation, links to abbreviations, cross links to other definitions, etc.), but the mechanics and approval authority for doing this are not well defined.

After the XSG SIG meeting, and lunch, David attended Area Director Nestor Peccia's MOIMS Closing Plenary at 1500. Attendance at the Plenary included: Nestor Peccia (Area Director), Roger Thompson (Deputy Area Director), Mario Merri (SM&C Chair), Daniele Bouçon (DAI WG Chair), David Giarretta (RAC WG Chair), David Berry (Navigation WG Chair), Brigitte Behal, Tiago Nogueira, Marilyn Newhouse, Mehran Sarkarati, John Garrett, and several other members of the SM&C WG.

Mario Merri presented the SM&C report. They have approximately 20 members at these meetings (!). There were a couple of interesting points in the SM&C report, for example, they have developed an "MO Graphical Editor" that is targeted for Open Source; it will produce automatic XML service specs, associated Word documents, and Java skeleton code. Apparently NASA has blocked (on at least one occasion and possibly more) publication of the Monitor & Control Green Book. There have been longstanding issues of overlap with the Cross Support Services Area, and during these meetings there were two special evening meetings of the principals involved to try to resolve them (CMC, System Engineering, SM&C, Service Management). Apparently there was an arrangement worked out and clear lines of responsibility defined (though the details have not been published). The Navigation WG doesn't have a stake in this overlap discussion since we have not been defining services, rather, just exchange message formats.

For the Navigation WG, the report shown immediately below was presented. During discussion of the resolutions, Nestor Peccia indicated that a CESG/CMC poll was not necessary in order to add the ODM revision project to the Framework. Otherwise, there was no particular issue.

The reports of the DAI WG, RAC WG, Telerobotics WG, and Mission Planning BOF were also presented. After the various MOIMS WG's presented their reports, the meeting week was concluded.

## **MOIMS CLOSING PLENARY / NAVIGATION WORKING GROUP REPORT**

- DOCUMENTATION STATUS
- Orbit Data Messages (ODM)
  - Completed review of 3 sets of proposed modifications to the ODM (NASA/JSC, ESA/ESAC, ISO TC20/SC14/WG3)
  - Completed determination of ODM Reconfirmation Review: concluded that REVISE is the appropriate action

- Tracking Data Message (TDM)
  - Completed review of the required ICS annex with the WG
  - Completed review of anticipated Pink changes (Book/Sheet) with CSSDS Editor in preparation for Agency Review
- Navigation Green Book
  - Continued discussion of edits to Nav Green Book (version 4, volume 1)
  - Completed review of a new set of simplified process diagrams for inclusion in the updated Green Book
- Navigation Hardware Message (NHM)
  - Completed comprehensive discussion of issues arising from internal review of NHM White Books 8 and 9
- Spacecraft Maneuver Messages (SMM)
  - Continued discussion of high level document and message design using SMM use cases as the basis
  - Completed setting direction for first SMM Blue Book (maneuver plan)
- Attitude Data Messages (ADM)
  - Continued review of potential major revisions to the ADM (no new draft yet)
- Events Message (EVM)
  - Resumed discussion of orbital events that might be pertinent to a Navigation events message; no discussion of formats and no book planned due to TDE inheriting the formatting role
- Pointing Requests Message (PRM)
  - No discussion due to ESA/ESOC lead editors not in attendance (due to ROSETTA critical events)
- Cross-Area Meetings & Technical Issues
  - ISO TC20/SC14/WG3 was present Mon/Tue for discussion of requested ODM changes
  - Completed joint meeting with SM&C on Navigation Services topic
  - Completed participation in XSG SIG... cannot attend during 4 day meetings, but 5 day schedule allowed participation.
- Administration
  - WG Charter: Reviewed charter, no updates
  - Document Schedules: Updated in Framework (1 exception... a bug being worked by CCSDS Technical Support)
  - Project Resources in Framework: No changes
  - Navigation Working Group 5 Year Plan: Completed updates based on Framework and projected new work items
- Issues
  - We are nearly recovered from the 2.5 year long “laser focus” on the CDM that caused significant delays to occur in other work.
  - The group addressed and resolved 2 of 3 “thorny issues” that have arisen several times in the past but have not been definitively answered
  - Tuesday telecon worked “OK”, but was at times difficult to understand the presenter; less productive than face-to-face
- Overall Assessment
  - Satisfied top priority goal for meetings (ODM Reconfirmation Review decision)
  - Made good progress catching up on items delayed by intensive work on CDM (NHM, ADM, SMM, Green Book, EVM)

- Modest (not substantive) progress on TDM, no progress on PRM
- Requested Feedback Items
  - None
- Unsolicited Feedback Items
  - Facilities:
    - Location was excellent (close to hotels, underground)
    - Meeting rooms were spacious, quiet, well equipped, secure
    - Meeting room materials (projectors, whiteboards) were excellent
    - Provision of refreshments (coffee, tea, water, cookies) was excellent
  - Staff:
    - Friendly and accommodating
- RESOLUTIONS Issued
  - Resolution 1:
    - The Navigation WG requests the applicable poll(s) (CESG?/CMC?) on decision to revise the Orbit Data Messages Blue Book
  - Resolution 2:
    - The Navigation WG expresses appreciation to the staff of UKSA and BSI for their excellent support of these meetings.

