Introduction to GNSS Base-Station

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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 Observation.

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

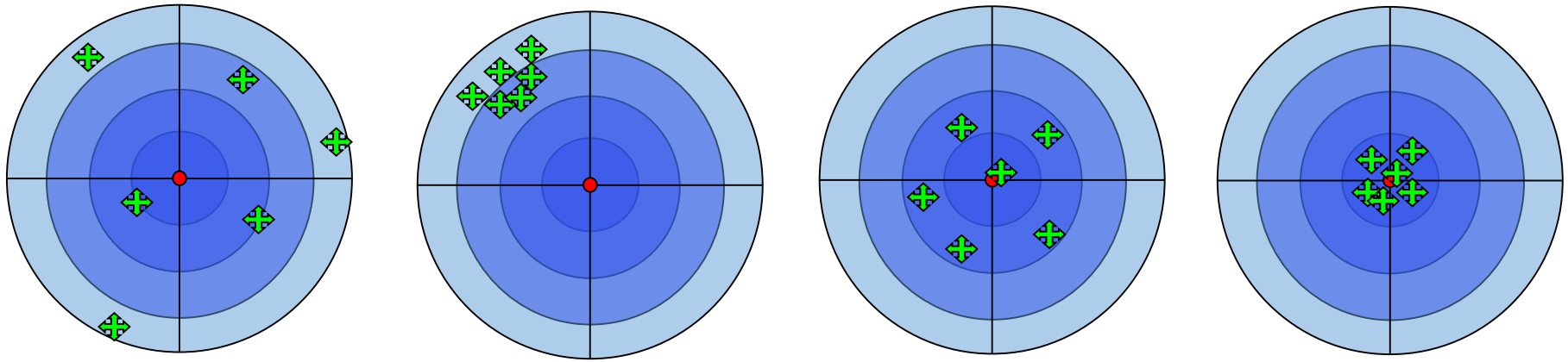
- In the next few slides, we will see types of errors and how they can be removed.

What is a Base-Station?

- A Base-Station is a station where a GNSS receiver is installed at a known location.
  - Also called Reference Station
  - CORS (Continuously Operating Reference Station)
- The location is pre-surveyed by either traditional methods or by GNSS observation for multiple days.
- The Base-station then provides error data for every observation compared to it's known location.

Accuracy vs. Precision

- Accuracy
  - Capable of providing a correct measurement
  - Measurement is compared with true value
  - Affected by systematic error
- Precision
  - Capable of providing repeatable and reliable measurement
  - Statistical analysis of measurement provides the precision
  - Measure of random error
  - Systematic error has no effect



Neither Precise nor Accurate | Precise but Not Accurate | Accurate but Not Precise | Precise and Accurate

