

# H24VSP Project 3

## PRACTICAL PPP WITH VERIPOS DL5<sup>a</sup>

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NGI

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<sup>a</sup>History of changes at <https://github.com/DfAC/TeachingSlides/>.

In last practical of the H24VSP module we will explore the capacities of the Precise Point Positioning (PPP) by comparing it with real-time kinematic double-differenced positioning (RTK) that you are already familiar with. During practical we will be using **Leica GS10** receiver and maritime<sup>1</sup> **Veripos LD5** receiver using AsterRx chipset<sup>2</sup>. We are interested in assessing difference between:

- convergence time;
- precision - estimated and actual after convergence;
- accuracy after convergence.

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<sup>1</sup>For application examples see [www.veripos.com/applications/overview/](http://www.veripos.com/applications/overview/).

<sup>2</sup>For short introductory video see <http://bit.ly/VeriposLD5>.

You will collect:

- RTK GPS solution;
- RTK GPS+GLO solution;
- Network RTK GPS solution;
- Network RTK GPS+GLO solution.

The PPP data will be provided for you at the end of practical. It is your task to **select approximate point and time span** to carry out comparison between RTK and PPP solutions.

- LD5 will be restarted at 07:30. This will allow for PPP convergence.
- You will collecting RTK data between 08:30 and 10:50.
- Apart from collected data (GS10) you will be given Veripos NMEA strings for Ultra and Apex<sup>2</sup> (LD5).
- **Make sure that Veripos NMEA file has been split into \$GPGGA and \$GPGST ones before leaving.**

## Veripos Services

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Veripos is a commercial company providing high accuracy GNSS positioning, offering both hardware (receivers) and correction services<sup>3</sup>:

- **Apex Service** uses Veripos own Orbit and Clock Determination System (OCDS) and their network of reference stations<sup>4</sup>. Apex utilises dual-frequency GPS, APEX<sup>2</sup> dual-frequency GPS/GLONASS and APEX<sup>5</sup> dual-frequency GPS/GLONASS/Beidou/Galileo/QZSS receivers observations for dm level accuracy.

- **Ultra Service** uses JPL Orbit and Clock Determination System (OCDS) which uses data from JPL network<sup>5</sup>. Ultra utilises dual-frequency GPS and Ultra<sup>2</sup> GPS and GLONASS.
- **Standard Service** - provide high integrity, meter level service. Standard provide single frequency code DGPS and Standard<sup>2</sup> single frequency code GPS and GLONASS DGPS.

All corrections are transmitted via Inmarsat geostationary satellites<sup>6</sup> - 25E, 98W, 143.5E, AORE, AORW, IOR, POR. All coordinates provided are in ITRF2014.

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<sup>3</sup><https://www.veripos.com/services/overview/>.

<sup>4</sup><http://bit.ly/VeriposNet>

<sup>5</sup><http://bit.ly/JPLnetwork>

<sup>6</sup><http://www.veripos.com/global-coverage.html>

## Single frequency code GPS DGPS.

- Provides RTCM Type 1<sup>7</sup>, 3<sup>8</sup> messages.
- Normal accuracy: 1-2m.
- Typical latency: 4 seconds<sup>9</sup>.
- Single difference code solution (DGPS) using GPS C/A code on L1 frequency.

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<sup>7</sup>DGPS corrections.

<sup>8</sup>GPS reference station parameters.

<sup>9</sup>Average age received 10s. Typical correction update interval is 15 seconds.



## Single frequency code GPS and GLONASS DGPS.

- Provides RTCM Type 1, 3, 31<sup>10</sup>, 32<sup>11</sup> messages.
- Normal accuracy: 1-2m.
- Typical latency: 4 seconds.
- Single difference code solution (DGPS) using GPS and GLONASS C/A code (L1/G1)<sup>12</sup>.

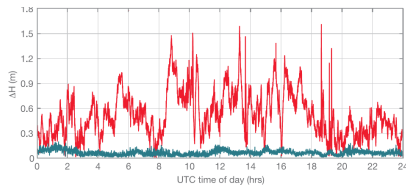
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<sup>10</sup>DGPS GLONASS corrections.

