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***“Timing-oriented” Processing
of Geodetic GPS Data using a
Precise Point Positioning (PPP) Approach***

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- **The Precise Point Positioning (PPP) Geodetic Approach**
 - ⇒ Autonomous stand-alone positioning
 - ⇒ IGS products (precise satellite coordinates and satellite clock)
- **Preliminary Timing-oriented Performance of PPP**
 - ⇒ Software implementation provided by the Geodetic Survey Division (GSD) of Natural Resources Canada (NRCan)
 - ⇒ Analysis of differential delay of two geodetic GPS receivers
 - ⇒ Time transfer assessment over European link between IEN and PTB
- **Open Issues**
 - ⇒ Better understanding of clock model and daily batch handling

Geodetic Approach

- *Post-processing* approach using un-differenced dual frequency pseudorange and carrier phase observations coming from a *single geodetic GPS receiver* together with the high-quality GPS products provided by the *IGS* (International GPS Service) in *near real time*
 - ⇒ *Precise Satellites Coordinates*
 - ⇒ *Satellite Clock Estimates*
- Relying on both the *IGS* products and proper *algorithms*, the PPP eliminates the need to acquire simultaneous observations from a reference station or a network of tracking stations
 - ⇒ Alternative to the *differential positioning* (reference station(s) with known position)
- *Stand-alone position* of a single geodetic GPS receiver can be *autonomously* estimated with cm precision, even if the *receiver is not part of a network* of stations (such as, the world wide distributed IGS network)
 - ⇒ Receiver clock offset estimates with *sub-ns* precision (static mode)