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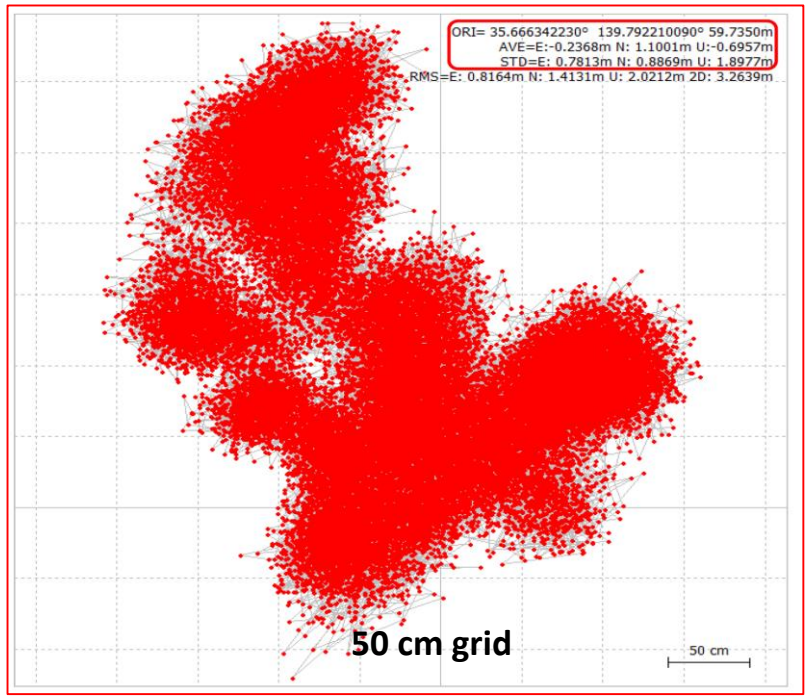
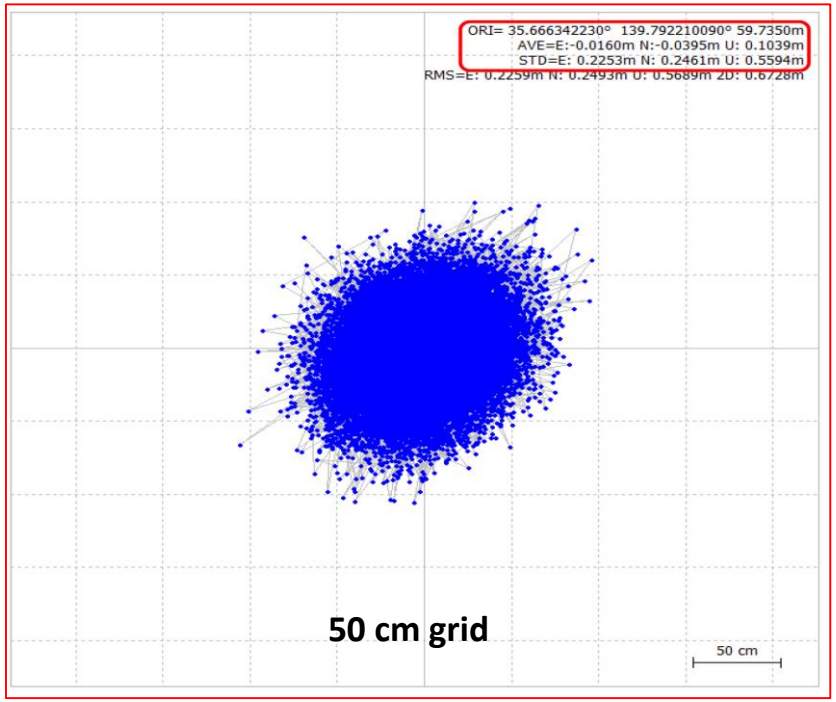
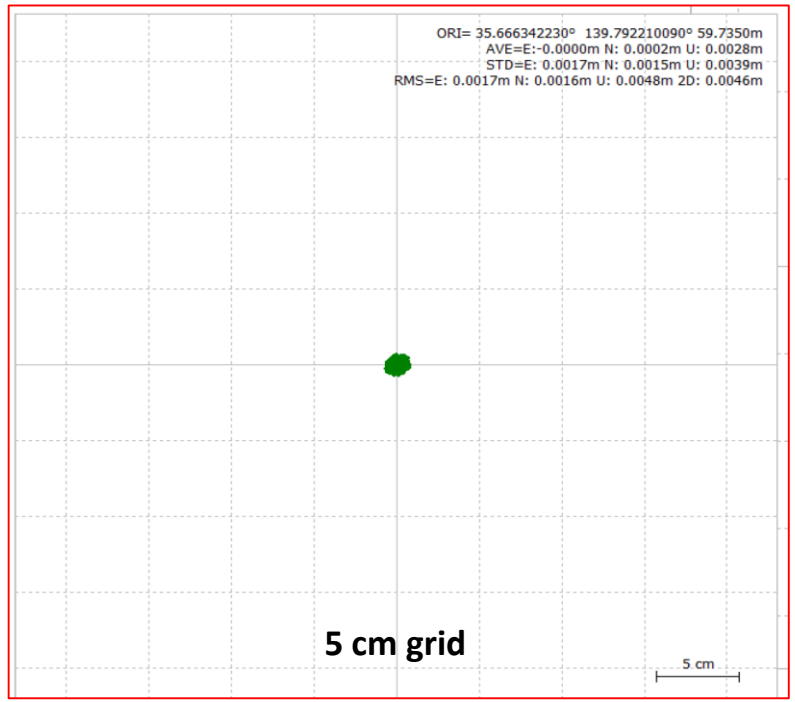
How accurate is GPS Position?



