NS-HP
RTK-Capable GNSS Receiver

NS-HP : High-Performance GNSS Receiver

- L1/B1 C/A Code
- 20 ch GPS/SBAS/QZSS + 6 ch BDS
- Sensitivity: -148dBm cold start, -160dBm tracking
- Update Rate: 2 / 4 / 5 / 8 / 10 / 20 Hz
- Position accuracy: 2.5m CEP
- Velocity accuracy: 0.1m/sec
- Timing accuracy: 10nsec
- 40mm x 38mm
- 50mA @ 3.3V

NS-HP : RTK Capable

- Support RTK base and rover modes
- 20 ch GPS/SBAS/QZSS + 6 ch BDS
- RTK position accuracy: centimeter-level
- 70mA @ 3.3V
- Update Rate 1Hz

Mode	Output	Output Baud Rate	Input	Input Baud Rate
Rover	NMEA-0183	9600 ~ 115200 *	RTCM-SC104 3.0, 3.1 or SkyTraq-Raw	57600
Base	SkyTraq-Raw	38400 ~ 115200**		

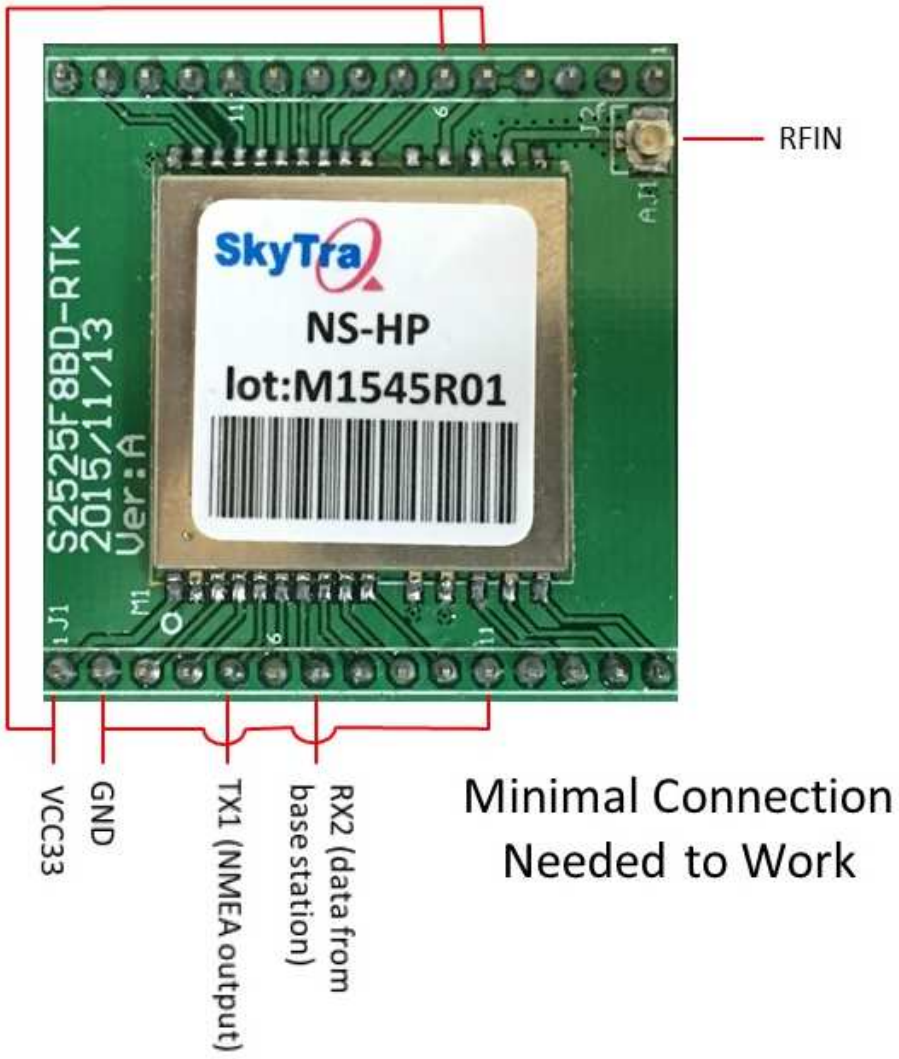
* default 115200

** when switching to base mode, need to manually change to 57600 to work with rover

NS-HP Pin-Out

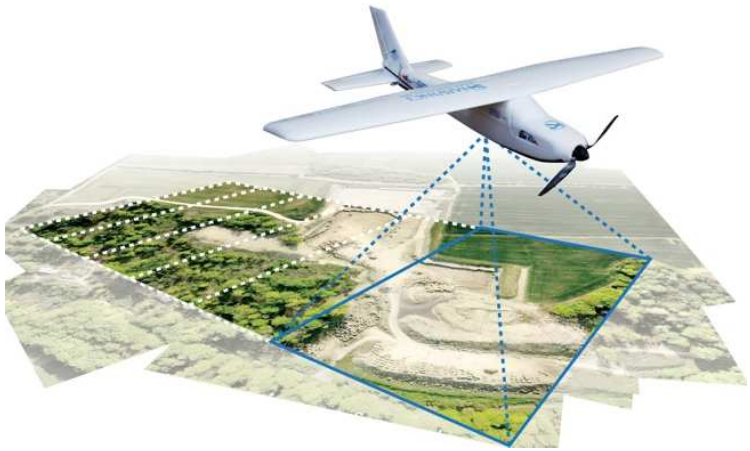
* Available only for NS-HP-5S and -10S, 5Hz and10Hz RTK version with precision time/position stamp

