MINUTES OF NAVIGATION WORKING GROUP FALL 2022 WORKSHOP 30-Oct-2022
David S. Berry / Chair

The CCSDS Fall 2022 Navigation Working Group Meetings were conducted in person in Toulouse, France, from 17-Oct-2022 through 21-Oct-2022. Although the meetings were held in person, the ability to attend virtually was also offered to those who could not travel. CNES hosted the meetings. This is a summary of the activities of the Navigation Working Group (WG) during the Meetings. 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), Julien Bernard (SANA), Vitali Braun (ESA/ESOC), Juan Crenshaw (NASA/GSFC), Jean Gilbert (SANA), Cheryl Gramling (NASA/GSFC), Julie Halverson (NASA/GSFC), Ralph Kahle (DLR/GSOC), Alain Lamy (CNES), Jose Miguel Lozano (GMV/ESA/ESOC), Mario Merri (ESA, MOIMS Area Director), Dan Oltrogge (NASA (COMSPOC, ISO TC20/SC14)), Brian Swinburne (Airbus/UKSA), Patrick Zimmerman (NASA/JSC).

TELECON PARTICIPANTS

Frank Dreger (ESA/ESOC), Hideaki Hinagawa (JAXA),

AGENDA

The final agenda for the WG meetings is available on the Navigation WG CWE at: https://cwe.ccsds.org/moims/docs/MOIMS-NAV/Meeting%20Materials/2022/Fall/navwg-agenda-fall-202210-final.pdf . In the meeting proceedings below, the detailed agenda for each meeting day (as realized) is included in the minutes to provide context.

CURRENT ACTION ITEMS

The following action items were either produced during the meetings or carried forward from previous meetings if they had not yet been completed. They are also available on the CWE at https://cwe.ccsds.org/moims/docs/MOIMS-NAV/Meeting%20Materials/2022/Fall/navwg-action-items-202210.pdf . The action items and due dates below reflect the status as of the end of the meetings; the list on the CWE will be updated periodically between the end of this meeting series and the beginning of the next meeting series. The list on the CWE will thus reflect relative completion progress and any new action items added after the meeting series.

If "Status" = "Open", then "Date" = "Target Date"
If "Status" = "Complete", then "Date" = "Completion Date"
If "Status" = "Cancelled", then "Date" = "Cancellation Date"
Sort by "Status" (Descending), "Date" (Ascending)

##	Action Item	Category	Actionee	Status	Due Date (Original)	Date
39	Attend CCSDS Editor's Boot Camp for refresher	General	All	Open	13-May-2022	21-Oct-2022
06	Answer Dan's question regarding ODM V.3 Test #9	ODM	David	Open	23-Oct-2022	23-Oct-2022
85	Update OCM schema to reflect ODM text changes, upload to SANA	NDM/XML	David	Open	23-Oct-2022	23-Oct-2022
04	Send SANA presentations to Julien	SANA	David	Open	26-Oct-2022	26-Oct-2022
01	Get PRM MS Word from Tom Gannett	PRM	David	Open	28-Oct-2022	28-Oct-2022
86	Update NDM/XML Test Harness OCM tests to reflect ODM text changes	NDM/XML	David	Open	30-Oct-2022	30-Oct-2022
87	Correct all XML samples in the ODM V.3 draft	NDM/XML	David	Open	30-Oct-2022	30-Oct-2022
17	Update Navigation Terms in CCSDS Glossary (original + RDM terms)	Glossary	Secretariat	Open	31-Aug-2019	31-Oct-2022
51	Finalize ODM prototypes and Test Plan; commence testing	ODM	Dan	Open	27-Apr-2022	31-Oct-2022
90	Prepare new project for NDM/XML 4	NDM/XML	David	Open	31-Oct-2022	31-Oct-2022
92	Submit Revised Orbit Centers Registry data for SANA Registry	SANA	David	Open	17-Dec-2018	31-Oct-2022
94	Library of referenced papers on CWE	CWE	David	Open	10-May-2021	31-Oct-2022
60	Produce NDMO G-2.0.3	NDMO	Patrick	Open	04-Nov-2022	04-Nov-2022
70	Submit NDMO G-2.0.3 to Secretariat	NDMO	David	Open	07-Nov-2022	07-Nov-2022
02	Identify all registries that reference the U.S. Air Force and provide list to SANA Team	SANA	Dan	Open	15-Nov-2022	15-Nov-2022
03	Run setup-ndmxml test against 1.0.D registries on SANA.	NDM/XML	David	Open	15-Nov-2022	15-Nov-2022
05	Provide "final" ODM update to David so the XML schemas can be updated	ODM & NDM/XML	Dan	Open	15-Nov-2022	15-Nov-2022
74	Prepare Navigation references for SANA Registry	SANA	David	Open	31-Oct-2018	15-Nov-2022
10	Create Nav WG standard Blue Book template with Nav WG approved Annex ordering	Template	David	Open	28-Jul-2021	30-Nov-2022
95	Produce CDM P-1.0.4 draft	CDM	Brian/Dan	Open	30-Nov-2022	30-Nov-2022
09	Produce ADM Test Plan version 5	ADM	Alain / Julie	Open	02-Dec-2022	02-Dec-2022
00	Check XML floating point number ranges	All	David	Open	14-Dec-2022	14-Dec-2022
88	Refresh FDM Concept Paper	FDM	Vitali	Open	14-Dec-2022	14-Dec-2022
89	Refresh LDM Concept Paper	LDM	Dan	Open	14-Dec-2022	14-Dec-2022
97	Research open floating point number questions	All	David/Dan	Open	14-Dec-2022	14-Dec-2022
96	SANA implementation of Nav References	SANA	SANA	Open	31-Jan-2019	15-Dec-2022
98	Produce Navigation Events Message initial draft	NEM	Alain	Open	31-Jan-2018	15-Dec-2022
91	Prepare new project for Fragmentation Data Message	FDM	David	Open	31-Dec-2022	31-Dec-2022

##	Action Item	Category	Actionee	Status	Due Date (Original)	Date
93	Prepare new project for Launch Data Message	LDM	David	Open	31-Dec-2022	31-Dec-2022
99	Produce PRM Corrigendum	PRM	Jose Miguel	Open	31-Dec-2022	31-Dec-2022
61	Produce TDM P-2.0.2 update	TDM	Juan / Cheryl	Open	18-Nov-2022	18-Jan-2023
08	Distribute "Divide & Conquer" review assignments for TDM P-2.0.2 draft	TDM	David	Open	17-Aug-2022	20-Jan-2023
79	Modify/clarify floating point number rules	General	Dan	Open	09-Dec-2020	22-Feb-2023
71	Review TDM P-2.0.2 draft	TDM	All, as assigned	Open	20-Dec-2022	28-Feb-2023
53	Determine organization for Italian RDM Provider role	RDM	Elena	Open	26-Feb-2020	01-May-2023

