***Radio Technical Commission for Maritime Services***

1150 18th Street NW, Suite 910

Washington, DC 20036 USA

[*www.rtcm.org*](http://www.rtcm.org)[*hq@rtcm.org*](mailto:hq@rtcm.org)

*Telephone:* +1-703-527-2000

24 January 2022

**Plenary Meeting Summary Record**

**RTCM Special Committee No. 104**

**Recommended Standards for Differential GNSS Service**

Time/Date: Wednesday, January 19, 2022: 9:00 AM – 1:00 PM (EST)

Thursday, January 20, 2022: 9:00 AM – 12:00 PM (EST)

Location: Teleconference

The RTCM Special Committee 104 met by teleconference. The main objectives of the meeting were the following:

1. Criteria for Moving a Working Group to Inactive Status
2. BDS Working Group Status
3. Network RTK Working Group Status
4. QZSS Working Group Status
5. SC134 Status
6. DGNSS Beacon Services and SBAS Working Group Status
7. GLONASS Working Group Status
8. NavIC Working Group Status
9. NMEA Working Group Status
10. Coordinate Transformation Working Group Status
11. SSR Working Group Status
12. Ntrip Working Group Status
13. Version 3 Working Group Status
14. RINEX Working Group Status
15. Galileo Working Group Status

### SUMMARY RECORD

### RTCM SC-104 Plenary Meeting (Teleconference)

Wednesday, January 19, 2022: 9:00 AM – 1:00 PM (EST)

Thursday, January 20, 2022: 9:00 AM – 1:00 PM (EST)

1. **Welcome and Opening Remarks – Robert Snow, SC104 Chair**

Robert welcomed everybody and thanked them for attending.

1. **Self-introduction of Attendees – All**

Each participant in attendance at the beginning of the meeting introduced themselves.

1. **Review of Meeting Summary from September 2021 – Robert Snow, SC104 Chair**

There were a few comments prior to the meeting on the Summary Record from September 2021. Robert revised the summary record with these comments and posted to Basecamp. No other comments were submitted by plenary attendees. The September, 2021 summary record was accepted by the plenary committee.

1. **Discuss access to meeting recordings – Robert Snow, SC104 Chair**

Ed and Robert have been discussing this topic and would propose that only SC104 members can access the recordings and that releases be signed whereby members agree to not re-distribute the files. Legal counsel will be sought.

David Kelley suggests that this could be dangerous and expose RTCM to liability. Ignacio is firmly against saving these recordings. Joe Sass commented that even though he likes the idea, he has decided not to pursue this idea within Special Committee 135.

Ed inserted that there may still be a method for making the recording available to members only for a very limited time.

1. **Patent Disclosure – Robert Snow, SC104 Chair**

*Chairmen of Special Committees will ask, at an appropriate time in each meeting, whether anyone has knowledge of their own or other organizations’ patents, including published pending patents, the use of which may be required to practice or implement the standard being considered. The fact that the question was asked shall be recorded in the meeting summary record, along with any affirmative responses.*

Robert read this statement. There were no respondents.

1. **CDV Review – Robert Snow, SC104 Chair**

There are no current CDV’s pending. A CDV for Version 3.3 with Amendment 2 needs to be issued and is pending release by Ed. This has been added as [Action Item 122](#AI122) in Appendix 3 below.

1. **Criteria for moving a Working Group to Inactive Status**

Robert cited the “Network RTK WG” as an example of a working group that might be put to inactive status. Dr. Liu asked for some time to consider and he will respond later. This topic was never fully discussed, but the idea has been put out for further discussion.

1. **Review of Open Action Items – Robert Snow, SC104 Chair**

A review of the Open Actions was conducted. Several items were closed. See Appendix 4 for a list of closed Action Items and Appendix 3 for a list of currently open Action Items.

1. **BeiDou Status – Shaowei Han, BeiDou WG Chair (by Dr. Liu)**

Dr. Liu reviewed the current status of BDS (see RTCM Paper [2022-SC104-1261](https://3.basecamp.com/4141755/buckets/10176240/uploads/4562006870)). 15 BDS-2 and 29 BDS-3 satellites are operational. Basic PNT services, PPP and SBAS services are also being provided.

Since the last plenary meeting, the BDS B-CNAV messages have been proposed based on the GPS CNAV proposals. Technical details of these proposals were reviewed. These have been posted to Basecamp ([2022-SC104-1279](https://3.basecamp.com/4141755/buckets/10176240/uploads/4562070021)). The interoperability proposal is also based on the GPS CNAV proposals. However, BDS has three CNAV messages while QZSS and GPS only have two.

Next actions will be updating the CNAV and Interoperability proposals based on latest inputs, then prepare and conduct interoperability testing.

One issue that Dr. Liu raised is that some applications still apply RTCM 10402.x and they require support for GNSS other than GPS and GLONASS. Can version 2.4 be released?

1. **Network RTK – Liu Hui, Network RTK WG Chair**

Overview of WG status provided by Dr. Liu ([2022-SC104-1280](https://3.basecamp.com/4141755/buckets/10176240/uploads/4562083994)). A questionnaire was previously sent to the WG in 2000 asking how new network RTK messages (NRTK residual error messages to support BDS2, BDS3, GAL, QZSS, IRNSS) should be developed. The ambition is to set up a test bench in China.

Interesting tables shown regarding RTCM support/non-support of MAC, FKP and Non-Physical Reference Stations. GPS and GLO support is well covered. But for the other constellations, there is very little NTRK support within the standard.

Network RTK messages should support more signal and constellations while maintaining compatibility with existing NRTK services and groups. Summary slide presented the needs to extend the messages to multi-system services that need to be developed that will support full service (dual-frequency with optimization for accuracy, baseline length, etc.) operation.

Three steps: Development of new single-system GNSS NRTK message; composition of messages and then interoperability tests for new messages. Dr. Liu compiled a slide showing the Group Name and Message Types required for full-service operation and then the Method required such as updating existing messages or developing new messages.

Cameron raised some questions about changing the definitions of 1005 and 1006. A technical discussion ensued about managing the additional constellations. 1005 and 1006 changes would (likely) negatively affect many implementations.

