GPS Activities at the National Measurement Institute, Australia

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Abstract

The National Measurement Institute (NMI) in Australia has been actively pursuing the development of reliable, high-integrity and remotely-operable GPS-based systems for precise time and frequency transfer. Recent developments include the establishment of a geodetic monitoring station, the construction of a portable system and the use of this system in an APMP intercomparison.

1. Introduction

The National Measurement Institute (NMI) in Australia, incorporating the former CSIRO National Measurement Laboratory, has for a number of years been developing reliable, high-integrity and remotely-operable GPS-based systems for precise time and frequency transfer. These systems include:

- CCTF-compatible [1] dual-frequency GPS common-view time transfer software and hardware, based on the Javad/Topcon Euro-80 GPS engine
- Temperature stabilization of the GPS receiver
- GPS integrity monitoring software which uses the receiver data to generate reports on the timing of individual satellites with respect to a local clock
- Network Time Protocol (NTP) hardware and software, allowing the system to operate as an NTP server with the local clock as the time reference, and
- RINEX [2] file generation software, to allow the system to serve as a geodetic reference station.

2. Geodetic monitoring station

A geodetic monitoring station has been constructed at NMI Lindfield, in a joint project with Australia's national mapping agency Geoscience Australia (GA). The antenna is mounted on a stable concrete pillar sited for good reception conditions, and an optical fibre link is used to transmit the GPS signal to a Topcon Euro-160 dual-frequency GPS receiver in the laboratory (Figure 1). The station supports high-quality GPSCV time transfer, and contributes data to the Australian Regional GPS Network (ARGN) for mapping and geodesy. It is also anticipated that this data will be used by the International GPS Service (IGS) in calculating GPS data products.

The same raw GPS data is post-processed to produce both CCTF-format time-transfer data [1] and RINEX-format geodetic data [2]. Raw data is logged continuously in real time, but data processing can run in parallel as required. Currently, CCTF-format files are generated daily, and 30-second RINEX data generated both daily and hourly; we also plan to generate one-second observations processed every fifteen minutes. Hourly (and sub-hourly) data is made available to support calculation of rapid and ultra-rapid data products across the monitoring network. RINEX files are automatically uploaded to GA, who co-ordinate all ARGN data.

3. Portable time-transfer system

In 2003, the NMI was commissioned by Telecommunications Laboratories (TL) of Taiwan to build a portable version of our time-transfer system based on the Topcon Euro-80 receiver (Figure 2). The portable system has been made available by TL for an intercomparison of receiver delays among APMP laboratories. The features of this system are:

1. Dual frequency L1/L2 receiver: high quality time transfer due to direct measurement of ionospheric delays, L1-L2 phase offset calibrated by transfer from GPS simulator
2. Processing of raw data to RINEX-format geodetic data: allows self-survey of precise local antenna coordinates
3. Storage of raw GPS and timing data: allows post-processing with precise coordinates
4. Temperature stabilization of receiver
5. Components are all integrated into an aluminium honeycomb flight case with shock-mounted 19” rack, for easy setup and packing
6. Modem/network access: allows remote monitoring.

The portable time-transfer system was developed to support round-robin intercomparisons of GPS receiver internal delays among APMP laboratories (§4).

4. APMP round-robin intercomparison

Previous comparison campaigns within the APMP have suffered from poor reliability of the travelling receiver [3]. High reliability was therefore one of the key design goals of the NMI portable system (§3). It is hoped that this system can support ongoing intercomparison, important not only for calibrating time-transfer within the region but also to establish the long-term stability of receiver delays.

A first round of comparison has been conducted among the laboratories NMI, TL, NICT, NMIJ and SPRING. The portable system was also compared to the OP AoA TTR5 receiver at BNM-SYRTE in Paris, which has acted as the reference point for a number of BIPM campaigns. Analysis of the data has been completed, and a report was presented to the APMP TCTF meeting. Data and calculations have been made available at the NMI FTP site [4].

Acknowledgments

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References

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[2] http://www.navcen.uscg.gov/pubs/gps/rinex/

[3] P. T. H. Fisk and R. B. Warrington, ‘Report on the APMP Round Robin GPS Common-View Time Transfer Receiver Intercomparison Experiment’: ‘Round 1: October 1999 to May 2000’, ‘Round 2: March 2001 to July 2001’, and ‘Interim Appendix’ (2002), available at ftp://time1.tip.csiro.au/pub/timedata/gps/APMP_data/GPS_Calibration/ .

[4] ftp://time1.tip.csiro.au/, or email time@measurement.gov.au.

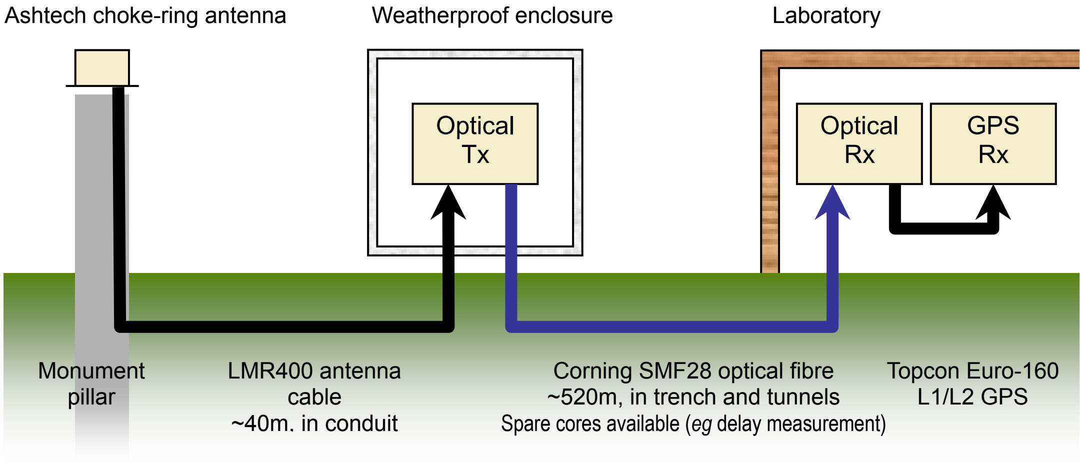

Figure 1: The geodetic monitoring station. A Vialite GPS fibre-optic transmitter (Tx) and receiver (Rx) propagate the GPS antenna signal over long distances without attenuation. The optical fibre delay can be measured by OTDR or calibrated by transfer. The Topcon Euro-160 is a geodetic-quality dual-frequency GPS receiver, with an external 10 MHz clock input.

Figure 2: Anura Gajaweera of the NMI Time and Frequency group with the completed portable time-transfer system.