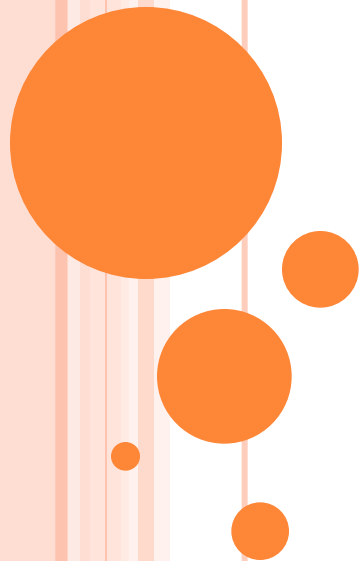


INTRODUCTION TO GPS

GPS WORKSHOP
February 10, 2011 OSU

Michael Olsen, PhD
Mark L. Armstrong, PLS



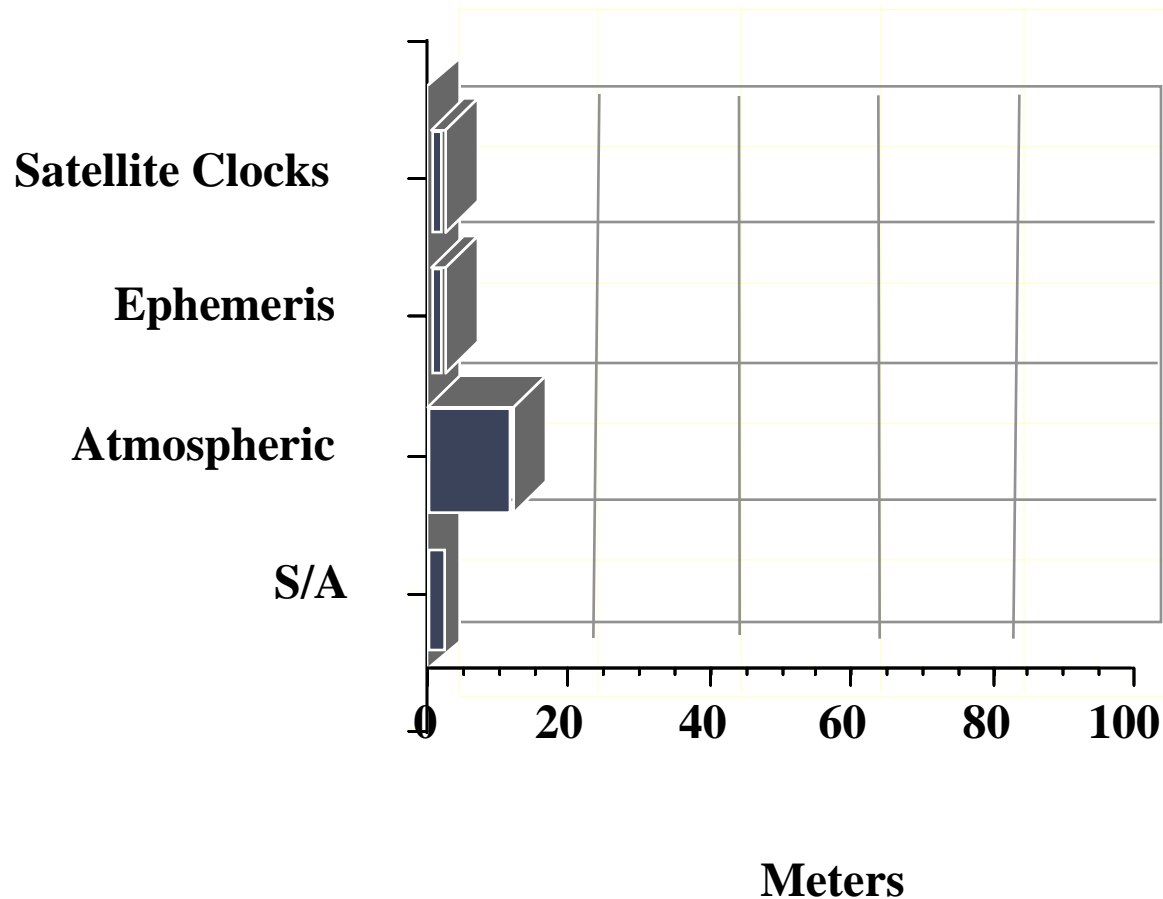
PART II

- Error Sources and concerns in GPS



GPS ERROR TYPES

- System-wide errors - DGPS Correctable



GPS ERROR TYPES

Local (related to a single GPS receiver) errors - Not DGPS Correctable

- Multipath
 - Use a ground plane on antenna
 - Move away from multipath source
- Receiver Channel noise
 - Use a different GPS receiver
- 2-D fix with a bad altitude
 - Use Manual 3D when collecting data
- High PDOP (Position Dilution of Precision)
 - Wait for the geometry to change



MANY ACCURACIES CAN BE ACHIEVED

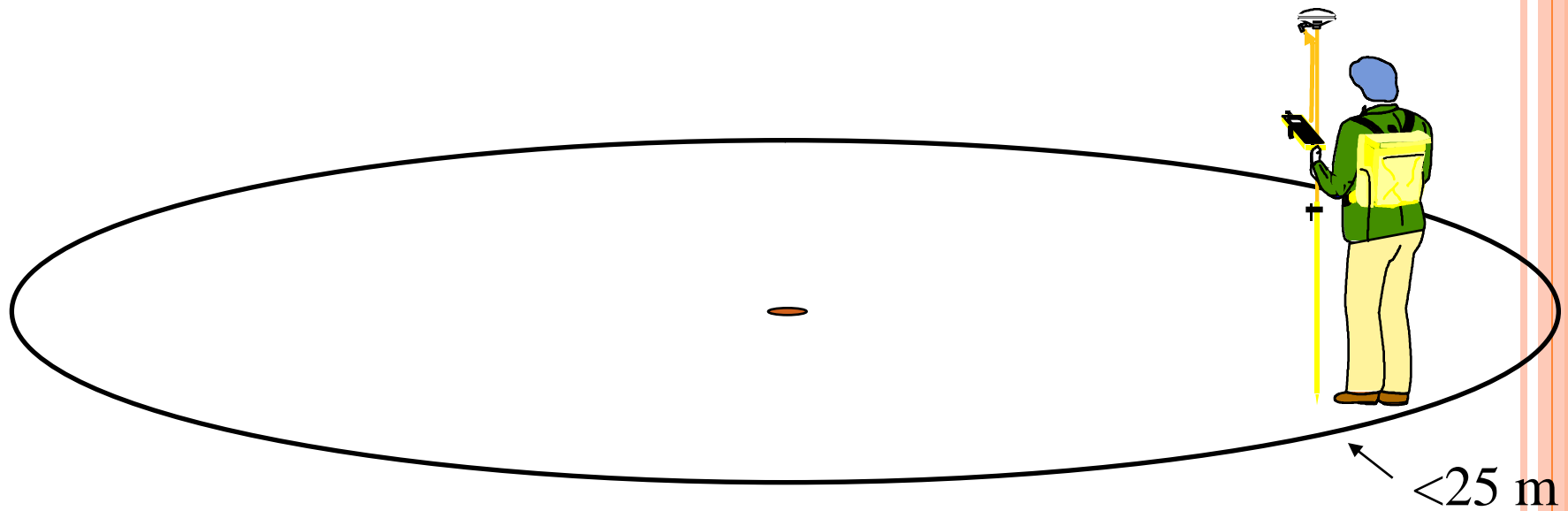
These depend on some variables

- Design of receiver
- Relative positions of satellites
- Time spent on measurements
- Use of Differential techniques