WORKSHOP PROCEEDINGS

MONDAY 17-Oct-2022

0845-1000: CCSDS Opening Plenary / Schedule Details

Sylvain Teodomante, the CNES representative to the CMC, opened the meetings with a few remarks. He indicated that he was taking over role formerly performed by Jean Marc Soula, and on behalf of CNES welcomed us to Toulouse. Sylvain quickly turned the meeting over to Klaus Juergen Schulz, the Chair of the CESG. Klaus Juergen welcomed us to the first CCSDS in-person CCSDS Meeting in 3 years for this 5-day technical meeting. He provided a number of statistics on CCSDS documents that had been published since the Spring 2022 Meetings (2 new blue books since Spring 2022, 0 magenta, 1 orange, 0 green books, 2 Agency reviews, 2 new projects for CSS, 1 new project for SLS). He also provided information on the distribution of leadership across the CCSDS Member Agencies. He stated that there had been only one change in leadership of CESG/CMC: Holger Dreihan deputy for CSS given the retirement of Colin Haddow, Deputy Area Director for Cross Support Services. Resources update: NASA and ESA dominate standards editor/co-editor 50%/40%, and testing. CNES 10%, other agencies 0. He highlighted a number of topics that had been occupying the CESG since the Spring meetings:

1. Addressing issues with the Message Abstraction Layer (MAL) Blue Book Version 2. There was a major dispute on PIDs (Poll Item Dispositions). Further discussions will be held this week. This particular issue has more or less caused work in SM&C and MP&S to grind to a halt.
2. Lunar inter satellite N/W: Initiative to have commonly agreed user/customer interfaces.
3. MO Service Infusion: agreement to focus on ground/ground services for MP and Mission Data Product Distribution.
4. Terminology: Proposal to clean up terminology using the SANA Terminology registry in line with agreed method with ISO SC14. To be discussed at CESG 24-Oct-2022, will likely lead to dedicated actions to ADs and WGs.

The Opening Plenary covered a few of the customary topics. Here are a few keynotes:

- The Area Directors (ADs) each discussed the character and plans for their associated working groups.

Mario characterized the Nav WG as "a very active group", with a number of documents at various levels, including a number of revisions. As noted above, the SM&C WG has several documents "on hold" while awaiting a revision of the MAL, a controversy which is being discussed in the CESG. Mario announced his pending retirement, stating that this would probably be his last CCSDS Meeting. The process of selecting a new AD will soon kick off. Other Area Directors described the work situation in their areas. Notably, only 3 of the 6 ADs had their material included in the presentation for some reason.

- The informational Plenary presentation provided by the Secretariat was not distributed as it has been in prior years. The Plenary presentation also did not provide future meeting data beyond that provided for Spring 2023 (meeting series, host agency) as it has in prior years. The information below on future meetings is from last Spring's presentation. The location of Fall 2023 is "semi-informed speculation".

a) Spring 2023 Meetings will be hosted by NASA at Huntsville, Alabama, USA, dates 05/08/2023 - 05/12/2023, in the Westin Hotel at Bridge Street Town Center. The venue was characterized as a "shopping village", with many amenities within walking distance. Mason Hall & Vinny Rustovski (CCSDS DTN lead) were introduced; they will be organizing the Spring 2023 Meeting series.
b) Fall 2023 hosted by ESA at ESTEC (The Hague?), dates TBD
c) Spring 2024 hosted by NASA at TBD, dates TBD
d) Fall 2024 hosted by UKSA at TBD, dates TBD
e) Spring 2025 hosted by NASA at TBD, dates TBD
f) Fall 2025 hosted by ESA at TBD, dates TBD

- Amber Massaquoi, the new coordinator for the Secretariat, informed the group that lunches would be served in the Mercure central gathering area, and that there would be a Wednesday evening reception hosted by CNES.
- On the topic of the ESA Lunar initiative/Luna Net/Intersatellite Link, it was stated that the CCSDS role is indeterminate.

The Opening Plenary sort of fizzled out at the end... and people started going to their respective Area or Working Group meeting rooms. The MOIMS Opening Plenary began immediately after the CCSDS Plenary.

1000-1100: MOIMS Opening Plenary

Mario indicated that there was not much to report from his perspective... and then he reiterated his goodbye to the Area due to his pending retirement. He indicated that the MOIMS Dinner would be on Tuesday evening, not on Wednesday as usual given that CNES has invited everyone to dinner on Wednesday. The Closing Plenary was scheduled for Friday at 1600, but subsequently rescheduled to 1400. He reminded the SM&C WG about necessary actions for the CESG Meeting. DAI was characterized as healthy, high momentum, and on a good track with their OAIS-Interoperability Framework Architecture. He mentioned the ISIL satellite interlink effort, and encouraged all to discuss the topic in their respective working groups and provide a report in the MOIMS report. Navigation was characterized as a very active WG with a lot of ongoing work. He reiterated that the SM&C MAL document submission for Agency Review has stopped at the CESG poll, causing months of delay and a ripple effect to the SM&C and MP&S Working Groups. CESG is in the process of addressing the topic. Mario pointed out that they still have a spot in the SM&C for Navigation Services (which the Nav WG has consistently avoided). Discussion of terminology issues with SC13 and SC14 has commenced, and will hopefully bear fruit.

1100-1230: Navigation WG Meeting

Attendance in person this day included: David Berry, Vitali Braun, Juan Crenshaw, Cheryl Gramling, Julie Halverson, Ralph Kahle, Alain Lamy, Jose Miguel Lozano, Dan Oltrogge, Patrick Zimmerman. Attending via Webex was Frank Dreger.

1100-1145: Nav WG Introductory Meeting (Intro, Action Items, etc.)

After an around the room "face-to-face" introduction after a hiatus of 3 years, David presented the "Introduction to the Navigation WG" material. We didn't have any truly new members this time (for some it was the first "in-person"), so the details of each document were not presented; however, David had updated the "next steps" portion of each document in the Backup Material so that was briefly presented. The presentation was distributed to the WG mailing list, and also uploaded to the Nav WG CWE. During this period we also briefly reviewed the outstanding action items from the Spring 2022 meetings, but none of the dates needed adjustment. Any open items from prior meetings will be moved into the Fall 2022 action item list.

