Real Time Analysis Centre and AC Coordination Activities at ESOC

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Introduction

Over the last 10 years, ESOC has embarked on a program to build a Real Time GNSS software infrastructure. RETINA (system for REal TIme NAvigation) has been modelled after ESOC's experiences in Real Time satellite control systems and includes many of the elements for data processing, archiving and visualisation that are common to such systems.

The RETINA software has enabled ESOC to assume both the roles of Analysis Centre and Analysis Centre Coordinator in the IGS Real Time Pilot Project. With the launch of the new IGS Real Time Service, these roles will transition to parallel roles in the new service, requiring a high degree of robustness and reliability.

Combination Process

The Clock combination process is described in the block diagram in Figure 1. The system makes use of BKG's NTRIP client to decode the RTCM binary orbit and clock streams from the Real Time Analysis Centres (RTAC), as well as a dedicated Broadcast Ephemeris stream. The resulting ASCII orbit and clock corrections are converted to SP3-like streams by a "Read Clock" (RC) RETINA task, decoded using the broadcast ephemeris information which is processed by a "Read Ephemeris" task (RE). The decoded streams are combined by the Combination (CO) software and the resulting combination stream is sent to BKG's NTRIP Server (BNS) by a "Write Clock" (WC) process, as an ASCII SP3-like stream. BNS encodes the solution into RTCM messages, using broadcast ephemeris information from the RTCM ephemeris stream.

Throughout RETINA, extensive use is made of circular History Files. These allow archiving and retrieval of all processed data as well as capabilities for post-processing, mainly for generation of automated reports for long-term performance monitoring.

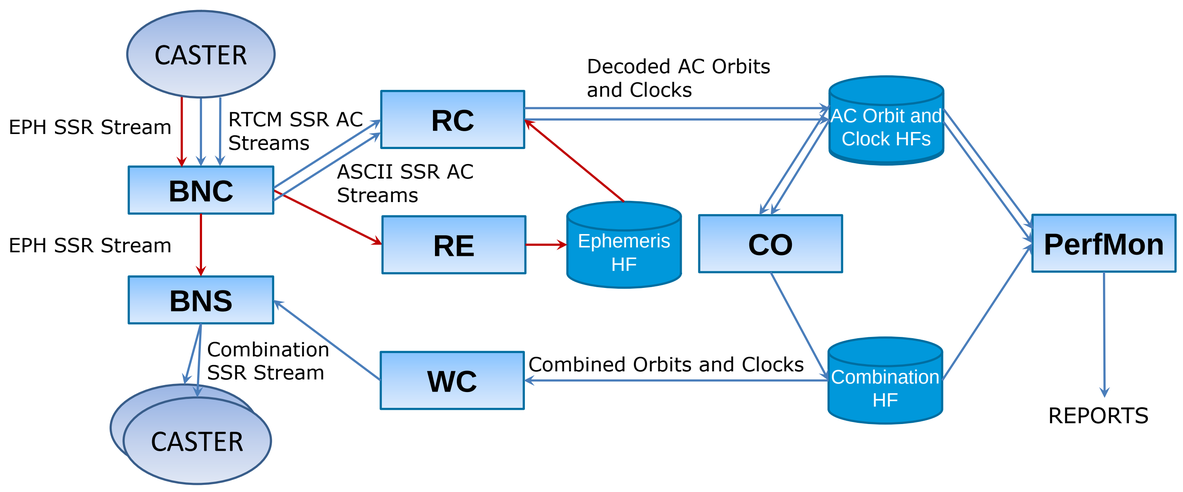

Figure 1 – Combination Process Block Diagram

Redundancy And Robustness Considerations

In order to improve solution availability, a number of measures are being implemented or are being considered for implementation. These measures aim to minimise or completely remove single points of failure and to anticipate and investigate failure modes and effects, allowing for easy recovery actions. The overall redundancy concept is illustrated in Figure 2 and the measures implemented so far are listed below:

