EXTENDING THE TRACKING SCHEDULE OF A SINGLE-CHANNEL GPS TIME RECEIVER

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Abstract

There are now available four types of navigation satellites suitable for time and frequency transfer: GPS, GLONASS, WAAS, and EGNOS. This paper describes a new time transfer system TTS-3, based on a Javad Legacy receiver, allowing observations of these satellites simultaneously in multi-channel and multi-frequency mode. The following codes are used: C/A code for GPS, WAAS, EGNOS, and GLONASS; P-code for GLONASS; and reconstructed P-code for GPS. Receiver hardware, treatment of observations, and output data fulfill the recommendations of the CCTF Group on GNSS Time Transfer Standards (CGGTTS). The structure of the new time transfer unit is described in brief, and the results of some multi-system time transfer tests are presented.

WHY?

• Our NBS-type receiver can store 48 tracks data in memory. The BIPM schedule is limited by this number.

• Consequently, it can only perform 48 over 90 possible 13 minutes tracks per day. It is resting 47% of the day.

• When power recycled, it can store only the last 19 tracks data in backup memory. This is only 40% of a complete day's tracks.

PREVIOUS WORK

• Real Observatorio de la Armada (ROA) has developed its own source code to:
  – download GPS data automatically and periodically
  – Upload the BIPM official tracking schedule a few minutes before 00:00 UTC of the changing date.

• If we are able to establish a continuous dialog with the GPS, why not increase the number of tracks per day, extending the tracking schedule by changing the content of the memory registers?
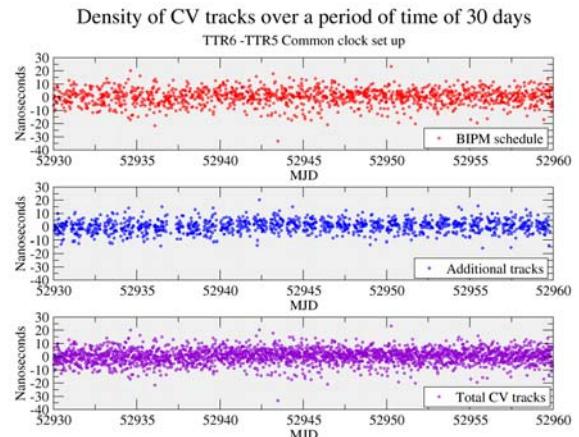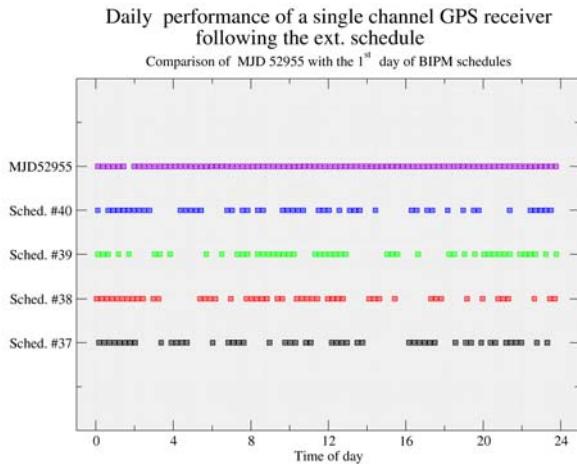
EXTENDING THE SCHEDULE

• At first, we used register #7 because it contained a satellite that was under 15 degrees of elevation.

• A new schedule table was rebuilt covering the gaps with class 'EE' tracks (see below).

- The European list of the schedule issued by the BIPM is used to create a new file that serves as reference to the system.

- A file containing all the tracks for the next running day is generated at midnight and used as reference for the official and extended tracks.

- A protocol is established to upload the data of the next EE track to the location #7 of the memory of the GPS receiver.

- After the extended track has begun, the information of the next EE track information is uploaded.

