Introduction to GNSS Base-Station

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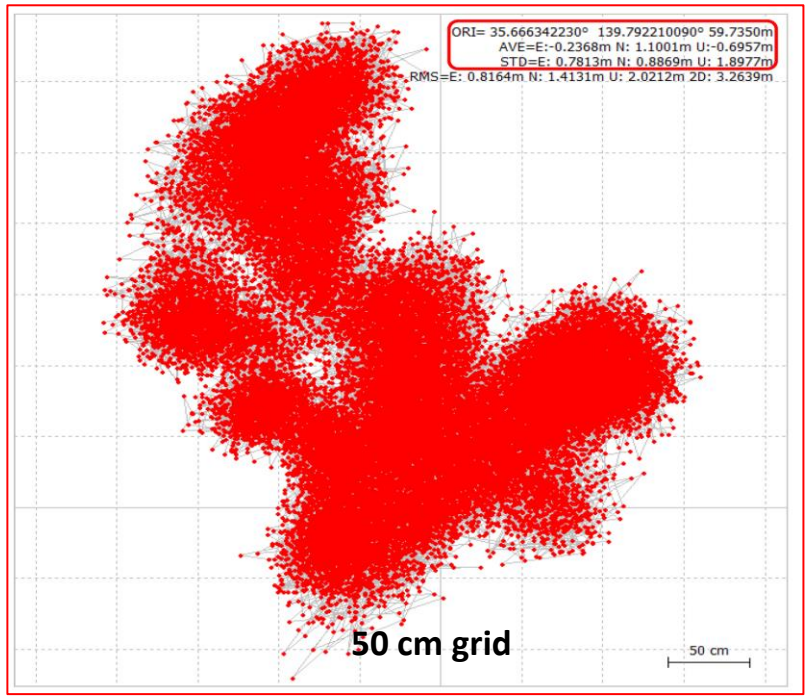
GNSS Errors Introduction

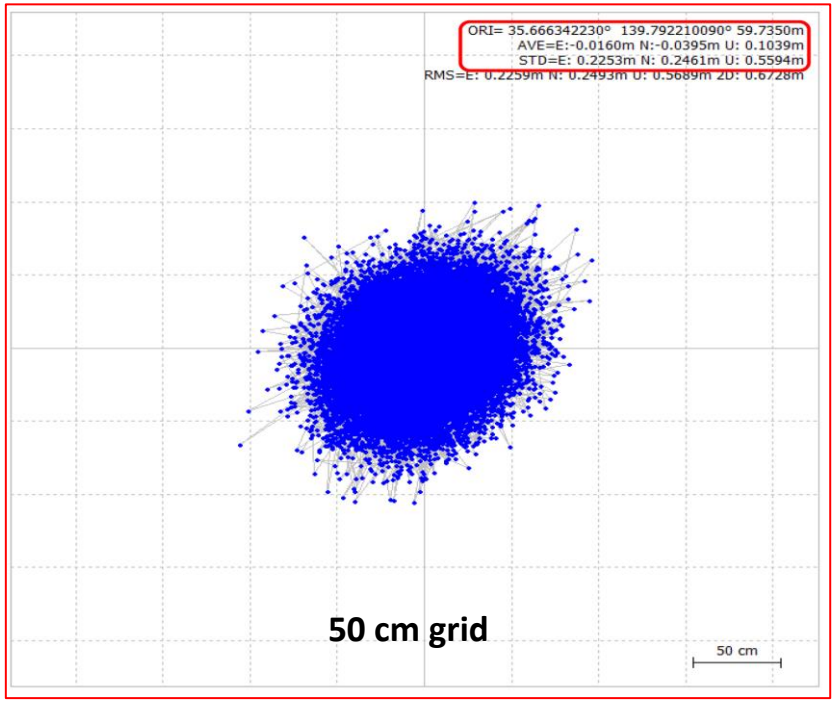
- GPS or GNSS observation has many types of errors. Due to these errors, the accuracy of a GPS receiver is limited. Currently about 10m accuracy is possible with Single Standard Observation.

- However, *some of these errors can be removed or reduced by using proper observation techniques* to provide few centimeter accuracy. This can be done by using a Base-Station within a limited base-length from the Rover (user) receiver.