The following slides are horizontal RMS (Root Mean Square - 95th percentile)



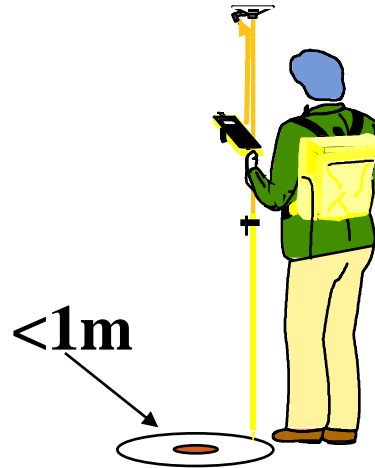
STANDARD POSITIONING SERVICE -SPS (C/A-CODE) - AUTONOMOUS GPS



HIGH QUALITY MAPPING RECEIVER SPS-DGPS



Base Station



SURVEY GRADE GPS



Base Station



<1 to 2 cm



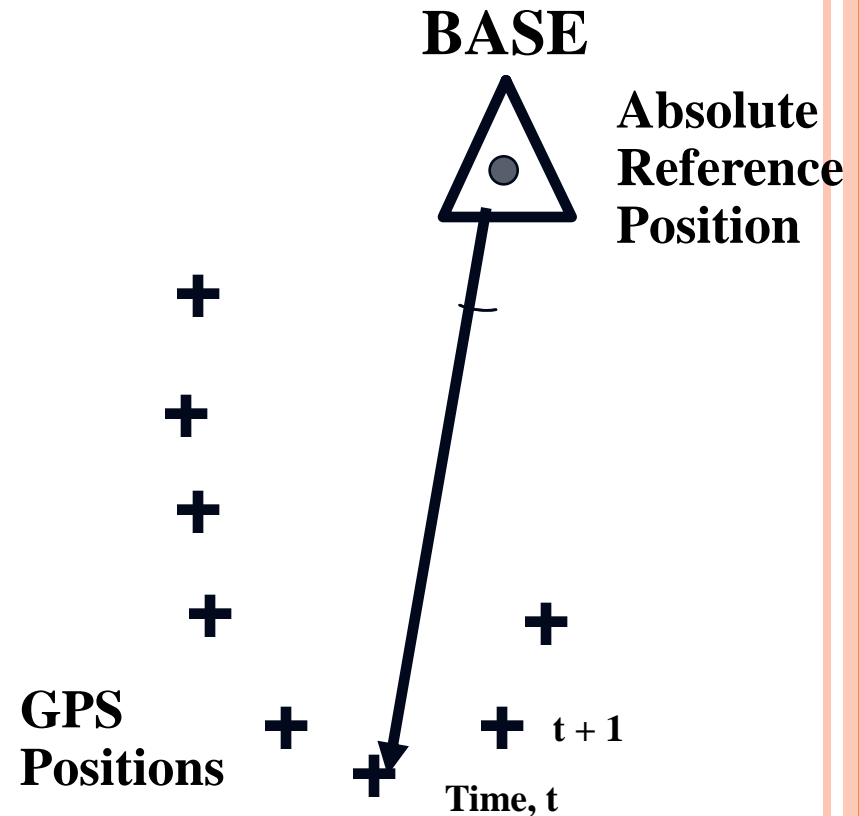
DIFFERENTIAL CORRECTION

- Base Station generates corrections for all satellites in view
- A roving GPS receiver uses these corrections to remove correctable errors
- Differential correction can be performed in either real-time or postprocessed mode

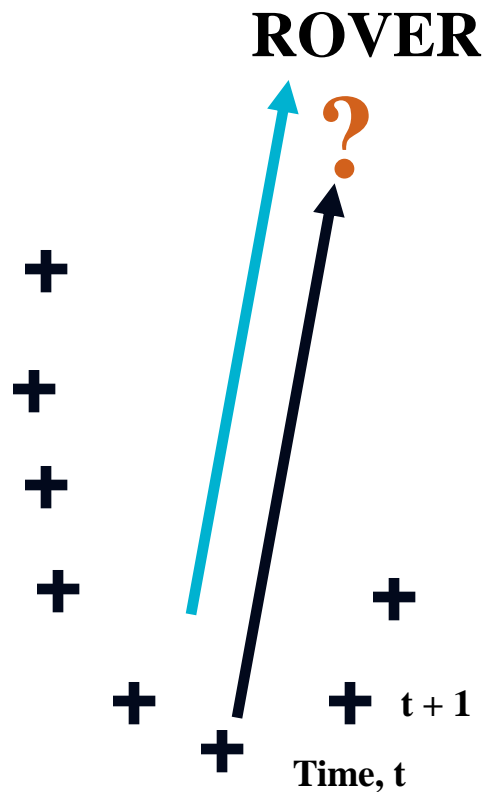


DIFFERENTIAL CORRECTION (SIMPLIFIED)

- If you collect data at one location, there will be errors
- Each of these errors are tagged with GPS time



