

Real Time Pilot Project

Minutes of Teleconference

IGS RTPP

16 June 2011

1 Meeting Summary

This teleconference was held on 16 June 2011 and was hosted by NRCan and chaired by Loukis Agrotis.

Participants were:

BKG: Georg Weber
CDDIS: Carey Noll
CNES: Denis Laurichesse
DLR: Norbert Jakowski
ESOC: Loukis Agrotis, Drazen Svehla, Ignacio Romero (representing the IC). Javier Tegedor
Fugro: Erik Vigen
JPL: Steve Fisher
Geo++: Gerhard Wübbena
GFZ: Maorong Ge, Jan Dousa
GMV: Christina Garcia Serrano
NRCan: Mark Caissy, Ken MacLeod
TUW: Robert Weber
UPC: Manuel Hernandez-Pajares

The meeting agenda items are listed below:

1. Analysis Status (including Ionosphere)
2. Network Status
3. RTCM Activities
4. Ambiguity Fixing Activities
5. Bias WG Issues
6. Future Developments
7. AOB

2 Introduction

Loukis summarised the main developments since the last teleconference in September:

- Wuhan has joined the PP as a RT AC
- JPL and Fugro have joined the PP for product evaluation and are also contributing 3 streams each, with some very useful additions to the network (Easter Is, Hawaii, Tokyo, Abu Dhabi, Svalbard, Oslo). NGS are contributing some useful stations, particularly in the Pacific and Carribean.
- On the Analysis side we have new RT streams from CNES, included CNES and GFZ in the combination and are evaluating a new combination stream from BKG, based on a Kalman filter approach.
- A joint IGS-RTCM working group headed by Ken has been formed to take responsibility for the future evolution of the RINEX format
- The State Space representation format has approved by RTCM
- RTPP participation in the definition of the new RTCM Multiple Signal Messages
- Ionosphere work has been progressing well, led Norbert and Manuel

- Ambiguity fixing WG collected all the available material and are working towards recommendations on implementation
- The Bias WG is organising a workshop in January with the possibility of also organising an RTCM/RINEX WG meeting in Berne during the same week

3 Analysis Status

The individual organisations that are participating in the Real Time PP were polled to report on their status.

Ionosphere:

DLR: Norbert gave a brief description of the ionospheric processing at DLR. The global RT streams are processed to derive a world TEC map and associated products that are updated every 5 minutes. The results are available on the DLR website at <http://swaciweb.dlr.de/>. DLR is also working towards providing a re-broadcast service by taking the GNSS streams from BKG and disseminating them to the IONO community.

UPC: Manuel said that UPC has re-organised the information on their web site at <http://g1.upc.es/tomion/real-time/quick/>. The UPC TEC maps and IONEX files are updated every 15 minutes.

Discussions are ongoing between UPC and DLR to resolve some issues with formats and to start generation of comparisons and of a combination product. In the first instance, such a product will initially have an update frequency of 15 minutes. Ken said that NRCan are also doing work on the ionosphere for some time and may start contributing to the PP in the next 6 months. The exchange format will initially be IONEX. Ken suggested that there is more data that can be made available, including some new stations from UNAVCO. Ken will disseminate the names of these stations to the PP.

Orbits and Clocks:

BKG/TUP: Georg gave the status from BKG/TUP. There have been improvements in the RTNet software, including capability of more stations in the solution and improvements in performance and outlier detection.

CNES: Denis described the orbit and clock estimation process used by CNES. They compute two solutions. The first solution is a classical float ambiguity solution, with clocks aligned to the IGS to have a small RMS. The second solution is directed towards ambiguity resolution and has a rather high RMS but should have a smaller sigma. Approximately 80 stations are used from a wide number of casters. The orbits are taken from the IGS ultras, updated as soon as a new update is available. In the future CNES may use IGN orbits that are updated every 2 hours. Clock filter updates are every 5 sec. Loukis commented CNES for the quality of the two solutions.

CDDIS: Carey said that CDDIS are archiving the products and the high rate data received from some groups (e.g.BKG). CDDIS may start collecting data and archiving the high rate data themselves. The possibility of using CDDIS as a RT broadcaster can be discussed at a later stage. Carey will send this year's statistics for access to the RT products.