- The computer also downloads the data from the receiver every 20 minutes to avoid losing data. The receiver memory can store 150 tracks of information, but it cannot store the data of 2 complete days now.
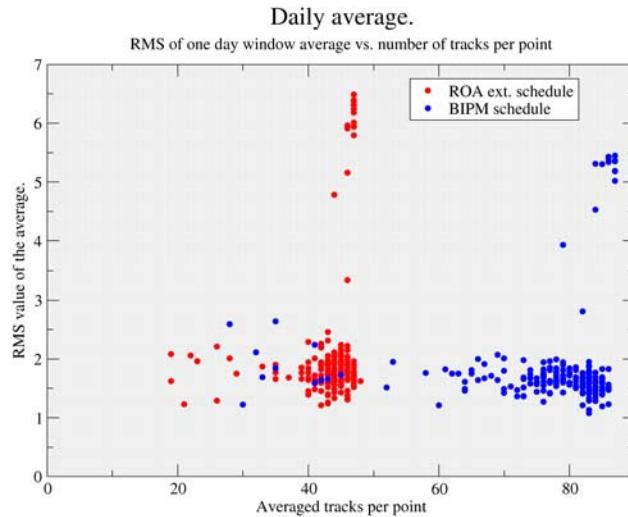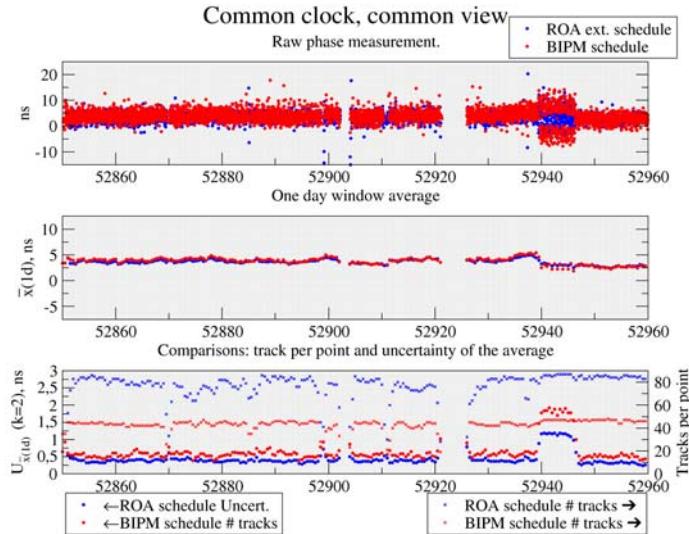
DENSITY OF TRACKS PER DAY

- The receiver is tracking 98% of the time during a day.

- Common clock setup:
  – Raw differences of satellites included in the BIPM schedule
  – Ditto for class EE tracks
  – Total of tracks show a more uniform density during the entire period considered.

RESULTS: COMMON CLOCK

- MJD 52940: an intentional error in antenna position was introduced in one receiver.

- The 1-ay average was calculated with a lower uncertainty. The contribution of this uncertainty to the total uncertainty of CV was better determined.
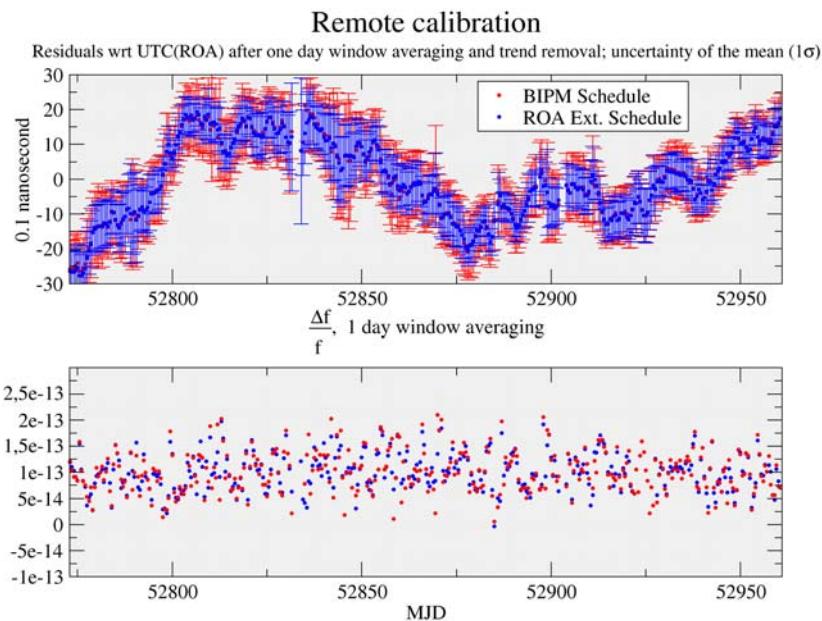
• When an error in positioning existed, the average performed better because 'EE' tracks covered deficiencies in elevation and azimuth.

• Increasing tracks resulted in lowering the RMS values of the average.

REMOTE CALIBRATION RESULTS

• The setup consisted of:
  – A cesium clock located at Madrid ~ 700 km from ROA
  – TTR-6 receivers on both sides
  – Control by means of an Internet connection.

• The dispersion of results was lower when 'EE' tracks were included.

• The contribution to the total uncertainty of the result decreased.

CONCLUSIONS

• A new way of operating one single-channel GPS receiver was attempted.

• A dedicated selection of satellites to fill the gaps can contribute to avoid biasing the results where the aspect of satellite geometry of the BIPM schedule is not optimal.

• Increasing the tracks per day shows better performance in the statistical contribution to the uncertainty of the CV method.

• Studies of the uncertainty in the time domain using TDEV and modified ADEV are underway.

• Studies for a comparison with a multi-channel GPS receiver are planned.

• This method will be used on GPS calibration trips in the near future.