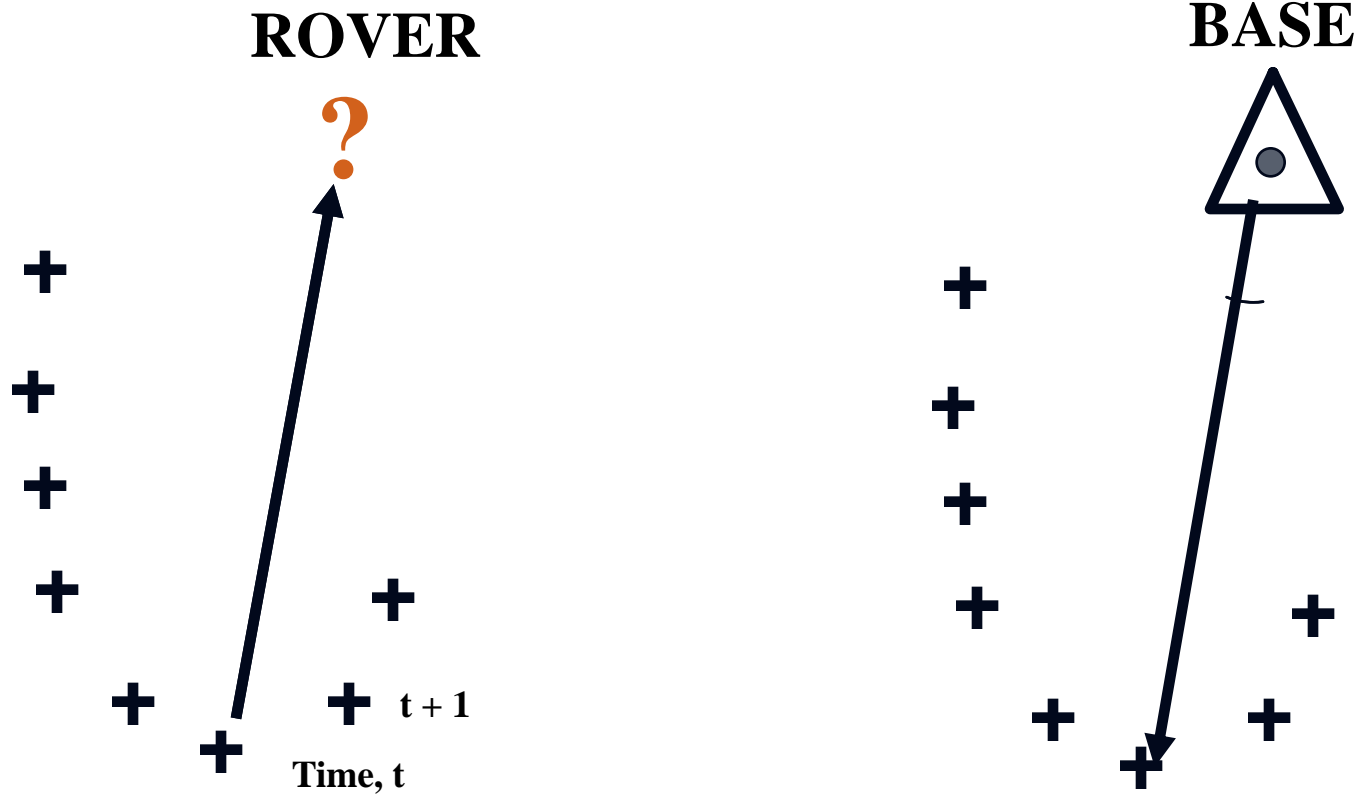
DIFFERENTIAL CORRECTION (CONT.)



- At the same time, the errors occurring at one location are occurring everywhere within the same vicinity



DIFFERENTIAL CORRECTION (CONT.)