- DLR: Could not participate in this teleconference.
- ESOC: Loukis gave the ESOC status. There are two ESOC solutions running at the moment, at ESOC and in the UK. The combination is currently performed in the UK. The intention is to provide an independent combination stream from ESOC and/or NRCAN. The RT combination now includes 6 ACs – BKG, CNES, DLR, ESOC, GFZ and GMV. The batch combination also includes NRCAN, which is not yet available in RT. We are also processing solutions from TUW from both batch submissions and their RT stream. Wuhan university has recently been accepted as an AC and started making batch submissions. Some centres have two solutions, so the batch comparisons are currently processing 15 solutions and the RT-based comparison is processing solutions from 12 streams. Included in these is the new BKG combination solution based on a Kalman filter approach. Georg said that he is not receiving the comparisons made from the RT streams. Loukis said that this is a problem caused by spam filters and hopefully it can be corrected next week.
- Fugro: Erik said that the Oslo station will be updated with a Galileo-capable receiver and hopefully disseminate data from the IOV satellites.
- Geo++: Gerhard explained that Geo++ perform a complete estimation for both orbits and clocks and find it difficult to generate sp3 files for submission to the PP. Loukis agreed with Gerhard to discuss if ESOC can generate the sp3 and clk files from the RT stream. Gerhard also mentioned that their solution is more code-focused because the RTCM SSR development so far gave more emphasis on the code. The next stage will concentrate on phases and on ambiguity fixing.
- GFZ: Maorong said that there have been no recent changes in the clock estimation. The main recent development was the introduction of weekly solutions for the station coordinates. Junping has now left GFZ so the team is one man short.
- GMV: Emailed a short report: solution has been running mainly unattended for quite a long time with reasonable availability. We have a slight performance degradation lately that we'll try to sort out in the next weeks. We are running a parallel RT GPS+GLONASS solution since some months ago. It's a true GNSS solution (in the sense of Tim's IGSMAILs) that works quite well, yet there is some tuning to be made before we decide to make it public (it's available in our caster already; just a matter of permissions). Like the GPS-only solution, it is based on our own orbits, updated every 15 min. The solution itself is quite good for GPS+GLONASS PPP, but there is a bias wrt IGS time that we need to compensate (so GPS comparison with the rapid is currently not good)
- JPL: Steve had to drop out because of a bad connection to the telecon
- NRCAN: Ken said that NRCAN purchased 3 new servers to be introduced early next month and coincide with the RT SSR dissemination of the solution stream. The SSR messages will be sent in a mode that minimises bandwidth for customers, where slow-changing messages are sent at different rates to the fast-changing messages. For the purposes of the RTPP combination, NRCAN will also transmit streams where all the information is contained in one message type, in the same way as for the remaining ACs. This will mean that the NRCAN streams can be processed by the ESOC combination/comparison

software without modification. NRCan are also implementing openMP to speed up their processing and move to 1 Hz processing from the current 0.5 Hz. They are also adding capabilities for GLONASS and Galileo, hoping to be able to deploy them in the next 6-12 months. NRCan will make a server available to Loukis to allow configuration of a separate combination stream from NRCan. Mark asked

TUW: Robert said that a new person has started work on the Real Time activities. The orbits are good but they are tightly constrained to the IGUs. The clocks are generated from smoothed pseudo-ranges, and they will be improved over the summer.

Nottingham: Jenghui was expected to participate but was not available during the telecon.

IC: Nacho said he was interested in the status of the RTCM MSM.

4 Network Status

Georg said that there are more streams now, with the recent additions from Fugro and JPL. We have more than 6 broadcasters operating worldwide. There are around 1500 stream downloads (listeners), the majority being used by the RT ACs, but there are many other users. There are no bottlenecks in the system, with more than enough resources to satisfy the demand for the foreseeable future.

Mark asked about the implementation of the redundancy concept and on how many station streams are coming directly to BKG, as opposed to being rebroadcast. Georg replied that around 30% of the streams on the BKG caster are coming directly from stations, with the rest from other broadcasters. Thematic broadcasters, e.g. for the ionosphere, should pull all the streams from igs-ip.net for redistribution to their communities.

Mark asked how many ACs take all their streams from only one broadcaster. ESOC, CNES and NRCan take data from a number of diverse casters. Maorong said that GFZ take all their data from their own caster, which retransmits a number of BKG streams but also streams taken directly from GFZ stations. Mark said that the ACs should take data from diverse casters to ensure less reliance on one caster. Ken said that NRCan operates casters in two data centres and there is a possibility that one centre may go down for maintenance, so the recommendation is to ensure that the region is covered by taking streams that provide adequate coverage from each server individually.

