

**Real Time Pilot Project**  
**Minutes of Teleconference**  
**IGS RTPP**  
**21 October 2009**

## 1 Meeting Summary

This teleconference was held on 21 October 2009 and was hosted by NRCan and chaired by Loukis.

Participants were:

BKG: Georg Weber  
CDDIS: Carey Noll  
DLR: Oliver Montenbruck  
ESOC: Loukis Agrotis, Pedro Alfaro, Ignacio Romero (representing the IC), Maria Lorenzo  
Geo++: Martin Schmitz  
GFZ: Maorong Ge, Junping Chen, Jan Dousa, Markus Ramatschi  
GMV: Daniel Rodríguez Porcheron  
Lantmäteriet: Gunnar Hedling  
NRCan: Mark Caissy, Ken MacLeod, Paul Collins  
UPC: Manuel Hernandez-Pajares

The meeting agenda items are listed below:

1. RTCM meeting debrief from Ken/Georg
2. AC Status and Developments (GMV, TUC, GFZ, Geo++, NRCan, DLR, BKG, ESOC)
3. RTPP Issues (Mark)
  - a. New contributions to RTPP
  - b. Web Page
  - c. Setting up of IGS RTPP mail
4. Network Issues (Georg)
  - a. Network robustness and load distribution (e.g. multiple broadcast points)
  - b. Establishment of accurate coordinates for RT stations
5. AC Combination (Loukis)
  - a. Current performance
  - b. Transition to RT
6. Ionosphere Workshop to discuss RT Formats (Georg)
7. AOB

## 2 Briefing on RTCM meeting

Ken briefed the participants on the meeting of RTCM SC104, which took place in Savannah in September during ION. It was attended by Ken and Georg. The subject of most interest was the GNSS Real Time data format. There are two observation data proposals submitted to the RTCM, one from Magellan and the other from Geo++. The Magellan proposal has generic support for all GNSS constellations and signals, but not the precision required for all needs. Ken is trying to add higher precision messages to the Magellan proposal. The Magellan proposal is evolutionary and simple and seems to be supported by the RTCM members. The current Geo++ messages do not support all GNSS signal types. Geo++ have also proposed message types with a compression algorithm that will take a significant amount of time to develop.

Georg reminded everyone that a table of requirements has been compiled to check compliance of current and proposed new formats. RTCM has decided that temporary message numbers are to be assigned to both approaches (Geo++ and Magellan).

Martin said that the Geo++ proposal is an interim proposal submitted 2 years ago and would fit into the current message formats. Magellan's is a generic new message. The agreement is to move to a generic message and add new features like compression (proposed by Geo++) later on. NRCan plan to have software to support the Magellan format by the time of the Sweden RTCM meeting in February. People at the RTCM meeting in Savannah seem to be in agreement with the proposal for higher precision. The high precision messages have the same structure as the currently proposed Magellan messages, with some extra bits for increased precision.

Mark expressed concern about agreement for the way forward but proposes to go ahead under the assumption that changes will be minimal. At the next RTCM meeting in February, both the Magellan high and standard precision messages will be presented and reviewed by the RTCM working group. Hopefully the messages will be approved in principle and move towards a vote on the final formats.

Martin raised a concern that there may be a reluctance to change from one message format to another in 2-3 years time, to switch to the Geo++ compressed format.

It was agreed to work on the assumption that the Magellan is the first draft for multi-constellation messages and other developments will be added later.

Loukis asked about another issue with RTCM, in that the current formats require clock steering. This makes it impossible to make meaningful receiver clock comparisons with IGS results. Ken said that there was agreement to include a configuration parameter for this in the Magellan format.

### **3 AC Status and Developments**

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

GMV: Daniel Rodriguez said that his group now has authorisation to push with the development of the RT infrastructure. GMV plan to complete software development by the end of the year and should be able to contribute their solution by February. The GMV software provides orbits and clocks in Real Time using two modules; one for orbit at 5 min update intervals and a second for clocks at 1 sec.

TUC: System has been connected for several weeks. TUC is trying to move forward with new formats.

GFZ: Now running two parallel analysis using EPOS-RT software; one is relative clocks updating every second, and the other is absolute clocks updating every 5 seconds. For the IGS contribution (target is end of this year) GFZ will submit absolute clocks.

Geo++: Martin said that Geo++ will be working on the conversion of their software for orbits and clocks but have no time scale for completion yet.