Satellites Used

1 2 3 4

1 3 5 6

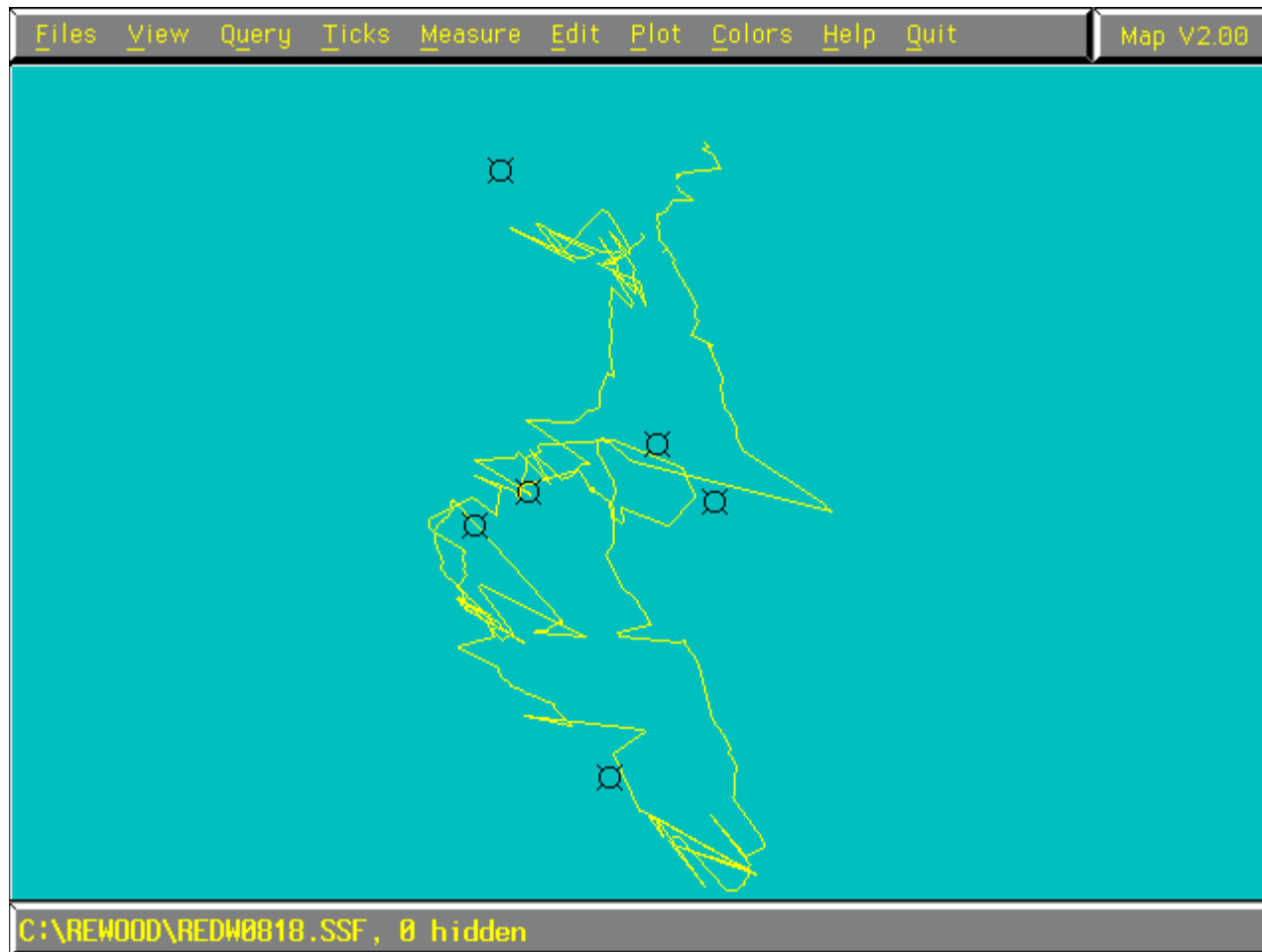
Any Combination of Base satellites

Satellites Seen

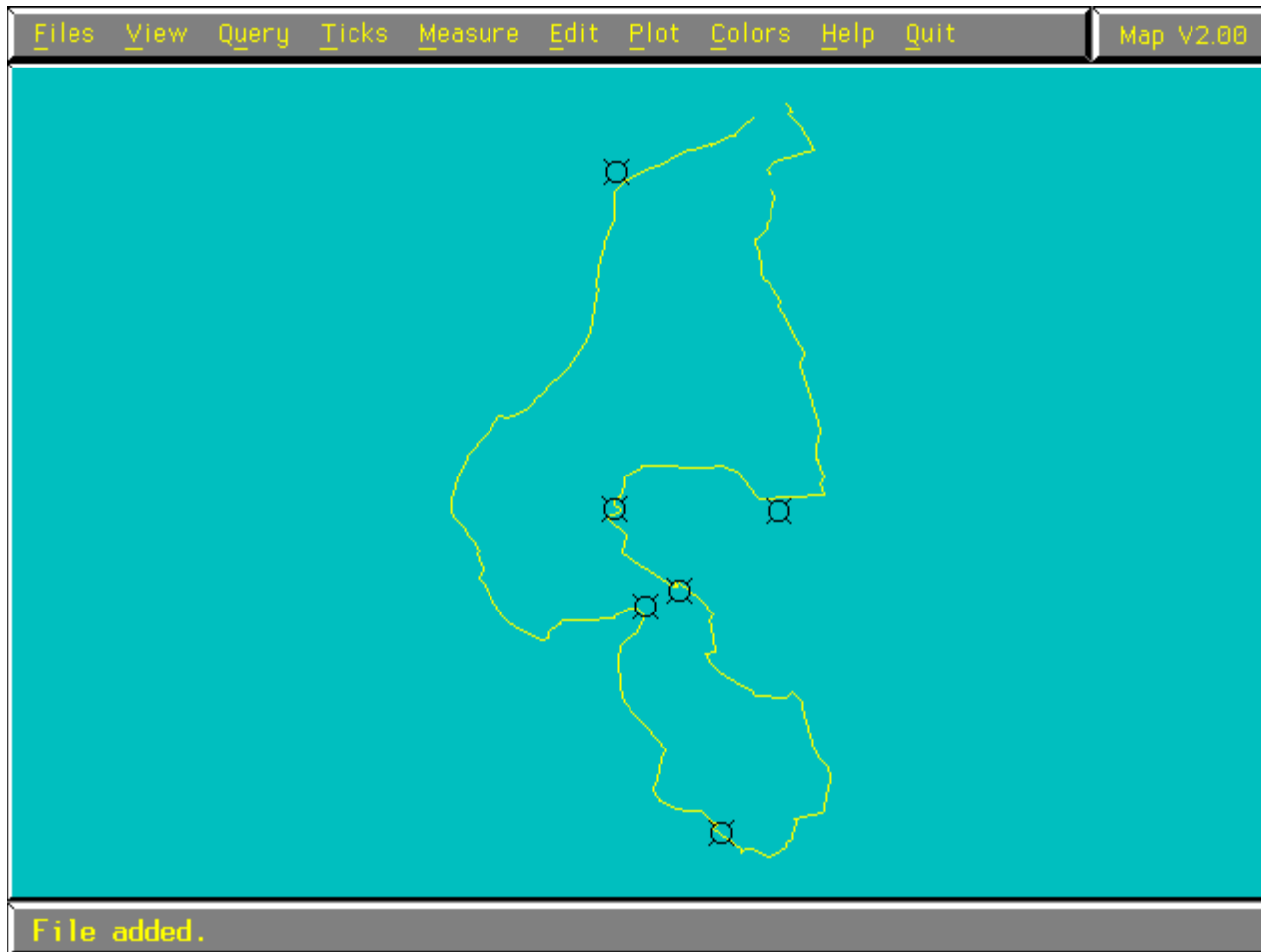
1 2 3 4 5 6 7 8



EXAMPLE OF UNCORRECTED FILE



EXAMPLE OF CORRECTED FILE



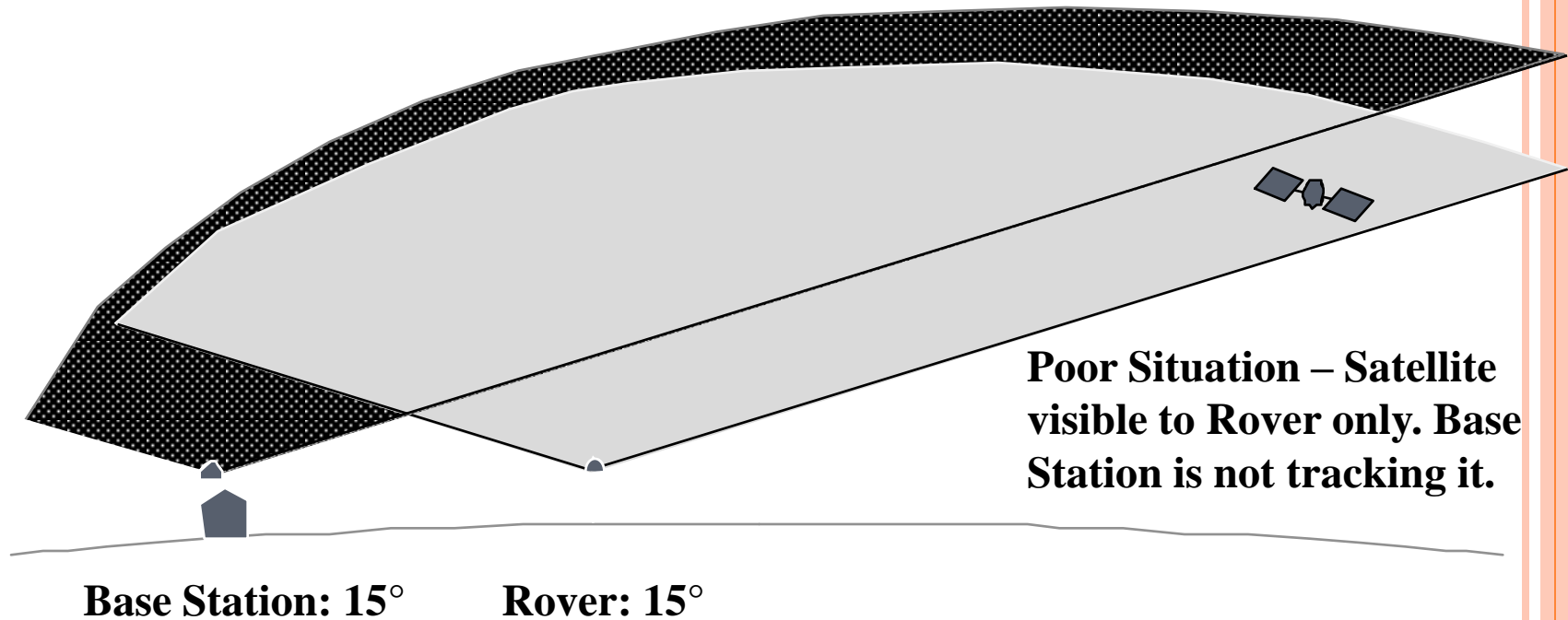
BASE STATION SITE REQUIREMENTS

- Clear view to satellites
- Autonomous or seeded coordinates
- Clear of transmitters (TV, radar)
- Line of site to rover is not necessary