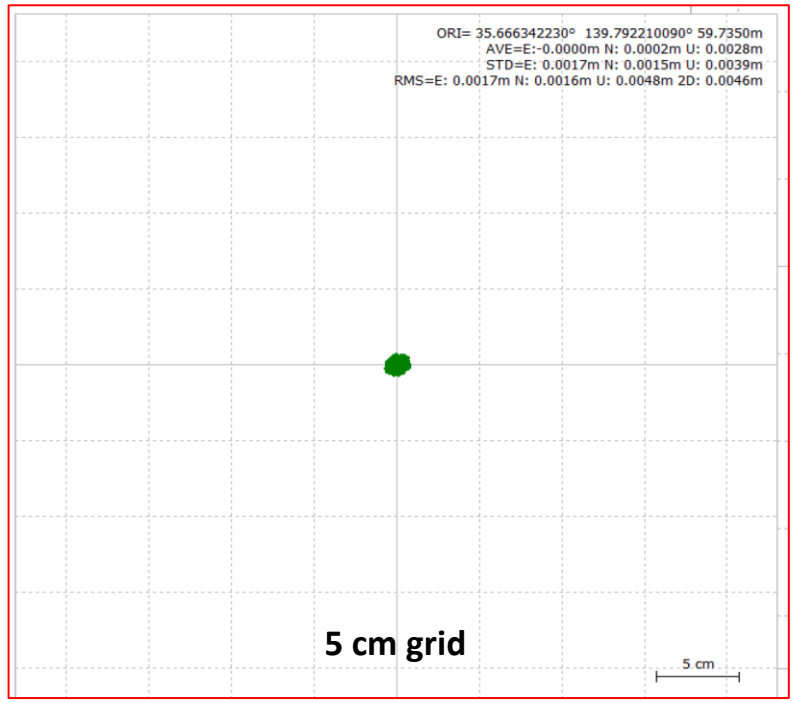
How accurate is GPS Position?



SPP (Single Point Position)



DGPS (Differential GPS)



RTK (Real Time Kinematic)

How to get accuracy from Red Dots to Green Dots?

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Errors in GPS Observation (L1C/A Signal)

Error Sources	One-Sigma Error , m		Comments
	Total	DGPS	
Satellite Orbit	2.1	0.0	Common errors are removed
Satellite Clock	2.1	0.0	
Ionosphere Error	4.0	0.4	Common errors are reduced
Troposphere Error	0.7	0.2	
Multipath	1.4	1.4	
Receiver Circuits	0.5	0.5	

If we can remove common errors, position accuracy can be increased.

Common errors are: <u>Satellite Orbit Errors, Clock Errors and Atmospheric Errors (within few km)</u>

Table Source : http://www.edu-observatory.org/gps/gps_accuracy.html#Multipath

The values shown here are only approximate values for comparison purpose. Actual values may differ.

High-Accuracy Observation Methods

- Basically three types of Observation
  - DGPS (Differential GPS)
    - Code-phase observation
    - Requires Base-station (Reference Station)
  - RTK (Real Time Kinematic)
    - Code-phase and Carrier-Phase Observation
    - Requires Base-station (Reference Station)
  - PPP (Precise Point Positioning)
    - Code-phase and Carrier-phase observation
    - Does not require base-station