NRCan: Paul said that NRCan has enhanced the network with new stations (Hawaii and Africa). A new shadow eclipsing model for 2A satellites will be introduced in the solution soon. He suggested that the satellites should be grouped in the combination statistics: one group for the block 2A's and all the others in another group. Nacho added that these

satellites are not correctly modelled for the IGS Rapids. Loukis commented that there has been a nice improvement in the recent NRCAN results.

**DLR:** Oliver said that Andre has been working on tuning RETICLE to improve solution stability.

**BKG:** Georg said that BKG corrected an issue with use of DCBs and added “on the fly” configuration changes.

**ESOC:** Loukis said that work for migrating from Solaris to Linux has been completed and is being tested on an experimental system in the UK. The ESOC2 solution is now running exclusively on Linux from the UK. This is a precursor to the work for making the Real Time combination, for which formal kick-off is expected this week. Development expected to be complete by the end of the year. Roll-out will involve installation at ESOC which will take us into February 2010, but a test stream may be available by the end of the year from the UK.

**CDDIS:** Carey had sent an email to Loukis with the summary of ftp retrievals (number of files) from CDDIS for Jan-Aug/2009 as below:

Korea	220
CLS	1
Unknown	6
DLR	1350
NRCAN	91
ESOC	2
Network	3
Oxford	727
AIUB	38
Statens Kartverk	14
Netherlands	1
Nottingham	5
CNES	1
GMV	1
Japan	2
Sweden	109

#### **4 RTTP Issues**

Mark pointed out to the successes and significant progress achieved so far in the RTTP:

1. Network – introduced a significant number of RTCM3 stations. The emphasis has now moved on the issue of formats.
2. Work on the combination products with a lot of advances and contributions.

However, some things are not getting done. For example an AI to send a questionnaire to user groups has not been started. Mark proposed to start a teleconference on a weekly basis with a group of people to move things forward. Initial suggestion is to have a core group with Georg, Loukis, Carey and Mark and others as needed. It was agreed to start this sequence of teleconferences initially on a weekly basis, but perhaps move to a lower frequency if it is found that they are too frequent.

### **New contributions to RTPP**

Ken said that there have been good discussions with NGS and CNES at ION for further participation. There are some very useful South Pacific and Caribbean stations from NGS which could be added to the network (Samoa, Guam, Caribbean, South Florida). CNES also has stations in some strategic locations (Tahiti, South Africa) and are interested in contributing as an Analysis Centre.

Georg said that when he was at ION he had some conversations with Mr T. Takasu, who developed RTKlib as an Open Source package with graphics and NTRIP interfaces for RTK solutions (see <http://gpspp.sakura.ne.jp/rtklib/rtklib.htm>). Mr Takasu said that he will add an RTPP option, which would make this an important tool for the users of the RTPP products. Georg will be in contact with Mr Takasu and monitor progress in this.

### **RTPP Web Page**

This was released shortly after the last teleconference. It contains links to NTRIP/RTIGS web sites, as well as data on key activities and teleconference minutes.

Combination/comparison results are to be sent to NRCAN from ESOC. A set of plots were produced by Pedro and sent to all RTPP participants. Product web pages will contain these orbit and clock results. Some discussions are needed on the best way to include these results on the web page.

### **Setting up of IGS RTPP mail**

It was agreed that this is a good idea. This topic will be addressed during the weekly teleconferences.

## **5 Network & Data Centre Issues**

### **Network robustness and load distribution (e.g. multiple broadcast points)**

Georg announced that public broadcasters for the RTPP are currently operating from GSAustralia and China (Wuhan). In the near future, an additional broadcaster will be operated from GFZ, carrying 30-40 streams. This is operational now for internal use. GMV is also considering the operation of a broadcaster. The next step is to move over to these broadcasters, as soon as they are checked, to take the load away from the BKG-operated caster.

BKG's proposal is to set up thematic broadcasters (only for a specific project like the RTPP) and Regional broadcasters, like the one serving Asia from Wuhan University in China.

A table (see <http://www.rtcn-ntrip.org/home>) contains all the current broadcasters, with links to show the available streams from each one.

NRCAN plan to access NTRIP streams directly from: BKG, NGS, Brazil, South Africa and Australia and then re-broadcast to RTIGS users.

Loukis expressed a concern about the existence of a single point failure if BKG's caster is unavailable. Georg said that the idea is that stations with capacity should be sending out two parallel streams in the future. The strategies for redundancy will be added as a topic for discussion at the weekly teleconferences.