Minimum Connection to Work



Potential RTK Applications

UAS Mapping



Agriculture

Driverless Vehicle

Surveying

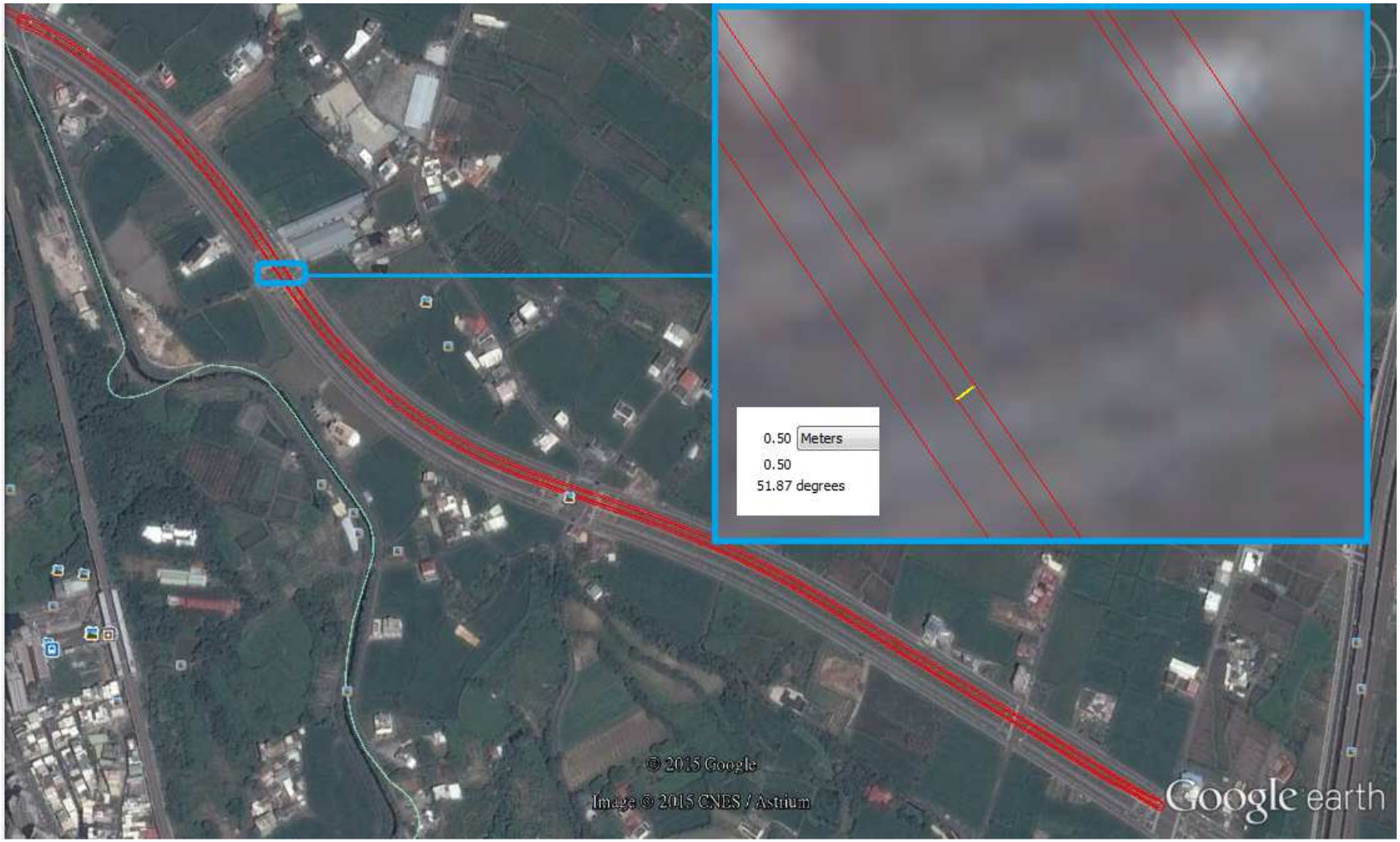
Construction

RTK Dynamic Performance (1/2)

Driving on inner lane making loop rounds 3 times, in 3 separate tests using 3 different antennas placed at the same location. Each color represent result of a test with a particular antenna. Deviation less than 40cm.

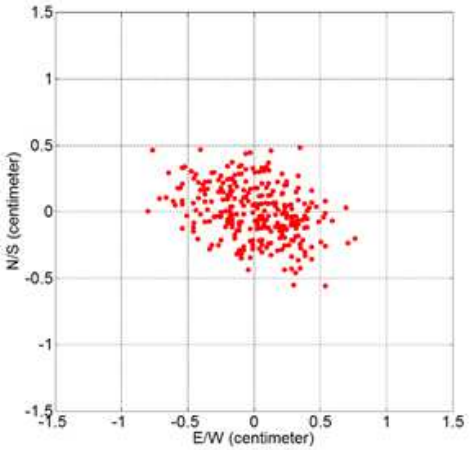
RTK Dynamic Performance (2/2)

Same test as previous using a popular brand normal GPS/GLONASS receiver. Deviation is larger than RTK receiver as expected.



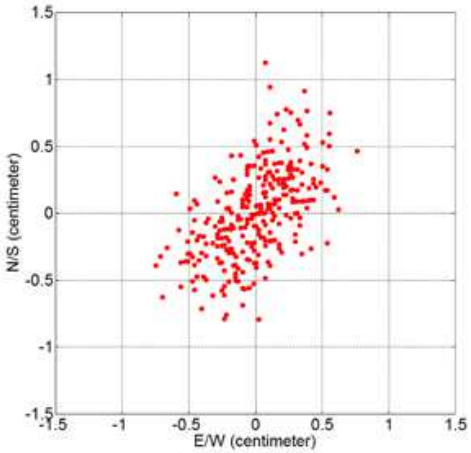
Baseline vs RTK Accuracy

1Km baseline



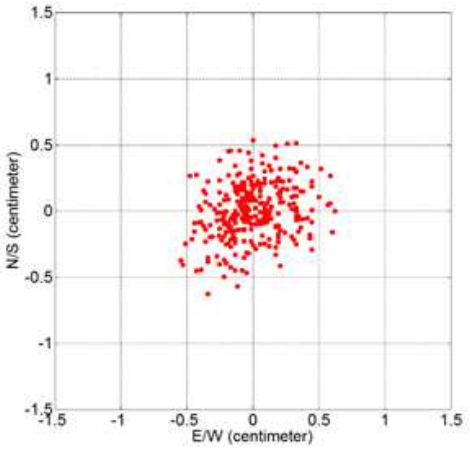
R95: 0.61cm

1.5Km baseline



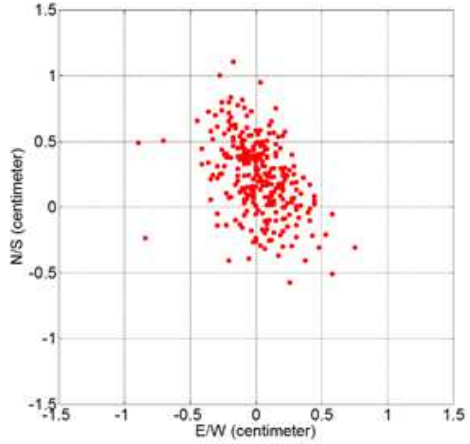
R95: 0.76cm

6.2Km baseline



R95: 0.55cm

9.6Km baseline



R95: 0.62cm

Precision Time & Position Stamp* (1/2)