## NAVIGATION STANDARDS 5 YEAR PLAN

The following plan for future work was produced based on discussions during the meetings. The basis for the plan was determination by the respective lead editors as to when they would be ready for an Agency Review of their works. Due to time constraints we did not discuss in detail each of the dates. Target dates for the activities that occur after Agency Review were extrapolated based on previous experience. In the plan there are only two date milestones per year, specifically, the Spring Meetings and Fall Meetings, which are generally in April/October respectively (with some variations +/- one month). For this reason, the "Mtg" here may not correlate exactly to the dates on the CWE Framework which have granularity at the month level. Additionally, some of the projects below are not yet registered in the CCSDS CWE Framework; they will become registered when there is a more definitive plan to produce them. This plan is also available on the CCSDS CWE at <http://cwe.ccsds.org/moims/docs/MOIMS-NAV/Meeting%20Materials/2014/Fall/navwg-5-year-plan-201411> .

Mtg	Year	Document	Deliverable	Prty
Fall	2015	Tracking Data Message Version 2	Pink Book/Completed Agency Review	1
Fall	2015	Navigation Green Book Version 4, v.1	Green Book complete	2
Spring	2016	Tracking Data Message Version 2	Blue Book complete	1
Spring	2016	Pointing Requests Message	Red Book/Commence Agency Review	2
Spring	2016	Spacecraft Maneuver Message (V1/MPM)	Red Book/Commence Agency Review	3
Spring	2016	Navigation Hardware Message	Red Book/Commence Agency Review	4
Fall	2016	Orbit Data Messages Version 3	Pink Book/Completed Agency	1

<b>Mtg</b>	<b>Year</b>	<b>Document</b>	<b>Deliverable</b>	<b>Prty</b>
			Review	
Fall	2016	Satellite Re-Entry Message	Abstract/Concept Paper complete	1
Fall	2016	NDM/XML Version 2	Pink Book (common schemas only)	2
Fall	2016	Attitude Data Messages Version 2	Red Book/Commence Agency Review	3
Spring	2017	Navigation Hardware Message	Blue Book complete	1
Spring	2017	Spacecraft Maneuver Message (V1/MPM)	Blue Book complete	2
Spring	2017	Attitude Data Messages Version 2	Blue Book complete	3
Fall	2017	Pointing Requests Message	Blue Book complete	1
Fall	2017	Orbit Data Messages Version 3	Blue Book complete	2
Fall	2017	Satellite Re-Entry Message	Initial White Book complete	2
Spring	2018	Navigation Green Book Version 4, v.2	Green Book complete	1
Spring	2018	NDM/XML Version 2	Pink Book/Completed Agency Review	1
Spring	2018	Spacecraft Perturbation Message	Abstract/Concept Paper complete	3
Fall	2018	Conjunction Data Message	5 year review complete	1
Spring	2019	NDM/XML Version 2	Blue Book complete	1
Spring	2019	Events Message	Initial White Book complete	1
Spring	2019	Spacecraft Perturbation Message	Initial White Book complete	2
Fall	2019	Satellite Re-Entry Message	Red Book/Commence Agency Review	1
Spring	2020	Spacecraft Maneuver Message (V2/MDM+MAM)	Red Book/Commence Agency Review	3
Fall	2020	Spacecraft Perturbation Message	Red Book/Commence Agency Review	1
Spring	2021	Events Message	Red Book/Commence Agency Review	1
Spring	2021	Tracking Data Message Version 2	5 year review complete	1
Fall	2021	Satellite Re-Entry Message	Blue Book complete	1
Spring	2022	Spacecraft Maneuver Message (V2/MDM+MAM)	Blue Book complete	1
Spring	2022	Navigation Hardware Message	5 year review complete	3
Fall	2022	Spacecraft Perturbation Message	Blue Book complete	1
Fall	2022	Pointing Requests Message	5 year review complete	2

**NEXT TELECON:**

The WG established Wednesday 12/10/2014 @ 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 and action item status (we have 10 action items with scheduled by 12/15/2014).