### **Establishment of accurate coordinates for RT stations**

On BKG's NTRIP broadcaster there are around 100 IGS stations, where accurate coordinates are available. The full list can be found under [http://igs.bkg.bund.de/index\\_ntrip.htm](http://igs.bkg.bund.de/index_ntrip.htm), by selecting "streams" and then "streamlist\_igs\_ip.htm". The site logs are also available from this page. For the other 50-60 stations, accurate coordinates and site logs are not always available. Usually people do their individual solutions. Loukis proposed that the individual ACs should exchange this information between them. The subject will be discussed in the upcoming weekly telecons. Another proposal is to use NRCAN's CSRS-PPP ([http://ess.nrcan.gc.ca/2002\\_2006/gnd/csrs\\_e.php](http://ess.nrcan.gc.ca/2002_2006/gnd/csrs_e.php)) service on a regular basis to determine the station coordinates.

Nacho said that all stations could apply for IGS status, but applying for IGS status is complicated. If they fill holes in the network there is an easier way to get in. Guarantee of continuity is also an issue. For this reason, mapping agency stations are preferred.

## **6 AC Combination**

### **Current performance**

Loukis pointed out the performance of the combination product in the plots disseminated by Pedro prior to the teleconference (reproduced in these minutes). Most days it is comfortably within the target 0.3 ns from the IGS solution. When it deviates, it is because one solution goes wrong (usually in one satellite) and there are not enough participating solutions in the combination to detect outliers.

### **Transition to Real Time Combination**

The main requirement is to have a number of available RTCM solution streams from the participating ACs. Currently, BKG, DLR and Geo++ are available (latter possibly not usable). ESOC2 will also be available, allowing an experimental combination by end of the year. The combination stream from ESOC should be available by end of February 2010 (subject to resolution of LAN firewall issues). NRCAN's solution should also be available in the same timeframe. A solution frequency of at least 10 sec is needed and each AC should ensure that estimates are available at the 10 sec epochs. This means that the possible intervals are every 1s, 2s, 5s, and 10s.

## **7 Ionosphere Workshop to discuss RT Formats**

Georg said that he would like to convene an ionosphere workshop to discuss future ionospheric product Real Time formats. Currently there are different ideas from different people, some thinking in terms of RTCM and others in terms of maps and polynomial interpolations. He proposed a 2-day workshop in Frankfurt to talk about the approach for ionospheric corrections. The ideas are so far apart that it will be difficult to just have teleconferences.

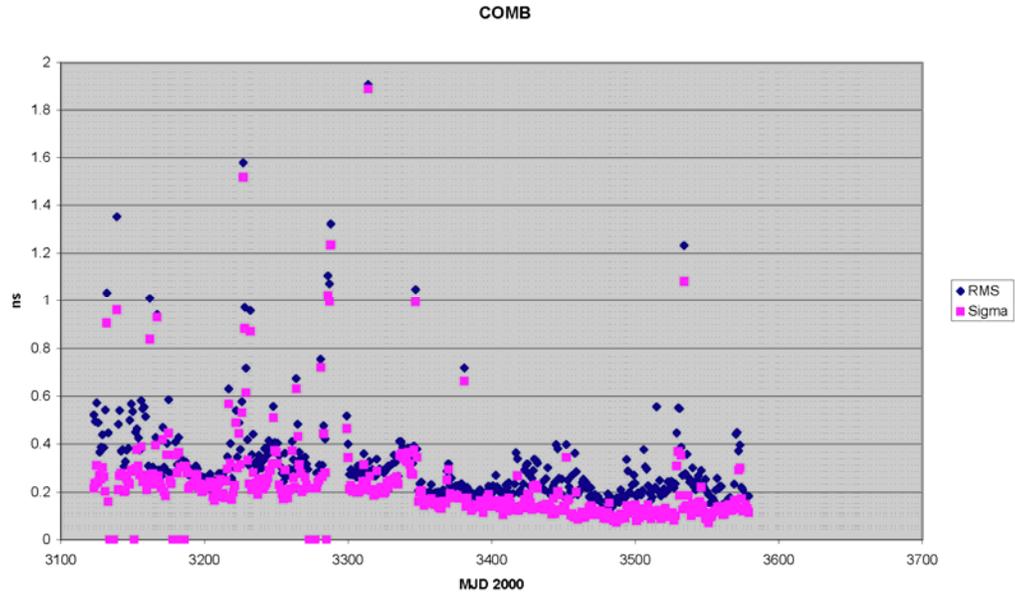
Manuel already had discussions with the DLR group of Norbert Jakowski. He was wondering if some action could be taken in advance of the workshop to improve the efficiency. He thought the workshop is a good idea but was reluctant to commit to 2-days participation due to time constraints.