Mark asked which ACs provide a GLONASS solution. Currently this is available from Geo++, DLR and BKG/TUP. Also GMV is expected to release this capability soon (see above). CNES, TUW and ESOC will also start providing GLONASS solutions in the next few months, depending on development schedules. In addition, BKG will have Galileo solutions once the IOV satellites are launched. Georg said that future stations should be multi-GNSS. Ken said that NRCan will start disseminating GLONASS data from their stations as soon as the MSM formats are approved.

Loukis said that Steve Fisher had just sent an email apologising for dropping out of the teleconference and mentioning that the Multi GNSS Asia campaign will make additional real time stations available to IGS. The call for participation is online at http://www.satnavi.jaxa.jp/e/news/qz-1106012_e.html. He has suggested that we respond with a single coordinated IGS application that would consider Multi GNSS as well as real time network needs. The Executive Committee is discussing this now. Robert Weber added that he had already sent the draft call for participation for a new Multi-GNSS Signal Tracking Campaign. This is an IGS initiative and the expectation is that JAXA and other organisations will cooperate with this

IGS effort. The call will be finalised in Melbourne. Robert suggested that the RTWG should think about how to handle the additional streams. Loukis said that specific contact points from the RTWG should be included in the call and suggested Mark and Georg's details as the most appropriate.

5 RTCM Activities

Ken led this discussion point and started by congratulating Gerhard for his work on the State Space Representation formats. The main area of activity is the MSM format and it is disappointing that there is a delay, but the main focus is to make sure that we get them right. The phase alignment issue, which has been one of the main problems so far, has been resolved with an agreement to align the phases with the primary signals. This will not change through the lifetime of the system. The remaining issues are mostly details. One particular issue is the requirement to have the slot numbers and the frequency numbers in the GLONASS messages. The issue is how to transfer the information in an efficient manner but also to make sure that the information is available to the user immediately after a frequency change occurs.

Gerhard added that another issue is the desire to have compatibility between these messages and the older messages, for example when it comes to units and resolution of the measurements.

Ken also said that the process is very constructive and the messages are getting better with each iteration. The only problem is that it is taking a long time. Ken will send feedback on the latest messages by Friday and circulate it among IC and RTWG members. Additional messages proposed by Ken and others from the IGS will take a back seat until the primary observation messages are adopted.

Nacho asked about the process for generating RINEX files from binary format. Ken said that the MSM messages, with the additional messages, will hold all the information for generating RINEX. These can be held in a binary file. In the end it is up to the manufacturers to decide if they want to store BINEX or the new formats.

Moving on to RINEX, Ken will poll IGS members to see who may be interested in joining the new RINEX WG within RTCM. He already collected some names from the RTCM members. He said that it was clear that the manufacturers do not support further evolution of RINEX 2.xx, and want to see all the effort going into RINEX 3. Nacho said he wanted to consult the IC members about this issue.

The bias issue was a hot topic and a number of SC-104 members wanted to participate at the Bias workshop in Bern. Loukis said that at the Mannheim RTCM meeting there were questions about the bias issue and a desire to see this issue handled by the IGS. There is a suggestion to take advantage of the venue of the bias workshop and to try and hold an SC-104 or RINEX WG meeting in Bern to run consecutively with the bias meeting. The RTCM members are going to be balloted on the idea.

Georg mentioned that the BNC application can serve as an Open Source tool to convert MSM messages to RINEX 3. Ken added that we are also missing the TEQC Quality Control functionality. This should be part of the discussion in the future, also involving the IC.

6 Ambiguity WG Activities

Maorong said that the Ambiguity Fixing group had decided to develop and test their individual techniques. At GFZ they are investigating 3 approaches:

1. Transmission of phase biases to users to allow them to fix ambiguities at the user side. This works but needs some time to fix the solution.
2. Use RT ionospheric model to speed up ambiguity fixing. This can work properly in the medium to large regions.
3. Use undifferenced observation corrections on a regional scale

PPP software to test the above methods will be provided by end of June-July.

There followed a discussion on the objectives of the WG. Loukis stressed that the issue is to specify an approach that could be adopted by the RTPP. Georg said that the objective is to define something that could become an RTCM standard. Loukis agreed that this is a longer term objective, but the primary interest of the PP is to define and validate the most promising approach and not let the formats drive the discussion. Maorong said that he is not sure what format can be used because he is not sure what approach could be accepted by everyone. Ken said that NRCan are interested in ambiguity fixing but they made a conscious decision to focus all their current efforts in the float ambiguity method for GPS, GLONASS and Galileo. They can also spend some time on specifying messages for future work.