Frank asked if these proposals have been presented to the WG prior to this meeting? Dr. Liu replied that he will post his presentation to Basecamp ([2022-SC104-1280](https://3.basecamp.com/4141755/buckets/10176240/uploads/4562083994)). Frank countered that the poll that was taken two years ago may not be applicable to today’s needs. Gleb believes that FKP and MAC are slowly being replaced by SSR approach. But it may be worthwhile to extend the non-physical reference station messages to support the additional constellations. Frank countered that the non-physical approach relies on bi-directional communication whilst SSR (and MAC and FKP) are broadcast formats. Shaowei insisted that there needs to be message development that can utilize all or at least more of the available signals to improve rover performance.

Gang suggested that the original questionnaire of two years ago be redistributed and updated to gain consensus on current needs. For instance, do FKP and MAC need to be extended to support other constellations? [Action Item 119](#AI119) has been entered in Appendix 3 below for a new questionnaire to be distributed to WG by Dr. Liu for an updated perspective. Cameron asks if the questionnaire can be explicit that there will be no changes to MT’s 1005, 1006 and 1013.

1. **QZSS Working Group – Rui Hirokawa, QZSS Working Group Chair**

QZS 1R was successfully launched in October 2021. There is a public test phase from January 31 to April 1. In November, 2021, a test campaign on the new signal (L1 C/B) was conducted. Development of QZS 5,6, and 7 is ongoing. Development for QZS 2-3R is planned to be started in 2025. Regional PPP service is planned to be operational by 2024. See RTCM Paper [2022-SC104-1262](https://3.basecamp.com/4141755/buckets/10176240/uploads/4563013876).

Rui prepared QZSS CNAV/CNAV2 ephemeris messages based on the GPS CNAV proposal ([2022-SC104-1263](https://3.basecamp.com/4141755/buckets/10176240/uploads/4563027551)). QZSS L1 C/B definition was proposed for NMEA 0183. Interoperability tests for QZS-1R are currently being conducted. Feedback has been sent to each GNSS receiver manufacturer. At least one more participant in the interoperability testing is requested. [RINEX 4.00](https://3.basecamp.com/4141755/buckets/10176240/uploads/4563032710) including support for the QZSS L1 C/B signal has been released.

Cameron had questions about experimental and permanent message number assignments. Jean-Marie asked about the guarantee of phase alignment with the new L1 C/B signal. Rui had nothing official to report.

Joe Sass composed the following two questions which were voted on and approved with no objections or abstentions:

*Are the formats proposed for QZSS CNAV and CNAV2 messages described in document number 1263 approved? (Assuming there are no changes inside the WG)*

*Is the test plan proposed in document number* [*2022-SC104-1276*](https://3.basecamp.com/4141755/buckets/10176240/uploads/4563053100) *for QZSS CNAV and CNAV2 approved? (Assuming there are no changes inside the WG)*

These are contingent decisions that will be taken as long as the version 3 working group does not make any changes to the proposals and interoperability test plans.

1. **Message Proposal and Interoperability Test Plan for GPS CNAV and CNAV-2 Signals – Gang Lu, Trimble**

Gang presented the detailed proposal for these messages ([2022-SC104-1277](https://3.basecamp.com/4141755/buckets/10176240/uploads/4563057840)). Gang also provided an interoperability test plan ([2022-SC104-1278](https://3.basecamp.com/4141755/buckets/10176240/uploads/4563059758)). Gang asked for two participating companies on both the rover and base station sides to participate in encoding/decoding tests.

Jean-Marie asked about the possibility to provide CNAV-2 data since there are no satellites transmitting this signal. Nacho confirmed that real satellite data cannot be provided by the IGS. Due to this condition, CNAV-2 interoperability testing will be delayed until over-the-air (OTA) signals become available.

The plenary agreed with the message proposals. Interoperability test plan for GPS CNAV as proposed was approved and can proceed. (This was not approved for CNAV-2 since this is not broadcast yet OTA.)

Frank asked about the necessity of using RINEX 4 data versus a straight binary exchange. Gang replied that he considered this approach, but having a textual representation that is standardized is preferable for comparing data sets. Gang went on to suggest that a binary data exchange in addition to the RINEX 4 data is also desirable. David Kelley stated that the (content-described) binary exchange is preferred within his organization over the use of RINEX.

Jean-Marie questioned the veracity of the source RINEX file. How does the group accept the file as being correct and a representative example? Jean-Marie favors a live signal versus a post processed one.

In the end, it was decided that this needs to go back to the Version 3 WG to make decisions about the format that should be used for the interoperability testing – live or using RINEX 4?

Gerhard asked about fields in the IS GPS 200M ICD that are not included in the RINEX standard and probably the RTCM proposals. Gang replied that there are data fields that are likely not applicable to RTCM needs. This aspect needs to be more closely considered and discussed inside the WG. Gerhard will provide a list of missing fields that should be considered for inclusion. This has been recorded as [Action Item 120](#AI120) in Appendix 3 below.

Joe Sass conducted a plenary vote as follows:

*Setting aside CNAV-2...and considering GPS CNAV only...*

*Is the message format as proposed for CNAV in document* [*2022-SC104-1277*](https://3.basecamp.com/4141755/buckets/10176240/uploads/4563057840) *approved by the plenary committee? (Assuming there are no changes inside the WG)*

*Is the interoperability test plan for CNAV as proposed in document* [*2022-SC104-1278*](https://3.basecamp.com/4141755/buckets/10176240/uploads/4563059758) *approved by the plenary committee? (Assuming there are no changes inside the WG)*

For both of these questions, there were no abstentions or objections. These two proposals have been approved by the plenary committee. If there are changes to the proposal or the interoperability testing plan, the messages and/or the interoperability test plan will need to be approved by the plenary committee again.

The BDS CNAV message proposals ([2022-SC104-1279](https://3.basecamp.com/4141755/buckets/10176240/uploads/4562070021)) and the interoperability test plan ([2022-SC104-1275](https://3.basecamp.com/4141755/buckets/10176240/uploads/4563091250)) will be tabled for now pending further consideration.

1. **SC134 Status – Roberto Capua, SC134 Chair**

Roberto did not attend this session. Nothing to report. Some members of the plenary committee expressed their wish to continue receiving SC134 updates at this meeting.