- Input: rising edge on TRIG pin as trigger
- Output: PSTI,005 message with time and position occurrence estimate on the trigger
- Accuracy
  - Time: 100nsec
  - Position: max 1msec moved distance error on top of RTK positioning error

If 50km/h speed ➔ maximum 1.4cm error on top of RTK positioning error

***** Available only for NS-HP-5S and -10S, 5Hz and 10Hz RTK version with precision time/position stamping

Precision Time & Position Stamp* (2/2)

- Alternative RTK, at 50Km/hr speed 10Hz RTK rate, 139cm distance moved between 2 RTK points. When movement is not constant velocity, incorrect to linear interpolate ➔ not possible to derive precise position from time stamp

- PSTI,005 offers direct centimeter-level accuracy RTK position stamp ➔ maximum error of 1.4cm on top of RTK's 1cm + 1ppm error at 50Km/hr speed ➔ far accurate than simple time stamp offered by alternative RTK solutions

Known Issues for RTK Usage

- Works below 10Km baseline
- Works under open sky without interference
- Require signal over 38dB/Hz
- Require 7 or more satellites above 15 degree elevation angle with good satellite geometry

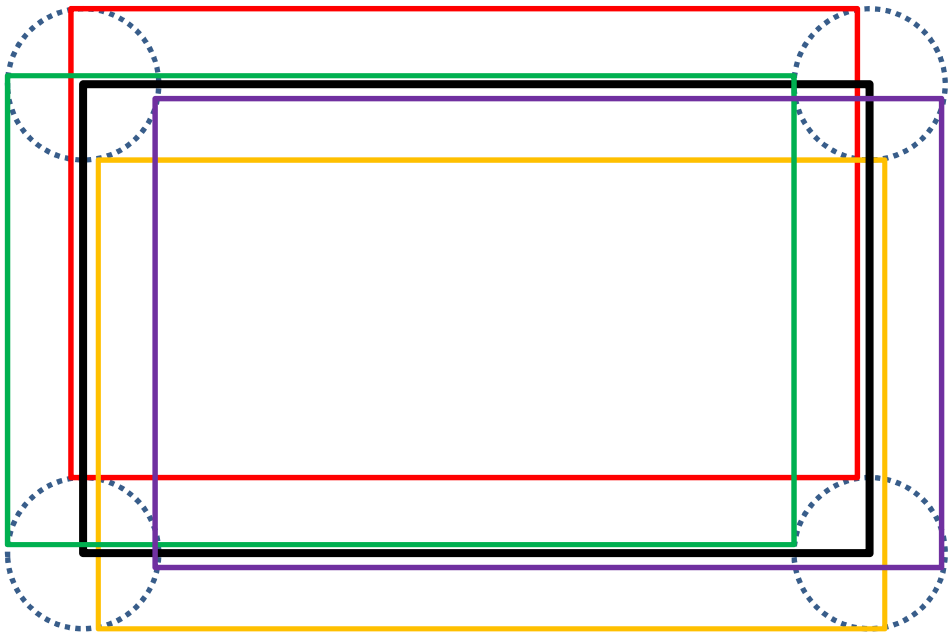
If above condition is not met, NS-HP will only have float or single solution, behaving like a normal GPS receiver.

GPS Receiver

- Most GPS receivers use C/A code to measure position
- A C/A code chip is roughly 300 meters
- GPS receiver can determine position with resolution to fraction of a C/A code chip, resulting in 2.5 meter CEP 50%* accuracy from 4 or more GPS satellites

* 2.5m CEP 50% means 50% of the location points fall within 2.5m radius.
It is equivalent to 95% confidence level falling within 5 meter radius

GPS Receiver Error



A rectangular land with 4 corners measured using GPS at different time on different days. When plotted on Google Earth, these 4 measured corners defined rectangular lands may have area shifted by 0 ~ +/-5 meters.

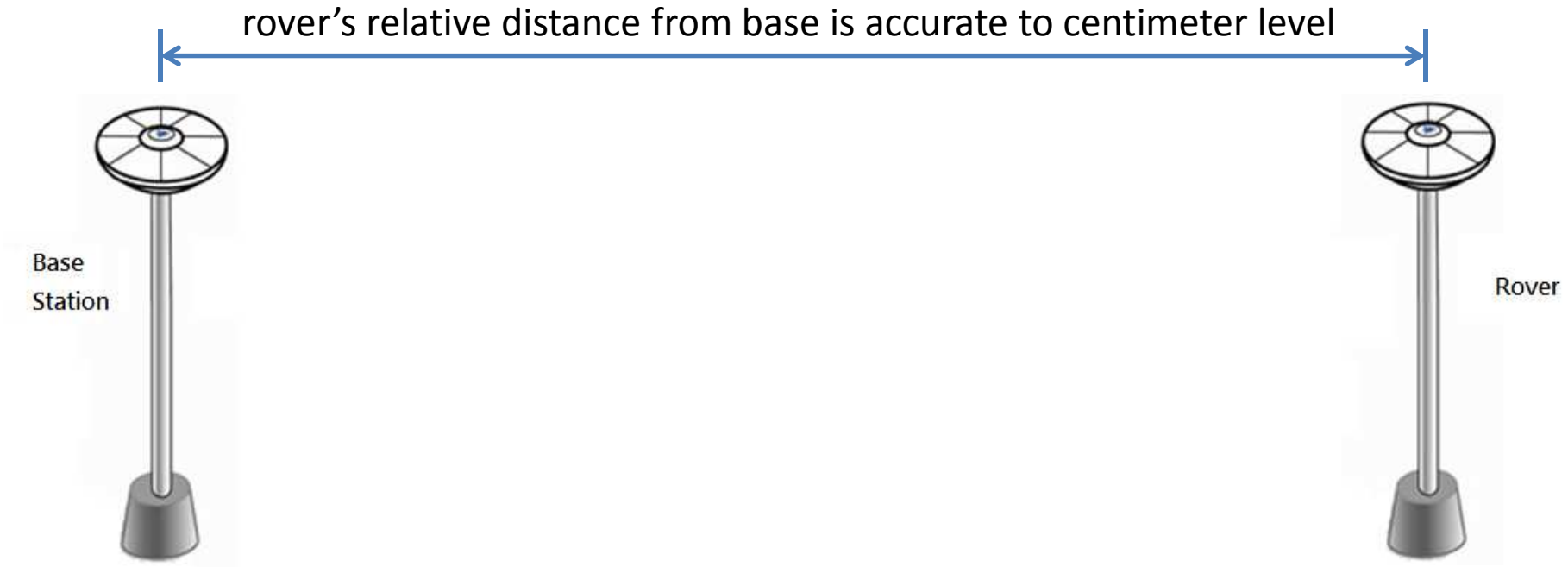
Shifted 10 meters for the worst case +5m and -5m shifts.