1145-1230, 1330-1430: Orbit Data Messages (ODM) (Testing Status, XML Status, etc.)

As the introductory material took less time than was allocated, Dan started his discussion of the current status of the ODM testing status (started before lunch and completed after). He indicated that Comspoc has an OCM tool that will ingest a KVN OCM and output both KVN and XML. He indicated that the prototype is currently processing all inputs as strings, but will soon be able to process the numeric strings as numbers and the testing can commence in earnest. During the demonstration, it became apparent that there had been a few changes in the ODM text made after the dispositioning of RIDs had been completed, e.g., the position in the table for the ORB_AVERAGING keyword was changed and the M/O/C was changed from "M" to "C" (these both affect the schema). Dan will send his latest version of the document to David so the OCM schema can be updated, and the schemas on the beta SANA registry can be updated; David took action items to perform the schema updates. The group had some discussion regarding the degree to which standards in development can be modified between the Agency Review and publication. Generally, once RIDs have been dispositioned, the text of the standard should not be changed unless some error condition that necessitates changing the document arises in the prototype testing. Later on, in the NDM/XML discussion (next item), we also tried to validate all of the XML examples in the ODM text, and there were some unexpected errors that David will need to correct in the examples.

It is likely that the ODM V.3 will publish in early 2023.

1430-1645: Navigation Data Messages/XML (NDM/XML) 3.0+4.0 (Issues, Naming, Schedule)

The ODM discussion did not take as much time as allocated, and the group briefly discussed some scheduling matters. Cheryl and Juan (and possibly some others) indicated a desire to attend the Time Management discussion on Wednesday afternoon, so we did some schedule arranging to accommodate the request. One change was to move the NDM/XML material originally planned for Tuesday morning to Monday afternoon. Other changes are reflected in the online schedule.

The NDM/XML material focused on the various issues we have had over the years with schema names and versions, especially in documents where they have frequently been out of sync with what is on the SANA Registry. David presented the original material describing the various problems, updated with the solutions that he and Jose Miguel discussed that have for the most part been implemented. In general this was not controversial, however, there was one area where Jose Miguel felt the solution could be improved. This related to the SANA Team's previously stated desire to not maintain all of the schema set

versions on the SANA website. Jose Miguel observed that the URL of each schema contained a level ("/files/") that implied that the schema files might still be maintained in the SANA Registry, but just not displayed as the active registry. In essence, this implies that the URL to older, retired schema sets would still be available even though the schema files would not be visible on the registry. Jose Miguel agreed to draft material for the Thursday meeting with SANA to discuss his proposition. David also explained the problem with scheduling between the ODM publication and the companion NDM/XML Version 3. If everything works "perfectly" there will be an out-of-sync condition for at least a month. We are working to minimize that condition. David also stated that he will soon be proposing a version 4 of the NDM/XML document to accommodate the changes in the ADM in hopes of avoiding another out-of-sync condition there; the history of how we got into this "situation" (polite word for "mess") was also briefly shared. Decisions regarding the implementation of the XML specification that seemed correct at the time (dating back to approximately 2005) may not have been the right decisions.

TUESDAY 18-Oct-2022

Attendance this day included: David Berry, Vitali Braun, Juan Crenshaw, Frank Dreger, Cheryl Gramling, Julie Halverson, Hideaki Hinagawa, Ralph Kahle, Alain Lamy, Jose Miguel Lozano, Dan Oltrogge, Brian Swinburne, Patrick Zimmerman.

0845-1200: Attitude Data Messages (ADM) (Agency Review Results, Test Plan)

Alain started with ADM testing philosophy: "Test only what is necessary", implying inspection and analysis where possible. For example, portions of the APM and AEM may be tested largely by inspection and analysis if it can be definitively shown that the information in the modified data structures provides the information necessary to perform the required astrodynamics function. During part of this discussion, we determined that if there is a governing equation for a particular function, and we can establish that the parameters for these equations are in either in the message, or can establish that they can be derived from the contents of the message, there may not be a need for an actual test; in these cases we can verify by analysis.

David indicated that he does not necessarily envision Agency software being replaced by CCSDS formats, at least not immediately. This can happen over time, in a software evolution. But generally, these CCSDS formats are initially simply "exchange mechanisms", the contents of which are mapped to the inputs required to run existing agency software. The group had a very stimulating discussion of "testing". Towards the end of this discussion, Dan inquired about "ODM V.3 Test Plan #9" in particular, and inquired whether or not it needs to be simplified.

Towards the end of the ADM discussion, we started trying to determine which agencies/WG members would participate in the ADM testing. Vitali indicated he would check with colleagues regarding possibility to test, and Ralph indicated a possible DLR AEM test.

It is likely that the ADM V.2 will publish in early 2023.

1200-1230: Conjunction Data Message (CDM)

In a few minutes prior to lunch, Brian discussed CDM XML issues... there are 3 pages of comments in the P-1.0.2 draft that he cannot resolve. David asked for the CRM to be able to address them, which Brian supplied. David said he would respond to these as soon as possible.

We also discussed the issue of the "CLASSIFICATION" keyword, and where it should be placed. This appeared for the first time in the OCM data structure, and Dan had placed it in the Header section. At that time (some time ago) David indicated that it should be in the Metadata Section, since it describes an attribute of the data. Also, we have endeavored over the years to keep the Header composition standardized, though there are exceptions (most notably the CDM). We spent some time discussing without resolving the issue of placement of the "CLASSIFICATION" keyword, which has become an issue for the CDM, OCM, TDM, and RDM.

1330-1600: Tracking Data Message (TDM)

After lunch, Juan presented us with the first look at the main updates incorporated in the TDM P-2.0.1. Although Juan had provided the draft document prior to the meetings, not many had had the time to give it a look prior to the meetings. Juan provided rationales for the main updates as well, and it was clear that he had become pretty familiar with the TDM Version 2 as part of the assignment. For example, he indicated that he was trying to establish a foundation for real time data transmission of the tracking data, and David pointed out the existence of the Cross Support Transfer Service - Tracking Data Service Blue Book (CCSDS 922.2-B-1), and Juan commented that he didn't understand the rationale for the use of the "atomic segments" incorporated in that standard. Briefly, the reason is that a real time session might interleave tracking data from several tracking instruments, and you could get conflicting metadata if you tried to have one metadata section describing a multi-instrument data section.

When Juan described adding a keyword that included the word "TASKING", David inquired if this was generally used terminology, and would it be understood internationally; that the only environment in which he had encountered that word was when the WG was working on the CDM and it was a word used by the USAF in their radar tracking. Might "tracking request" be better? Cheryl and Juan indicated that "tasking" was a word used in other contexts as well, and should be understood.

