Federal Agency for Cartography and Geodesy

Latency aspects of IGS Real-Time Data and Products

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Introduction

The generation of products for the International GNSS Service (IGS) Real-Time Service (RTS) requires a high demand on the timeline. The latency of such products is a key parameter which may limit the usability of those products significantly. This is especially true for applications with a high requirement on the time line, such as kinematic positioning (Martin et al., 2015).

The latency optimization of the entire production chain requires a detailed analysis of every single step, since each one adds a certain amount of time delay. The Federal Agency for Cartography and Geodesy (BKG) operates a real-time facility for the IGS RTS. It consists of maintaining real-time stations, broadcasters for the data and product delivery, as well as a real-time analysis center and a combination facility (Stürze et al., 2014)

Data flow in Real-Time Processing

A suite of steps within the processing chain accumulates small time delays to a significant total delay (Figure 1):

At the beginning, real-time observations need to be transferred from a set of globally distributed observation stations to the so-called broadcasters. These broadcasters are collecting and distributing the data via internet connections.

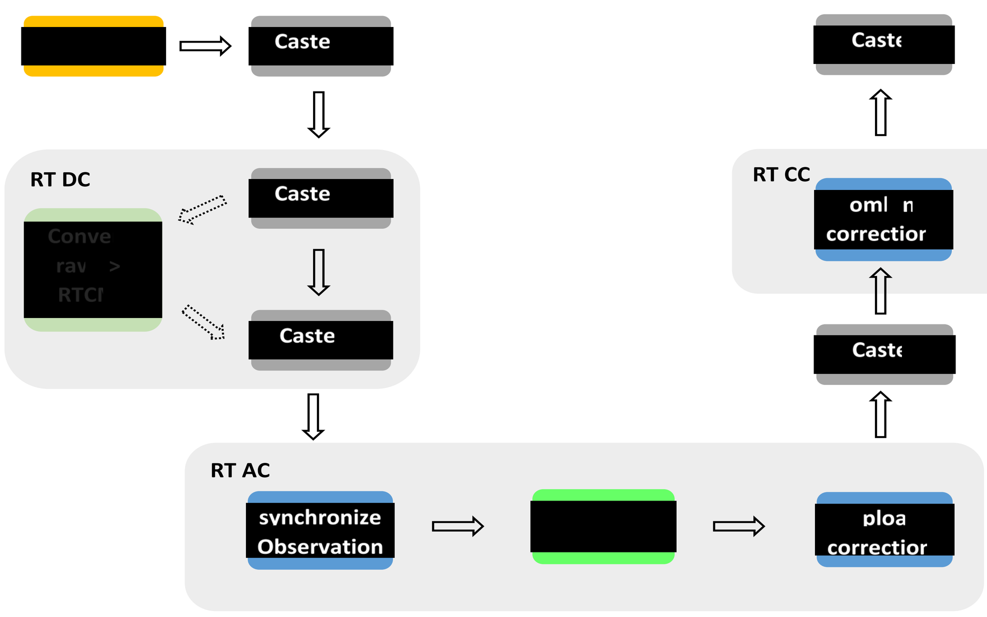

Figure 1: Processing chain of real-time GNSS processing

Some of the data streams are arriving at the broadcasters in a raw data format and need to be converted to RTCM before they are forwarded.

Due to current arrangements, data streams are transferred through several broadcasters, until they are received at the Analysis Centers (AC).

First step within the analysis software is the synchronization of the different data streams. Early arriving data streams are hold back until others arrive. The ensuing delay may take up to 10 seconds, depending on the settings of the software.

After the analysis software processed the data and computed the orbit and clock corrections, these corrections are uploaded to a broadcaster.

Solutions from different analysis centers may be received, combined and uploaded again to a broadcaster, where the final solution can now be found.

Time delay due to Casters

One of the typical time delays is caused by data transfer through several broadcasters (Figure 2). Usually, the data streams are transferred through several broadcasters within the IGS infrastructure. This might be national casters of the observing agencies, IGS broadcasters at BKG or relay casters, such as the relay caster at the IGS Central Bureau.

Whereas data from the receiver arrive with a latency of not more than 0.2 seconds, we are already facing a latency of about 0.7 seconds at the first broadcaster.