1. **DGNSS Beacon Services – Stig Erik Christiansen, DGNSS Beacon Services and SBAS WGs Chair**

Stig Erik combined his presentation ([2022-SC104-1264](https://3.basecamp.com/4141755/buckets/10176240/uploads/4563121401)) about DGNSS beacon services and the activities of the SBAS WG (see below). IALA has reported that they will need time to survey members to answer the question if a new version of the V2 standard is still required. There is the possibility that a completely new service needs to be considered. Work on RTCM 2.4 and RSIM 1.3 will be put on hold until there is definitive leadership from IALA on the topic.

1. **SBAS Working Group – Stig Erik Christiansen, WG Chair**

IEC Presentation on SBAS L1 Standardization by Guillermo Fernández of ESSP ([2022-SC104-1281](https://3.basecamp.com/4141755/buckets/10176240/uploads/4563118640)). This presentation has been shown to other groups. The project name was called MARESS (MAritime Receiver SBAS Standardization). The proposed standard was approved at the IEC in June of 2021. The tests that were drafted in the standard have already been executed in the scope of the MARESS project. Objective is for publication of IEC standard 61108-7 in mid-2023.

1. **GLONASS Working Group Status– Alexei Zinoviev, GLONASS WG Chair**

See Alexei’s presentation [2022-SC104-1265](https://3.basecamp.com/4141755/buckets/10176240/uploads/4563136311). Currently, there are 24 satellites in operation and there are no significant updates since the last plenary session. According to TASS, Reshetnev company is developing 8 GLO-K1 and 4 GLO-K2 satellites. 11 additional GLONASS-K2 satellites shall be produced in total according to the contract with Roskosmos.

A paper written by Sergey Karutin, Nicolay Testoedov and Sergey Donchenko called “A New Epoch for GLONASS” ([GPS World, December 2021](http://digital.gpsworld.com/?m=59713&i=734537&p=28&ver=html5)) contains many interesting and informative details about the next generation of GLONASS satellites and services.

Work is ongoing to develop an initial version of a new ephemeris message for CDMA signals (Center of Mass versus Antenna Phase Center).

1. **NavIC Working Group – Alexei Zinoviev, WG Chair**

See Alexei’s paper [2022-SC104-1266](https://3.basecamp.com/4141755/buckets/10176240/uploads/4563141630). S-band interoperability testing was approved by SC104 plenary members in September, 2021. Two companies implemented both provider and user services: Javad and NTLab. Results of the tests were reported to be successful (RTCM Paper [2022-SC104-1267](https://3.basecamp.com/4141755/buckets/10176240/uploads/4563153299)). Details (including detailed reporting from participants) can be viewed in Alexei’s presentation which has been posted to Basecamp. On day two of the meeting the plenary voted to accept the S-band interoperability test results.

Next steps will be preparing a CDV and distributing to RTCM for official voting (January – May, 2022) and then review the voting results at the next plenary meeting. A draft CDV for NavIC S-band signal is posted as RTCM Paper [2022-SC104-1268](https://3.basecamp.com/4141755/buckets/10176240/uploads/4563147860).

Alexei commented that approval of the S-Band interoperability test results will allow NavIC to become a dual-frequency system.

After lengthy discussions, Joe Sass framed the following question for plenary vote:

*Are the proposals for extending the MSM to include S-Band NavIC signals ready to go to a 60 days CDV?*

There were no objections or no votes. There was one abstention. This proposal will go out for a 60 days CDV which will be organized by Ed and Alexei. This has been recorded as [Action Item 121](#AI121) in Appendix 3 below.

The plenary decision is that this is mature enough to go to a 60 days CDV; this includes the message proposals and the interoperability test results.

1. **NMEA Working Group Status, Move to Inactive Status? – Morgan Zhang, NMEA WG Chair**

Email to Robert Snow from Lee Luft about current NMEA activities. Nothing significant to report for RTCM members.

Morgan Zhang sent an email to Robert Snow and Joe Sass on January 19th stating that he had nothing to report at this time.

1. **Coordinate Transformations Working Group Status – Martin Schmitz, Coordinate Transformations WG Chair**

Martin reports (RTCM Paper [2022-SC104-1269](https://3.basecamp.com/4141755/buckets/10176240/uploads/4563157582)) that there was a successful CDV on “CDV Clarification.” The resolved document with the clarification has been provided to Cameron Ellum for inclusion into the RTCM 3 standard.

There was a CDV on the 15-P transformation, but it was realized that a data field DF148 was missing. There is now one additional data field. The original CDV document on Basecamp [2020-SC104-1193](https://3.basecamp.com/4141755/buckets/10176240/uploads/3341670637) needs updating to reflect these changes and needs committee review.

There is general agreement with committee members on the content of Service-CRS and RTCM-CRS messages. However, there are different opinions on message design. Original proposal is for two different messages: Service-CRS and RTCM-CRS. Second proposal is to extend Service-CRS that includes RTCM-CRS information. A third option was a compromise proposal to make the RTCM-CRS inside of the Service-CRS optional. Voting was conducted on these three approaches. Option one, the original proposal ranked first in a ranked voting by 4 respondents.

At the last plenary meeting, it was requested to develop a new deformation and/or velocity model message. This is a work in progress.

Next steps include continued 15P transformation messages, work on Service-CRS / RTCM-CRS Message and begin discussion on deformation and/or velocity model message.

Sebastien V. from Trimble asked where the technical specifications can be seen for the 15P and CRS proposals. Martin reported that this will be posted to Basecamp immediately following this plenary session. Sebastien agreed to actively participate in the interoperability testing. Sebastien reports that increasing number of issues are being seen since there are increasing number of reference frame realizations.

Joe Sass asked if this was in the domain of the RTCM message, the NTRIP Sourcetable or both. David tends to believe it can/should be both.

1. **State Space Representation Working Group Status – Gerhard Wübbena, State Space WG Chair**

An SSR task force was created after the September 2021 plenary session and is meeting about every two weeks (every other Tuesday). Gerhard asked Frank Takac to bring the plenary up to date with the task force’s activities. See Frank’s presentation [2022-SC104-1270](https://3.basecamp.com/4141755/buckets/10176240/uploads/4563179223). Currently, there are 23 members.

