Real-time GNSS Issues

by G. Weber and W. Söhne

RTCM is about to release several new open standards these days which are of importance to EUREF. The two new sets of Version 3 messages we would like to mention explicitly are

- High Precision Multiple Signal Messages (HP MSM), and
- State Space Representation Messages (SSR) Step-1.

It is the first time that we have fully compatible open standards for streaming any kinds of GNSS observations (RTCM v3) and archiving them (RINEX v3). Understanding that TEQC will not support RINEX v3, decoding and converting RTCM v3 streams including the new HP MSM messages has already been integrated in the Open Source tool BNC.

Following the standardization process it is likely that using SSR Step-1 messages with satellite orbit and clock corrections now becomes part of receiver firmware. IGS with its Real-time Working Group activities may consequently grow into the role of a best effort service provider for world-wide real-time Precise Point Positioning (PPP). The global performance we get from there for a geodetic dual frequency receiver is 20 centimeters or better after about 20 minutes of convergence time.

As of today, the following Real-time IGS Analysis Centers (ACs) provide RTCM v3 streams carrying orbit and clock correctors streams: BKG/TUP, ESA/ESOC, DLR/GSOC, GFZ, GMV, and TUW. Geo++, NRCan and the GNSS research center at Wuhan are in the process of joining the group. Each AC uses its own real-time GNSS engine to estimate the orbits and clocks. In addition, combined real-time clock products are generated by ESA/ESOC and BKG/TUP.

Plans exist to proceed with the SSR approach to

- “SSR Step-2” which will have RTCM v3 messages for phase biases and considering global ionospheric effects, and
- “SSR Step-3” to finally standardize messages for instantaneous positioning with centimeter-level accuracy (PPP-RTK).

It is not likely that the IGS group can contribute much to this. The density of the IGS network just limits the institution’s interest to the subject of perfect real-time orbit and clock estimation. Furthermore, the global IGS will not support regional reference systems such as ETRF2005, NAD83, GDA94, or SIRGAS95 in their solutions. This would however be in the interest of regional IGS densifications like EUREF.

Meanwhile several groups developed solutions for SSR Step-2/Step-3 approaches to demonstrate that regional augmented PPP works. It is not clear which approach makes most sense in view of standardization requirements RTCM might have (patents?).

The EPN is not dense enough for SSR Step-3. Centimeter-level PPP-RTK requires support from national networks with one reference station about every 100 kilometers. Cooperation with National Mapping Agencies maintaining such networks is therefore important.

Involving EUREF more in the real-time PPP area could mean the following:

1. Let EUREF become a best effort PPP service provider for Europe with a transformed orbit/clock product leading directly to ETRS89 coordinates.
2. Base EUREF's PPP service on a combination product to guarantee a minimum of outliers and outages. Several independent European AC products would have to be combined.
3. Advocate the EUREF PPP service while clearly saying what "best effort" means and what the difference to a commercial service is.
4. Cooperate with the National Mapping Agencies and encourage them to become high-accuracy PPP service providers for their own territory.
5. Let the "Real-time Analysis" project in EUREF establish a PPP Working Group for the further evolution of the technology and for helping in the coordination of PPP services on the European and on national levels.
6. Becoming a PPP service provider requires access to appropriate real-time software. The PPP Working Group in EUREF could spread information about existing packages, monitor the performance of products, and adopt standards to guarantee interoperability in Europe.

Because an SSR/RTCM standard is available, we are convinced that it would be wise for EUREF to follow IGS developments and come up with its own ETRS89 decimeter-level service. However, maintaining such a service in a reliable manner requires additional efforts.

We are furthermore convinced that centimeter-level PPP-RTK services will soon become reality. It would therefore be in the interest of National Mapping Agencies to take advantage from their exclusive control of national networks and consider a more active role in this.

The SSR approach allows merging real-time products coming from global, regional, national, and local networks. In principle each of the networks provides what it can provide best. We consider this as a strong argument for EUREF and the National Mapping Agencies to extent their efforts to allow real-time access to the reference frame at all accuracy levels.

Advocating a Precise Point Positioning Service by EUREF