Another major change in this draft of the TDM is the inclusion of a number of configuration details. In the original Concept Paper of the Tracking Data Message, the first principle was "1. The Tracking Data Message format should be independent of the equipment that was used to perform the tracking." Should this configuration data be provided? David posed the question as to whether the TDM is intended for inter-agency exchange? or to provide a diagnostic tool for tracking instrument engineers? There are also a few instances of multiple units being allowed for a data type (e.g., m**2 and dBsm for RCS). David gave a brief history of units in the TDM (i.e., all keywords had only a single possible unit, with the exception of ranging, and that was due to a phenomenon that arose in testing). Due to the lively discussion in this session, we only made it through page 11 of 24 of Juan's presentation material.

Juan's material is on the CWE at https://cwe.ccsds.org/moims/docs/MOIMS-NAV/Meeting%20Materials/2022/Fall/presentation_TDM%20v2.01%20Overview%20CCSDS%20Fall%202022%20Discussion%20set%20(Oct20).pdf.

For reference, Tomas' original TDM White Paper (which largely governed the philosophy with respect to content of the eventual TDM standard), is available on the CWE at https://cwe.ccsds.org/moims/docs/MOIMS-NAV/Draft%20Documents/Tracking%20Data%20Message%20(TDM)/TDM%20Archive/TDM_white_paper-200309-draft1.pdf .

WEDNESDAY 19-Oct-2022

Attendance this day included: David Berry, Vitali Braun, Juan Crenshaw, Frank Dreger, Cheryl

Gramling, Julie Halverson, Hideaki Hinagawa, Ralph Kahle, Alain Lamy, Jose Miguel Lozano, Mario Merri, Dan Oltrogge, Brian Swinburne, Patrick Zimmerman.

In conversation before we officially started the meeting, we resolved the issue of the "CLASSIFICATION" keyword that had been raised on Tuesday. Logically it belongs at the top of the messages, in the Header. When there was only one message that wanted to include CLASSIFICATION, it was not appropriate to put it in the Header; however, now that more Lead Editors want to include it, it makes sense to put it in the Header. A comment was made that if people put classified info in the comments in the Header, it could be problematic, however, the solution for that is easy; i.e., don't put classified comments in the Header.

0845-1015: Conjunction Data Message (CDM)

We continued discussion of review comments from the CDM P-1.0.2 draft. One item proposed moving material from Annex F into the SANA Registry for the RTN and TVN reference frames used in the CDM. Ultimately it was decided to leave the CDM definitions in place in Annex F. As discussion continued, we decided to CANCEL the previously planned internal WG review of CDM P-1.0.3, and Brian/Dan will create a P-1.0.4 as soon as possible with the newly resolved issues from CDM P-1.0.2.

Given the 10:15 discussion end time, it was a convenient time for a break. Early on in the break, Cheryl discovered the "We Learn" on the same floor. The room was empty, and significantly bigger than our originally assigned room, with a very short sign up list (about 1/3 the size of our group). Additionally, since it was on the back of the hotel, there was no street noise. We obtained permission from Amber in the Secretariat to move from the "We Change" room to the "We Learn" room.

1045-1230: Future Topics

David noted that because several of our document updates are in-line for publication in the relatively near future (ODM, ADM, CDM), we will have time to consider some new topics. It was our good luck that Mario had chosen to sit in with our WG on this morning because now when the Concept Papers and New Project requests for these future topics cross his desk, he will already have at least a passing background into them.

First up was Vitali, who did a presentation on the Fragmentation Data Message (FDM). Not much has changed from the previous presentation 2 years ago (and we were reminded that it was originally proposed at the same time as the RDM, in 2015). Vitali explained that a fragmentation application is used internally at ESA. When a breakup is happening, they produce FDMs and exchange with others who are performing analysis for comparisons. Mario inquired about the process: detect event, then publish FDMs?, to which the answer was affirmative. In a CCSDS Nav WG standard, an FDM could have links to relevant ODMs, TDMs, CDMs, and RDMs as applicable, without having to recreate that content. We discussed the Russian Cosmos 1408 ASAT test, which produced a large number of fragments. An FDM can provide analysis based on a breakup model almost immediately (same day of event), then the data converges over time to be based increasingly on observations and confirmed observations. With an FDM and analysis tools, analysts can provide simulations of the risk from debris to missions in operations. David inquired about the number potential producers of FDMs there might be? In discussion we decided that for an effective standard it may not matter how many producers there are if the number of consumers is large. The CDM is a good example for comparison, where the number of producers is small relative to the number of consumers. Vitali took an action item to refresh the Concept Paper. David took an action item to produce the "New Project" request for consideration by the CMC.

Next up was Dan, who reviewed the Launch Data Message (LDM) proposal. This message will be useful in launch conjunction assessment. It is also useful in the current environment when there are so many launches and they are happening frequently. The Launch Data Message seeks to improve all data exchange, coordination, and inter-organizational aspects of both domestic and international launches, thereby reducing operations costs, increasing overall efficiency and minimizing operational risk. Dan took an action item to refresh the Concept Paper. David took an action item to produce the "New Project" request for consideration by the CMC.

Dan brought up the "Super Message", which conceptually could reduce the (sometimes large) amount of time we are spending trying to enforce consistency between the various standards that utilize the same or similar data structures. Such a project will lead to some group synergy.

Finally, Alain presented some material on the NEM from an older presentation that he had prepared. The WG completely stopped working on the NEM so that we could focus on the ADM update, which was long overdue. Mario reminded us of the Cross Support Services Magenta Book that defines the Abstract Event Definition (CCSDS 902.13-M-1 https://public.ccsds.org/Pubs/902x13m1.pdf) . David noted that several of the Nav WG members (Cheryl, Alain, Dan, Fran) had worked with the CSS team on the abstract event definition included in that book, and it was our intent to incorporate that into the NEM. Alain inquired whether or not CSS Magenta events could be extended? Extensibility will be an important concept in the NEM. This is something we will have to research once we resume serious NEM work.

Each of these future ideas was proposed some time ago, however, David explained he has been reluctant to start new projects given that our production of the ODM, ADM, and TDM five-year review updates has been delayed for quite some time. Adding several new projects in such a scenario would create overload (and it's not just the Lead Editors... we need the members of the WG to be reviewers to perform their critical function too). Now that the ODM, TDM, and CDM are moving towards completion, we can start to propose some new things to work on. David reminded the group that we cannot just start working on things that attract us... we need to have a Concept Paper that sells the project, and a new project application. And of course these necessarily include prototypers. Note that the NEM has one advantage over the other ideas discussed, and that is that it is already an approved project.