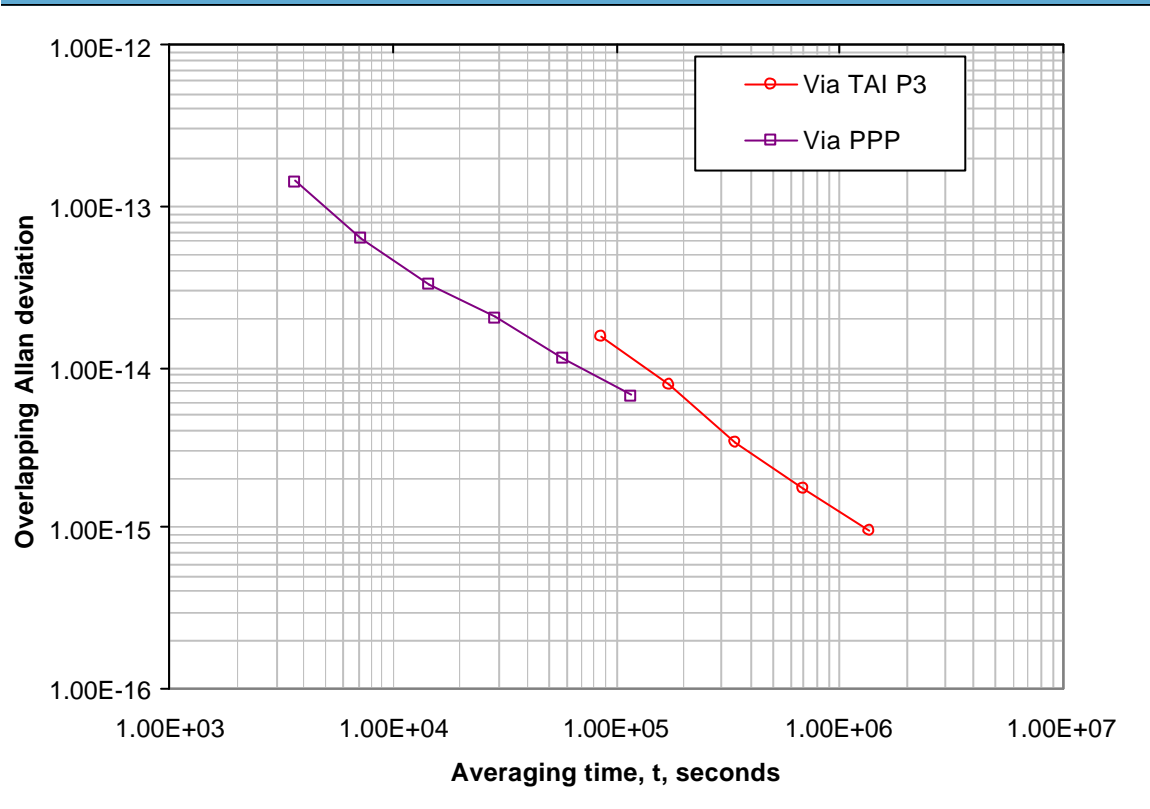
PPP algorithm software implementation

kindly provided by the

Geodetic Survey Division (GSD) of



(NRCan)



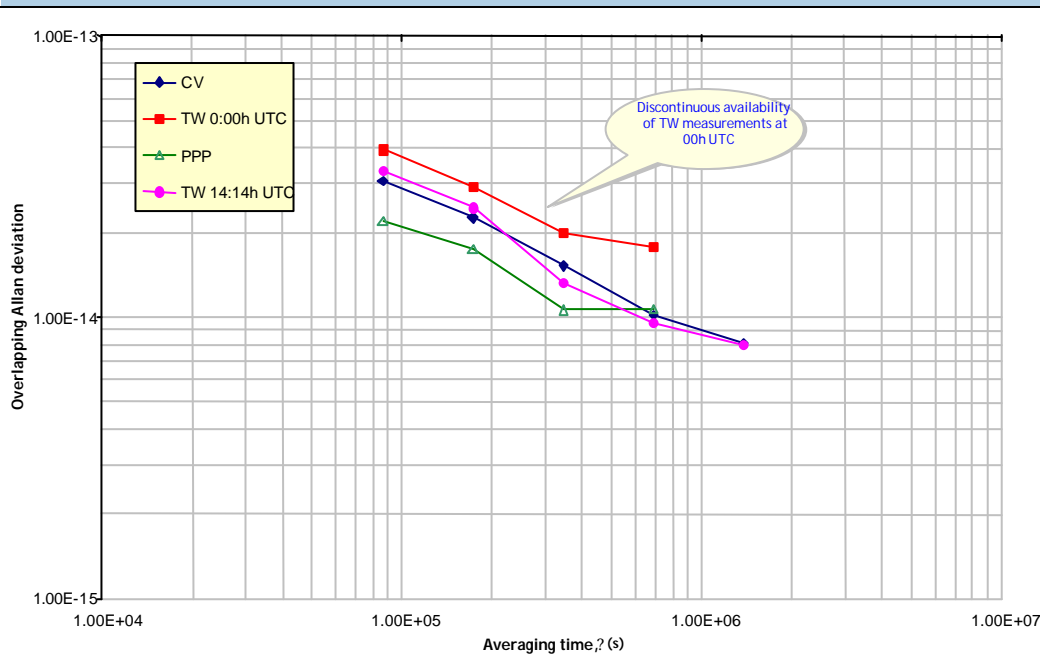
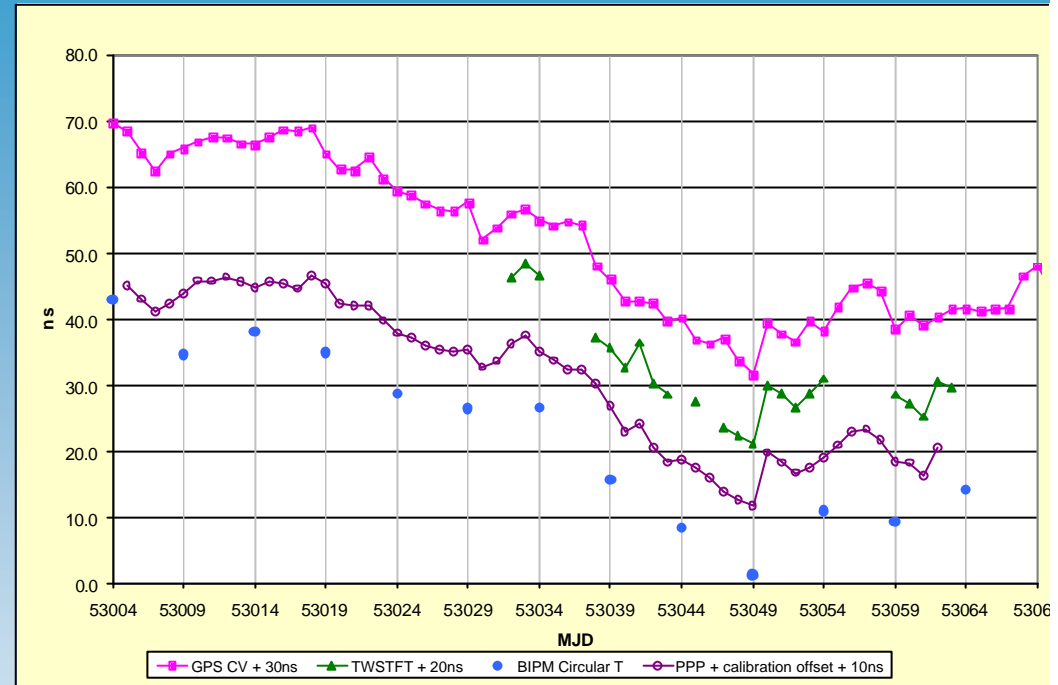
✓ **Better stability performance** thanks to the use of dual-frequency carrier phase measurements in the PPP algorithm, as well as the availability of high-quality GPS data as provided by IGS

