GIS Data:
Sources and Capture

Data Collection

- Capture: becomes digital
  - primary: “born digital”
  - secondary: digitized
- Transfer: acquired/digitized by someone else
- Either way, you still may have to
  - edit and clean
  - re-project
  - generalize

Data Collection Techniques

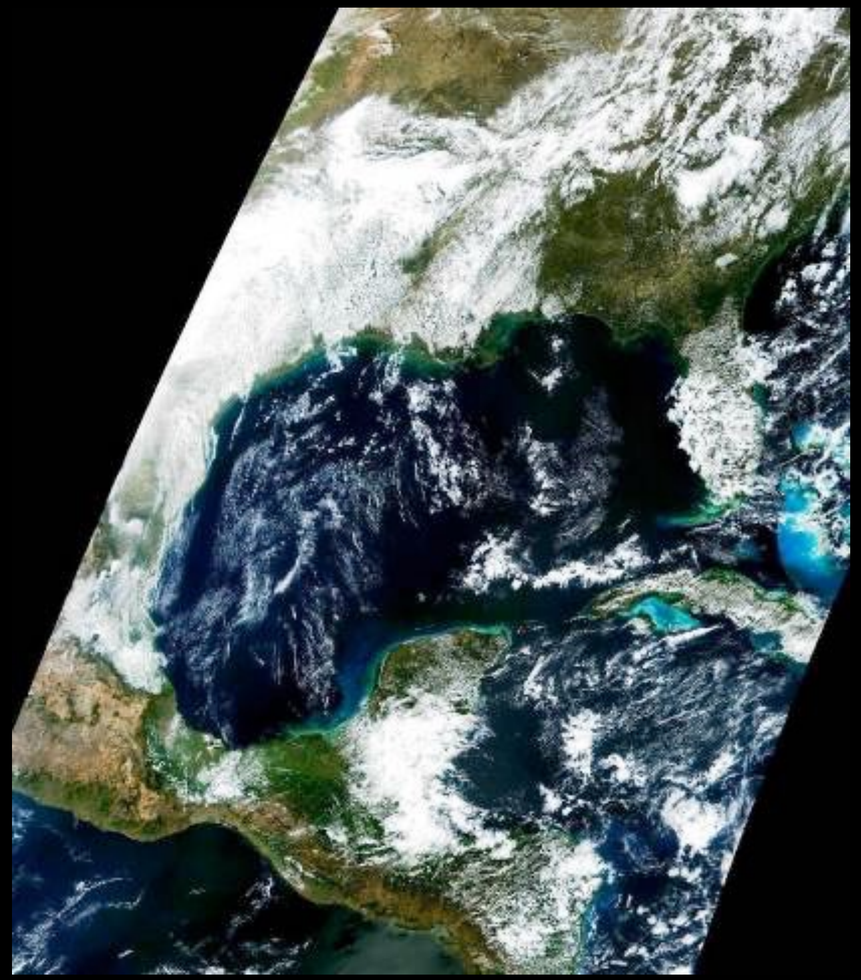
- Raster
  - primary
    - digital remote sensing
  - secondary
    - scanned photographs
    - scanned maps
    - DEMs from maps
- Vector
  - primary
    - GPS
    - surveying
  - secondary
    - topographic surveys
    - toponomy from text

Raster Primary Data Capture

- Remote sensing
  - passive
    - optical scanners
    - microwave radiometers
  - active
    - radar
    - lidar
- Resolution
  - spatial
    - cell size
    - swath width
  - spectral
    - bandwidth
    - #bands
  - temporal
    - repeat cycle
  - radiometric
    - range
    - precision

MODIS

(**MOD**erate-resolution **I**maging **S**pectrometer)



Platforms
- EOS Terra (since Feb 2000)
- EOS Aqua (since May 2002)

