Position Paper for the Real-time Network and Products Session

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Introduction

At the 27th IGS Governing Board meeting held last December, approval was given to proceed with a call for participation in an IGS Real-time Pilot Project. This paper is intended to inform the reader about the pilot project and about several of the topics which will be discussed during the real-time sessions at the 2006 IGS workshop.

The pilot project is expected to proceed in phases focusing initially on the expansion of the real-time network, data handling and network management. A product generation phase will follow completion of the first phase. The two phases will likely overlap particularly if the network expansion proceeds quickly.

This paper begins with a status report on the IGS prototype network followed by background information on the Networked Transport of RTCM via Internet Protocol (NTRIP) and briefly, the interoperability of both RTIGS and NTRIP application protocols.

IGS Prototype Network: Status report

The IGS prototype real-time network has grown to include a network of over 40 stations with contributions from more than ten agencies. The network continues to increase and with recent and planned contributions from ESA, BKG and GFZ, the network is projected to contain 60+ stations by the start of the pilot project. Figure 1 illustrates the planned network. In addition to the contributions from regional networks, the prototype network includes IGS global data centers, IGS analysis centers and representatives from several user communities.

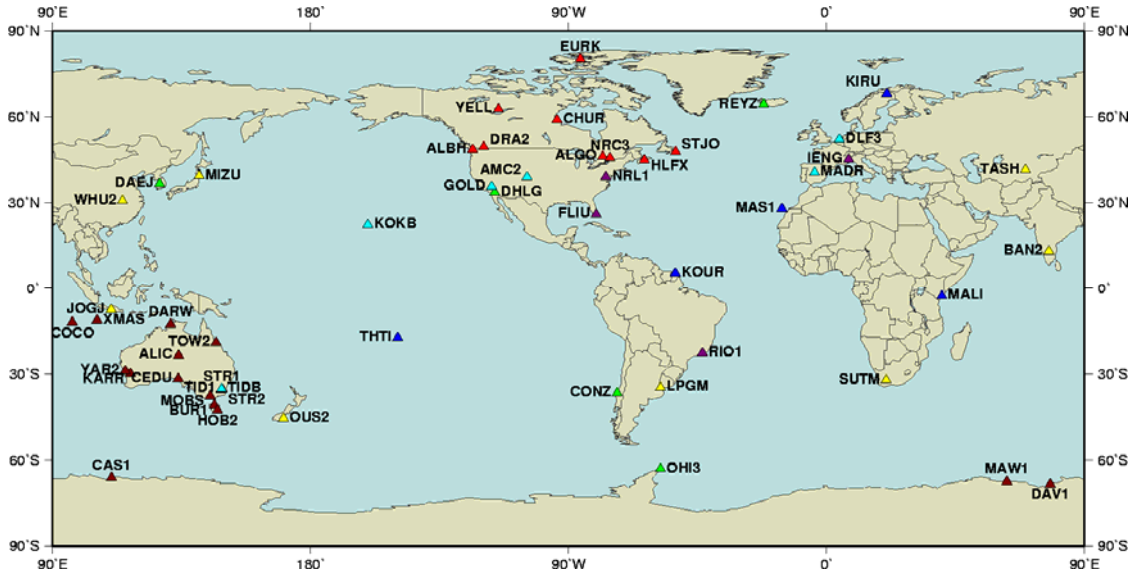

Figure 1: Network for Start of Pilot Project

The real-time working group (RTWG) has developed a suite of tools for gathering, distributing, archiving and processing real-time data. These tools have been shared with more than nine IGS agencies and have enabled the development of prototype and research oriented real-time applications. Table 1 shows the tools that are available, their purpose and the agencies that are using them in the prototype network.