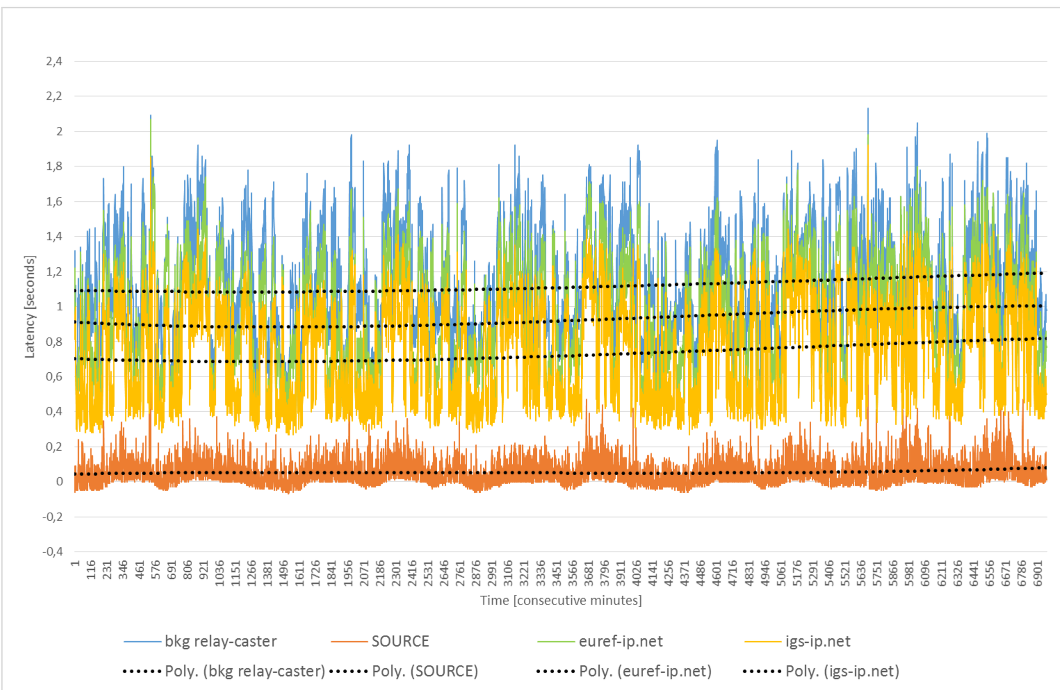

Figure 2: Latency of stream SKE0, observed at different casters, over 5 days. Latency is significantly smaller if data could be pulled directly at the station.

Any further broadcaster adds at least 0.2 seconds or more on the timeline. Thus, latencies of more than 1 seconds are the common case.

In order to reduce the time delay, one solution is to pick up a data stream most close to its source. Doing so with a large number of users, one would run into another issue related to the limited bandwidth.

In order to ensure a meaningful balance between the bandwidth problem and the reduction of latency, an optimized architecture of the different casters is necessary.

Time delay due to Processing

The IGS Analysis Center at BKG runs RTNET (Rocken et al., 2006) for the processing of a global real-time GNSS network and the computation of correction data. More than 90 percent of the data streams arrive RTNET within a latency of not more than 2.5 seconds (Figure 3). In order to get a good global network coverage, a synchronization time is defined aiming the inclusion of data streams with a larger latency.