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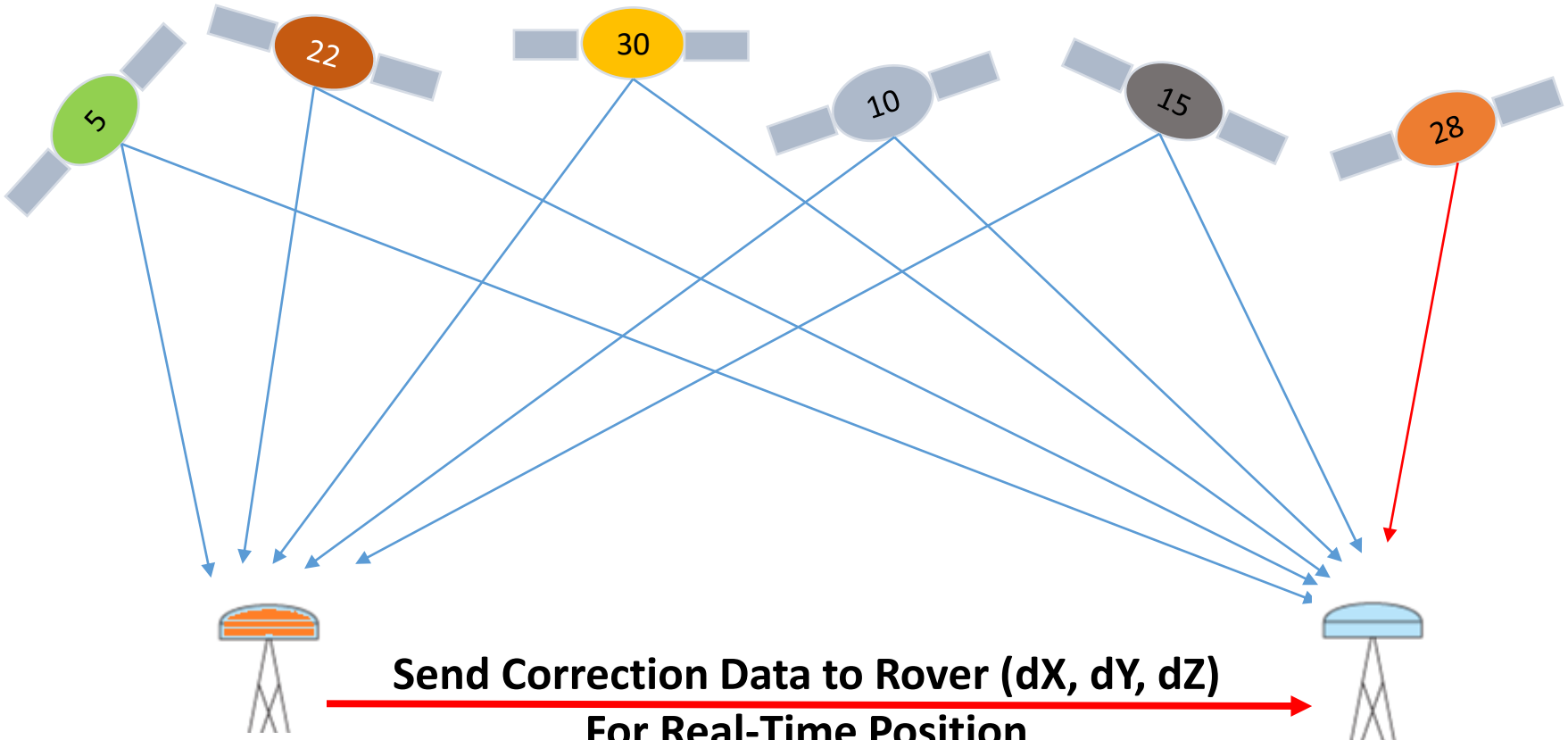
Principle of Differential Correction (DGPS and RTK)



SPS (Standard Positioning Service) vs. PPP (Precise Point Positioning)