SPP (Single Point Position)



DGPS (Differential GPS)



RTK (Real Time Kinematic)

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.

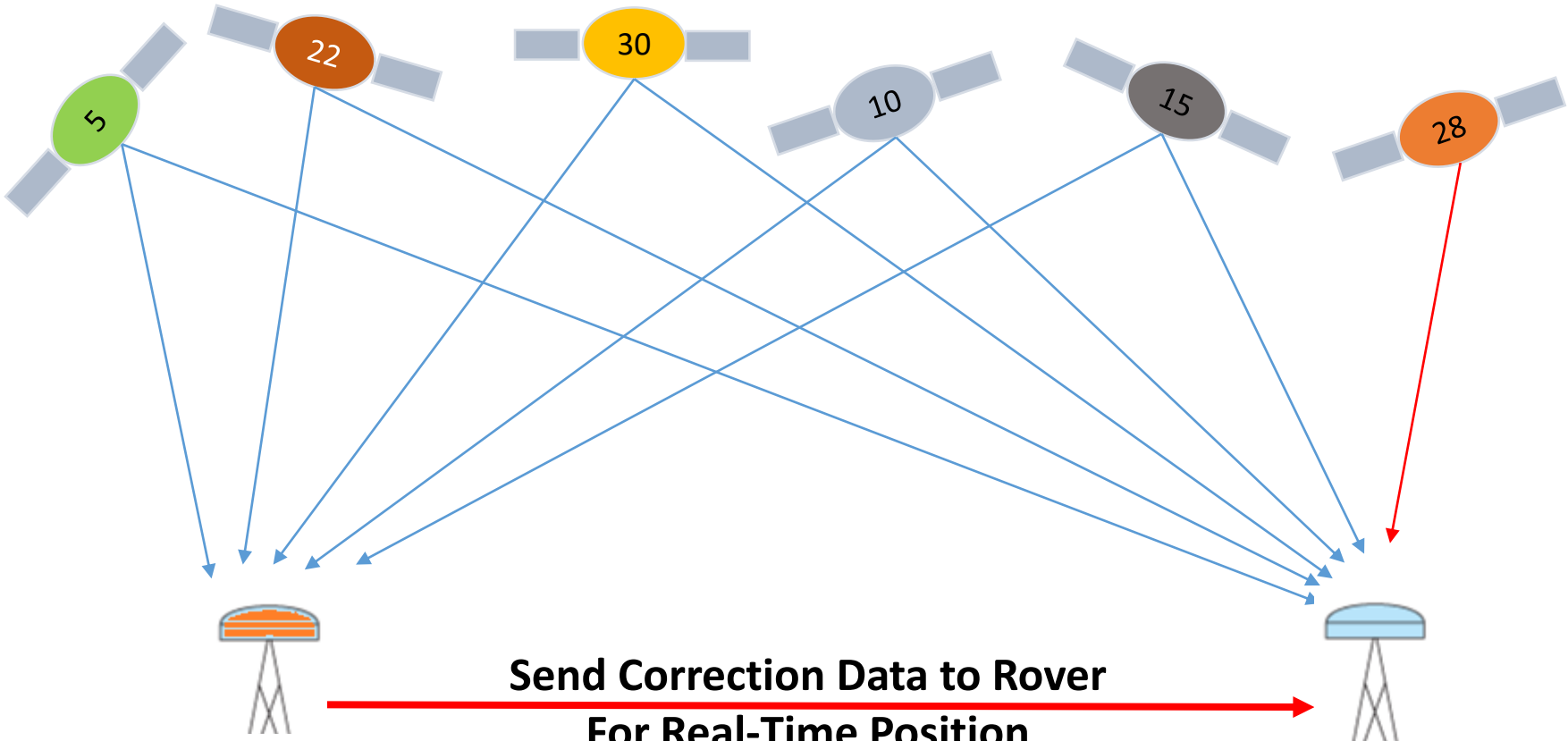
Common errors are: <u>Satellite Orbit Errors, Clock Errors and Atmospheric Errors (within few km)</u>

