



Australian Government
National Measurement Institute

WG on GNSS Report



APMP Technical Committee on Time and Frequency
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Michito Imae and Yasuhisa Fujii
National Metrology Institute of Japan (NMIJ)
Bruce Warrington
National Measurement Institute, Australia (NMIA)



Mission:

- To support time and frequency applications of Global Navigation Satellite Systems (GNSS) in APMP

Objectives:

- Support research into GNSS time and frequency transfer
- Coordinate GNSS time and frequency comparisons within APMP
- Develop support for new GNSS techniques and applications

- Coordinator: Dr. Bruce Warrington (NMIA)
- Sub-coordinator: Dr Yasuhisa Fujii (NMIJ)

Action Plan 2008–09–10

1. Comparisons supporting GNSS time and frequency transfer

- Continue to coordinate the comparison of GPS receiver delays by circulating a dual-frequency GPS receiver system among APMP economies (with thanks to TL)
- Reduce the time between comparison visits by circulating an additional single-frequency GPS receiver system (with thanks to NMIJ and APEC TILF)
- Extend the dual-frequency comparison to support additional evaluations, for example to separate receiver delays at L1 and L2 frequencies in support of P3 or carrier-phase time transfer
- Work towards establishing formal recognition of APMP GNSS comparison campaigns, for example as regional Supplementary Comparisons within the CIPM MRA framework

Comparisons: work in progress

i. Develop a formal protocol for the intercomparison

- APMP TCTF and WG GNSS previously identified the importance of a formal protocol, to ensure recognition of results (for example, to support reduction of u_B for laboratories contributing to TAI)
- At CCTF 2009, Dr Felicitas Arias noted that ongoing characterization of GNSS receiver delays is necessary for the preparation of TAI and the dissemination of UTC. A proposal has been prepared to involve the regional metrology organisations more actively in supporting these campaigns, and was discussed by the CCTF (CCTF/09-39)

CCTF/09-39

**PROPOSED RECOMMENDATION CCTF # (2009)
Characterization of delays of GNSS time transfer equipment in TAI contributing laboratories**

The Consultative Committee for Time and Frequency,

considering that

- the characterization of the delays of time transfer equipment is essential to ensure the accuracy of the time links for International Atomic Time (TAI),
- uncompensated changes of the hardware delays in a time link may cause a significant instability in TAI,
- the Consultative Committee for the Definition of the Second (CCDS) and the Consultative Committee for Time and Frequency (CCTF) have stressed the importance of calibration of time transfer equipment in laboratories participating to the calculation of TAI at the BIPM;

aware that

- the Time, frequency and gravimetry section of the BIPM makes efforts for measuring the relative delays of GNSS equipment in laboratories contributing data to the formation of TAI,
- considerable human resources and equipment are necessary to calibrate all GNSS equipment in TAI, and to keep them updated;

recommends that

- the BIPM continues organizing and running campaigns of measurement of delays in GNSS equipment in laboratories,
- these campaigns be principally organized for calibrating equipment in a selected subset of laboratories, and that they constitute a primary comparison,
- the Regional Metrology Organizations (RMOs) support the BIPM by organizing campaigns of measurement of delays within the frame of regional comparisons to be linked to the primary one conducted by the BIPM.

Comparisons: work in progress

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- A working group has been formed to prepare a draft protocol, including representatives from BIPM, PTB (Andreas Bauch) and NMIA (Bruce Warrington)
- If anyone else would like to assist with preparation or review of this protocol, *please let the WG GNSS know*
- This work essentially supercedes previous work towards recognition of APMP comparison campaigns as Supplementary Comparisons within the framework of the MRA and KCDB

Comparisons: work in progress

ii. Current program of APMP receiver intercomparisons

- Dual-frequency system has completed three main rounds throughout the region and a side visit to NMISA in South Africa.
- We intend to prepare final results in accordance with the comparison protocol, to support formal recognition of comparisons completed so far. This increases the preparation work required.
- We will continue to prepare the final report for review by participating laboratories, and we regret the extended delay which is partly due to limited resources.
- If any laboratory would like details of their comparisons immediately, please contact Bruce Warrington directly.
- We also intend to prepare the next rounds of the comparison in accordance with the formal protocol. Laboratories interested in participating should contact Bruce Warrington, Michito Imae or Yasuhisa Fujii.