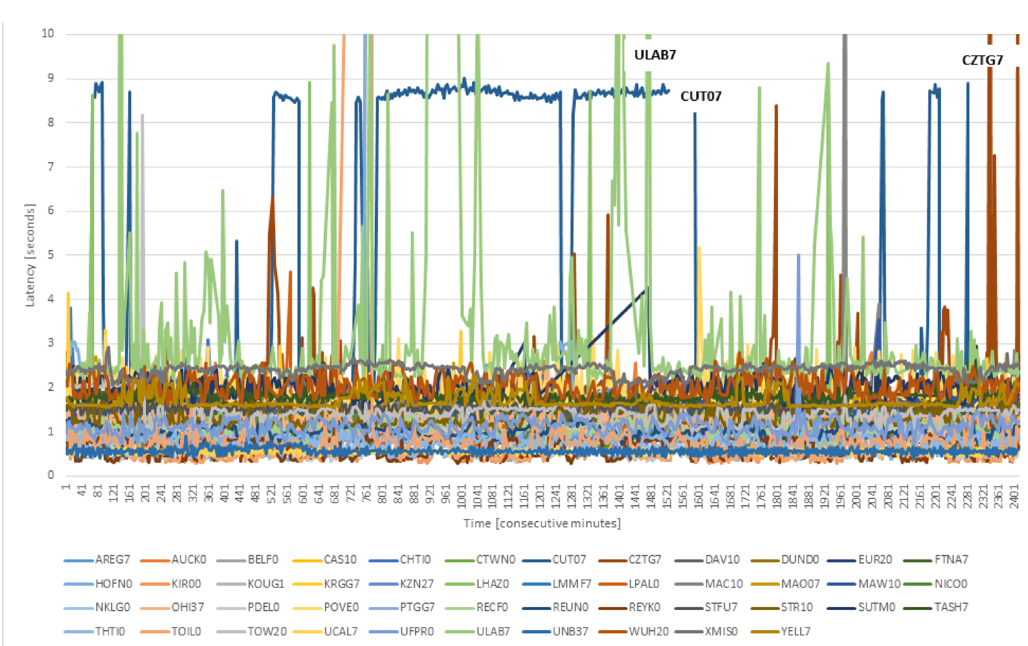

Figure 3: Latency of data streams used as input for real-time software RTNET, over 1.7 days

Thus, an increased latency of a small number of data streams may yield to a significant delay in the entire processing chain.

When selecting the best value for the maximum synchronization wait time, one has to find an optimized weighting between maximum network coverage and a short time delay of the real-time results.

During a test we were able to significantly shorten the synchronization wait time without obtaining relevant losses in the network coverage. The latency of the GPS and GLONASS correction data stream CLK 11 could be shortened by up to 7 seconds (Figure 4).

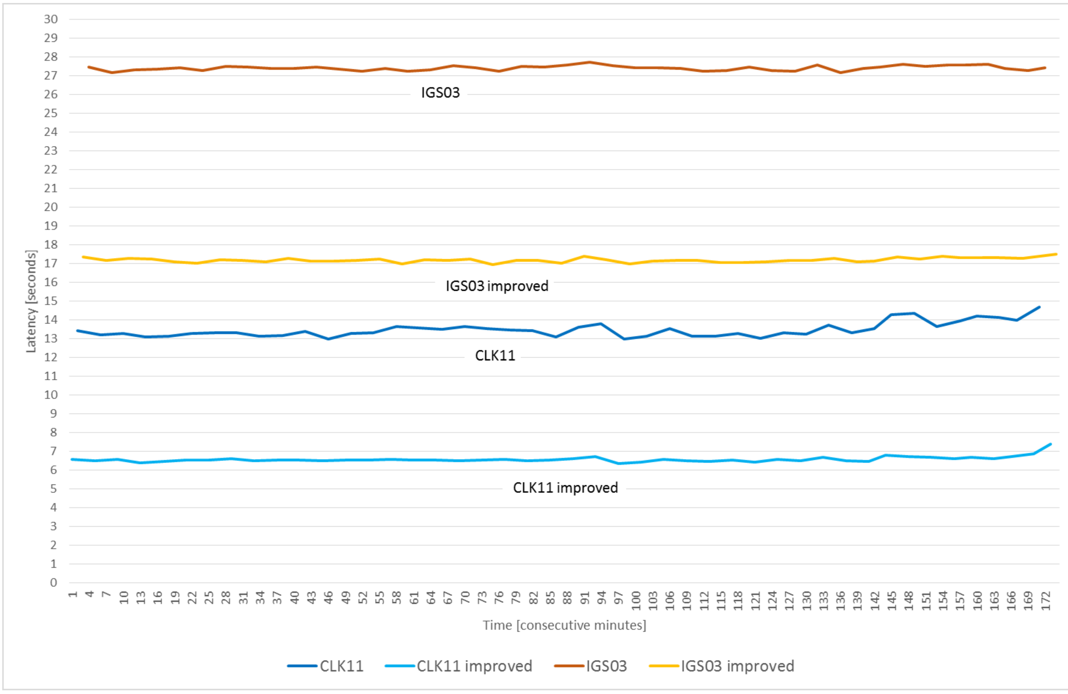

Figure 4: Original and reduced latency for individual clock correction stream CLK11 and for combined clock correction stream IGS03 (both GPS+GLONASS)

With a well-considered selection of stations for the processing and an optimization of the internet transmission routes this reduction should be achieved permanently.

