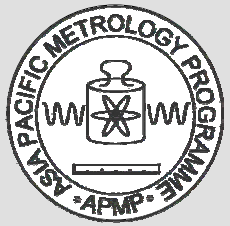
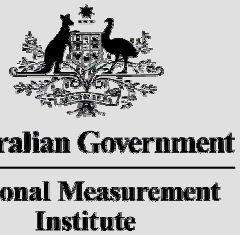
Australian Government
National Measurement Institute

APMP Round-Robin Intercomparison of GPS Receiver Delays

Preliminary Report on the First Round of the 2004 Campaign TCTF, October 19 2004, NIM





Background

- GPSCV time-transfer important in Asia-Pacific Region
- Previous intercomparison campaign circulated an AoA TTR6 receiver (NMI): Round 1 Oct 1999–May 2000, Round 2 March 2001–July 2001, with analysis presented to TCTF at ATF2002
- Difficulties with receiver reliability during this campaign; TTR6 also a single-channel receiver
- Report to TCTF therefore noted the possibility of developing a new portable system for the next round of intercomparison
- Portable system based on Topcon Euro-80 L1/L2 receiver developed at NMI under commission from TL
- First round kept comparatively short, to evaluate performance of portable system before beginning a longer campaign

Portable time-transfer receiver system

Anura Gajaweera of the NMI Time and Frequency group with the completed system

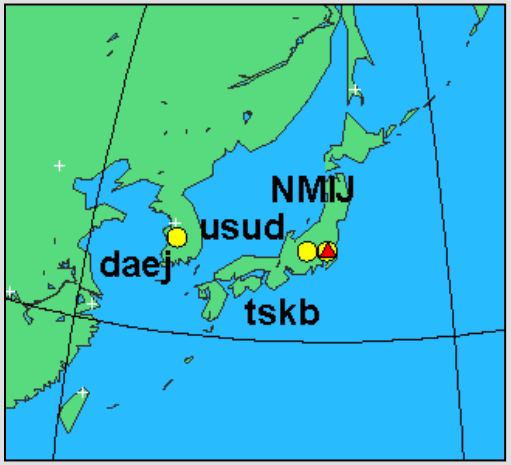
- Commissioned by TL Taiwan and developed at NMI Australia
- Based on dual-frequency Topcon Euro-80 receiver
- Self-survey of precise antenna coordinates
- Temperature-controlled GPS receiver housing
- Rugged casing, to withstand shipping

Schedule

	Host receiver	Serial number	Start		Stop	
NMIA (1)	NMI/Topcon	8RQRFKXT534	52970	27/11/03	53029	25/01/04
BNM-SYRTE	AoA TTR5	051	53062	27/02/04	53075	11/03/04
NMIA (2)	NMI/Topcon	8RQRFKXT534	53082	18/03/04	53101	6/04/04
TL	NMI/Topcon	8RJJBNWROCG	53115	20/04/04	53128	3/05/04
	AoA TTR6	479				
NICT	NMI/Topcon	8PN45EETDKW	53142	17/05/04	53149	24/05/04
	AoA TTR6	451				
NMIJ	AoA TTR6	484	53151	26/05/04	53156	31/05/04
SPRING	NMI/Oncore		53164	8/06/04	53172	16/06/04
NMIA (3)	NMI/Topcon	8RQRFKXT534	53180	24/06/04	53208	22/07/04

- First round of intercomparison includes BNM-SYRTE (OP): adopt this receiver as reference, and calibrate internal delay of portable system
- Portable system returned to NMI to test consistency of results

Self-survey of antenna coordinates



3 Computed Coordinates, ITRF2000

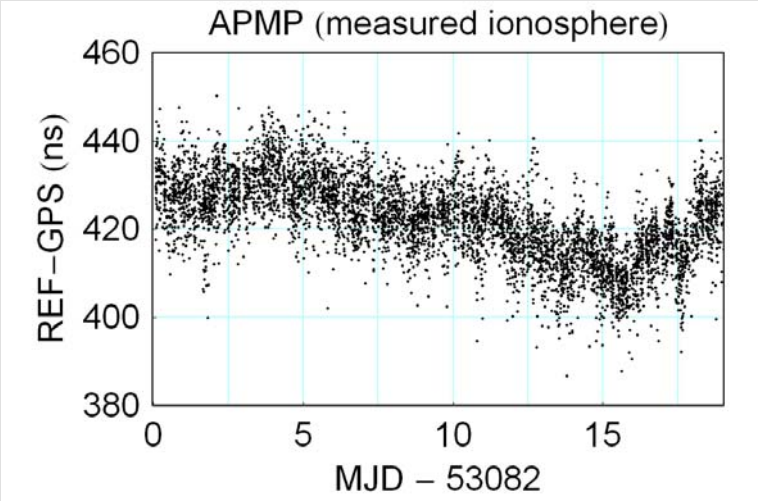
All computed coordinates are based on the IGS realisation of the ITRF2000 reference frame, provided by the IGS cumulative solution. All the given ITRF2000 coordinates refer to a mean epoch of the site observation data. All coordinates refer to the Ground Mark.