- Two identical Combination Centres are being operated by ESOC, one in the UK and one in Canada (NRCan)
- All software at each Combination Centre is running under the RETINA infrastructure. This includes a watchdog which automatically restarts any failed process
- Each Combination Centre sends the combination solutions (IGC01 in Centre of Mass coordinates and IGS01 in Antenna Phase coordinates) to two NTRIP broadcasters.
- Both Combination Centres address the same mountpoints on each Broadcaster, allowing the backup solution to take over seamlessly if the prime solution is unavailable

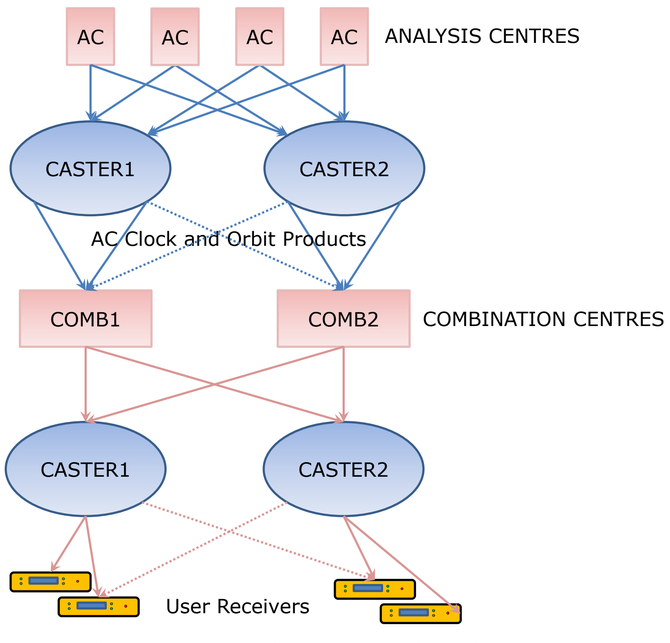

Figure 2 – Combination Solution Redundancy Concept

The following additional measures need to be implemented before the service becomes operational:

- Each Analysis Centre to send their individual solutions to two Broadcasters
- Each Combination Centre to obtain the AC solutions from separate Broadcasters
- Implement redundant processes and Broadcasters to generate and disseminate the RTCM Ephemeris stream
- Investigate and resolve known software issues (for example the BNC software occasionally stops processing all streams at the same time at both Combination Centres)

In addition, further measures will be taken over time in order to gradually improve the robustness of the individual solutions, including increased redundancy in the observation streams and use of diverse Broadcasters.

ESOC Real Time Solutions

There are two Real Time solutions produced by ESA. The first is hosted at ESOC and uses orbit predictions from automated runs of the NAPEOS software every 2 hours, under RETINA Job Scheduler control. Real Time data are taken from NTRIP broadcasters as well as from NRCan's RTIGS infrastructure. The data flow is illustrated in Figure 3 below.

A second RETINA solution, hosted in the UK, uses only NTRIP data and is based on orbit predictions from the IGS ultra-rapid products.