- Close to where you are surveying (typically within 70 km)



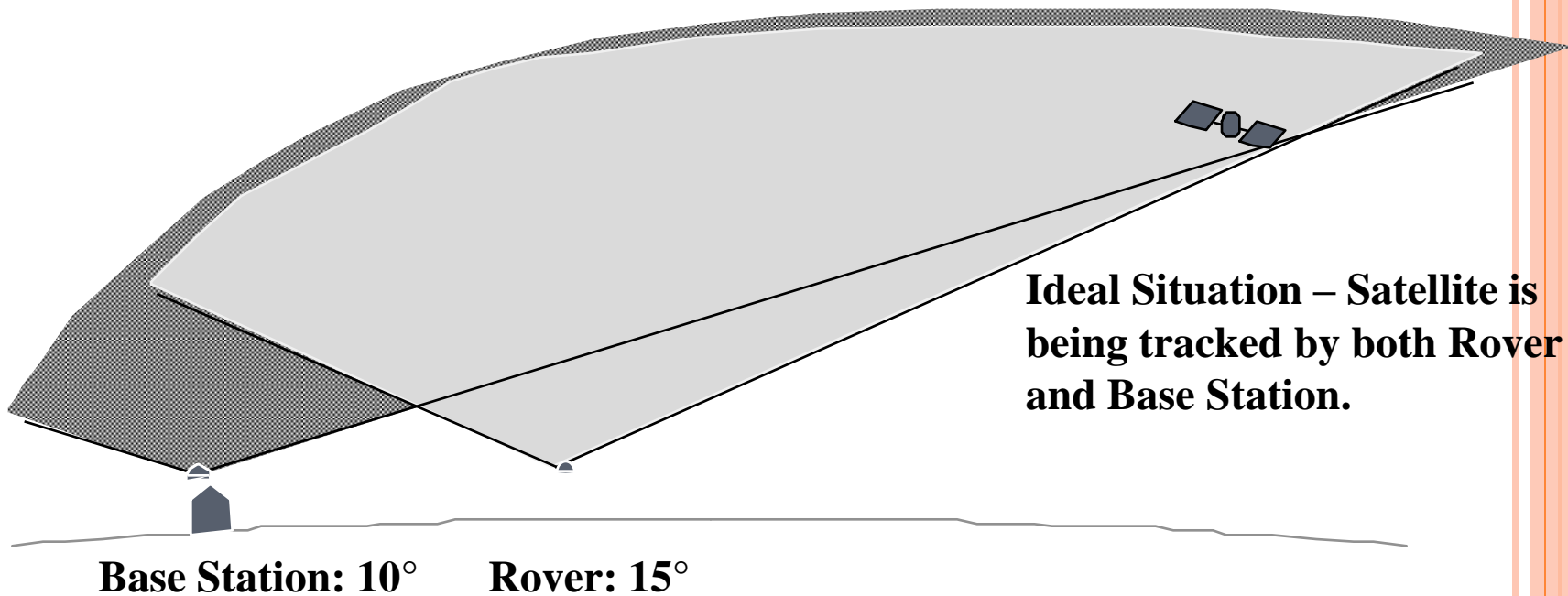
POSSIBLE PROBLEM...

setting the elevation masks



SOLUTION...

Set base elevation mask less than rover



Ideal Situation – Satellite is being tracked by both Rover and Base Station.

1° per 100 km distance between base and rover



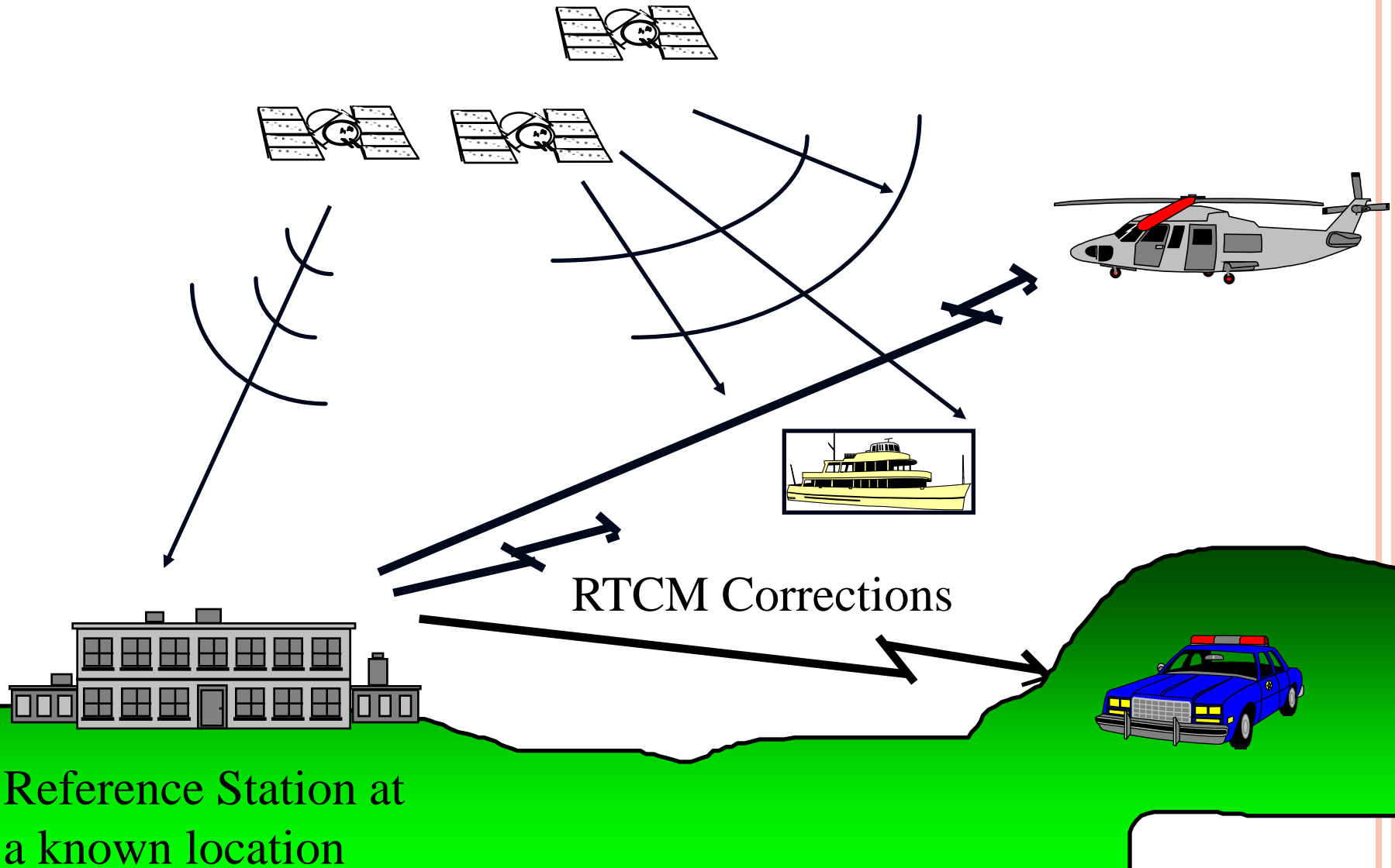
SOURCES OF BASE DATA FOR POSTPROCESSED DGPS