The primary goal is to produce a set of SSR messages which support centimeter-accurate, fast-convergence and ambiguity-fixed position in real-time (aka PPP-RTK). An interoperability test plan will be developed. Bandwidth requirements, while important will not be optimized at this time but will be considered in the future. Tom Morris asked Frank to expand on the topic of bandwidth optimization and its secondary consideration. Frank spoke to the decisions that must be made along the road to standardization. Bandwidth is important and will be dealt with, but bandwidth is not the most critical. Uncompressed content developed today will have compression possibilities built into the format.

All relevant documents are posted to a [folder on Basecamp](https://3.basecamp.com/4141755/buckets/24257686/vaults/4196796265) dedicated to this group. Frank talked the plenary members through the content of the phase-bias message including phase-bias range and resolution, signal integer indicator, yaw angle and convention, yaw rate, etc.

The task force will propose two phase-bias messages: General phase-bias and widelane phase-bias.

The next meeting will discuss ionospheric and tropospheric messages (January 25, 2022). Robert Snow asked about a timeline for completion. Frank did not want to commit to any specific date, but he does feel that significant progress has been made and anticipates continued movement forward.

1. **NTRIP Working Group Status – David Kelley, WG Chair**

Steady progress is being made. See presentation [2022-SC104-1271](https://3.basecamp.com/4141755/buckets/10176240/uploads/4563189187). The work has been divided into short-term and long-term goals. The first deliverable will be a “Best Practices” document to try and help network service providers properly configure their NTRIP settings. David would like the RTCM BoD to give permission to freely distribute their “Best Practices” document. Drafts are on Basecamp in the [NTRIP WG Folder](https://3.basecamp.com/4141755/buckets/10176240/vaults/3078243311).

NTRIP Rev2 provides a “Filter” method which has not been widely used due to its complexity in implementation. After discussing this topic with WG members, the need was perceived for an easier method to filter the SOURCETABLE. A simplified filter has been developed. If this approach is acceptable, this will likely be folded into an NTRIP Rev3 version.

The use of the word “Host” needs improvement. The primary need for the Host keyword is with virtual host and gateways to direct traffic to the correct Caster. Other things can be done with the word “Host” including redirects to secure connections.

Next steps include publishing and distributing the Best Practices document to encourage the improvement of Caster configurations. The next meeting for this working group is Tuesday, January 25, 2022.

1. **Version 3 Working Group Status – Cameron Ellum, Version 3 WG Chair**

See presentation [2022-SC104-1272](https://3.basecamp.com/4141755/buckets/10176240/uploads/4563198423). Cameron has distributed a draft of Version 3.4. This includes Amendments 1 and 2 which contain support for many new signals, the addition of an informative annex and references for the ICD’s. Many other minor fixes were also included.

The proposed plan is to get feedback over the next 4 weeks with a rough deadline around February 18, 2022. Cameron will incorporate the feedback and then issue a 60 days CDV with a deadline before the end of the first day of the May meeting. If this can happen, version 3.4 can be released during the summer. This aggressive timeline requires the latest draft to be critically reviewed by members.

Cameron asked Ed to please publish Amendment 2 to version 3.3 which does not show up on Basecamp but is nonetheless officially approved. Ed will work on this but was hesitant to provide a definite timeline. ([Action Item 121](#AI121))

Cameron asked the SSR working group if there are experimental numbers that can be returned to the pool. Cameron also confirmed that the NDF experimental numbers can be returned to the pool of experimental numbers.

1. **RINEX Working Group Status – Nacho Romero, RINEX Working Group Chair**

See presentation [2022-SC104-1273](https://3.basecamp.com/4141755/buckets/10176240/uploads/4563202792). Version 4 Observations (and Meteo) files are backward compatible to Version 3. Navigation files are not backwards compatible. Early RINEX 4 format adoption and testing is necessary and encouraged. Feedback from the GNSS community helps keep the format “fit for purpose.”

RINEX 4.0 was approved by the IGS with 20 Yes votes and 0 No votes. Nacho requests the RTCM SC104 officially approve this version too. Inputs to the version 4 subsequent to the IGS approval are not substantive.

The decision was taken by RTCM to post RINEX version 4 (or a link) on its website for downloading at no charge.

Gang Lu asked the RTCM RINEX WG if there is a possibility to provide a common set of navigation files for the interoperability testing of the new CNAV and CNAV2 messages. Nacho responded that yes, he should be able to provide these. This has been recorded as [Action Item 118](#AI118) in Appendix 3 below. (Note, Nacho will likely wait until after January 28, 2022. By this date, the QZSS should be broadcasting their CNAV2 signal which can then be encoded into RINEX 4.)

1. **Galileo Working Group Status – Alvaro Mozo, European GNSS Agency**

There are 22 satellites in service for navigation. 24 in service for SAR. Two are undergoing commissioning. Two auxiliary satellites are not in service.

In December, 2021, the [OS SDD 1.2](https://www.gsc-europa.eu/sites/default/files/sites/all/files/Galileo-OS-SDD_v1.2.pdf) was released and can be downloaded from the Internet. There are improvements to the minimum performance levels, new parameters for DOP at Worst User Location, text clarifications, alignment of Annex D to the Galileo SARPs (Standards and Recommended Practices), etc. Alvaro’s presentation, which contains many technical elements is uploaded to Basecamp for further dissemination by committee members (See presentation [2022-SC104-1282](https://3.basecamp.com/4141755/buckets/10176240/uploads/4563218558)).

For the Galileo HAS testing (high-accuracy), RTCM permission is requested to use the message definitions already in draft form.

A discussion ensued regarding the use of proprietary and experimental message numbers in the HAS testing. Galileo has been using messages in the 1200 number range and has not considered the work being performed by the SSR task force. Gang asks that the Galileo work on HAS be postponed by a few weeks to observe the formatting and content being developed by the SSR task force to more closely align the combined efforts.

1. **Next Meeting**

After discussing the various travel restrictions, COVID variants, virtual versus in-person meetings, it was decided to hold the next meeting on **May 17 and 18, 2022** in Tampa to coincide with the RTCM annual assembly. (Florida Aquarium in Tampa) This will be a virtual meeting (teleconference). For those that are attending the RTCM annual assembly in person, there will be possibilities to meet with colleagues face to face during breaks and other non-meeting times.

1. **Other Business**

Ed commented that there have been recent improvements to Basecamp. Some of these changes have been at the suggestion of our users.

1. **Meeting Action Items Review – Robert Snow, SC104 Chair**

A review of the open action items was conducted. This included recently closed items, newly entered items and existing entries.