Towards the end of this session, since we were discussing future topics, Mario invited the Nav WG to start designing some services!

Miscellaneous comments towards the end of this discussion:

- The European Union’s Space Surveillance and Tracking has 3 functions: conjunction assessment, re-entry, and fragmentation analysis. They are not direct consumers of RDMs, but browse ESA re-entries.
- Ralph mentioned an upcoming DLR TET satellite re-entry in mid-to-end November, and said that DLR could produce an RDM for this.
- Dan wondered about the capability of including pictures in a message (e.g., for an FDM).
- Dan provided a link related to his company: https://www.comspoc.com/resources/content. Dan mentioned this as source of many technical documents and reports applicable to the Navigation WG.

1330-1400: Navigation Data Messages Overview V.3

Patrick explained that Draft 1 of the update had 47 comments, mostly grammar. The major change requested was to add the OCM description. Draft 2 had only 14 comments, all minor. After brief discussion, the group concluded that the document is ready for CESG/CMC Polling for Approval to

Publish after Patrick finishes applying the comments to the text. David will add a Resolution to this effect to the Nav WG Report to Area Director.

1400-1430: PRM Five Year Review

The PRM was published in Spring 2018, and is thus coming up on 5 years since publication. David explained the 5 Year Review process: we choose to either reconfirm, revise, or retire. Usually we proceed by eliminating options, starting with retire. If the standard is still useful, as in this case, the answer to "retire?" is "no". We then usually ask "reconfirm?", because most of the time previously people have known of improvements they would like to make. However, in this case we are not aware of any desire for revision. So in this case, we examine the question "revise?"; in this case "no" (although there is an outstanding promise of a corrigendum). This leaves us with the question "reconfirm?". In this case, we opt to prepare a corrigendum requested by the MP&S WG, and then reconfirm the standard.

1430-1500: Review Major Document Schedules

On the CWE Framework we looked at the schedules for the major documents in progress, both to update them if necessary and to gather data for the 5 Year Plan scheduled to be discussed on Friday. We updated schedules as follows: ODM publication target 01/15/2023, ADM publication target 06/30/2023, CDM publication target 12/31/2023 (based on a potential last Pink Book version 1.0.5).

1500-1700: TDM Continued Discussion

We continued discussion of the TDM, which hadn't been scheduled for this time period, but the Time Management meeting attended by Cheryl and Juan completed sooner than planned. There was discussion regarding phasing out EPHEMERIS_NAME_n in favor of ODM_LINK_n in the TDM; there was consensus to retain EPHEMERIS_NAME for backwards compatibility. There was discussion about the modality of data, in particular, the meaning of the "PLAYBACK" value. Juan also introduced the concept of data quality and correction indicators on each observation. When we started the discussion, the group was a bit flagged and we agreed to go for one hour, but with Juan's guidance we regained our momentum and continued for a little over two hours.

At the end of the day, Vitali had to depart the meetings given that he only had approval for attending the first 3 days of the meeting series.

THURSDAY 20-Oct-2022

Attendance this day included: David Berry, Juan Crenshaw, Frank Dreger, Cheryl Gramling, Julie Halverson, Ralph Kahle, Alain Lamy, Jose Miguel Lozano, Dan Oltrogge, Brian Swinburne, Patrick Zimmerman.

0845-1230: Numerical Values in NDMs

We reviewed the section that describes the data types that appear in the Navigation Data Messages. While the focus was on the numerical data types, we also reviewed and proposed adjustments to comments and normative text in value fields. This discussion was motivated by several suggestions that have been made over the years to change the value ranges.

In the course of reviewing the numerical values, we also had occasion to review some of the things David had questions about with respect to enumerations in the NDM/XML. We can check in the schema

validation that prescribed values are in fact used, but though we have suggested that people use values from the SANA Registry on Time Systems, if we enforce it we create a maintenance nightmare. The group agreed to remove the enumerations from the NDM/XML common that relate to time systems, etc. Action item to David.

In particular, we spent a fair amount of time reviewing the floating-point number specifications, which were based upon the IEEE standard for floating-point arithmetic from 1985 (since revised in 2008 and 2019). David and Dan took action items to resolve some questions that we posed during the discussion. We also looked back at the numerical values proposal that David had prepared for the ODM in response to a RID in 2004, and it had some proposals that were similar to the kinds of recommendations Dan made (e.g., regarding 64-bit architectures and number of decimal digits in the numerical values). Some minor textual changes were made in the ODM draft based on this discussion.

Note that numerical range changes were not yet made in any document; these changes are technical enough that they will require an Agency Review, which the ODM and ADM have already been through. The following plan was established: incorporate the new recommended numerical ranges in the upcoming CDM draft prior to Agency Review. If the changes are accepted via the CDM Agency Review, we will provide appropriate Corrigenda for the ODM, ADM, TDM, and RDM. The outcome of the discussions is shown below. Items colored green are part of the current proposal; items colored yellow are to be researched via the Action Items assigned to Dan and David:

1.1.1 Comments and free-text value fields may be in any case (or mix of upper and lower case) desired by the user.

1.1.2 Apart from comments and free-text fields, normative text value fields shall be constructed using only exclusively all uppercase or exclusively all lowercase.

1.1.3 Integer values shall consist of a sequence of decimal digits with an optional leading sign ('+' or '-'). If the sign is omitted, '+' shall be assumed. Leading zeroes may be used. The range of values that may be expressed as an integer is:

$-2{,}147{,}483{,}648 \leq x \leq +2{,}147{,}483{,}647$ (i.e., $-2^{31} \leq x \leq 2^{31}-1$).
(OR -9223372036854775808 <= x <-= +9223372036854775807 (i.e., $-2^{63} \leq x \leq 2^{63}-1$).

NOTE – The commas in the range of values above are thousands separators and are used only for readability. They are not included in the integer representation in the actual message.

1.1.4 Non-integer numeric values may be expressed in either fixed-point or floating-point notation. Both representations may be used within an OPM, OMM, OEM, or OCM.

1.1.5 Non-integer numeric values expressed in fixed-point notation shall consist of a sequence of decimal digits separated by a period as a decimal point indicator, with an optional leading sign ('+' or '-'). If the sign is omitted, '+' shall be assumed. Leading and trailing zeroes may be used. At least one digit shall appear before and after a decimal point. The number of digits shall be 16 or fewer.