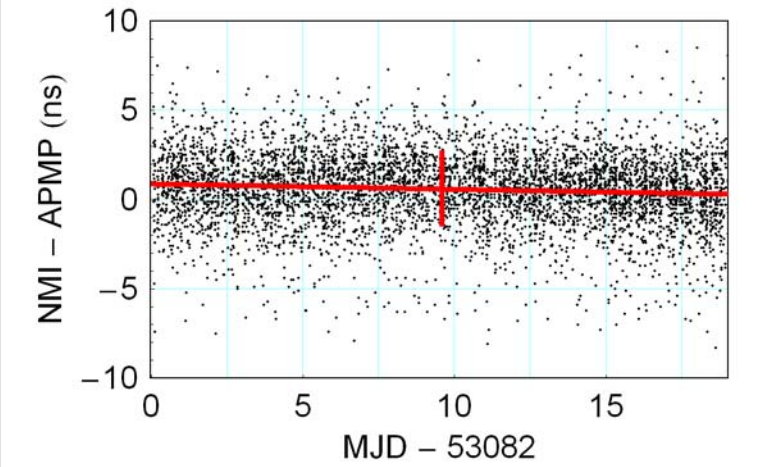
3.1 Cartesian, ITRF2000

	X(m)	Y(m)	Z(m)	ITRF2000 @
usud	-3855263.022	3427432.544	3741020.314	2004/05/28
tskb	-3957199.245	3310199.711	3737711.650	2004/05/28
daej	-3120041.961	4084614.888	3764026.905	2004/05/28
NMIJ	-3962302.243	3308875.364	3733523.235	2004/05/28
NMIJ	0.002 m	0.001 m	0.003 m	RMS

- Dual-frequency system allows accurate self-survey of antenna coordinates for portable system
- RINEX-format data submitted to AusPOS (Geoscience Australia) for processing
- Raw GPS and timing data reprocessed to CCTF output using precise coordinates
- Coordinates made available as a cross-check of host receiver antenna coordinates

Data and data processing





- Both receivers record CCTF data for approximately one week at host laboratory
- Form common-view difference
  $[\text{REF–SV}]_{\text{Host}} - [\text{REF–SV}]_{\text{APMP}}$
- Fit straight line (with slope) to extract mean offset
- Correct for any variation in delay parameters
- Use calibrated portable receiver internal delay to obtain a comparison value for the internal delay of the host receiver

Values for receiver delays

	Host receiver						Travelling receiver						
	Reported			Internal			Reported				Internal		
	INT	REF	CAB	INT	REF	CAB	INT	REF	CAB	AMP	INT	REF	CAB
NMIA (1)	46.5	76.	75.9	46.5	68.9	75.9	44.79	85.9	159.8	0.0	44.79	85.64	159.8
BNM-SYRTE	54.	304.	168.	54.	304.	168.	44.79	306.	159.8	0.0	44.79	85.64	159.8
NMIA (2)	46.5	76.	75.9	46.5	68.9	75.9	44.79	85.9	159.8	0.0	44.79	85.64	159.8
TL	45.1	30.7	119.1	45.1	30.7	119.1	44.79	37.6	159.8	0.0	44.9	37.6	159.8
NICT	47.2	344.123	152.15	47.2	344.123	152.15	44.79	319.97	159.8	0.0	44.9	319.97	159.8
NMIJ	50.	27.	259.	50.	27.	259.	44.79	510.6	159.8	0.0	44.9	510.6	159.8
SPRING	–30.	14.8	344.	–30.	16.	344.	44.79	72.	270.	–1.0	44.9	72.	270.
NMIA (3)	46.5	76.	75.9	46.5	68.9	75.9	44.79	85.9	159.8	0.0	44.79	85.64	159.8

