# H24VSP Project 3

## Practical PPP with Veripos DL5[a]

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NGI

[a] History of changes at `https://github.com/DfAC/TeachingSlides/`.

# Introduction

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]. 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` **Veripos LD5** receiver using AsterRx chipset.

# 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 approximate point and time span** to carry out comparison between RTK and PPP solutions.

# Practice layout



- 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$^2$ (LD5).
- **Make sure that Veripos NMEA file has been split into $GPGGA and $GPGST ones before leaving.**

# 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`

# Standard Service I



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].

[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: 0.1m 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 corections depend on the service type).

# Veripos Standard and Ultra comparison



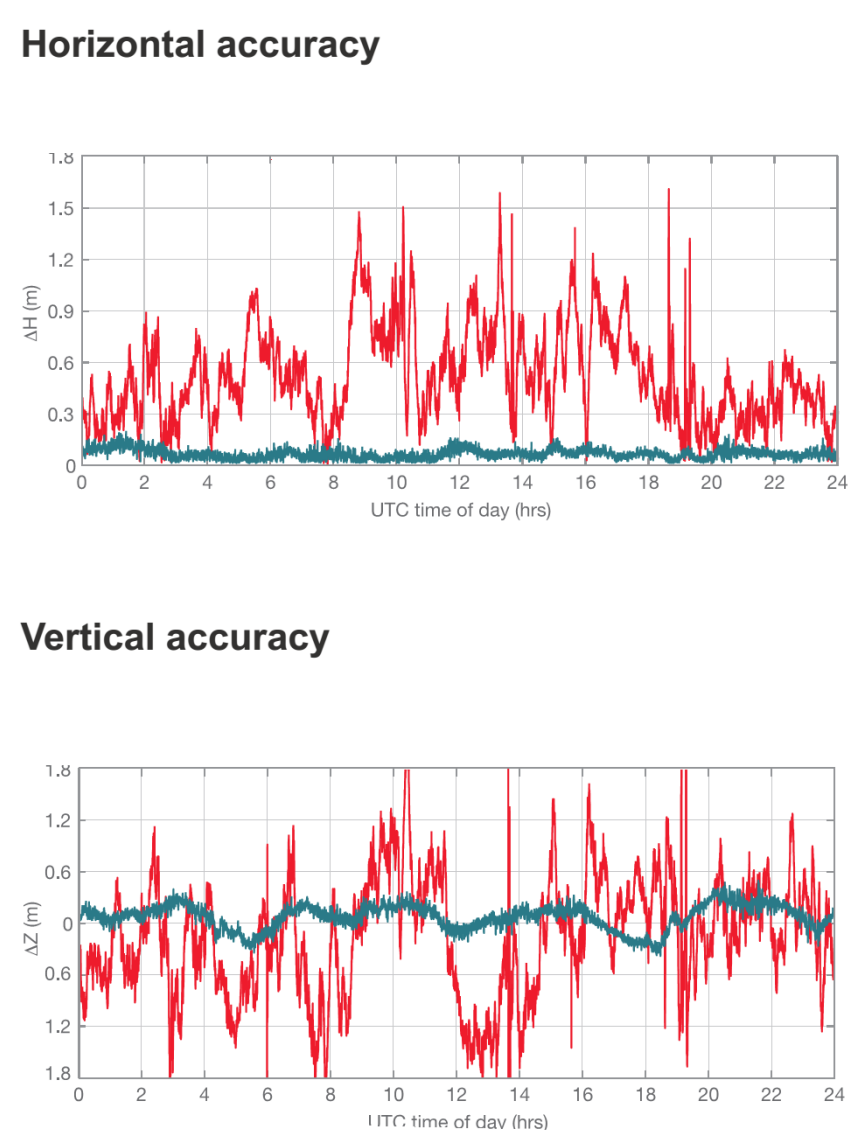


**Figure 1:** *Standard and Ultra solutions at a monitor site in Singapore.*

# Veripos demo

# Practical work

| Point | Frame | Lat $\phi$[deg] | Long $\lambda$[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 7.07154** | **01 11 1.42594** W | **91.486** | at antenna PCO[b] |
| **NGB5** | ITRF2014 | **5257.117859** | **0111.023766** W | **91.486** | 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 2017-12-06.

[c] To calculate error in meters at latitude $\phi$ of NGI, use $(\lambda_{NMEA} - \lambda_{truth}) * 1800$ and $(\phi_{NMEA} - \phi_{truth}) * 1200$. The 6th decimal place of GGA string is equivalent to 18mm N($\phi$) and 12mm E($\lambda$).

# 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 17s offset to GPS time.