SPS

Use Broadcasted orbit and Clock Information from Navigation Data

+

Satellite Tracking Information Pseudorange etc

=

Meter Level Position Estimates

PPP

Use Precise Orbit and Clock Information Provided by Service Providers

+

Satellite Tracking Information Pseudorange, Carrier Phase etc

+

Additional Error Modelling Atmospheric Models etc

=

Deci-meter to centimeter level Position Estimates

* This slide is based on Dr. Choy's lecture note on PPP

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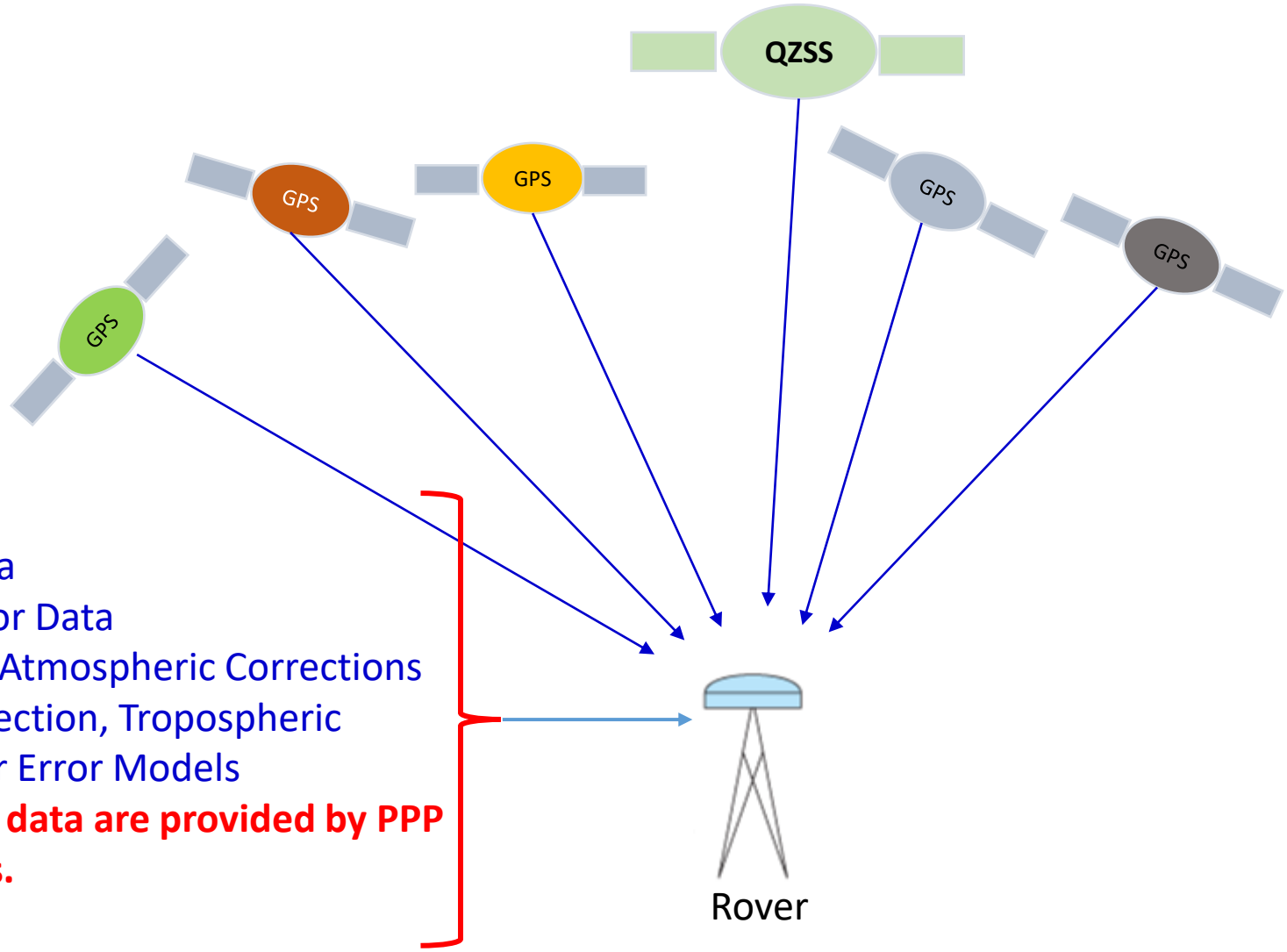
PPP Observation



Correction Data
Precise Orbit Data
Precise Clock Error Data
Error Models for Atmospheric Corrections
Ionospheric Correction, Tropospheric Correction, Other Error Models
These correction data are provided by PPP service providers.