**APPENDIX 1: Meeting Attendance Record – January 19 – 20, 2022, Teleconference**

| **Name** | **Organization** | **E-Mail** |
| --- | --- | --- |
| Robert Snow | RTCM  SC104 Chairman | rsnow@rtcm.org |
| Joe Sass | Spectra Geospatial  SC104 Secretary | [Joe\_Sass@spectrageospatial.com](mailto:Joe_Sass@spectrageospatial.com) |
| Ed Wendlandt | RTCM  RTCM President | [president@rtcm.org](mailto:president@rtcm.org) |
| Alexei Zinoviev | NTLab | [alexei.zinoviev@ntlab.com](mailto:alexei.zinoviev@ntlab.com) |
| Alvaro Mozo | GSA | [Alvaro.MOZO@gsa.europa.eu](mailto:Alvaro.MOZO@gsa.europa.eu) |
| Anders M Solberg | Norwegian Mapping Authority | [anders.martin.solberg@kartverket.no](mailto:anders.martin.solberg@kartverket.no%20) |
| Andrea Stüerze | BKG | [Andrea.Stuerze@bkg.bund.de](mailto:Andrea.Stuerze@bkg.bund.de) |
| Cameron Ellum | NovAtel | [cameron.ellum@hexagon.com](mailto:cameron.ellum@hexagon.com) |
| Carmelo Hernandez | EUSPA | Carmelo.HERNANDEZ@euspa.europa.eu |
| Chris Hide | u-Blox | chris.hide@u-blox.com |
| David Kelley | Sub-Carrier System Corp. | [davidkelley@ITSware.net](mailto:davidkelley@ITSware.net) |
| Dmitry Kolosov | Topcon | [dkolosov@topcon.com](mailto:dkolosov@topcon.com) |
| Elisabet Lacarra | ESSP | [Elisabet.Lacarra@essp-sas.eu](mailto:Elisabet.Lacarra@essp-sas.eu) |
| Frank Pache | Leica Geosystems | [frank.pache@leica-geosystems.com](mailto:frank.pache@leica-geosystems.com) |
| Frank Takac | Leica Geosystems | [frank.takac@leica-geosystems.com](mailto:frank.takac@leica-geosystems.com) |
| Gang Lu | Trimble | [gang\_lu@trimble.com](mailto:gang_lu@trimble.com) |
| Geoffrey Kirk | Trimble | [Geoffrey\_kirk@trimble.com](mailto:Geoffrey_kirk@trimble.com) |
| Gerhard Wübbena | Geo++ | [gerhard@geopp.onmicrosoft.com](mailto:gerhard@geopp.onmicrosoft.com) |
| Gimin Kim | Korea Research Institute of Ships & Ocean Engineering (KRISO) | gkim@kriso.re.kr |
| Gleb Zyryanov | Spectra Precision | [gleb\_zyryanov@ashtech.com](mailto:gleb_zyryanov@ashtech.com) |
| Guillermo Fernández | ESSP - SAS | Guillermo.Fernandez@essp-sas.eu |
| Hans-Jürgen Goldan | SAPOS | [hans-juergen.goldan@lgln.niedersachsen.de](mailto:hans-juergen.goldan@lgln.niedersachsen.de) |
| Hirokawa Rui | Mitsubishi Electric | [Hirokawa.Rui@dx.MitsubishiElectric.co.jp](mailto:Hirokawa.Rui@dx.MitsubishiElectric.co.jp) |
| Hui Liu | WNLBS | liuhui@wnlbs.com; loweliu@whu.edu.cn |
| Hyeeun Seo | Korea Research Institute of Ships & Ocean Engineering (KRISO) | HSeo@kriso.re.kr |
| Jaime Alvarez | IALA | [Jaime.alvarez@iala-aism.org](mailto:Jaime.alvarez@iala-aism.org) |
| Janne Wubbena | Geo++ | [janne@geopp.omnicroft.com](mailto:janne@geopp.omnicroft.com) |
| Jason Bond | NRCan | [jason.bond2.nrcan-rncan@gccollaboration.ca](mailto:jason.bond2.nrcan-rncan@gccollaboration.ca) |
| Jean-Marie Sleewaegen | Septentrio | [jm.sleewaegen@septentrio.com](mailto:jm.sleewaegen@septentrio.com) |
| Kiyeol Seo | Korea Research Institute of Ships & Ocean Engineering (KRISO) | [kyseo@kriso.re.kr](mailto:kysea@kriso.re.kr) |
| Kate Hopeman | Rakon | [kate.hopeman@rakon.com](mailto:kate.hopeman@rakon.com) |
| Liwen Dai | NavCom Technology | dailiwen@johndeere.com |
| Liu Junning | Qianxun Spatial Intelligence | [nawei.ljn@wz-inc.com](mailto:nawei.ljn@wz-inc.com) |
| Lotti Jivall | Lantmäteriet | lotti.jivall@lm.se |
| Loukis Agrotis | IGS/ESA-ESPC | [loukis@symban.co.uk](mailto:loukis@symban.co.uk) |
| Martin Håkansson | Lantmäteriet | [Martin.hakansson@lm.se](mailto:Martin.hakansson@lm.se) |
| Martin Schmitz | Geo++ | martin@geopp.onmicrosoft.com |
| Nacho Romero | IGS | NACHO@CANARYADVANCEDSOLUTIONS.COM |
| Oleg Tubalin | Javad | [o.tubalin@javad.com](mailto:o.tubalin@javad.com) |
| Samieh Alissa | Lantmäteriet | [Samieh.alissa@lm.se](mailto:Samieh.alissa@lm.se) |
| Sebastien Vielliard | Trimble | [Sebastien\_Vielliard@trimble.com](mailto:Sebastien_Vielliard@trimble.com) |
| Sergey Smirnov | JAVAD | s.smirnov@javad.com |
| Sergio Rodriguez | ESSP | [Sergio.Rodriguez@essp-sas.eu](mailto:Sergio.Rodriguez@essp-sas.eu) |
| ShaoWei Han | WNLBS | [shaowei.han@sbcglobal.net](mailto:shaowei.han@sbcglobal.net) |
| Stig Erik Christiansen | Kongsberg | stig.erik.christiansen@km.kongsberg.com |
| Sulgee Park | Korea Research Institute of Ships and Ocean (KRISO) | sgpark@kriso.re.kr |
| Todd Richert | Hexagon | todd.richert@hexagon.com |
| Tom Morris | Topcon | [tmorris@topcon.com](mailto:tmorris@topcon.com) |
| Xuxintong | WNLBS | xuxintong@wnlbs.com |
| Yoaz Bar-Sever | Jet Propulsion Lab | yoaz.barsever@gmail.com |