This is mostly due to ionosphere and troposphere delays.

RTK GPS Receiver (1/2)

- RTK GPS receiver counts carrier cycles to determine relative position from base station
- Each carrier cycle has wave length of 19cm
- RTK receiver can determine relative position from base station with resolution to fraction of a carrier wavelength, resulting in centimeter-level position accuracy

RTK Receiver (2/2)

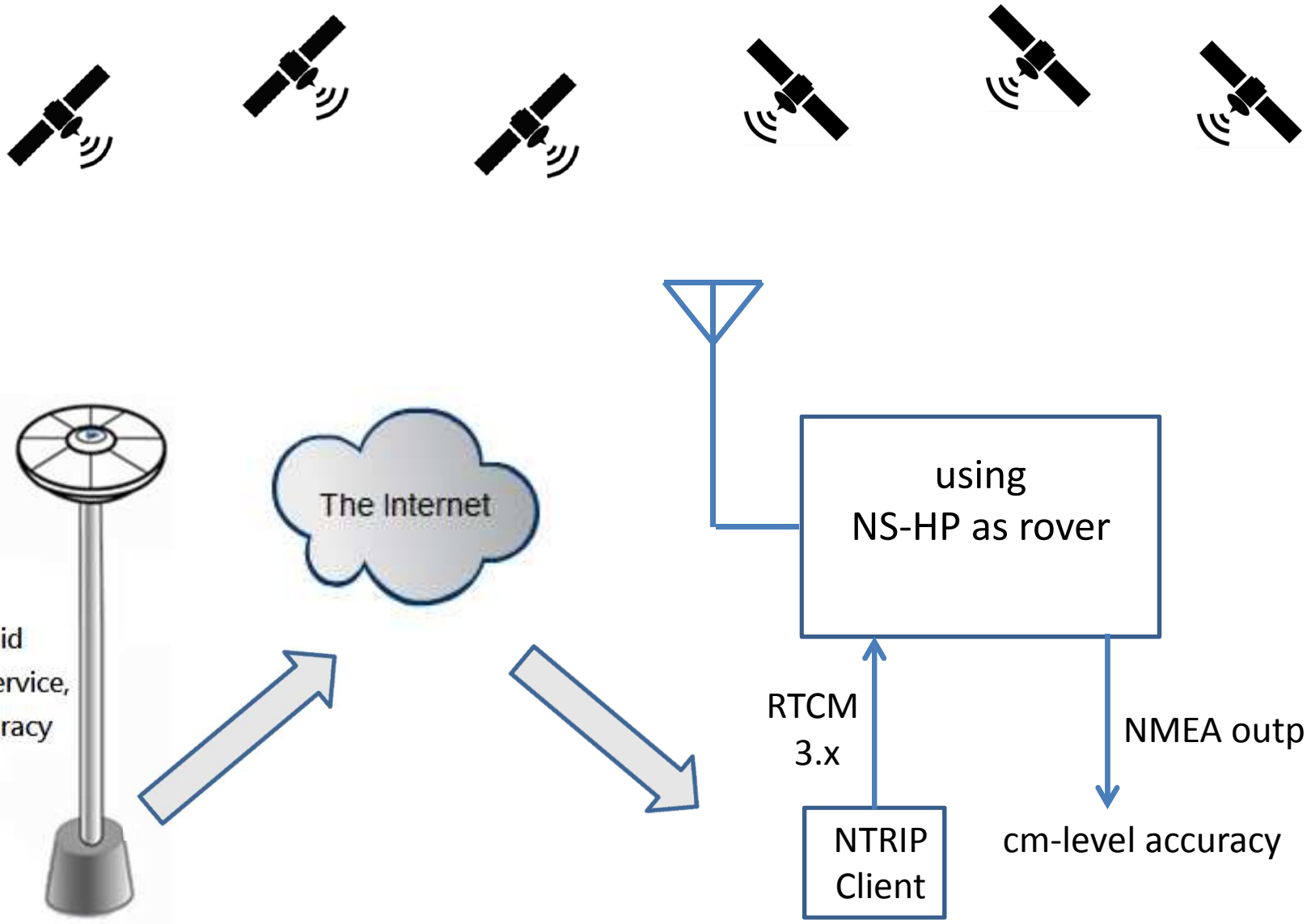


If base position* is accurate to millimeter ➔ rover position* will be accurate to centimeters

If base position* is accurate only to meters ➔ rover position* will only be accurate to meters but relative distance from base is still accurate to centimeters