1.1.6 Non-integer numeric values expressed in floating-point notation shall consist of an optional sign, a mantissa, an alphabetic character separating the mantissa from its exponent, and the exponent, constructed according to the following rules:

a) The sign may be '+' or '-'. If the sign is omitted, '+' shall be assumed.

b) The mantissa must be a string of no more than 16 decimal digits with a decimal point ('.') in the second position of the ASCII string, separating the integer portion of the mantissa from the fractional part of the mantissa.

c) The character used to denote exponentiation shall be 'E' or 'e'.

d) The exponent must be an integer and may have either a '+' or '-' sign (if the sign is omitted, then '+' shall be assumed). Exponent values can range from -324 to +308.

e) The maximum positive floating-point value is approximately 1.798E+308, with 16 significant decimal digits precision. The minimum positive floating-point value is approximately 4.94E-324, with 16 significant decimal digits precision.

A couple of other questions related to the floating-point wording: David did not know whether or not the word "division" appeared in the 754-1985 standard, so he will research that. We all agreed that Dan's suggestion of "separating" rather than "division" was better. David also wanted to try to find a RID from one of the documents that changed the number of decima digits from 18 (2004 recommendation) to 16, which is currently present in all of the documents. Dan had lingering questions as to the number of digits in the exponent of the floating-point number, and the range of values allowed. We did not research these in real time, but assigned action items to research them. There is some degree of urgency given the plan for the CDM Agency Review (with P-1.0.5).

During this discussion, David also showed a proposal from the 2018 Berlin meetings related to the maximum integer in a Navigation Data Message. In looking at the ODM, ADM, and TDM, one had spaces to separate each 3 digits, one had commas, and one had no spacers to assist the reader. We should probably be consistent assuming we replace the numerical data sections in these books. (Note however that since these standards are undergoing revision, we can choose one representation and put it in each of them.) During this discussion, Dan had a question regarding the reason why the maximum positive integer is 2^n-1, whereas the minimum negative integer is -2^n. The answer lies in the "two's complement" notation used to represent integers in computer internals (see, for example, https://en.wikipedia.org/wiki/Two%27s_complement).

At 10:30 we took break to go downstairs for the CCSDS Group Picture https://public.ccsds.org/meetings/2022Fall/CCSDS%20fall%202022%20meeting%20Toulouse.jpg . Afterwards we concluded discussion on the topic of "Numerical Values in NDMs".

1330-1500: Tracking Data Message (Continued Discussion)

Juan presented a couple of major changes in the TDM: (1) the proposal for an increase in the number of PARTICIPANTs in the TDM from 5 to 9 with justification based on the relay use case, and (2) the accommodation of changes in metadata items in the data section.

1500-1640: SANA Team Discussion

Julien Bernard and Jean Gilbert from the SANA Team joined us for a joint meeting; we've been having these joint meetings for several years now and they've been very beneficial. After introductions, David first asked the SANA Team "What's new at SANA?", and Julien responded with more information about the new system of betas they have developed to be better able to accommodate promotion of registries to Production that occur at different rates. For instance, the "nav.sanaregistry.org" that we already knew about is part of this new arrangement (Julien explained that "nav.sanaregistry.org" replaced the "beta2" we had for a while.) Another beta has been created for "iso-terms.sanaregistry.org" related to the SC14/CCSDS joint arrangement to harmonize terminology. These special betas can be regarded as "test

registries" (and it seems they could help us with our issues in specifying schemas in development and reviews). It may be the case that the beta system is still evolving, and this new system seems like a compromise between the "single beta" we formerly had, and the "infinite betas" concept that was mentioned in the Spring as a way to accommodate registries that are ready for production on different schedules. Julien also explained that the SANA Team has made progress with providing the ability for WG chairs to edit WG level registries; David set up his login ID (but it was not obvious which registries he is allowed to edit, nor how to do it so he will check with Julien as to how to proceed). This is also an area of the SANA that is changing.

After the discussion of this new SANA feature, David explained the latest set of modifications the Nav WG would like to see using material that had been collected earlier in the day. Some of the changes were characterized as "Minor Changes" and some as "More Significant Changes", as follows:

Minor SANA Changes

1. Implement, if possible, a default sorting of "Name" entries alphabetically, irrespective of whether the entries were from the "Assigned" or "Provisional" Entries. (NOTE: We later decided to use "Value" rather than "Name" since the entries are used as the values assigned to keywords... See item 7 below in this list.)
2. Orbit-Relative Reference Frames: Please bold "TVN", "UVW", and "RTN" in the "Others have referred to this as" column
3. Orbit-Relative Reference Frames: Please bold "SEZ", "TNW", "NTW" and "TWN" in the "Description column"
4. Orbit-Relative Reference Frames: Please replace all instances of "US Air Force" with "U.S. Space Force" (e.g., under "RSW_INERTIAL").
5. Celestial Body Frames: Change from items from "Provisional" to "Assigned"
6. Orbit Centers: Delete column "JPL SSD Name"
7. Make the header consistent for all SANA NAV WG tables, specifically we decided to adopt “VALUE” for them all, replacing the current set of headers “KEYWORD VALUE”, “NAME”, “ORBIT CENTER”, etc.

More Significant SANA Changes

1. Progression of "betas" (ODM to be published relatively soon). We have beta, had beta2, nav.sanaregistry.org
2. Preservation of past XML schema sets on the SANA, even if not visible

Item number 1 of the "More Significant Changes" had already been explained to us in the "What's New?" discussion, so we didn't spend any more time on that. The second idea is a proposal from Jose Miguel that would allow the URLs of older schema sets to be preserved and not expire. This is a companion idea to the schema set archive that David added to the CWE. Jose Miguel's presentation is on the CWE at https://cwe.ccsds.org/moims/docs/MOIMS-NAV/Meeting%20Materials/2022/Fall/presentation_20221020_CCSDS_XML_SANA_Meeting.pdf.
After the presentation, Julien indicated that this concept was already supported; David said he could test that. In closing the meeting, Julien indicated that the Navigation WG remains the most active user of the SANA registries.