**APPENDIX 2: RTCM SC104 Working Groups**

|  |  |  |
| --- | --- | --- |
| **WORKING GROUP (Working Group)** | **Working Group CHAIR** | **EMAIL ADDRESS** |
| BDS (BeiDou) | ShaoWei Han | [shaowei.han@sbcglobal.net](mailto:shaowei.han@sbcglobal.net) |
| Coordinate Transformations | Martin Schmitz | [martin.schmitz@geopp.de](mailto:martin.schmitz@geopp.de) |
| DGNSS Beacon Services | Stig Erik Christiansen | Stig.erik.christiansen@km.kongsberg.com |
| Galileo | Alvaro Mozo | [Alvaro.MOZO@gsa.europa.eu](mailto:Alvaro.MOZO@gsa.europa.eu) |
| GLONASS | Alexei Zinoviev | [alexei.zinoviev@ntlab.com](mailto:alexei.zinoviev@ntlab.com) |
| NTR Internet Protocol | David Kelley | [davidkelley@ITSware.net](mailto:davidkelley@ITSware.net) |
| NavIC | Alexei Zinoviev | [alexei.zinoviev@ntlab.com](mailto:alexei.zinoviev@ntlab.com) |
| Network RTK | Liu Hui | [liuhui@wnlbs.com](mailto:liuhui@wulbs.com) |
| NMEA | Morgan Zhang | [miaogeng\_zhang@esri.com](mailto:miaogeng_zhang@esri.com) |
| NTRIP | David Kelley | [davidkelley@ITSware.net](mailto:davidkelley@ITSware.net) |
| QZSS | Rui Hiroawa | [Hirokawa.Rui@dx.MitsubishiElectric.co.jp](file:///C:\Users\jsass\Documents\RTCM_SC104\Committee%20Meetings\2015_01_DanaPoint\Hirokawa.Rui@dx.MitsubishiElectric.co.jp) |
| RINEX Working Group | Nacho Romero | [nacho@canaryspaceconsulting.co.uk](mailto:nacho@canaryspaceconsulting.co.uk) |
| SBAS | Stig Erik Christiansen | [stig.erik.christiansen@kongsberg.com](mailto:stig.erik.christiansen@kongsberg.com) |
| State Space | Gerhard Wübbena | [gerhard.wuebbena@geopp.de](mailto:gerhard.wuebbena@geopp.de) |
| Version 3 | Cameron Ellum | [Cameron.ellum@novatel.com](mailto:Cameron.ellum@novatel.com) |

**Inactive RTCM SC104 Working Groups**

|  |  |  |
| --- | --- | --- |
| **WORKING GROUP (Working Group)** | **Working Group CHAIR** | **EMAIL ADDRESS** |
| Antenna Variations Working Group | Hans-Jürgen Euler | [h-j.euler@inposition.ch](mailto:h-j.euler@inposition.ch) |
| Biases | Ken MacLeod | [macleod@rinex.net](mailto:macleod@rinex.net) |
| Interoperability Test Working Group | Dixon Hoyle | [dixonhoyle@comcast.net](file:///C:\Users\jsass\Documents\RTCM_SC104\Committee%20Meetings\2015_01_DanaPoint\dixonhoyle@comcast.net) |
| Loran Comm Working Group | Bill Roland | [roland1@banet.net](mailto:roland1@banet.net) |
| Multiple Signal Messages | Gleb Zyryanov | [gziryanov@Ashtech.com](mailto:gziryanov@Ashtech.com) |
| High Precision Integrity Monitoring | Roberto Capua | [rcapua@sogei.it](mailto:rcapua@sogei.it) |
| NDF (Navigation Data Frame) | Dirk Stöcker | stoecker@alberding.eu |
| Private Services | Ivo Milev | [ivo.milev@technet-gmbh.de](mailto:Ivo.milev@technet-gmbh.de) |

**Appendix 3: Table of Open Committee Action Items**

|  |  |  |  |
| --- | --- | --- | --- |
| **Action Item** | **Description** | **Responsibility** | **Review Date** |
| SC104-122 | Ed W. will publish Amendment 2 of the RTCM Version 3.3 Standard document. This has already passed CDV and is ready for publication. | Ed Wendlandt | May, 2022 |
| SC104-121 | S-Band NavIC Interoperability test results have been approved. Next, prepare a 60 days CDV. Then review the voting results at the next plenary meeting. | Alexei Zinoviev, Ed Wendlandt | May, 2022 |
| SC104-120 | Gerhard will provide a list of missing fields that should be considered for inclusion inside the GPS CNAV messages proposed in document ending in 1277. | Gerhard Wübbena | May, 2022 |
| SC104-119 | The original questionnaire of two years ago shall be redistributed within the WG and updated to gain consensus on current needs. For instance, does FKP and MAC need to be extended to support other constellations? These proposals should be reviewed within the WG prior to plenary proposal. | Liu Hui | May, 2022 |
| SC104-118 | Nacho will provide a common set of RINEX 4 data to SC104 for the sole purposes of interoperability testing the new CNAV and CNAV2 messages. | Nacho Romero and Gang Lu (for re-distribution) | May, 2022 |
| SC104-117 | Propose process for making WG inactive. | Robert Snow | May, 2022 |
| SC104-107 | Hans-Jürgen Euler announced his retirement in 2019. Robert has drafted a letter of appreciation to be sent to Hans-Jürgen. It will be sent in the coming weeks.  Robert reported at January 2022 meeting that the RTCM BoD has approved a lifetime membership award to both Hans-Jürgen and Rudy Kalafas. Robert will begin drafting a letter to Rudy. Rudy’s email address is requested. | Robert Snow | May, 2022 |
| SC104-32 | Working Group Chairmen will email Joe Sass ([joe\_sass@spectraprecision.com](mailto:joe_sass@spectraprecision.com)) an active members list of their groups.  Working group chairs are reminded to send in their group lists periodically to Robert and Joe.  Robert asked that WG chairs review their lists and ensure that they are up to date. | Working Group Chairmen | May, 2022 |