- Analysis of the *differential delay* of two geodetic GPS receivers operated by IEN
 - ⇒ **Ashtech Z-12T**
 - ⇒ **Javad Legacy**
- Using the hourly data provided by the IEN local measurements system
- A *constant bias* has been removed

Receivers	s (ns)	$s_y(t) @ t = 1 \text{ day}$
3SN wrt TTS-2 via GPS CV	1.6	2.01×10^{-14}
Ashtech - Javad via P3	0.8	1.52×10^{-14}
Ashtech - Javad via PPP	0.3	@ 8.00×10^{-15}

Preliminary Timing-oriented Performance of PP

- Analysis of the *time transfer feasibility* over an European link between
 - ⇒ IEN (Turin, Italy)
 - ⇒ PTB (Braunschweig, Germany)
- Availability of both *TWSTFT* and *GPS CV* data for comparison
 - ⇒ IGS Clock products also available since January 2004



- The **bias** affecting the “PPP link” has been estimated with respect to the recent calibrated TWSTFT link
- ✓ **Stability performance better** than other time transfer methods (TWSTFT and GPS CV)

- *Even if a single geodetic GPS receiver is not part of a network of stations (such as, the world wide distributed IGS network), the PPP post-processing approach allows...*
 - ⇒ *Station coordinates* estimates with **centimetre** precision (static mode)
 - ⇒ *Receiver clock offset* estimates with **sub-ns** precision (static mode)
 - *Thanks to the use of dual-frequency carrier phase measurements as well as to the availability of high-quality GPS data as provided by IGS, the PPP approach seems to be very promising also for timing purposes as showed by preliminary results*
 - ⇒ *Low noise estimate of differential delay* between geodetic GPS receivers
 - ⇒ *Time transfer capability* with stability performance comparable with other methods (TWSTFT and GPS CV)
- ⇒ *Open issues and future works...*
 - ⇒ *Investigation of day boundaries gaps in PPP estimates*
 - ⇒ *Pre-processing of PPP estimates with the aim to filter out any outliers*