Gerhard stressed that the observation space corrections are already standardised in RTCM. Loukis agreed that the primary focus at this stage should be at the global level and not the regional level. Georg reminded everyone of the great work at CNES on the global level but expressed a concern about patents. Denis said that CNES will propose to send a letter to Gerhard and the RTCM, to state that CNES would not apply their patent for the RTCM or any project related to IGS. He also said that his method is already RTCM compliant. He can put the phase clock in the standard RTCM format. The only other input is the wide lane biases, which vary very slowly. Gerhard said that RTCM would not accept that the technique is not self-contained and would likely insist on incorporating the wide lane biases in the format. Gerhard suggested that there should be a proposal to the RTCM to cover the details of the technique. He encouraged all ACs to provide information on which additional message contents exactly they would like to see standardized by RTCM in view of phase biases and ionospheric corrections. Loukis suggested that there should be a teleconference of the WG to decide on the next steps. Maorong suggested that we should wait until the members of the group finish testing their techniques. Loukis asked for the time frame needed for finishing this testing. It was decided that a teleconference should be held after the summer holidays in roughly 2 months.

Gerhard described the stages for defining the SSR formats. The first stage of providing orbit and clock corrections is complete. The second stage involves provision of phase biases for the integer ambiguity fixing and also of global ionospheric corrections for single-frequency users. The third stage includes regional ionospheric and Tropospheric products.

There was some discussion on the problems encountered in the ambiguity fixing techniques by the different centres. Maorong and Manuel indicated that the techniques work very well in Europe, but not so well at the equator or in the middle of the ocean.

7 Bias WG Activities

The bias WG was not represented at the telecon, so the agenda item was dropped. Loukis reiterated the announcement of the bias workshop in Bern on 18/19 January and the possibility of an RTCM meeting on 16/17, 20/21 or 23/24 January.

8 Future Developments

Mark talked about the road map for the RTPP. He suggested that there should be a combined GLONASS clock by the end of the calendar year, needing at least 3-4 ACs with GLONASS solutions. Loukis will start looking at the GLONASS combination.

Mark also said that there are still some things that need to be implemented in terms of redundancy to be ready for an Initial Operational Capability (scheduled for end of June). Loukis will try to find additional casters willing to disseminate the combination stream. Mark asked about internal monitoring of the combination. Loukis said that there is an email that is sent automatically from BKG (Notice Advisory to Broadcaster User, NABU) if any clock stream is out for more than 15 minutes.

On the subject of station redundancy, Georg said that very few stations are uploading their streams to more than one caster. The BKG stations are using this concept (see http://www.epncb.oma.be/dataproducts/data_access/real_time/BroadcastConcept.pdf) and he encourages all the station operators to do the same.

Mark said that the requirement for the combination is to have two independent combination centres and availability monitoring. The IGS system would be deemed available if either of the two solutions is available.

Georg said that there is also a second independent combination technique developed by BKG. Loukis said that this will provide an excellent solution once the BKG system is validated over a period of time.

9 AOB

Loukis thanked everyone for their participation.

Please note that AIs from previous teleconferences were not discussed.

10 Action Item List¹

Action Item	Status	Submit Date	Due/Close Date	Title	Description	Actionee	Response
M4-1	Closed	25/02/09	14/03/09	PP Status	Summarise the main points of PP and RTCM as an IGS mail.	Mark Caissy, Loukis Agrotis	First draft written by Loukis and sent to Mark to finalise. Mark has sent it out.
M4-2	Closed	25/02/09	14/03/09	RTCM Liaison	Request the appointment of an IGS liaison person from the IGS Governing Board and formalise rules for communicating RTCM documentation.	Georg Weber	Jointly managed between Infrastructure Committee and RTPP.
M4-3	Closed	25/02/09	14/03/09	RT product dissemination	BKG, DLR and Geo++ to publish their RT streams on NTRIP and provide details on how to receive those streams.	Georg Weber, André Hauschild, Gerhard Wuebbena	<p>Broadcaster: www.igs-ip.net Port: 2101 Mountpoint: CLK10 (GPS-only) Reference System: ITRS2005 Authorization: none Engine: RTNet, TU Prague Encoder: BNS, v1.0 Decoder: BNC, V1.7 Format: RTCM message type 1060</p> <p>Broadcaster: www.igs-ip.net Port: 2101 Mountpoint: CLK11 (GPS+GLONASS) Reference System: ITRS2005 Authorization: none Engine: RTNet, TU Prague Encoder: BNS, v1.0 Decoder: BNC, V1.7 Format: RTCM message types 1060 and 1066</p> <p>Note: Mountpoint CLK00 is used to transmit the broadcast ephemeris information for all satellites.</p> <p>Broadcaster: gnss.gsoc.dlr.de Port: 2101 Mountpoint: CLKR0</p>