**Appendix 4: Table of Closed Committee Action Items**

| **Action Item** | **Description** | **Responsibility** | **Review Date** |
| --- | --- | --- | --- |

|  |  |  |  |
| --- | --- | --- | --- |
| ~~SC104-116~~ | ~~Develop ionospheric model messages for the various constellations.~~  ~~At the January, 2022 meeting, Alexei reported that this Action Item can be considered completed.~~ | ~~Alexei Zinoviev~~ | ~~January, 2022~~ |
| ~~SC104-115~~ | ~~Develop messages for GPS CNAV signal.~~  ~~At the January, 2022 meeting, Gang reported that he had submitted the proposal to Basecamp this week and that it contains all of the inputs from others. Gang also posted an interoperability test plan for consideration. He would like both to be approved during this plenary meeting.~~  ~~Rui has developed QZSS CNAV messages based on the GPS CNAV message proposal.~~ | ~~Gang Lu and Rui Hirokawa~~ | ~~January, 2022~~ |
| ~~SC104-114~~ | ~~Develop messages for Beidou BCNAV signal.~~  ~~Dr. Liu reports that proposals for BCNAV1, BCNAV2 and BCNAV3 have been uploaded to Basecamp. These proposals are based on the GPS CNAV proposals.~~ | ~~Shaowei Han~~ | ~~January, 2022~~ |
| ~~SC104-113~~ | ~~Can EUSPA in Prague host a near-future plenary meeting?~~  ~~Prague is still open to a meeting. But an Action Item is not required. Item closed in January, 2022 meeting.~~ | ~~Ed Wendlandt and Robert Snow~~ | ~~January, 2022~~ |
| ~~SC104-112~~ | ~~Cameron will assign an additional 20 experimental message numbers to SC134, 1 – 20 in addition to the existing numbers (51 – 56).~~  ~~This has been completed and AI is now closed at the May, 2021 meeting.~~ | ~~Cameron Ellum~~ | ~~May, 2021~~ |
| ~~SC104-111~~ | ~~David Kelley has posited that the network residual messages are likely valuable to SC134 Integrity activities. Robert Snow agreed to speak with Roberto Capua about this.~~  ~~Robert did speak with Roberto about this and yes, the integrity messages will be included in their standard which mitigates the need for this committee to act on this issue. This item closed at the May, 2021 plenary meeting.~~ | ~~Robert Snow~~ | ~~May, 2021~~ |
| ~~SC104-110~~ | ~~Ed will work with Hui and Cameron to publish a CDV on the BDS proposals. Gang is willing to help if needed as well. A 60 days CDV will be issued on March 21, 2021 which is 60 days prior to May 20. May 20 is the second day of the May plenary meeting.~~  ~~This AI was closed as completed at the May, 2021 meeting.~~ | ~~Ed, Hui and Cameron~~ | ~~May, 2021~~ |
| ~~SC104-109~~ | ~~Ed, Robert and Stig Erik will draft a letter to be sent to IALA with the questions in the meeting summary record under the DGNSS topic.~~  ~~This item was deemed completed and closed at the May, 2021 meeting.~~ | ~~Ed, Robert and Stig~~ | ~~May, 2021~~ |
| ~~SC104-108~~ | ~~Ed and Robert will draft a letter with a broad distribution asking for interested parties to contact Alexei Zinoviev regarding interoperability testing of the new NavIC S-band signal.~~  ~~Ed and Robert and Alexei will continue working on this.~~  ~~Completed and closed at the May, 2021 meeting.~~ | ~~Robert Snow and Ed Wendlandt~~ | ~~May, 2021~~ |
| ~~SC104-106~~ | ~~Ed will establish contact with GSA regarding logistics for the May meeting in Prague. During this, he will also ask for them to consider who might be a suitable chairman for the Galileo Working Group.~~  ~~In view of COVID restrictions, it seems more probable that a Spring 2021 meeting in Prague may be possible. Ed will follow up with this.~~  ~~Ed contacted GSA and they are tentatively happy to host our group. This committee will need to select a date and then propose to GSA. Ed will continue liaison. It is difficult to guess what travel restrictions may be in place.~~  ~~Ed reports that IALA has decided to have their symposium go virtual for February, 2021.~~  ~~Robert suggests that a decision about traveling for a meeting be deferred at least until the first meeting of 2021.~~  ~~This has again been deferred until the next plenary meeting in view of continuing travel restrictions.~~  ~~Closed. See AI number 113.~~ | ~~Ed Wendlandt~~ | ~~May, 2021~~ |
| ~~SC104-105~~ | ~~Robert will contact Mr. Chaloupka with u-blox and ask for more details about their request for a proprietary message. He will try to establish a contact within ITU-T to discuss this issue with them directly.~~  ~~There has been contact, but due to COVID restrictions, delays have been seen.~~  ~~Due to limited bandwidth at this time, this request has been tabled and lowered for now in priority.~~ | ~~Robert Snow~~ | ~~September, 2020~~ |
| SC104-104 | ~~A 30-days discussion window on coordinate transformations issues will begin immediately and conclude on Monday, February 17. At that time, the Working Group will publish their recommended interoperability testing procedures with a goal that the results be presented at the next plenary meeting and the interoperability testing plan be approved at that time. This is intended to be a sequential process whereby the 30 days elapse prior to the development of the interoperability testing plan.~~  ~~Martin reports that a new message has been developed, but there has been limited responses and due to COVID restrictions, activities have been delayed.~~  ~~Martin reported that the Working Group still has not reached consensus, so additional interoperability plans have not been agreed upon.~~  In the January, 2021 plenary teleconference, it was decided to close this Action Item as the work has returned to the Working Group for further refinement. | CTI Working Group | January, 2021 |
| ~~SC104-103~~ | ~~Robert Snow, Joe Sass and Loukis Agrotis will share responsibility to recover the RINEX Working Group email list~~ | ~~Robert Snow~~  ~~Joe Sass~~  ~~Loukis Agrotis~~ | ~~May, 2020~~ |
| ~~SC104-102~~ | ~~Robert Snow will contact former NTRIP Working Group chair (Dirk Stoeker) and get the email list from him and forward to Joe Sass and David Kelley (new NTRIP Working Group Chair).~~ | ~~Robert Snow~~ | ~~May, 2020~~ |
| ~~SC104-101~~ | ~~Dr. Liu Hui will formulate a BDS test plan modeled after Alexei’s recently concluded IRNSS interoperability testing.~~  *~~Dr. Liu submitted a plan to the Working Group on November 2nd. He has not received any responses from the Working Group.~~*  ~~As of April 20, there has been only a single response. The interoperability test plan is approved and testing can commence.~~ | ~~Dr. Liu~~ | ~~May, 2020~~ |
| ~~SC104-100~~ | ~~Frank Takac will work on a paragraph to be inserted into the standard that will describe the alignment relationship between GPS & QZSS~~  ~~Frank has done this and it will be presented by Cameron in the Version 3 update.~~ | ~~Frank Takac~~ | ~~May, 2020~~ |
| ~~SC104-99~~ | ~~Contact CTI Working Group chairman (Martin Schmitz) regarding technical questions from Arild Bråthen from Norway regarding DF170.~~  ~~Robert asked Martin to contact Arild and inform him that RTCM cannot provide this level of technical support. He agreed.~~  ~~There is also the question about a CRS message proposal submitted by Cameron.~~  ~~Martin will address this during his presentation and if necessary, a new Action Item can be created if there are questions that remain unanswered.~~ | ~~Robert Snow~~ | ~~January, 2020~~ |
| ~~SC104-98~~ | ~~Add two actions to next meeting’s agenda.~~  ~~1) Should FKP be extended/modernized?~~ | ~~Robert Snow~~ | ~~September, 2019~~ |
| ~~SC104-97~~ | ~~Ed will keep meeting announcements separate between the various SC’s. Within the meeting announcement, Ed will also include a “Reply” option so that intended attendees can decide in the moment if they will be attending the next meeting.~~  ~~Implemented. Close issue.~~ | ~~Ed Wendlandt~~ | ~~January, 2020~~ |
| ~~SC104-96B~~ | ~~Update QZSS signal mapping table.~~ | ~~QZSS Working Group~~ |  |
| ~~SC104-96A~~ | ~~Update BDS signal mapping table.~~  ~~Presentation will be given by Liu Hui.~~ | ~~BDS Working Group~~ | ~~September, 2019~~ |
| ~~SC104-95~~ | ~~Martin will issue two 60-days CDV. One for the 15P transformation and the other for CTI clarifications.~~  ~~Martin submitted the documentation to Robert and will prepare the CDV’s and post them.~~  ~~Ed will issue the CDV’s within a couple of weeks of SC104’s September 2020 teleconference.~~  ~~CDV’s were issued in October. 17 votes are needed to reach a quorum. 12 were obtained for the 15P transformation and 11 for the CTI messages. Additional discussions to ensue with a goal to reach a quorum. Martin emphasized the point that abstentions are included in the vote count to reach a quorum.~~  In the January, 2021 plenary teleconference, it was decided to close this Action Item as the work has returned to the Working Group for further refinement. | ~~Ed Wendlandt~~ | ~~January, 2021~~ |
|  |  |  |  |
| ~~SC104-94~~ | ~~Kendall will prepare a 60 days CDV regarding the proposed changes in NTRIP presented by Dirk.~~  ~~Kendall has liaised with Dirk regarding some additional changes and will attempt to get this issue out to CDV soon.~~ | ~~Kendall Ferguson~~ | ~~May, 2019~~ |