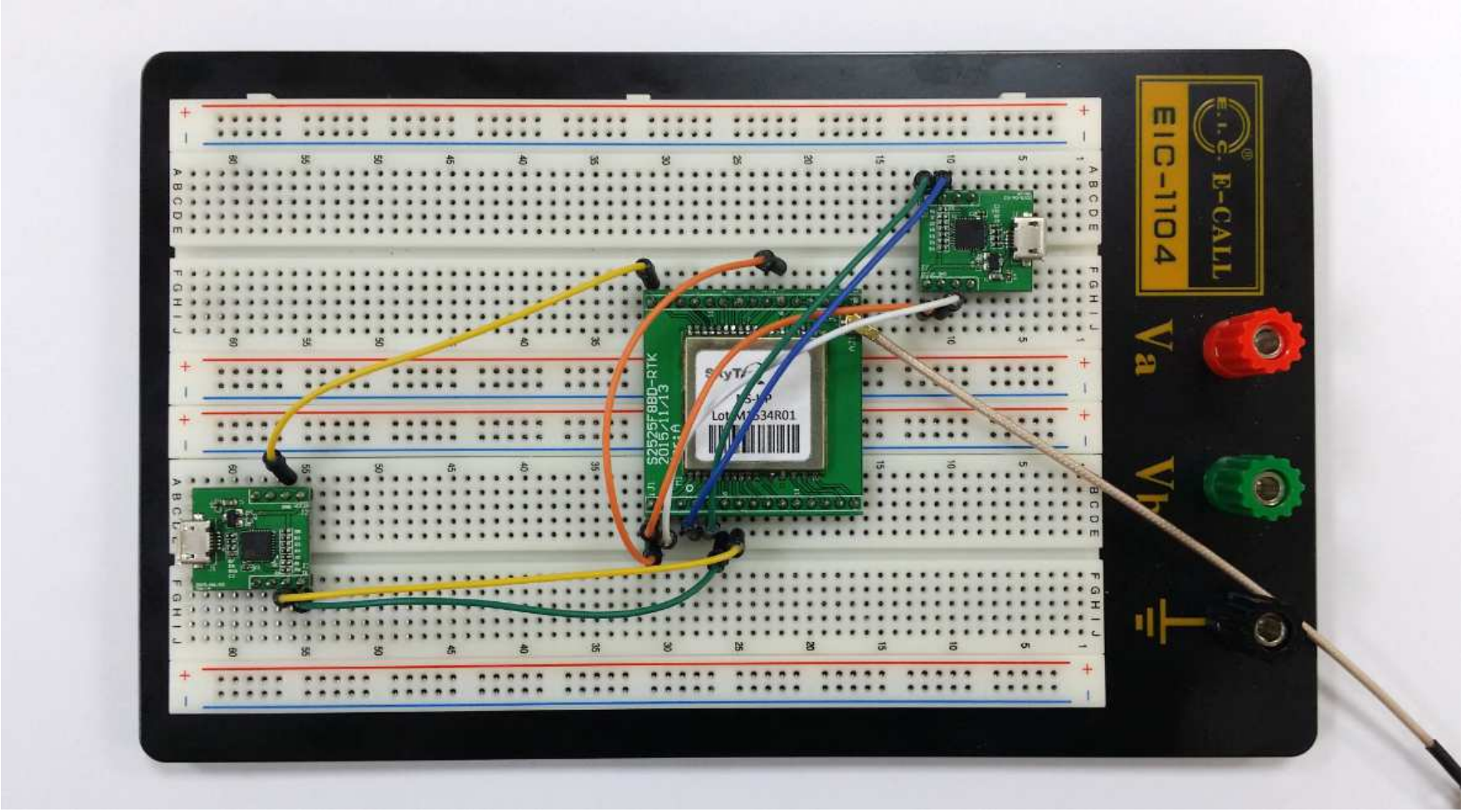
* position refers to the latitude and longitude numbers reported by base or rover

Usage Configuration 1 1/3



Usage Configuration 1　2/3

Can use two UART-to-USB adapter for connecting to PC for Internet connection and seeing result.



Usage Configuration 1 3/3

Upgrade your smartphone GPS to RTK precision

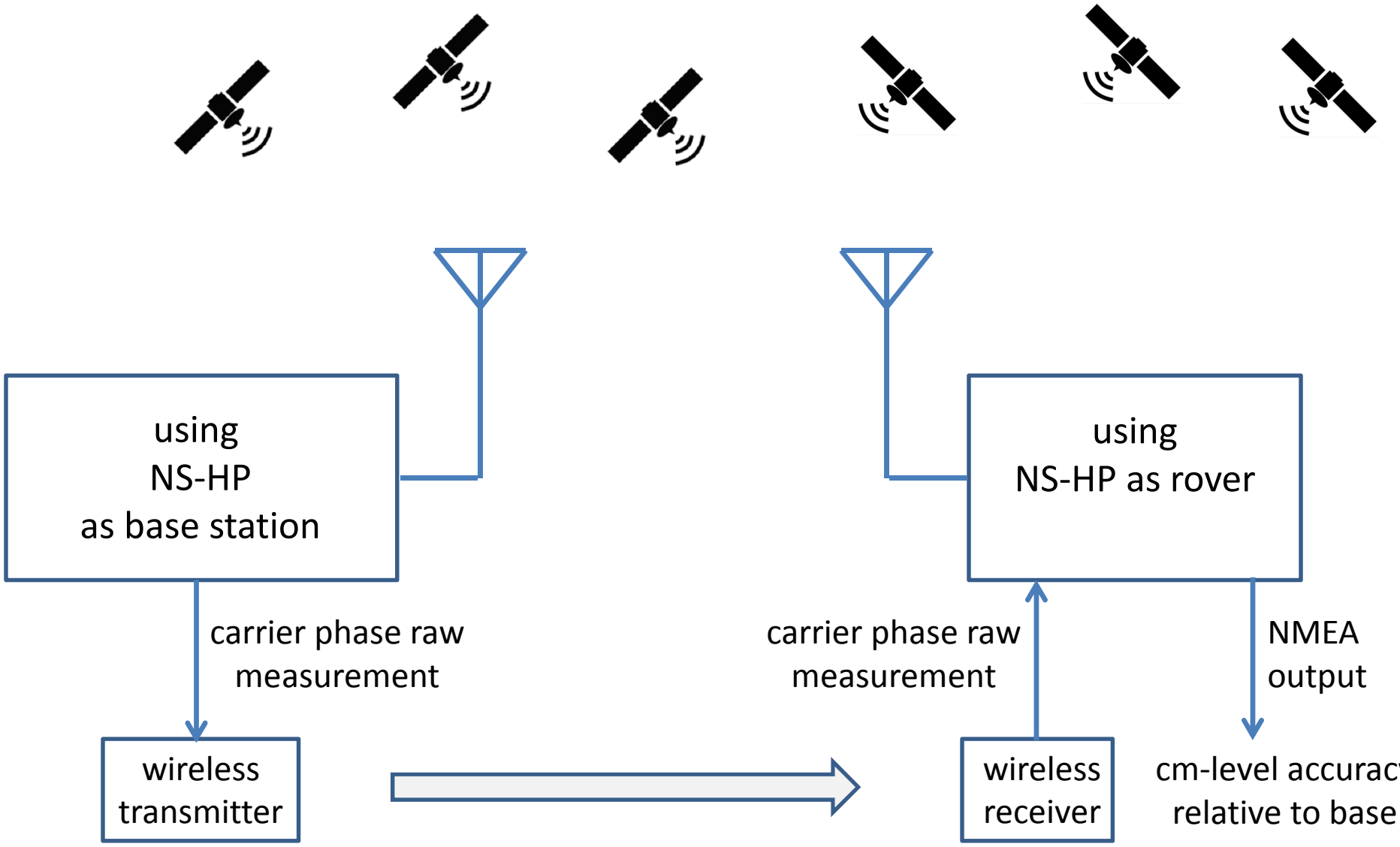
1. Have Internet-connected Android smartphone