Where does one get differential GPS base station data?

- Community Base Stations (CBS)
 - government, commercial or public (universities)
- BBS and Internet Access
- Set up your own
 - GPS Pathfinder CBS
 - Universal Reference Stations (URS)
 - Trimble rover units can be used as a base



REAL-TIME DIFFERENTIAL GPS



SOURCES OF REAL-TIME CORRECTIONS

Where does one get real-time differential GPS base station data?

- Commercial Real-time DGPS providers
- Government
 - Coast Guards
 - Mapping Agencies
- Set up your own real-time DGPS
 - Required
 - A source of DGPS correction in RTCM-SC-104 format
 - A data link, for example, a data radio (modem and transmitter)



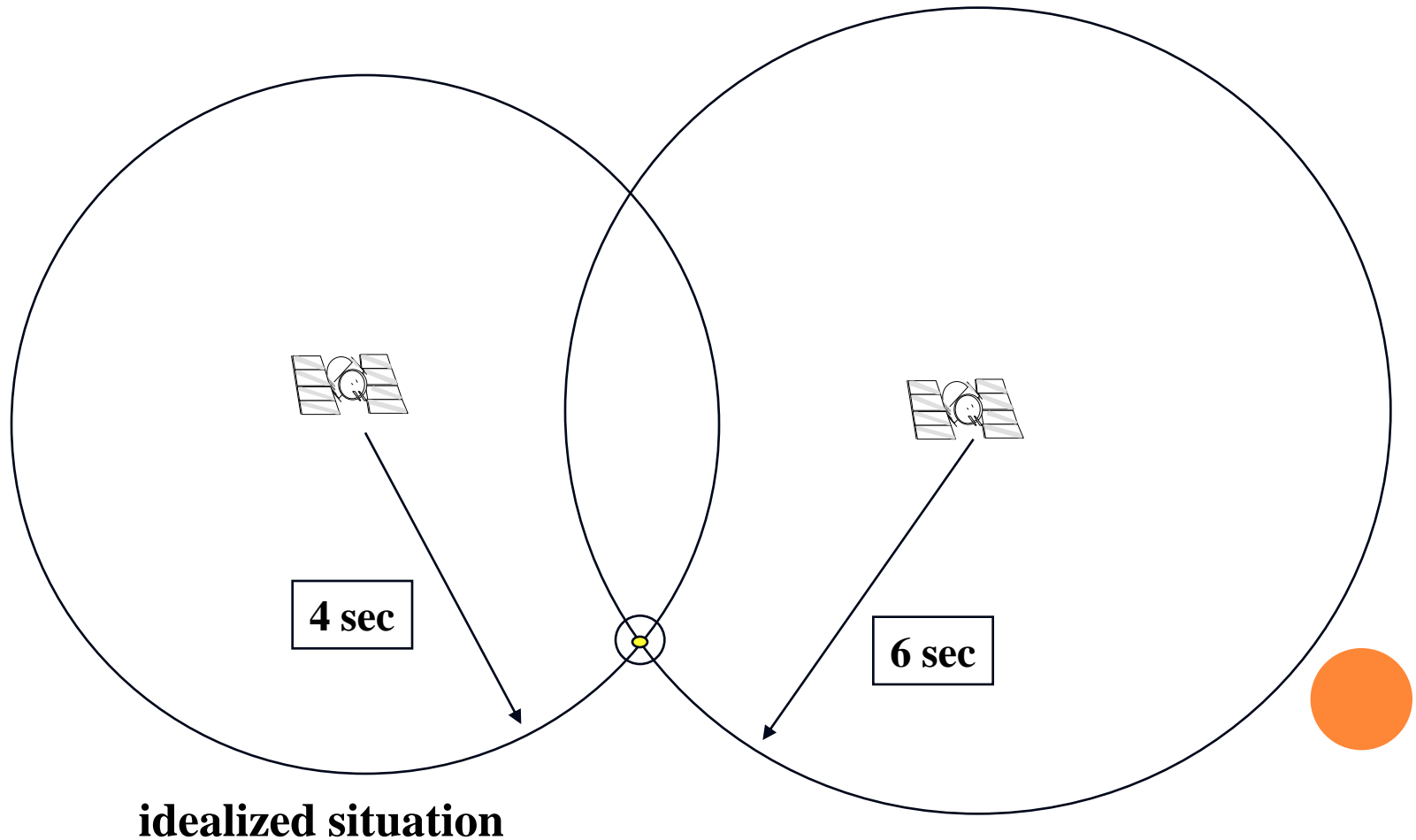
DILUTION OF PRECISION (DOP)

- A measure of Satellite geometry
- Indicates the quality of position fix
- Can be expressed in different dimensions
 - for example: PDOP, HDOP, VDOP, TDOP