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

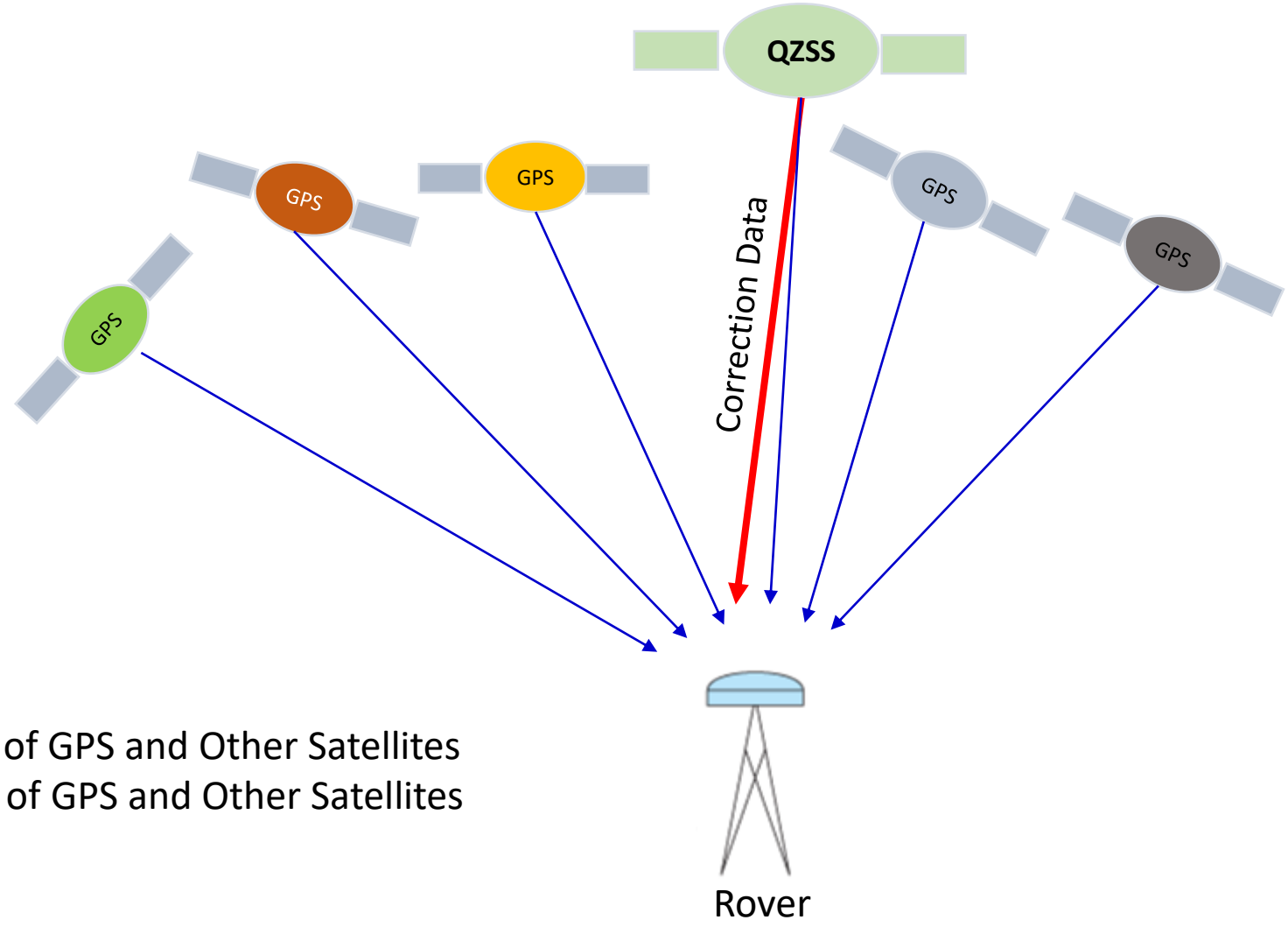
How to Remove the Errors?