Application	Purpose	Deployments
UdpRelay	Routes data and products to analysis centres, global data centers and end users.	JPL, GFZ, NRCan, ESA, GA, IEN, COSMIC
RTIGSA	Creates files based on RTIGS observation data .	NRCan, CDDIS, BKG, UCAT, NOAA -- Space Environment Center, TUV, KASI, GOPE
RTIGSMR	Reads and decodes RTIGS data messages and provides a frame work for real-time application development	TUV (facilitated interface between RTIGS data streams and custom application for IGU quality assurance)
[Ashtech, Benchmark, Javad/Topcon Readers	Configures, reads and translates raw receiver data into RTIGS data messages. Optional scripts perform complete station level data management.	IEN, NGS, NRL, ROB, ESA

Table 1: RTIGS Application Toolset and Their Deployment

Networked Transport of RTCM via Internet Protocol (NTRIP)

The NTRIP protocol is an adopted standard for streaming GNSS data on the open Internet. NTRIP enables data and product distribution and is thought to be a logical candidate for distributing future IGS real-time products. This is supported by the existence of NTRIP client ready appliances including personal digital assistants (PDAs) and GPS receivers. The real-time working group and NTRIP communities have collaborated to develop interfaces that facilitate interoperability between both the RTIGS and the NTRIP application protocols.

Discussion

The RTIGS prototype network has reached a level of maturity and reliability such that it is now feasible to take the prototype to the next phase in the development of official IGS services and products. The real-time pilot project will allow us to further refine the prototype with the goal of becoming an official IGS real-time service.

Phase one objectives in the IGS real-time working group's charter are nearing completion. We now have a functional and scaleable prototype network and we are demonstrating streaming and handling of real-time data. Contributions are being made from network operators, global data centers and analysis centers. This demonstrates a level of effort and preparedness required in order to proceed to the pilot phase.

The IGS user community is also engaged in real-time activities, including those involved in timing, atmospheric science and integrity monitoring of IGS predicted ultra rapid orbits. Moving to a pilot phase will provide an opportunity for an even broader community to become involved in real-time activities.

Call for Participation (CFP)

The first task is to announce the call for participation. Once the CFP has been announced, six weeks will be allowed before the first submissions are evaluated. The CFP will remain open for those who wish to participate at a later date. At this point in time it is anticipated that the start date for the pilot project will be in the September/October 2006 timeframe.

Pilot Project

One of the first goals of the pilot project will be the expansion of the real-time network. The focus of this effort will be on reference frame stations. Figure 2 demonstrates that the planned network is too sparse in some regions. This dilution of precision plot (DOP) can be thought of as a measure of the vulnerability of the satellite clock estimates to things such as outages or cycle slips. As the DOP tends to zero, the satellite clock solutions gets stronger and stronger. The DOP value is computed using cos(zenith)**2 as

a weighting function. To assist in reaching the goal of a stronger network, operators of continuous stations will be encouraged to contribute to the pilot project providing their stations are compliant with existing IGS standards.