Georg said that another argument is that he wants something that is showing as part of the receiver firmware, which could be taken up by the RTCM SSR working group in conjunction with the RTPP. Georg will send a short paper with a proposal and gauge interest for the workshop.

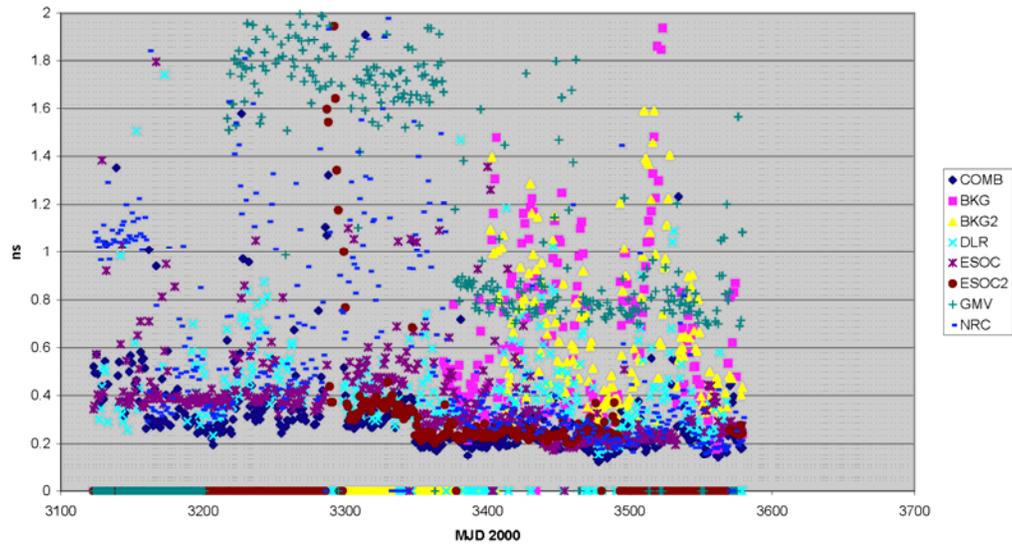
## **8 AOB**

The action items from the previous teleconference were reviewed (see updated list in these minutes). The open actions will be discussed during the weekly teleconferences.

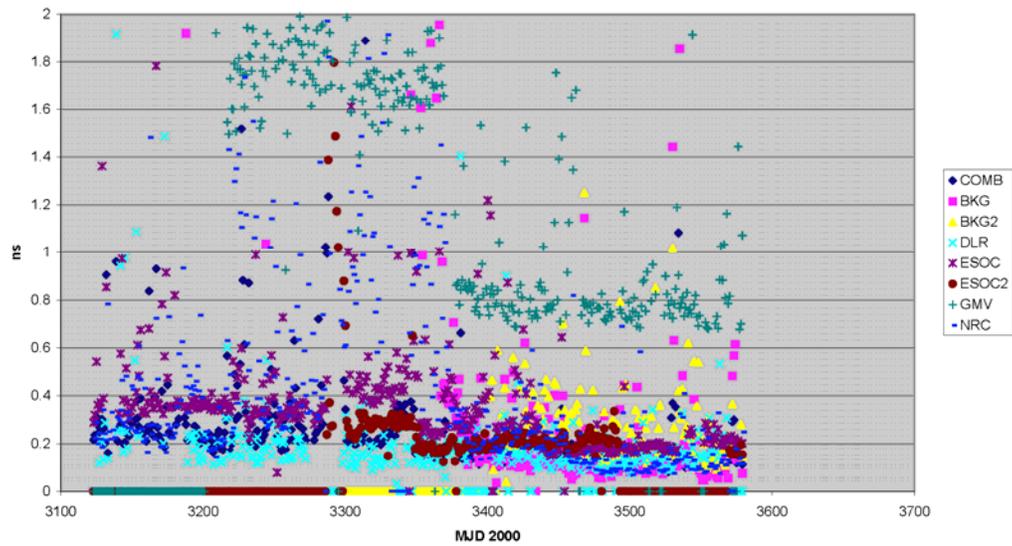
## 9 Performance of RT Comparisons and Clock Combination