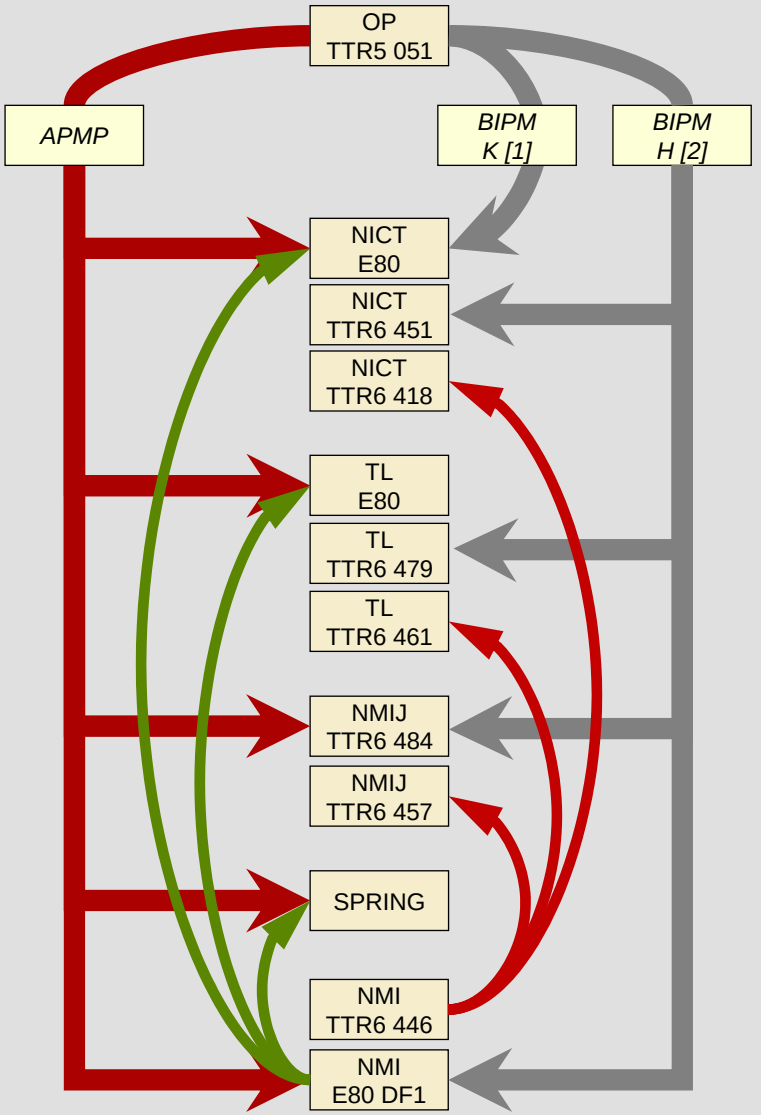
Values for delay parameters reported by the host laboratory are taken as the true values

Preliminary results

	Common Tracks	Offset (ns)				INT DLY (ns)	
		RMS	Mean	Delay	Total	Reported	Final
NMIA (1)	19526	2.0	0.6	6.84	7.44	46.5	53.9
APMP	539	2.6	–232.1	220.36	–11.74	44.79	33.1
NMIA (2)	5809	2.0	0.6	6.84	7.44	46.5	53.9
TL	1342	0.9	–3.8	–0.11	–3.91	45.1	41.2
NICT	2252	1.9	25.4	–0.11	25.29	47.2	72.5
NMIJ	230	2.4	52.7	–0.11	52.59	50	102.6
SPRING	2691	6.1	15.4	–1.31	13.09	–30	–16.9
NMIA (3)	9058	2.2	1.9	6.84	8.74	46.5	55.2

Conclusion

- Many independent comparisons now available among APMP receivers; coordinated by APMP, by BIPM, and by member laboratories
- Provides good data to evaluate consistency
  eg NMI E80 DF1: Δ~+8 ns cf BIPM H Δ=(+9±4) ns
- Laboratories encouraged to review results, especially delay parameters
- Portable receiver has demonstrated encouraging performance
- We look forward to continuing this important work among the Asia-Pacific region.



First round of current campaign

Transfer calibration when receiver commissioned at NML

APMP campaign 1999-2001 (TTR6)

Previous BIPM campaigns