Comparisons: work in progress

iii. Prepare additional calibrated receivers

- Current cycle time is about 3 years
- Multichannel single-frequency receiver prepared at NMIJ, supported by APEC TILF, to shorten this cycle time
- Software has been developed at NMIJ to set up the receiver and download the data
- Circulation of this receiver has similarly been postponed until 2010, to give time to complete preparation of the protocol and ensure recognition of results.

Comparisons: work planned to do

iv. Extend comparison to dual-frequency

- Currently calculate and report L1 C/A code delay only
- Delay values available in principle for both P/L1 and P/L2; comparison between BIPM Z12T and NMIA receiver shows good agreement between independent values for these delays
- Support P3 (code) time transfer for geodetic dual-frequency receivers
- Some issues still need to be explored; for example the differential offset between L1 P and L1 C/A codes

Recommendation CCTF 4 (2006):

- Laboratories participating in TAI consider acquiring state-of-the-art geodetic GNSS time-transfer receivers
- BIPM institute the operational collection of calibration information from the geodetic receivers of participating laboratories

Comparisons: work planned to do

iv. Extend comparison to support PPP time-transfer

- A number of APMP laboratories have purchased and are currently operating geodetic GNSS receivers
- TAIPPP pilot project has been operating successfully for approximately one year, with APMP laboratories participating
- At CCTF, BIPM reported that PPP links will shortly be included in the calculation of TAI
- A BIPM calibration campaign to characterize delays of selected receivers is currently in progress, including NIM, NTSC, A*STAR, NMIA and TCC (Chile)
- The WG intend to monitor the protocol and performance of this campaign, and work closely with BIPM to consider further regional campaigns to complement these results

Action Plan 2008–09–10

2. Survey the use of GNSS time and frequency transfer for remote calibration in APMP
 - provide an opportunity to discuss related issues such as the estimation of uncertainty, the use of GPSDO (or GNSS disciplined oscillators), and accreditation of calibration services
 - report back to the APMP TCTF summarising information which may be useful to economies operating or developing remote calibration facilities
 - consider guidelines for harmonization or standardisation of remote calibration services, and for the assessment of these services for CMCs under the CIPM MRA

The WG is especially grateful for the leadership of Michito Imae of NMIJ in this work.

Action Plan 2008–09–10

3. Support research and development of GNSS time and frequency transfer techniques
 - Question: NMIA currently download CCTF data from a number of APMP institutes, make this available by FTP, and report common-view GPS transfer results for selected laboratories. Is this still of use?
 - Question: Is there a need to extend or change this work to support RINEX data and PPP transfer results? How might this be achieved within available resources?
4. Provide opportunities for coordinated discussion on the impact of new satellite-based systems on GNSS time and frequency transfer in the APMP region
5. Develop support for other GNSS applications relevant to time and frequency as appropriate

Action Plan 2008–09–10

If you or your laboratory:

- have a need to complete another comparison with a travelling APMP receiver
- would be willing to help coordinate a comparison round
- would be willing to help develop a comparison protocol
- have other specific issues you would like to the WG to discuss

Please let the Coordinator Dr Bruce Warrington (NMIA) or the Sub-coordinator Dr Yasuhisa Fujii (NMIJ) know.

If you are able to assist with any of the work of the WG this would be particularly appreciated, as it will allow us to devote more resources to the Action Plan.



Australian Government
National Measurement Institute

National Measurement Institute
Bradfield Road
West Lindfield NSW 2070
Australia

Phone: +61 2 8467 3504

Email: bruce.warrington@measurement.gov.au

Web: www.measurement.gov.au/time