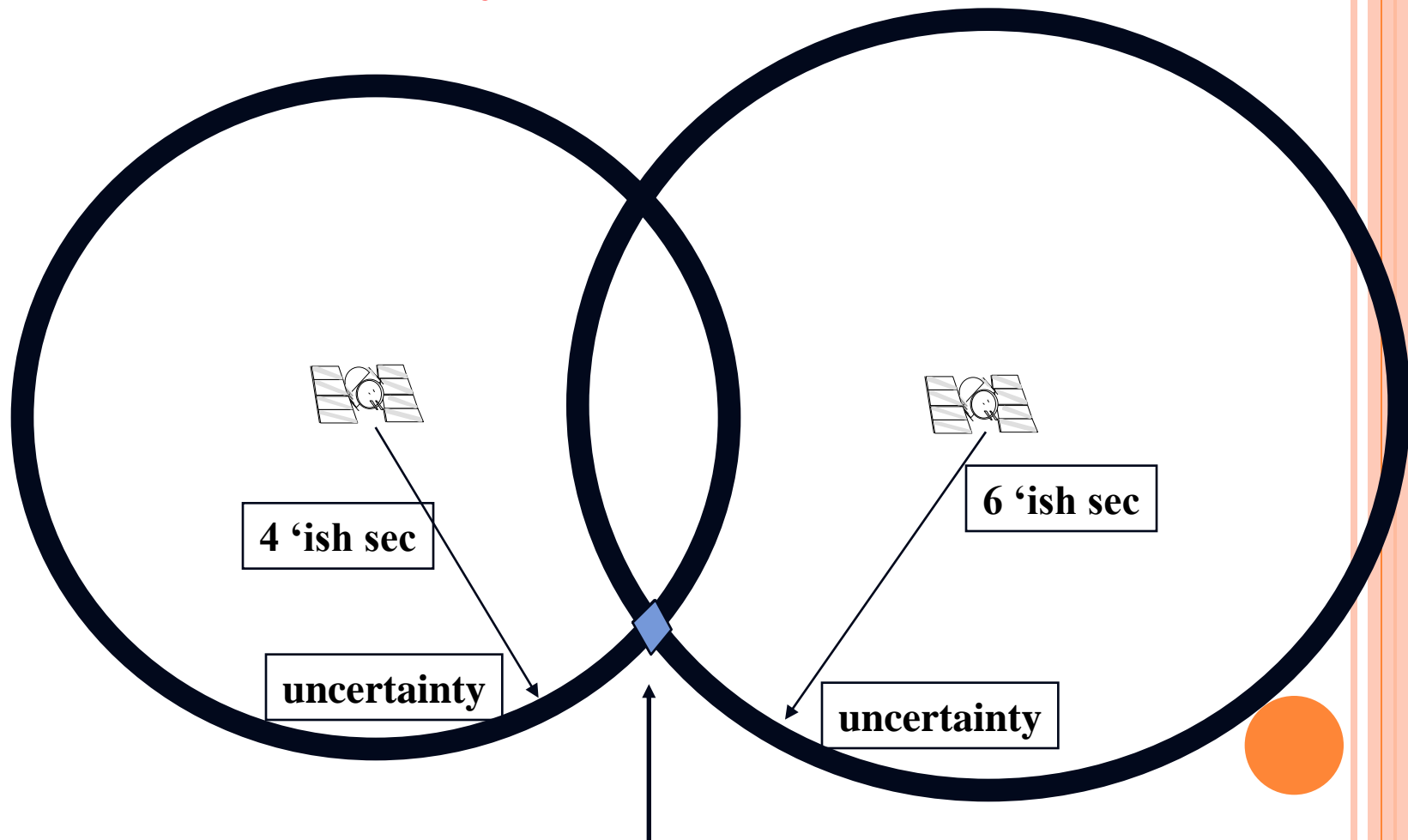
DILUTION OF PRECISION (DOP)

Relative position of satellites can affect error



DILUTION OF PRECISION (DOP)