2. Use a Bluetooth Serial module (2.1 EDR) connecting to NS-HP UART1 TX1 and UART2 RX2

3. Set smartphone Developer Options to allow mock locations enabling use of external GPS

4. Run NTRIP client software (Lefebure) on the smartphone to stream base station data to NS-HP, retrieve NMEA from NS-HP to make high-precision RTK position available for other Android applications

Usage Configuration 2 1/4



Usage Configuration 2 2/4

- If a known surveyed point exists with centimeter position accuracy, placing base station NS-HP antenna there, and enter the location coordinates into NS-HP, then the rover NMEA output will have cm-level position accuracy.

RTK Usage Configuration 2 3/4

- If no known surveyed point exists, place the base station NS-HP antenna at some fixed location that is to be later used as *reference point*.
- After base station NS-HP self-surveyed, take note of the latitude/longitude location reported, to be entered as base station location for future use; also mark the physical location of the *reference point* for future use.
- Using this method, the rectangular land defined by 4 corners measured by normal GPS receiver that we shown earlier, if measured using RTK receiver over many different days, will only have area shifted in centimeters on Google Earth, not 10 meter!

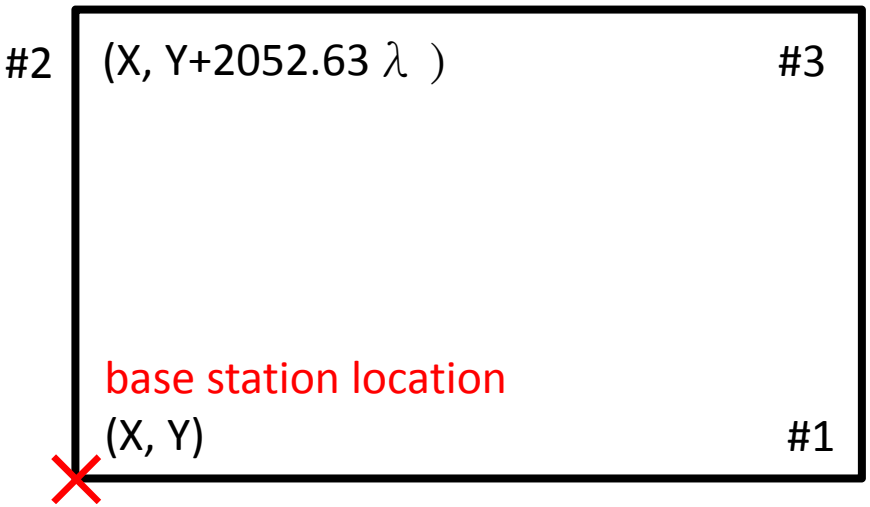
Usage Configuration 2 4/4

With base set at a fixed location, the RTK rover determines the other three corner locations as

#1: 3315.78 wavelength to the right
#2: 2052.63 wavelength to the north
#3: 3315.78 wavelength to the right and 2052.63 wavelength to the north

Once base (X,Y) is given a fixed coordinate, when RTK rover measures the other 3 corner coordinates at different days, the results will only differ by fractional wavelength, yielding centimeter-level accuracy relative to the base.

With this kind of rover-to-base relative positioning application, once base is set at a fixed location, accuracy of the (X,Y) coordinate that we measured, meter or centimeter, is not important, so long as the same (X,Y) coordinate number is used for base location, and base antenna is placed at same location afterwards when using rover to measure position.