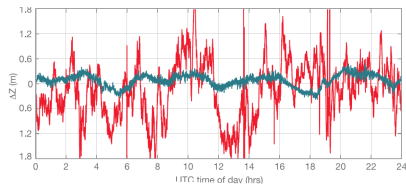
<sup>11</sup>GPS GLONASS reference station parameters.

<sup>12</sup>It is possible to calculate position using only GLONASS with this service.

## Horizontal accuracy



## Vertical accuracy



**Figure 1:** *Standard and Ultra solutions at a monitor site in Singapore.*

- Orbit and clock corrections in JPL GDGPS format.
- Nominal accuracy: 0.1m planar.
- Typical latency: 2 seconds with 30 s update rate.
- Precise Point Positioning (PPP) using C/A and P code and L1/L2 carrier phase for GPS and GLONASS G1/G2.
- Orbit and clock corrections in Veripos OCDS format.
- Nominal accuracy: 0.1m planar.
- Typical latency: 2 seconds with 30 s update rate.
- PPP, code and carrier phase on GPS L1/L2, GLONASS G1/G2, BeiDou B1/B2, Galileo E1/E5b, QZSS L1C/L2L (exact corrections depend on the service type).

## Practical work

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Point	Frame	Lat[deg]	Long[deg]	EllHt[m]	Notes
NGB5	ETRF97	52 57 7.05304	01 11 1.44953	91.212	at point
NGB5	ETRF97	52 57 7.05304	01 11 1.44953	91.392	at ARP
NGB5	ETRF97	52 57 7.05304	01 11 1.44953	91.434	at antenna PCO <sup>a</sup>
<b>NGB5</b>	ITRF2014	<b>52 57 7.07154</b>	<b>01 11 1.42594 W</b>	<b>91.486</b>	at antenna PCO <sup>b</sup>
<b>NGB5</b>	ITRF2014	<b>5257.117859</b>	<b>0111.023766 W</b>	<b>91.486</b>	at antenna PCO <sup>c</sup>

**Table 1:** *Coordinates of NGB5*

<sup>a</sup>Antenna offset for ionosphere free solution is  $2.545L_1 - 1.545L_2 = 2.545 * 55.3 - 1.545 * 64.2 = 41.5mm$ .

<sup>b</sup>Converted from ETRF97 to ITRF2014 at epoch 2017-12-06.

<sup>c</sup>To calculate error in  $N(\phi)$  and  $E(\lambda)$ , in meters, from NEMEA GGA string, at longitude of NGL, use  $\lambda_{NMEA} - \lambda_{truth} * 1800$  and  $\phi_{NMEA} - \phi_{truth} * 1200$ . Note that 6th decimal place of GGA string is equivalent to 0.0018  $N(\phi)$  and 0.0012 m  $E(\lambda)$ .

In Verpos provides two types of NMEA strings \$GPGGA and \$GPGST. \$GPGGA will behave differently in PPP mode with QA flag always 2 or 5. To obtain any information about solution we need to examine last flag before CRC(\*).

## Example

\$GPGGA,183324.00,5257.1178371,N,00111.0236798,W,5,17,0.7,42.76,M,49.01,M,30.5,0268\*54.

Values for the flag indicate:

**0068** ULTRA

**0268** *ULTRA*<sup>2</sup>

**0081** APEX

**0281** *APEX*<sup>2</sup>

**1006** *Standard*<sup>2</sup>

## Example

*\$GPGST,140545.00,3.81,0.02,0.01,81.00,0.02,0.01,0.02\*57.*

Cell	Notes
0	Message ID \$GPGST
1	UTC of position fix <sup>a</sup>
2	RMS value of the pseudorange or carrier phase (RTK/PPP) residuals
3	Error ellipse semi-major axis 1 sigma error, in meters
4	Error ellipse semi-minor axis 1 sigma error, in meters
5	Error ellipse orientation, degrees from true north
6	Latitude 1 sigma error, in meters
7	Longitude 1 sigma error, in meters
8	Height 1 sigma error, in meters
9	The checksum data, always begins with *

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<sup>a</sup>Notice 17s offset to GPS time.

## Veripos demo

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