¹ Greyed-out entries have been confirmed as closed

Action Item	Status	Submit Date	Due/Close Date	Title	Description	Actionee	Response
							<p>Reference System: ITRS2005 Authorization: none Engine: RETICLE, DLR/GSOC Encoder: RETICLE Format: Premature, RTCM 026-2008-SC104-429</p> <p>Broadcaster: gnss.gsoc.dlr.de Port: 2101 Mountpoint: CLKS0 Reference System: ITRS2005 Authorization: none Engine: RETICLE, DLR/GSOC Encoder: RETICLE Format: Plain ASCII SP3c</p> <p>Broadcaster: wox.geopp.de Port: 2101 Mountpoint: RTCMSSR Reference System: ITRS 2005 Authorization: basic Username: IGSRTTP Password: gppstream Engine: Geo++ GNSMART Encoder: Geo++ GNSMART Format: RTCM message types 1057, 1058, 1059, 1063, 1064, and 1065</p>
M4-4	Closed	25/02/09	14/03/09	RT Product Directories	Provide the directory structure for the RT products (report and combination solution) to be stored at CDDIS	Pedro Alfaro	Carey and Pedro have now set this up in ftp://cddis.nasa.gov/gps/products/rtp/
M4-5	Open	25/02/09	14/03/09	Data Centres	Approach the remaining Data Centres to ask for contributions in hosting the RT products.	Carey Noll	
M4-6	Open	25/02/09	14/03/09	User Community	Develop plan to involve the user community in processing the RTPP products	Mark Caissy, Loukis Agrotis	IGSmail from M4-1 will be the starting point for this. Some use by Newcastle and University of New Brunswick. Mark to send Questionnaire to RTPP participants.
M4-7	Closed	25/02/09	14/03/09	RTPP Web Site	Discuss with Mark about contributing to the effort for updating the web site	Loukis Agrotis	Brian Donahue from NRCan is now leading this activity.
M4-8	Closed	25/02/09	14/03/09	NTRIP links	Provide the links to be included in the	Georg Weber	On top of www.rtigs.net we currently have a table of links to the

Action Item	Status	Submit Date	Due/Close Date	Title	Description	Actionee	Response
				for Web Site	RTPP web page		<p>UDP topics "Stations, Protocol, Products, Architecture, Software, Network, FAQ". For a quick solution my suggestion would be to turn this table of links into a pull-down-menue offering equivalent links to both, the UDP and the NTRIP approach. Best regards, Georg</p> <hr/> <p>List of links with RTIGS contents not included in www.rtigs.net</p> <hr/> <p>Monitoring: http://www.igs.oma.be/real_time/ Operation: http://www.igs.oma.be/real_time/station_operation_details.php RTIGS, FAQ: http://www.igs.oma.be/real_time/ntripfaq.php Highrate RINEX: http://www.igs.oma.be/highrate/ NTRIP Broadcast: http://www.igs-ip.net/home NTRIP Streams, Map: http://igs.bkg.bund.de/root_ftp/NTRIP/maps/casters/IGS-IP.png NTRIP Stream Table: http://igs.bkg.bund.de/root_ftp/NTRIP/streams/streamlist_igs-ip.htm NTRIP Contributors: http://igs.bkg.bund.de/ntrip/contributors.htm NTRIP User Registration: http://igs.bkg.bund.de/ntrip/ntrip_register.htm NTRIP Provider Registration: http://igs.bkg.bund.de/ntrip/ntrip_register_provider.htm NTRIP Streams, Notice Advisories: http://igs.bkg.bund.de/root_ftp/NTRIP/nabu/igs NTRIP Streams, Outages: http://igs.bkg.bund.de/root_ftp/NTRIP/outages/igs NTRIP Software: http://igs.bkg.bund.de/ntrip/ntrip_down.htm</p>