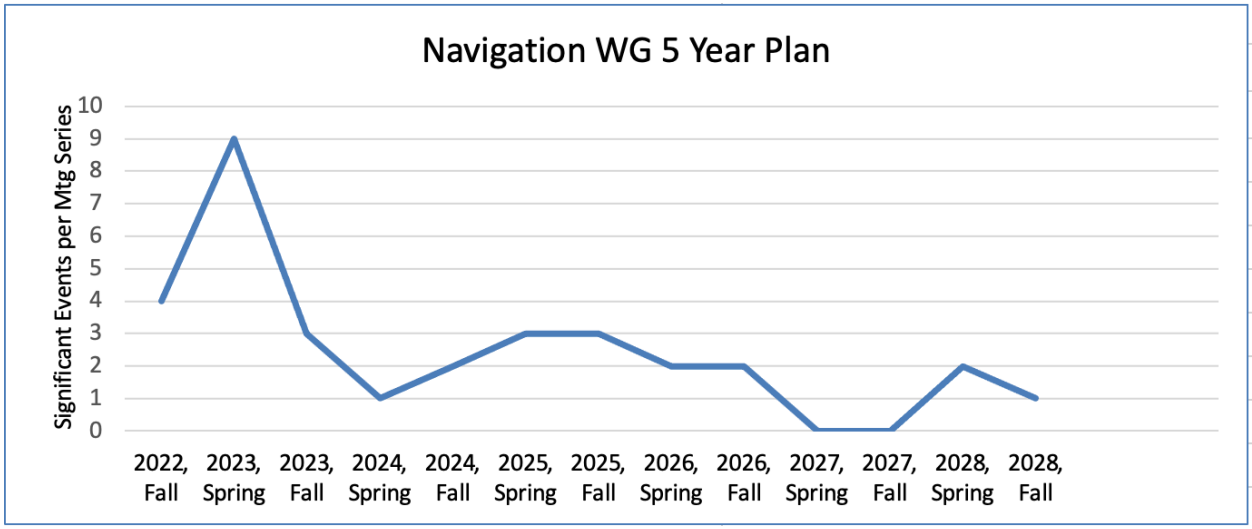
FRIDAY 21-Oct-2022

0845-1100: Final Report Preparation, Five Year Plan, Action Items

David reviewed the draft Final Report with the WG members, and we worked through it making

modifications as applicable. The report was presented at the MOIMS Final Plenary Meeting later in the day. The report presented is shown below in these minutes, and it is also available on the CWE at https://cwe.ccsds.org/moims/docs/MOIMS-NAV/Meeting%20Materials/2022/Fall/navwg-report-202210.pdf .

We reviewed the 5 Year Plan for the first time since Fall 2019. Since it had been a while, David explained the methodology: the process starts by roughly synchronizing the plan with the schedules on the CWE Framework that had been updated through the week. After that initial plan, several simplifications are utilized in order to keep the detail in the plan manageable. For example, there is a focus on the face-to-face meetings (restricted to April=Spring, October=Fall, other months are "rounded" to the closest meeting). David explained that there is probably a need for greater granularity in the dates because the half year range causes some unrealistic bunching when a document schedule is very rapid; monthly may be too much granularity for a 5 Year Plan, but quarterly might be feasible. There is a focus on 4 major events (Initial White book, Red/Pink Book/Agency Review complete, Blue Book complete, 5 Year Review), so many of the items in the full Framework schedule are ignored. A simple prioritization scheme is used for sorting (Blue Book=1, Red Book=2, White Book=3 or 4). The outcome of this process shows the number of major events that are planned to complete around the meeting series. Here is the plot for the current plan:



Note that Spring 2023 is distorted due to the situation with the aggressive schedule for NDM/XML V.3 and V.4, together with the planned publication of the ODM V.3 and ADM V.2 in the same time frame. The rest of the schedule looks more manageable. The detailed 5 Year Plan is available on the CWE at https://cwe.ccsds.org/moims/docs/MOIMS-NAV/Meeting%20Materials/2022/Fall/navwg-5-year-plan-202210.pdf

We also reviewed Action Items, and added a few, which are listed at the beginning of these minutes along with the link to the CWE site.

After all these activities, we all went our own ways after bidding safe travels to all, with expectations of meeting again at Huntsville in the Spring of 2023.

The dates for monthly telecons are listed at the end of these minutes. Meeting announcements will be sent in advance of each meeting. The single 1-hour meeting per month will be maintained.

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

https://cwe.ccsds.org/moims/docs/MOIMS-NAV/Meeting%20Materials/2022/Fall/

Draft documents reviewed during the meetings are in their respective directories on the CCSDS CWE: https://cwe.ccsds.org/moims/docs/MOIMS-NAV/Draft%20Documents/ (sort by "Name" for easier searching).

1400-1540: MOIMS Closing Plenary

Attendance at the Plenary included: Mario Merri (MOIMS Area Director), Marc Duhaze (MOIMS Deputy Area Director, MP&S Deputy Chair), David Berry (Nav Chair), Frank Dreger (Nav Deputy Chair), John Garrett (DAI Deputy Chair), Mike Kearney (NASA, DAI), Byoung Sun Lee (ETRI), Costin Radulescu (NASA/JPL), Mehran Sarkarati (SM&C Chair), Peter van der Plas (MP&S Chair), Roger Thompson (SM&C, MP&S). There were also several other members of MOIMS working groups: Olivier Churlaud (CNES, SM&C), Cesar Coelho (ESA/CGI, SM&C), Stefan Gärtner (DLR, SM&C), Serge Lacourte (CNES, ScalAgent DT, SM&C), Evridiki Ntagiou (???), Guillermo Ortega (ESA, ???).

In Mario's opening remarks he reiterated the fact that this was probably his last CCSDS Meeting due to his impending retirement. Some of the attendees seemed to have not heard of this yet. People expressed their well-wishes to Mario.

After Mario's introductory remarks, the Working Group Chairs delivered their reports: Mehran Sarkarati for Spacecraft Monitor & Control (SM&C), Mike Kearney for Digital Archive Ingest (DAI... note that DAI meets every week, not just during CCSDS Meeting series!), Peter van der Plas for Mission Planning and Scheduling (MP&S), and David Berry for Navigation (Nav). The Navigation report immediately below was presented during the Plenary. The report is also available on the CWE at https://cwe.ccsds.org/moims/docs/MOIMS-NAV/Meeting%20Materials/2022/Fall/navwg-report-202210.pdf . The MOIMS Area Director report to the CESG (which combines the reports prepared by all of the Working Groups) is available on the CWE at https://cwe.ccsds.org/cesg/docs/CWE%20Private/Meetings/2022-10-24%20CESG%20Meeting%20Toulouse/04%20F22-MOIMS-Report-to-CESG%20v1.pptx (Note: You must be logged into CWE to see access this site).

In the course of their presentations, every MOIMS Working Group Chair stated that the meetings are much more productive when we are onsite, face-to-face.

NAVIGATION WORKING GROUP CLOSING REPORT for TOULOUSE, FRANCE
NAV WG EXECUTIVE SUMMARY

Achievements for this Meeting Cycle

- Completed discussion of Navigation Data Messages Overview Green Book. Will submit to CCSDS Editor for CESG/CMC polling.
- Completed discussion of Conjunction Data Message V.2 Pink Book comments from internal review of Pink Book P1.0.2
- Completed discussion of Pointing Request Message 5 Year Review: decision is to prepare a minor Corrigendum, then "Reconfirm"
- Completed preview of content updates in first draft of Tracking Data Message V.3.