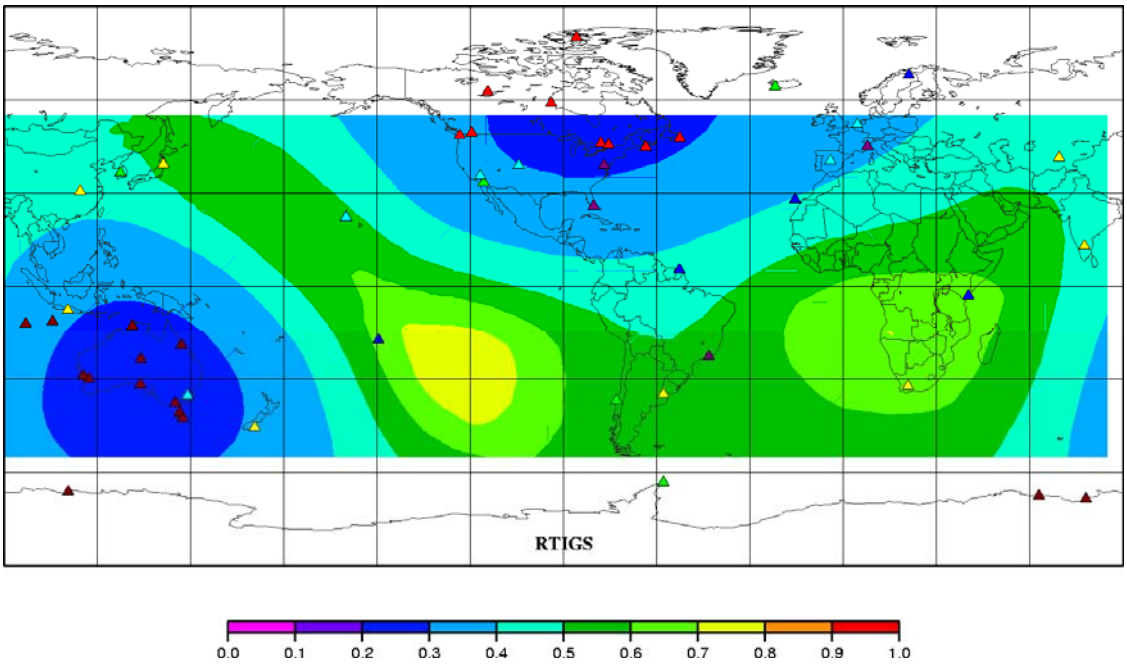

Figure 2: Satellite Clock DOP Estimates

Once the network has been strengthened, the focus will switch to network management. It will be important to keep statistics on station performance, data availability and planned as well as unplanned changes. Network management is an essential component of a successfully operated real-time network and critical to the success of the pilot project.

Near real-time (nrt) data will be one of the first products. It will be a goal of the PP to demonstrate the feasibility of creating nrt high rate data through the use of the existing toolsets deployed at the global data centers. In parallel to this, real-time data streams will be made available for those that wish to become involved with a priority on real-time analysis centers. In addition to nrt and real-time data, the following real-time products are proposed for development during the pilot project.

1. satellite clocks
2. station clocks
3. satellite orbits (IGU predicted orbits delivered in real-time)
4. IGU integrity information

Agencies considering the development of other real-time products will be encouraged to do so.

The following principles are proposed for how the pilot project will be administered.

1. An open data policy.
2. Open communication among all participants.
3. All components of the network will be documented and made available to participants.
4. Source code will be provided to assist in reading and decoding data and products.

NTRIP

It was previously mentioned that the pilot project is able to proceed because of the maturity and reliability of the existing prototype network, which is based on the architecture adopted during the Ottawa workshop in 2002. However, because the NTRIP protocol has been officially adopted as an industry standard for streaming GNSS information on the open Internet, it is proposed that during the pilot project the NTRIP protocol be evaluated in the following two areas:

1. As a data delivery mechanism to be used for the purpose of augmenting the global real-time network, particularly in areas where coverage is sparse.

2. As a tool for the distribution of IGS real-time products, for example satellite clocks and orbits.

It will therefore be a task, within the pilot project, to prepare a report on the results of the evaluation of the NTRIP protocol in these two areas.

Additionally, the NTRIP community is encouraged to implement a UDP transport option for the communication link originating at the NTRIP server. This would be a very significant development enhancing the interoperability of the NTRIP and RTIGS application protocols.

RTCM version 3.0

In developing the real-time prototype, we have devoted a lot of time and effort to integrating the various receiver types that are now in the RTIGS prototype network. Access to an industry standard data format, that meets our requirements, would have saved a lot of time. We will therefore be investigating whether or not RTCM 3.0 is a suitable candidate, and if not, whether or not to pursue convincing the RTCM community to make the changes and/or additions to the format so that it can meet the requirements of the real-time IGS community. Other formats, BINEX as an example, will also be investigated prior to any decision being made.

The following are specific requirements considered important if a format is to meet the needs of the IGS real-time community:

- The availability of all observables together with their quality information for a given epoch with no degradation in the observation precision.
- GPS, Glonass and Galileo capable.
- UDP streaming capability.
- 1 Hz data rate capability.

6. Recommendations

- That the call for participation in the pilot project be completed as soon as possible.

- That the RTIGS work to complete the planned network in time for the start of the pilot project.

- That the pilot project involves the broadest participation as possible from both within and outside of the IGS community.

- That RTCM 3.0 be investigated for the purpose of determining whether or not it is a suitable format for adoption as the standard for use within the real-time IGS

- That during the pilot project, NTRIP be evaluated as a data and product delivery mechanism.

- That the NTRIP community be encouraged to provide the UDP protocol as an option for the NTRIP server.