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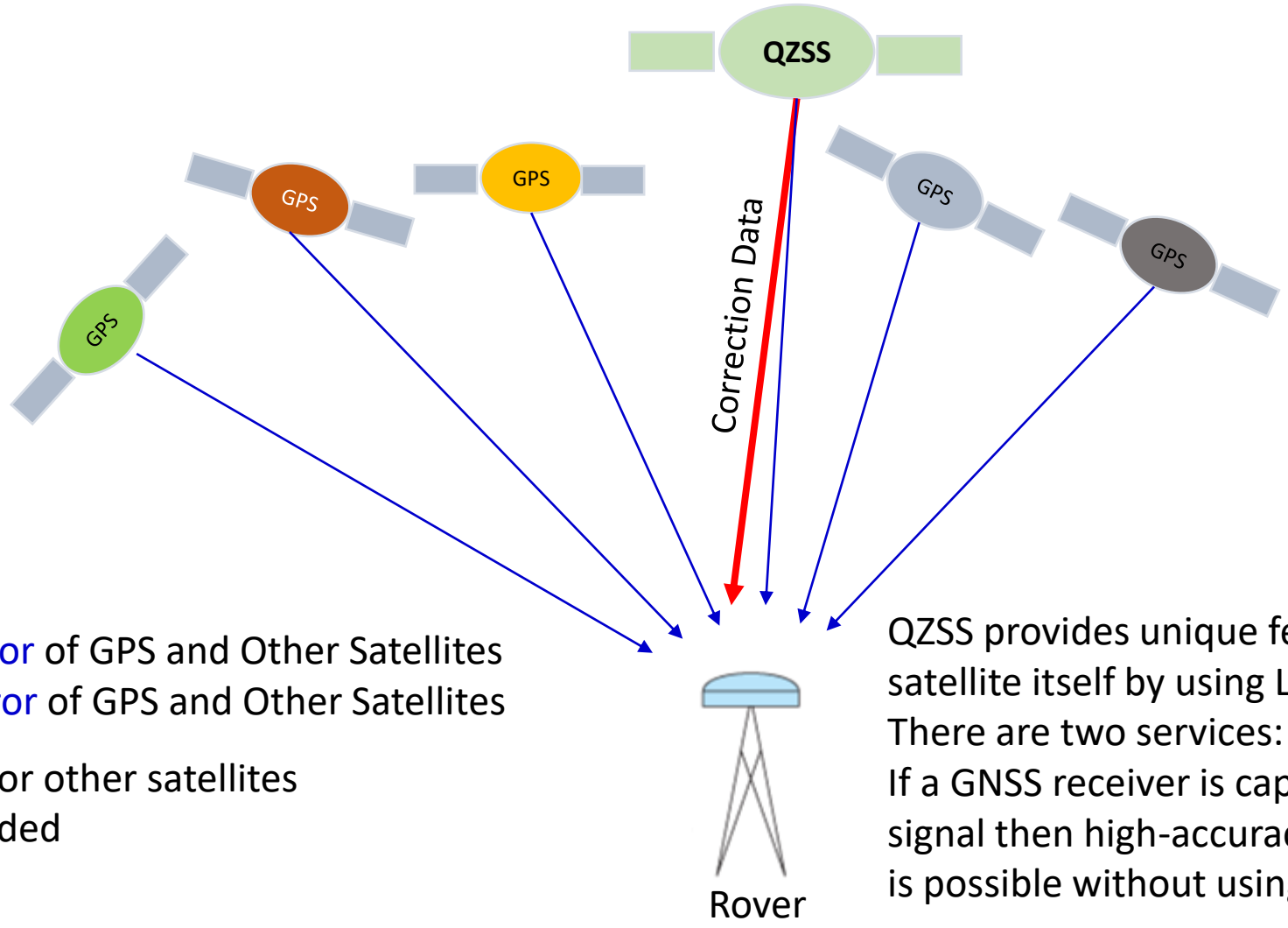
Principle of QZSS MADOCA and CLAS Services



Correction Data:
Satellite Orbit Error of GPS and Other Satellites
Satellite Clock Error of GPS and Other Satellites

Correction data for other satellites will also be provided

QZSS provides unique feature of PPP from the satellite itself by using L6 signal.
There are two services: MADOCA and CLAS
If a GNSS receiver is capable of receiving QZSS L6 signal then high-accuracy (few cm level) positioning is possible without using base-station data.

PPP Online Service Providers

1. CSRS-PPP: Canadian Spatial Reference System, Natural Resources Canada
2. MagicGNSS: GMV
3. CenterPoint RTX: Trimble Navigation
4. GAPS: University of New Brunswick
5. APPS: Jet Propulsion Laboratory
6. SCOUT: Scripps Orbit and Permanent Array Center (SOPAC), University of California, San Diego

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Submit RINEX Files

- CSRS-PPP
  - https://webapp.geod.nrcan.gc.ca/geod/tools-outils/ppp.php
- MagicGNSS
  - https://magicgnss.gmv.com
- CenterPoint RTX
  - http://trimblertx.com
- AUSPOS
  - http://www.ga.gov.au/bin/gps.pl
- GAPS
  - http://gaps.gge.unb.ca/submitbasic.php
- Trimble RTX
  - https://trimblertx.com/