- Averaging of Repeated Observation
- Modeling of Phenomena that Causes Errors
- Differential Corrections
  - DGPS, SBAS, GBAS
    - Single frequency observation is OK
    - Code Observation
  - RTK
    - Normally multi-frequency observations
    - Single frequency RTK is also performed for smaller base-length
    - Code and Carrier Observation
- PPP
  - Precise Point Positioning

Principle of Differential Correction

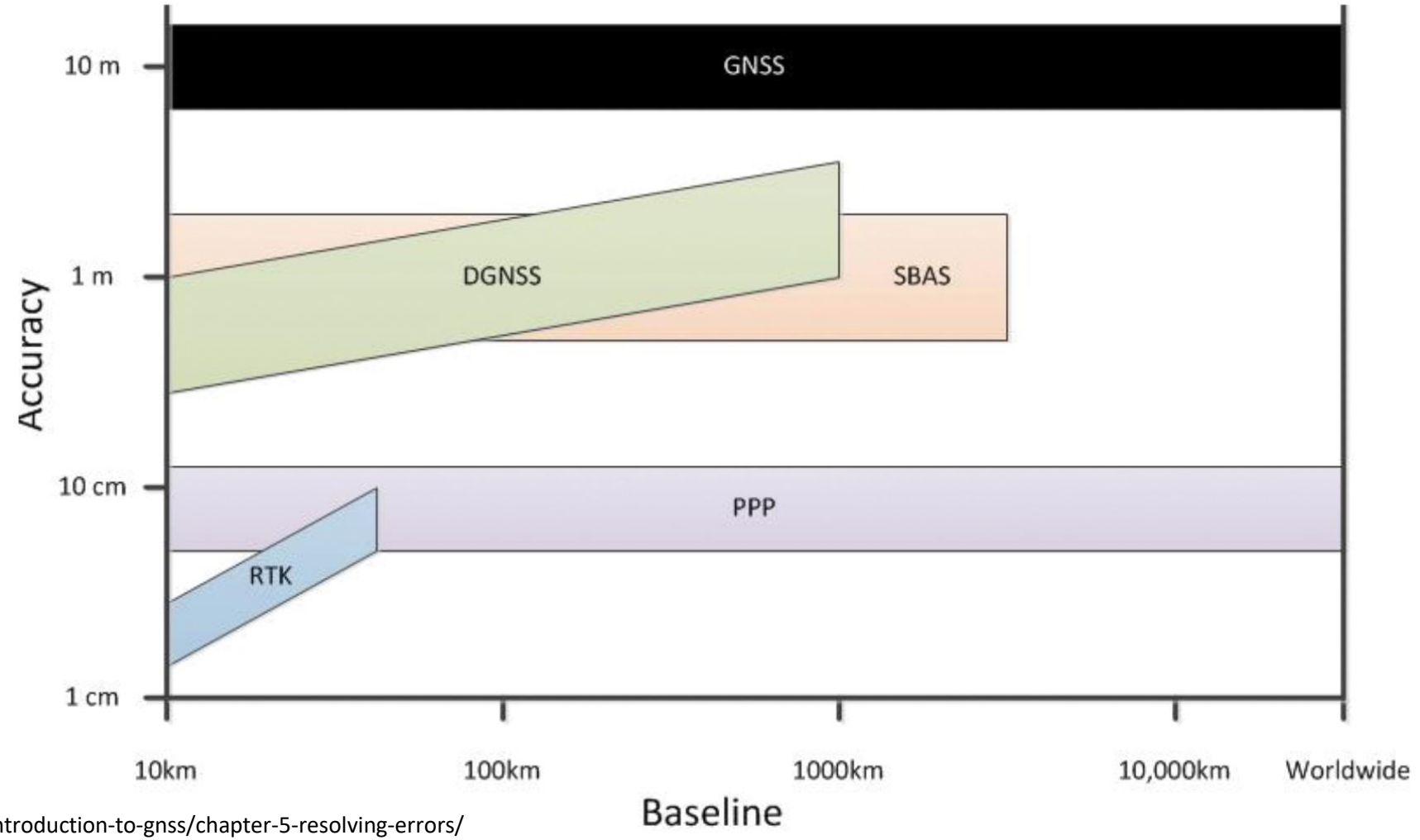


Principle of QZSS MADOCA / CLAS Service



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

Which Method: DGPS, SBAS, RTK, PPP?



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