Such a selection of stations for the data analysis is certainly helpful. Nevertheless, station operators need to be supported in their efforts to transport their data streams faster to the different official casters.

Time Delay due to Product Combination

Final element in the real-time processing chain is the combination of the individual solutions by the IGS Real-Time Analysis Center Coordinator (RTACC).

The great advantage of the orbit and clock correction data produced hereby is the reliability. Data gaps in an individual solution can be compensated by values from other solutions, outliers can be detected and eliminated. However, in order to combine the different solutions, one has to wait for all solutions to arrive at each processed epoch.

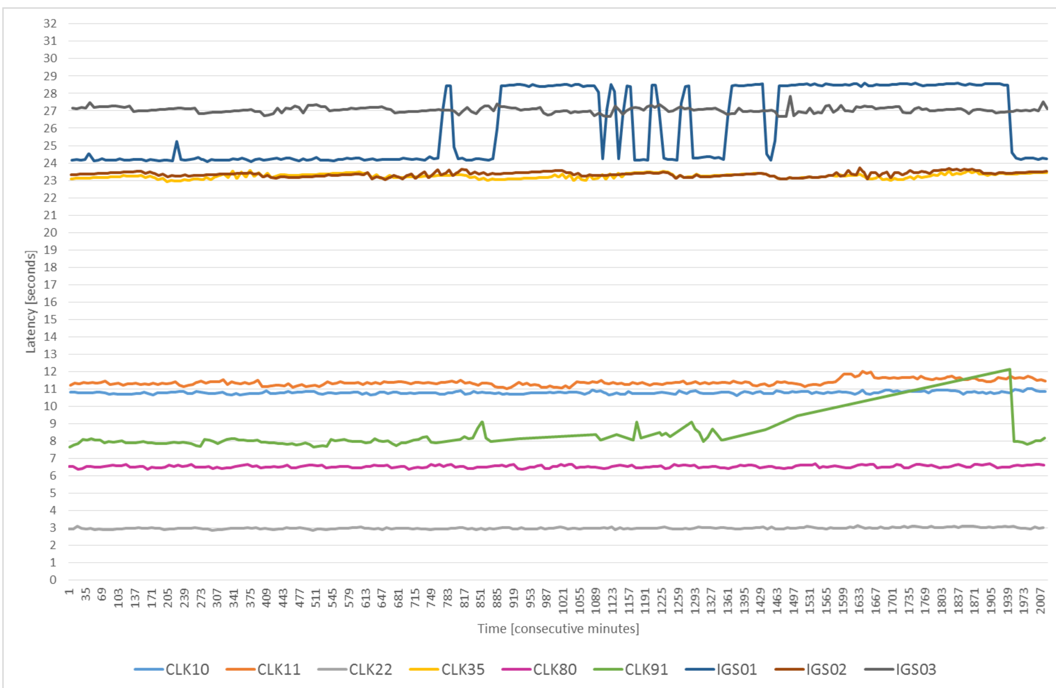

Figure 5: Latency of product streams at caster products.igs-ip.net. Latency of individual solutions is up to 12 seconds whereas combination streams have latencies of 23+ seconds.

Therefore, the high reliability of combined real-time solutions claim an increased latency in the outgoing data stream. The latency of the combined product streams IGS01, IGS02, IGS03 is larger by a factor of two to three in comparison to the product streams of individual analysis centers (Figure 5).

After successfully reducing the latency of the individual correction stream CLK11, we also managed to do this for the combined product stream IGS03. Another 5 seconds could be saved by reducing the repetition rate from 10 to 5 seconds (Figure 4).

Conclusions

The latency of the entire production chain of real-time products is an important key parameter. The reduction of the total time delay should be a goal of optimization within the IGS RTS. Taking into account the different steps of the real-time processing chain and trying to reduce the time delay of the final products, several action items could be considered of:

- Direct broadcasting of RTCM Multi-Signal Messages (MSM) observation streams to observation casters. This requires an implementation of the RTCM MSM messages of all constellations into the receiver firmwares.
- Optimization of the network design of broadcasters in order to meet requirements of latency and bandwidth limitations.
- Optimization of station network design for real-time processing within the IGS RT ACs.
- Providing individual AC solutions on a similar latency level in order to improve the combination.
- Definition of standards for the content of the data streams and assistance for the station operators in configuring the receiver and the internet access.

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