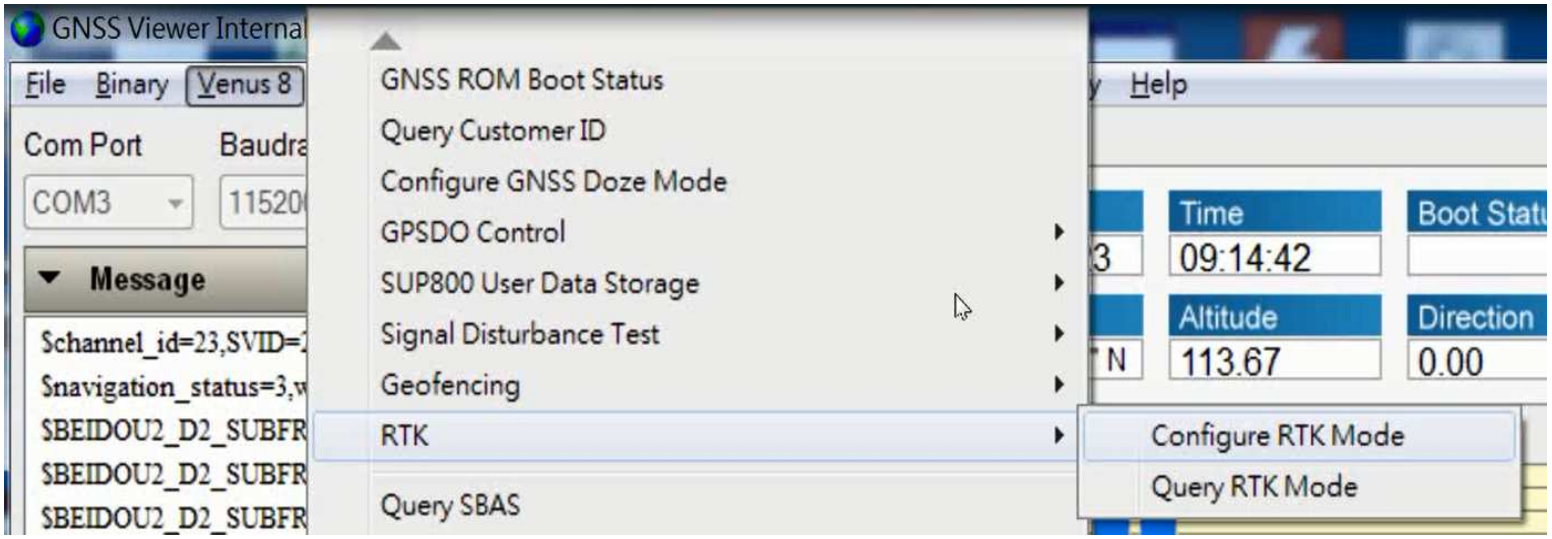


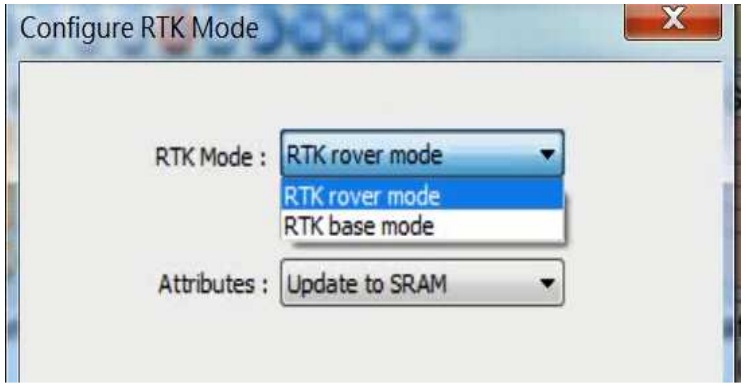
For short baseline open-sky relative positioning application, lower-cost single-frequency RTK receiver could be used, a considerable cost saving from alternative multi-frequency RTK receivers.

Setup as Rover

- From GNSS Viewer*

  Venus8 → RTK → Configure RTK Mode → RTK rover mode



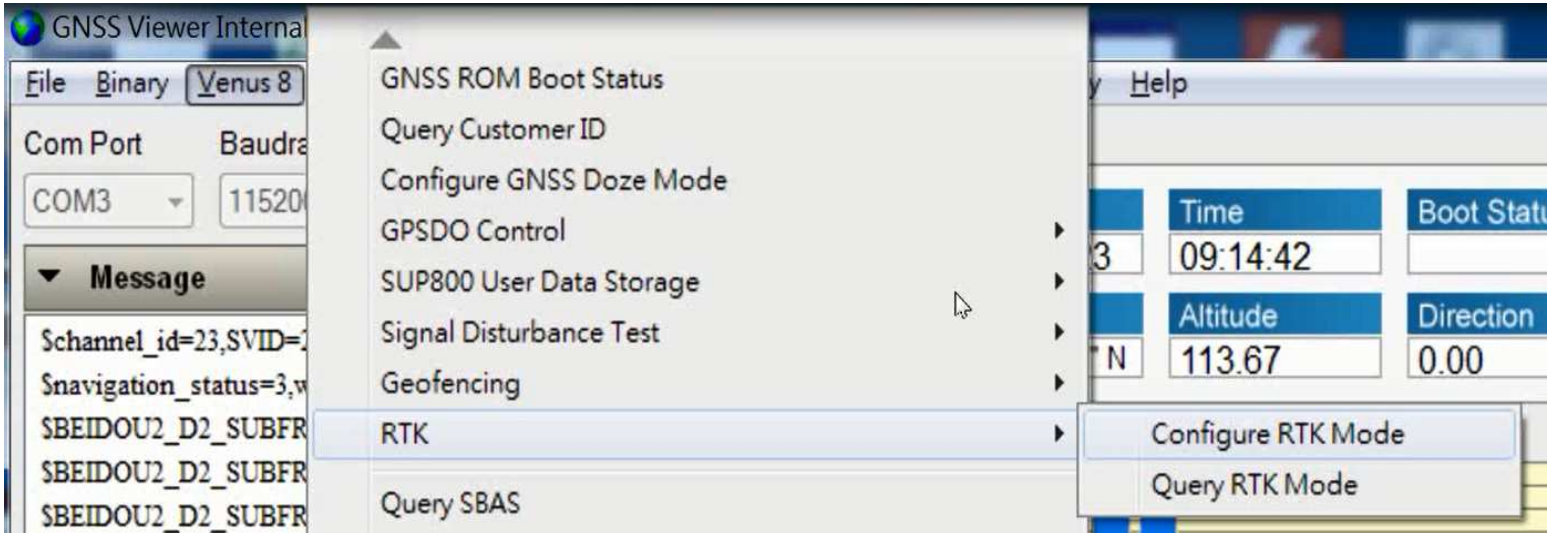


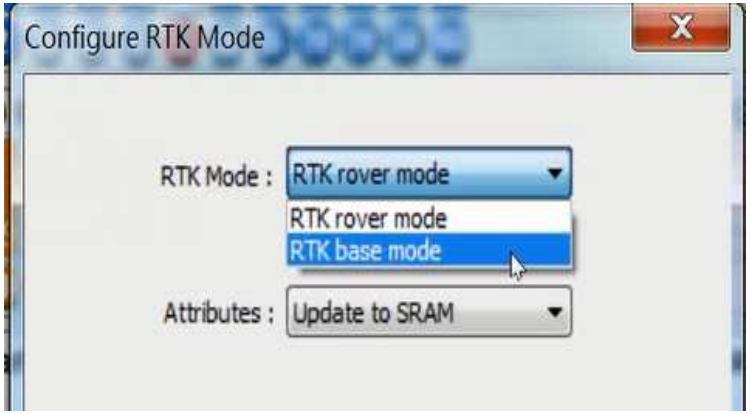
* Using SkyTraq GNSS Viewer
V2.0.166 or higher

Setup as Base (1/2)