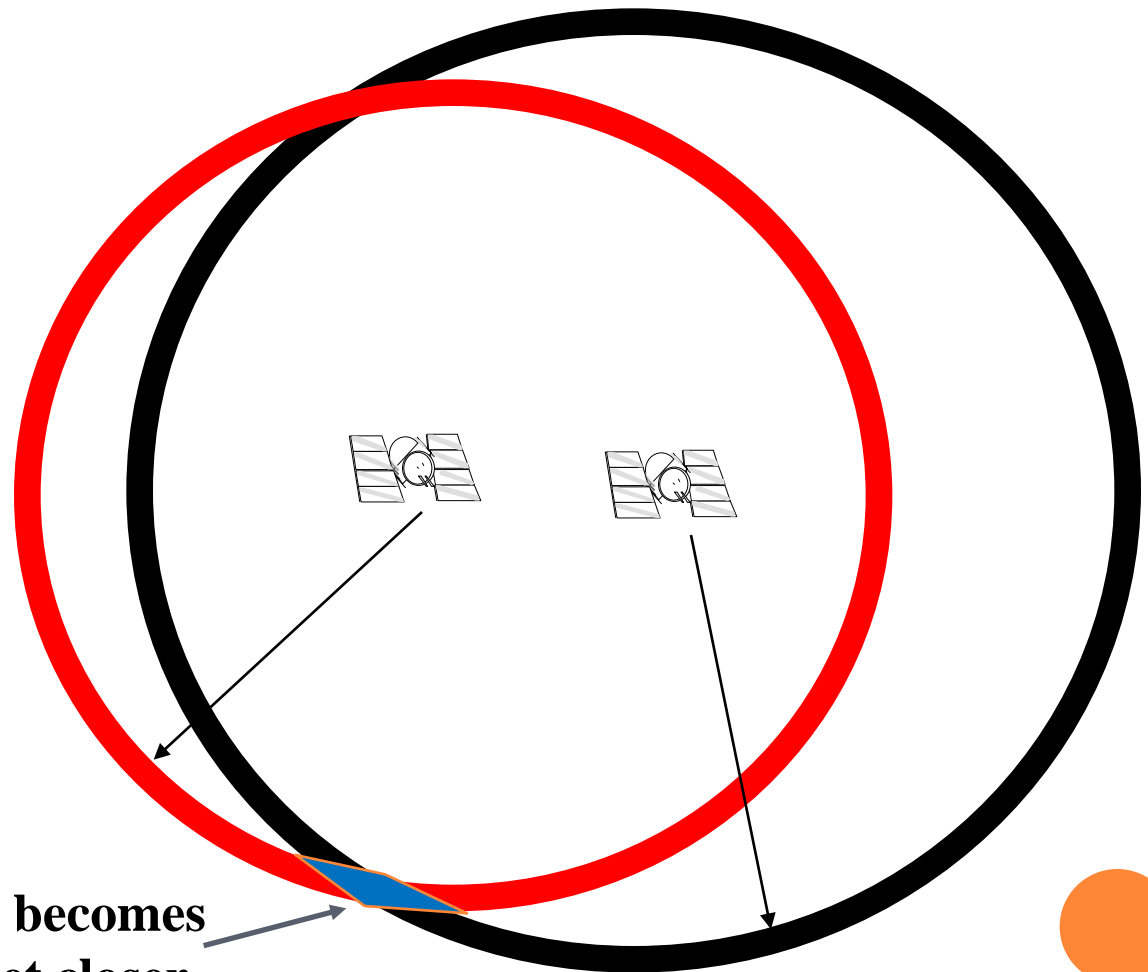
Real situation - fuzzy circles



Point representing position is really a box

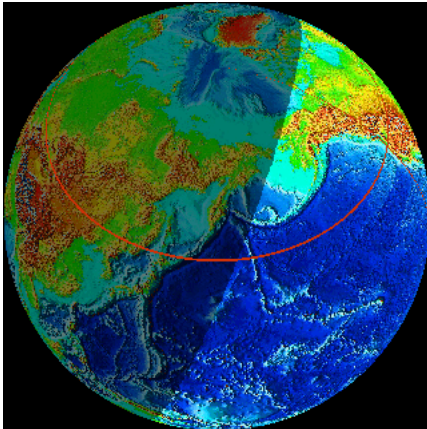
DILUTION OF PRECISION (DOP)

Even worse at some angles

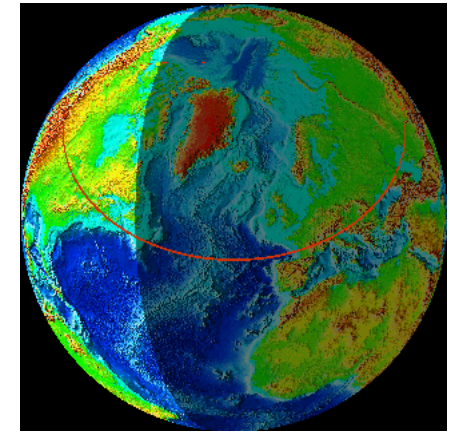


Area of uncertainty becomes larger as satellites get closer together

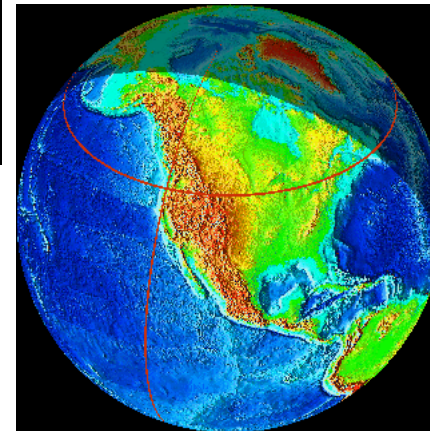
SV26 20182KM 54°17' N 159°00' E
29° EL 310° AZ



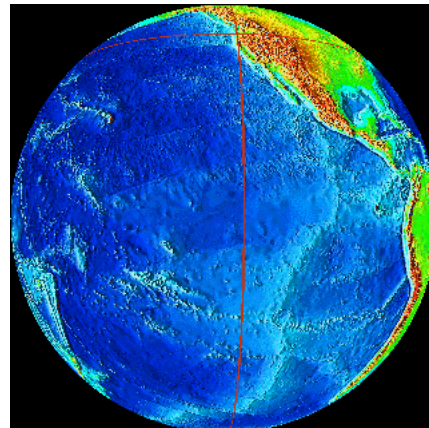
CORVALLIS
44°23' N 123°17' W
PDOP 2.6



SV31 20181KM 53°55' N 21°13' W
15° EL 41° AZ



SV27 20181KM 40°07' N 104°18' W
71° EL 102° AZ



SV7 20180KM 3°24' S 127°59' W
29° EL 186° AZ

<http://sirius.chinalake.navy.mil/satpred>



DILUTION OF PRECISION (DOP)

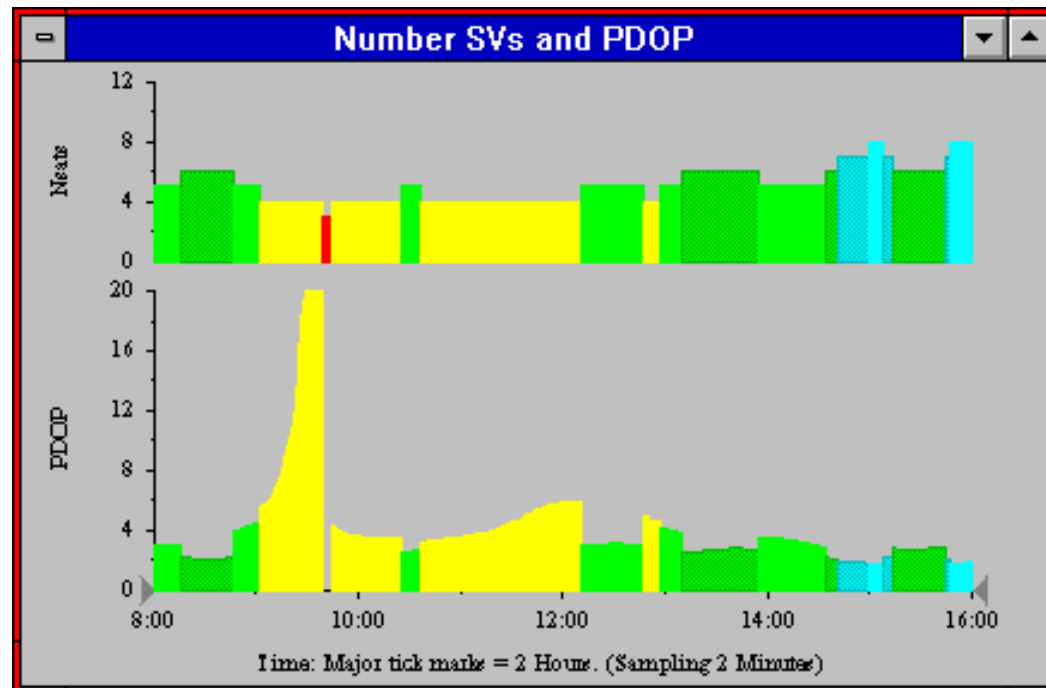
Can be expressed in different dimensions

- GDOP - Geometric dilution of precision
- PDOP - Position dilution of precision
- HDOP - Horizontal dilution of precision
- VDOP - Vertical dilution of precision
- EDOP - East dilution of precision
- NDOP - North dilution of precision
- TDOP - Time dilution of precision
 - $GDOP^2 = PDOP^2 + TDOP^2$
 - $PDOP^2 = HDOP^2 + VDOP^2$
 - $HDOP^2 = EDOP^2 + NDOP^2$



SATELLITE VISIBILITY AND PDOP

- Use an almanac from a GPS receiver to calculate the best times of the day for GPS.



QUESTIONS ?