|  |  |  |  |
| --- | --- | --- | --- |
| ~~SC104-93~~ | ~~RINEX 3.04: Loukis will send the latest draft copy to Kendall. Kendall will have the document posted to the SC104 website. Kendall will send a note to the SC104 mailing list asking for comments by November 1.~~  ~~The new version of RINEX has been posted to the RTCM SC104 and IGS websites. The new version has also been publicized through social media.~~ | ~~Kendall Ferguson~~ | ~~November, 2018~~ |
| ~~SC104-92~~ | ~~Kendall will send out a general email in the coming weeks asking for a meeting host in the September 2019 timeframe. A meeting room with a capacity of about 40 people for two, two-day meetings to be held sequentially.~~  ~~Kendall did not get this accomplished. The May meeting has been confirmed to be hosted by Hemisphere in Scottsdale, AZ.~~  ~~Kendall has committed to work on this soon.~~ | ~~Kendall Ferguson~~ | ~~May, 2019~~ |
| ~~SC104-91~~ | ~~RTCM 2.4 proposed changes: Kendall and Gang will formulate a questionnaire regarding the proposed changes so that all feedbacks can be aggregated and presented to the committee membership.~~  ~~Gang subsequently provided the following details in an email dated October 22:~~  ~~For BDS3, there are two signals for B1, B1I and B1Q. B1I is open access signal and B1Q is for authorized use only. Nothing is known about B1Q and B1Q should not be used or bothered by RTCM (even if B1Q could use a different PRN, but it does not matter to RTCM since it should not be used by us at all).~~  ~~B1C is yet another open access signal from BDS3, which has a different frequency from B1.~~  ~~Trimble confirms B1I and B1C use the same PRN # for now. B1I is referred as B1-2 in the RTCM and Rinex 3.04 documents and B1C is referred to B1 in Rinex 3.04 document~~  ~~But it would be good (if you can) for RTCM to get a definitive statement from CSNO that the PRNs for B1I and B1C signals for BDS3 will be always the same for the future.~~  ~~Stig recommended that this AI be closed (January 31, 2019) and the discussion resumed as part of the regular agenda.~~ | ~~Kendall Ferguson & Gang Lu~~ | ~~February, 2019~~ |
| ~~SC104-90~~ | ~~Dirk requests broader industry feedback. Kendall and Dirk will work on compiling a questionnaire asking about enforcement of NTRIP Version 2 and making it mandatory.~~  ~~Dirk and Kendall will send out this questionnaire finding out if pursuing a completed NTRIP Version 2 is worthwhile.~~  ~~With the changes occurring with http, it could become necessary to support Version 2.~~ | ~~Kendall Ferguson & Dirk Stöcker~~ | ~~May, 2019~~ |
| To view closed action items older than this, please refer to the May, 2020 meeting summary record (2020-SC104-1179) which contains the complete list to that date. | | | |