- From GNSS Viewer

  Venus8 → RTK → Configure RTK Mode → RTK base mode

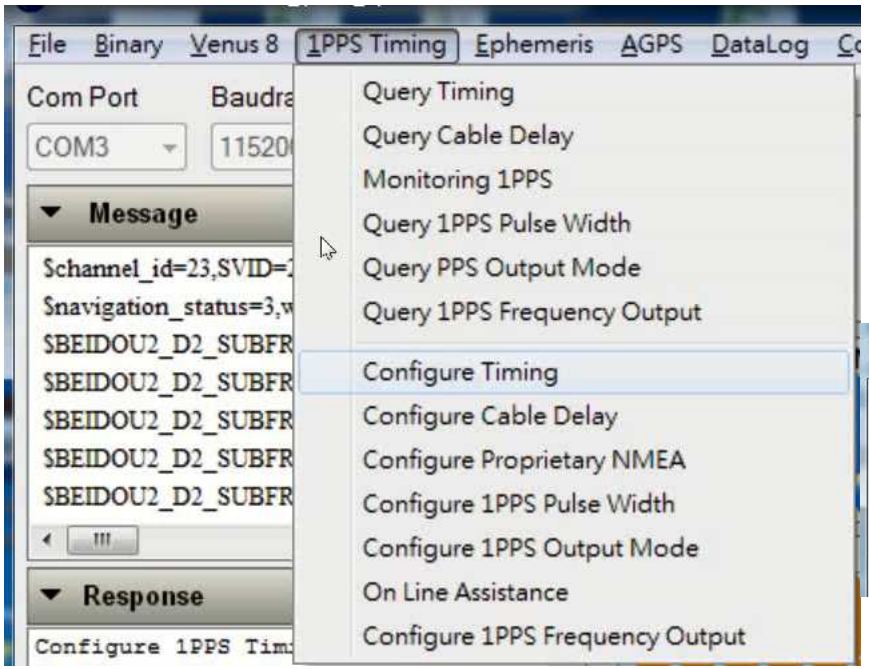


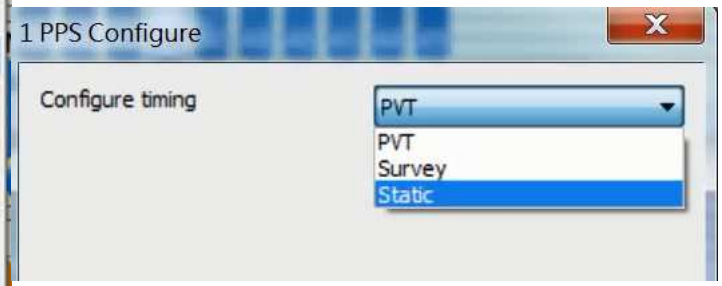


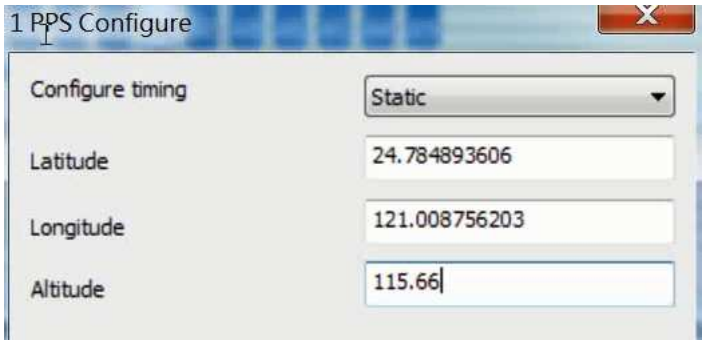
Setup as Base (2/2)

- From GNSS Viewer

  1PPS Timing → Configure Timing → Static (*input base position*)







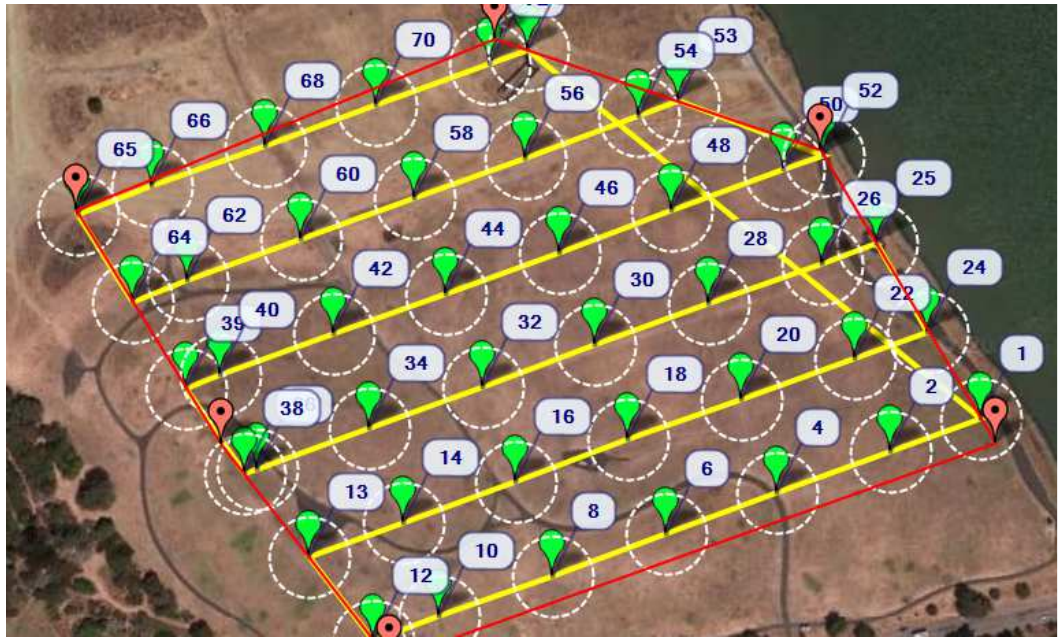
Application Example 1

- Precision Machine Control

  Once coordinates of the polygon corners are determined by the rover, precision steering of machine can be controlled by the autopilot software using the cm-level accuracy position provided by the RTK rover

Application Example 2

- Precision Aerial Imaging
  - RTK rover equipped UAV can take photo at predefined locations, centimeter-level exact, resulting in images that are always taken at the right spot, always consistent.
  - Acquire same amount of image data when flying against or with the wind.



Available Models

	RTK Maximum Update Rate			Time/Position Stamp
	1Hz	5Hz	10Hz	
NS-HP	X			
NS-HP-5		X		
NS-HP-5S		X		X
NS-HP-10			X	
NS-HP-10S			X	X

NS-HP
Affordable RTK Capable GNSS Receiver