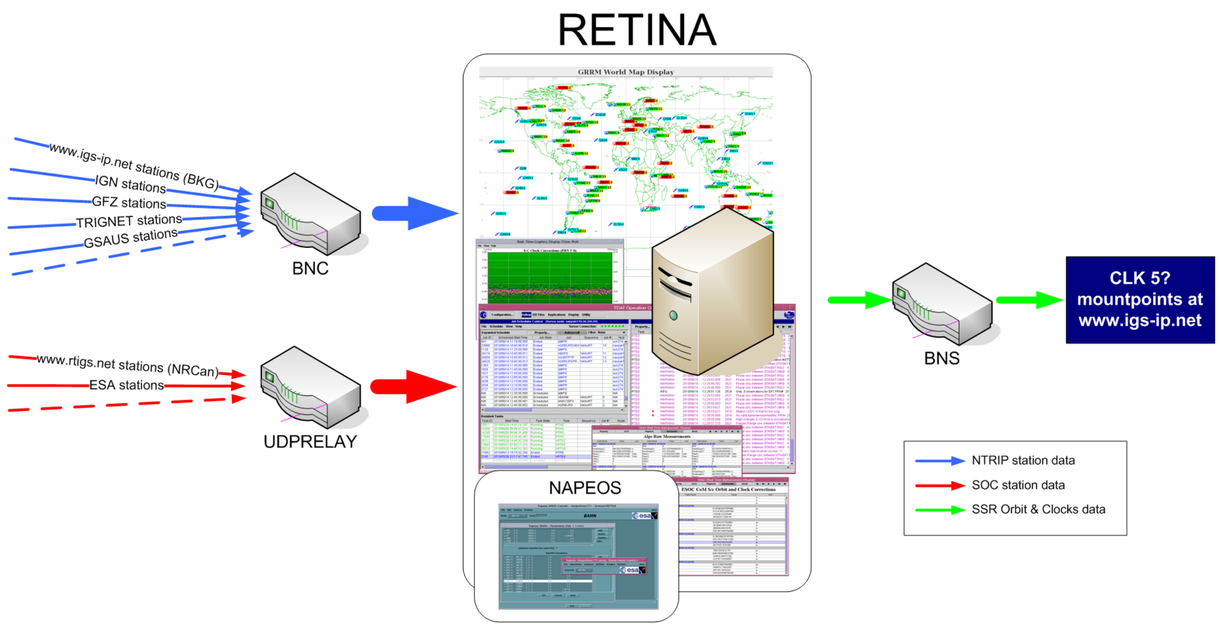

Figure 3 – RETINA Data Flow at ESOC

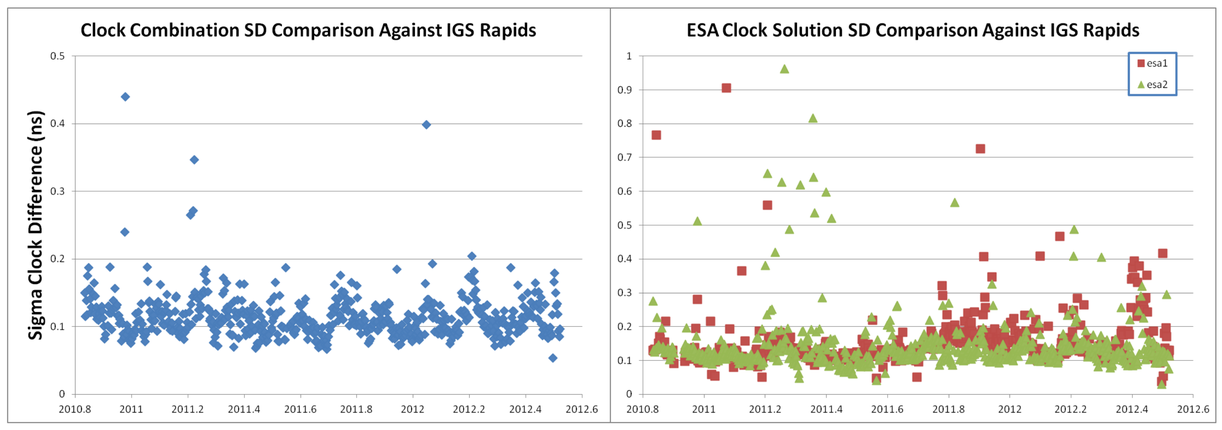

Figure 4 – Real Time Combination and ESOC Solution Results

The maintenance of two solutions has advantages in that the most important source of error in the clock solutions is the accuracy of the predicted orbit information. Using two independent sources of orbit information increases the chances that problems do not occur at the same time in both solutions. This can be seen in the clock comparisons results for the two solutions in Figure 4 (right-hand plot). The use of contrasting orbit information is also important for the combination, as the task of identifying and eliminating outliers is made easier. It can be seen that the combination results (Figure 4 left-hand plot) are almost completely free from outliers that are seen in the individual solutions. The results in Figure 4 depict the clock standard deviation in daily comparisons between the ESA Real Time solutions and the IGS rapid products.

Further information:

Real Time Pilot Project webpage: http://www.rtigs.net/

IGS RTPP NTRIP broadcaster: http://www.igs-ip.net/

Information on NTRIP and BNC: http://igs.bkg.bund.de/