- Continued discussion of Orbit Data Messages V.3 prototype testing status
- Continued discussion of NDM/XML V.3 and issues of schema naming, versioning, and schedule; implemented solution was highlighted.
- Continued discussion of Attitude Data Messages Pink Book prototyping and test planning.
- Resumed discussion of the Navigation Events Message after a long hiatus
- Initiated discussion of potential changes to Navigation Data Message data type descriptions (last updated in 2004).
- Initiated discussion of several future projects that have been "in waiting"

Interaction with Other WGs

- Met with SANA Operator Team to discuss various topics related to the Nav WG use of SANA Registries.
- Met with Time Management WG regarding Lunar Time instantiation
- Met with IOAG representative on Lunar Comm/LunaNet and CCSDS relationship

Working Group Status

- Very good attendance at these "in-person" meetings
- Active, "High Momentum"

Planning (Only Approved Projects):

Area & WG name	CCSDS Ref Nr	Document Title	Status / Comments	Start and / or Target Publication Date	
MOIMS NAV	500.2	Navigation Data Messages Overview	New project approved 10/07/2021 (CMC-P-2021-09-007). Not yet started	Start date End date	01-Jun-2022 28-Feb-2023
MOIMS NAV	502.0	Orbit Data Message (ODM) 5 Year Review Revision	Good progress. One prototype is "complete" (pending any changes from Agency Review). Second prototype is nearly complete.	Start date End date	16-Apr-2015 15-Jan-2023
MOIMS NAV	503.0	Tracking Data Message (TDM) Version 3 Revision	Excellent progress. Spent considerable time discussing changes incorporated in the first White Book of this revision.	Start date End date	06-May-2019 30-Aug-2026
MOIMS NAV	504.0	Attitude Data Message (ADM) 5 Year Review Revision	Good progress. Completed post Agency Review discussions. Discussed prototype test plan.	Start date End date	16-Apr-2015 30-Jun-2023
MOIMS NAV	505.0	Navigation Data Messages XML Specification Version 3 Revision	Acceptable progress. Discussed a number of proposed schema name and versioning changes to address problems in multiple CCSDS cohorts.	Start date End date	25-Oct-2021 15-Mar-2023
MOIMS NAV	507.0	Navigation Events Message (NEM)	Modest progress. Discussion in these meetings refreshed attendees memories of this oft deprioritized project.	Start date End date	07-Nov-2017 30-Nov-2024
MOIMS NAV	508.0	Conjunction Data Message 5 Year Revision	Good progress. Completed resolution of issues raised during internal review of Pink Book P1.0.2. Addressed lingering issues related to XML section and schemas.	Start date End date	14-Jan-2019 31-Dec-2023
MOIMS NAV	509.0	Pointing Request Message	Completed 5 Year Revision discussion with decision to prepare a Corrigendum, then Reconfirm.	Start date End date	N/A N/A

- **Resolutions Agreed Upon this Meeting:**

  - Resolution 1: Submit the Navigation Data Messages Overview Green Book Version 3 for CCSDS Editor processing and CESG/CMC Polls
  - Resolution 2: Our Thanks to CNES for superior event planning, cordiality, and hospitality (... and the entertaining hand towel packaging)
  - Resolution 3: To create a new project "Navigation Data Messages XML Specification Version 4" (for compatibility with ADM V.2

- **Further Resolutions Anticipated in the Next 6 Months:**

-
  - Resolution 4: To publish the ODM Pink Book 2.1 to Blue Book 3.0
  - Resolution 5: To publish the ADM Pink Book 1.1 to Blue Book 2.0
  - Resolution 6: To create a new project "Fragmentation Data Message"
  - Resolution 7: To create a new project "Launch Data Message"

- **Problems and Issues**

"We Change" room was too small given our group size, too warm, and there was insufficient power. We opened windows, but got lots of street noise (it was thus difficult to hear, especially during the protest) and secondhand smoke. We found a larger, quieter room with nearly zero attendees and "We Changed" (with approval from Secretariat). Trying to add virtual participants we spent a lot of time confirming the audio/video setup; once we arrived at "the formula" everything was OK

NAVIGATION WG UPCOMING NEW WORK ITEMS

Area and WG name	CCSDS Ref Number	Document Title	Target Start / Publication Date	Resources Needed (total, Editor, Proto 1, Proto 2)	TOTAL	EDITOR	PROTO1	PROTO2	Comments Rationale What if not started?
MOIMS NAV	505.0-B-4	Navigation Data Messages XML Specification	01-Dec-2022 30-Jun-2023	2022	1	1	0	0	Inconsistency between the existing XML Spec and ADM
				2023	6	6	1	*	
				2024	0	0	0	0	

* A prototype is typically not required for this standard given that the underlying Blue Book (ADM) will have been prototype tested. NASA will cover the required resources.

NAV WG Issues for CESG / CMC

- None

PARTICIPATION

- 5 sessions, Monday 17-Oct-2022 through 21-Oct-2022
- The return to in-person meetings was exhilarating... we hope it can continue.

Agency/Org	Number	Notes
ASI	0	
CNES	1	Alain Lamy
DLR	1	Ralph Kahle
ESA	4	Vitali Braun, Jose Miguel Lozano, Frank Dreger (virtual), Mario Merri
JAXA	1	Hideaki Hinagawa (virtual)
NASA	6	David Berry, Juan Crenshaw, Cheryl Gramling, Julie Halverson, Dan Oltrogge, Patrick Zimmerman
SANA	2	Julien Bernard, Jean Gilbert
UKSA	1	Brian Swinburne
Total	16	

NEXT TELECONS:

We will continue inter-meeting telecons, but will continue the 1-hour telecon monthly. If we are not making sufficient progress and the WG approves, we could go back to the 2-hour/meeting schedule.

- 09-Nov-2022 14:00-15:00 UTC
- 14-Dec-2022 14:00-15:00 UTC
- 18-Jan-2023 14:00-15:00 UTC
- 22-Feb-2023 14:00-15:00 UTC
- 29-Mar-2023 13:00-14:00 UTC
- 26-Apr-2023 13:00-14:00 UTC
- 08-May-2023 through 12-May-2023 Spring Meetings at Huntsville, Alabama, USA

NOTE:
US Standard Time ends 12-Mar-2023
Europe Standard Time ends 26-Mar-2023