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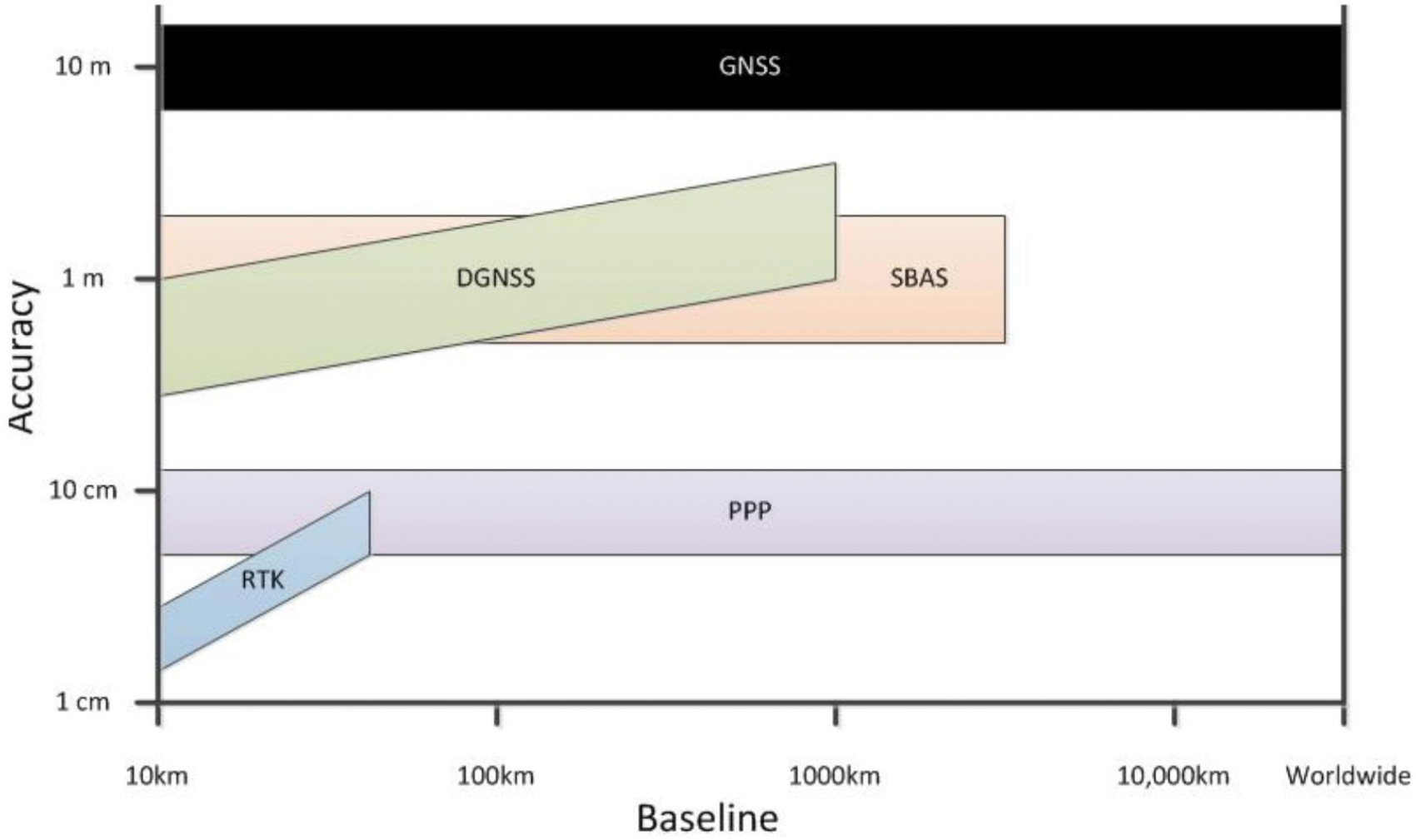
Which Method: DGPS, SBAS, RTK, PPP?



http://www.novatel.com/an-introduction-to-gnss/chapter-5-resolving-errors/