H24VSP Project 3

Practical PPP with Veripos DL5[a]

Lukasz K Bonenberg

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NGI

[a] 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 Positoning (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[1] **Veripos LD5** receiver using AsterRx chipset.. We are interested in assessing difference between:

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

[1] For application examples see `www.veripos.com/applications`

Data Collection

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 most appropriate RTK observation point and time span** to carry out comparison between RTK and PPP solutions.

Practice layout

- LD5 will be restarted at 08:00. This will allow for PPP convergence.
- You will collect RTK data between 09:20-10:40 and 11:20-12:40, using Leica GS10 receiver.
- You will also get Veripos NMEA strings for Ultra and Apex[2] (LD5).
- **Before you leave make sure that Veripos NMEA file has been split into $GPGGA and $GPST.**

Veripos Services

Veripos Services I

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

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

Veripos Services II

- **Ultra Service** uses JPL Orbit and Clock Determination System (OCDS) which uses data from JPL network[3]. Ultra utilises dual-frequency GPS and Ultra[2] GPS and GLONASS.
- **Standard Service** - provide high integrity, meter level service. Standard provide single frequency code DGPS and Standard[2] single frequency code GPS and GLONASS DGPS.

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

[2] www.veripos.com/about/coverage
[3] http://bit.ly/JPLnetwork

Single frequency code GPS DGPS.

- Provides RTCM Type 1[4], 3[5] messages.
- Normal accuracy: 1-2m.
- Typical latency: 4 seconds[6].
- Single difference code solution (DGPS) using GPS C/A code on L1 frequency.

[4] DGPS corrections.
[5] GPS reference station parameters.
[6] Average age received 10s. Typical correction update interval is 15 seconds.

Standard[2] service

Single frequency code GPS and GLONASS DGPS.

- Provides RTCM Type 1, 3, 31[7], 32[8] messages.
- Normal accuracy: 1-2m.
- Typical latency: 4 seconds.
- Single difference code solution (DGPS) using GPS and GLONASS C/A code (L1/G1)[9].

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[7] DGPS GLONASS corrections.
[8] GPS GLONASS reference station parameters.
[9] It is possible to calculate position using only GLONASS with this service.

Veripos Ultra and Apex[2]

- Orbit and clock corrections in JPL GDGPS format.
- Nominal accuracy: 0.10m 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: 0.05m 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).

Veripos Standard and Ultra comparison

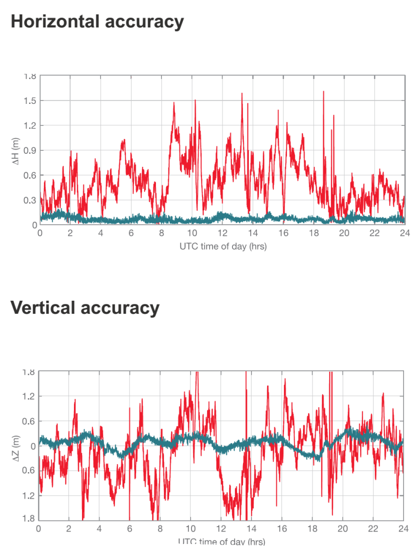

Figure 1: *Standard and Ultra solutions at a monitor site in Singapore.*

Veripos demo

Practical work

NGB5

Point	Frame	Lat ϕ[deg]	Long λ[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[a]
NGB5	ITRF2014	**52 57 7.07209**	**01 11 1.42505** W	**91.488**	at antenna PCO[b]
NGB5	ITRF2014	**5257.117868**	**0111.023751** W	**91.488**	at antenna PCO[c]

Table 1: *Coordinates of NGB5*

[a]Antenna offset for ionsphere free solution is $2.545L_1 - 1.545L_2 = 2.545 * 55.3 - 1.545 * 64.2 = 41.5mm$.

[b]Converted from ETRF97 to ITRF2014 at epoch 2018-12-05.

[c]To calculate error in meters at latitude ϕ of NGI, use $(\lambda_{NMEA} - \lambda_{truth}) * 1800$ and $(\phi_{NMEA} - \phi_{truth}) * 1200$. The 6th decimal place of GGA string is equivalent to 1.8mm for N(ϕ) and 1.2mm for E(λ).

Veripos $GPGGA NMEA strings

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*^{2}
0081 APEX
0281 *APEX*^{2}
1006 *Standard*^{2}

Veripos $GPGST NMEA strings

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[a]
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 *

[a]Notice 18s offset to GPS time.