Satellite RMS



Satellite Sigma



## 10 Action Item List<sup>1</sup>

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</p>

<sup>1</sup> Greyed-out entries have been confirmed as closed

Action Item	Status	Submit Date	Due/Close Date	Title	Description	Actionee	Response
							<p>Port: 2101 Mountpoint: CLKR0 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 <a href="ftp://cddis.nasa.gov/gps/products/rtp/">ftp://cddis.nasa.gov/gps/products/rtp/</a>
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.	Mark Caissy	
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.

Action Item	Status	Submit Date	Due/Close Date	Title	Description	Actionee	Response
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.
							<p>On top of <a href="http://www.rtigs.net">www.rtigs.net</a> we currently have a table of links to the UDP topics "Stations, Protocol, Products, Architecture, Software, Network, FAQ".</p> <p>For a quick solution my suggestion would be to turn this table of links into a pull-down-menu offering equivalent links to both, the UDP and the NTRIP approach.</p> <p>Best regards, Georg</p> <hr/> <p>List of links with RTIGS contents not included in <a href="http://www.rtigs.net">www.rtigs.net</a></p> <hr/> <p>Monitoring: <a href="http://www.igs.oma.be/real_time/">http://www.igs.oma.be/real_time/</a></p> <p>Operation: <a href="http://www.igs.oma.be/real_time/station_operation_details.php">http://www.igs.oma.be/real_time/station_operation_details.php</a></p> <p>RTIGS, FAQ: <a href="http://www.igs.oma.be/real_time/ntripfaq.php">http://www.igs.oma.be/real_time/ntripfaq.php</a></p> <p>Highbate RINEX: <a href="http://www.igs.oma.be/highbate/">http://www.igs.oma.be/highbate/</a></p> <p>NTRIP Broadcast: <a href="http://www.igs-ip.net/home">http://www.igs-ip.net/home</a></p> <p>NTRIP Streams, Map: <a href="http://igs.bkg.bund.de/root_ftp/NTRIP/maps/casters/IGS-IP.png">http://igs.bkg.bund.de/root_ftp/NTRIP/maps/casters/IGS-IP.png</a></p> <p>NTRIP Stream Table: <a href="http://igs.bkg.bund.de/root_ftp/NTRIP/streams/streamlist_igs-ip.htm">http://igs.bkg.bund.de/root_ftp/NTRIP/streams/streamlist_igs-ip.htm</a></p> <p>NTRIP Contributors: <a href="http://igs.bkg.bund.de/ntrip/contributors.htm">http://igs.bkg.bund.de/ntrip/contributors.htm</a></p> <p>NTRIP User Registration: <a href="http://igs.bkg.bund.de/ntrip/ntrip_register.htm">http://igs.bkg.bund.de/ntrip/ntrip_register.htm</a></p> <p>NTRIP Provider Registration: <a href="http://igs.bkg.bund.de/ntrip/ntrip_register_provider.htm">http://igs.bkg.bund.de/ntrip/ntrip_register_provider.htm</a></p> <p>NTRIP Streams, Notice Advisories: <a href="http://igs.bkg.bund.de/root_ftp/NTRIP/nabu/igs">http://igs.bkg.bund.de/root_ftp/NTRIP/nabu/igs</a></p> <p>NTRIP Streams, Outages: <a href="http://igs.bkg.bund.de/root_ftp/NTRIP/outages/igs">http://igs.bkg.bund.de/root_ftp/NTRIP/outages/igs</a></p> <p>NTRIP Software:</p>
M4-8	Closed	25/02/09	14/03/09	NTRIP links for Web Site	Provide the links to be included in the RTPP web page	Georg Weber	

Action Item	Status	Submit Date	Due/Close Date	Title	Description	Actionee	Response
							<a href="http://igs.bkg.bund.de/ntrip/ntrip_down.htm">http://igs.bkg.bund.de/ntrip/ntrip_down.htm</a>
M6-1	Open	21/10/09		Weekly Telecons	Organise weekly teleconferences between a small core of people, to advance RTPP issues.	Mark Caissy	
M6-2	Open	21/10/09		Iono Workshop	Send a short paper with a proposal and gauge interest for a workshop to discuss RT ionospheric product formats.	Georg Weber	