Spatial resolution
- 2330 km swath
- 250..1000 m / pixel

Spectral bands
- 36 visible, near-IR, thermal

Temporal resolution
- every 1..2 days
- 100% duty cycle

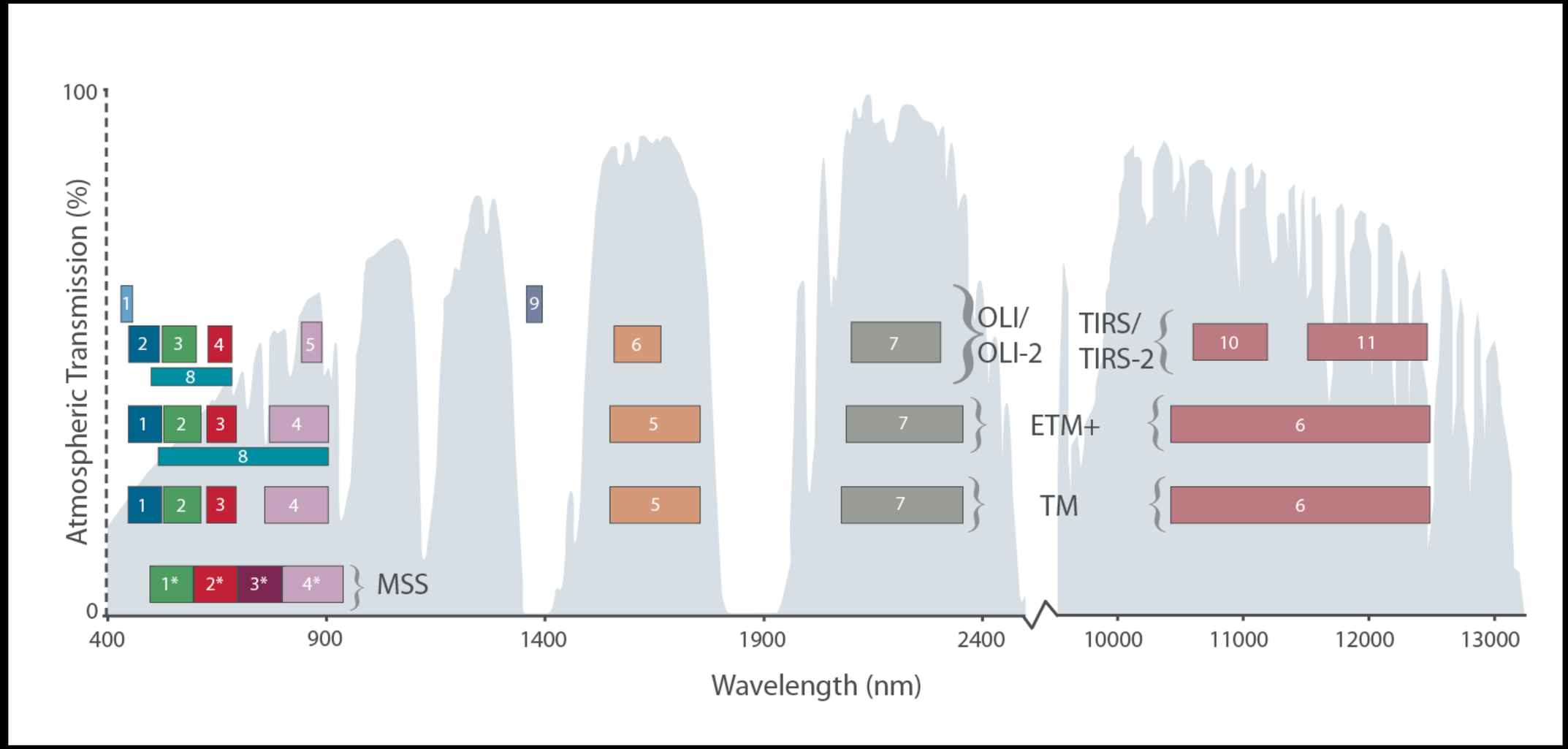
Landsat Satellites

satellite	sensor	data start	data stop
Landsat 4	TM	1982	1993
Landsat 5		1984	2011
Landsat 7	ETM+	1993	*
Landsat 8	OLI	2013	
Landsat 9		2021	

*partial images since 2003

- Spatial resolution
  - 185 km swath
  - 30 m / pixel
- Temporal resolution
  - every 16 days
    - every 8 days since 2013:
      most recent 2 Landsats 8 days apart

Landsat Spectral Bands



Planet (commercial)

platform	sensor	spatial resolution	spectral bands	temporal resolution
PlanetScope	PS2	3.7 m	4	daily
	PSB		8	
SkySat		≤ 1 m	4	targeted
		≤ 0.86 m	pan	

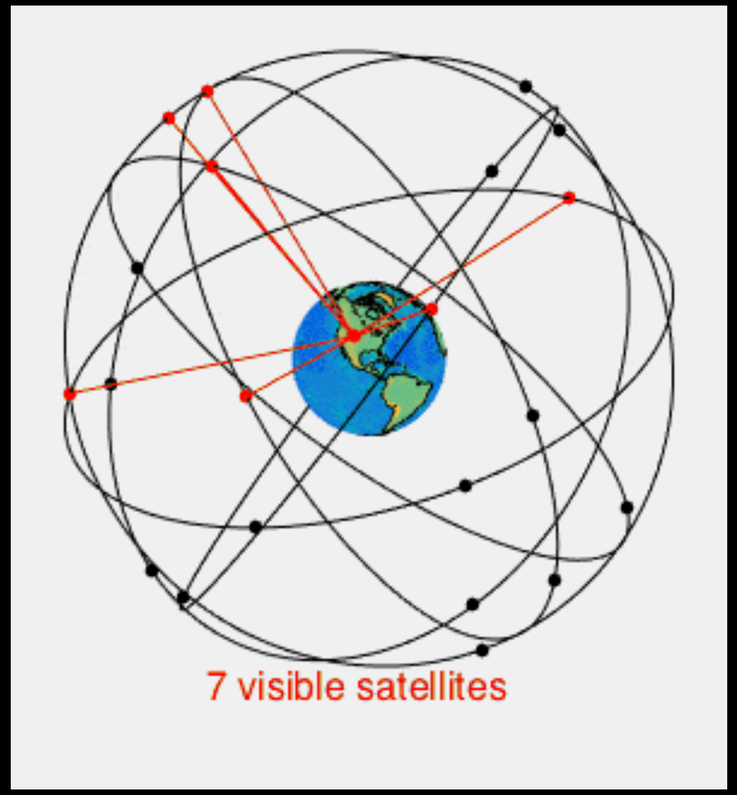
Vector Primary Data Capture

- Surveying
  - Angle and distance measurements from known locations
  - Expensive field equipment and crews
  - Most accurate method for large scale, small areas

- Global navigation satellite systems (GNSS)
  - Collection of satellites used to fix location re: Earth center
    - GPS (US), GLONASS (Russia), BeiDou (China), Galileo (EU)
  - Global Positioning System (GPS)

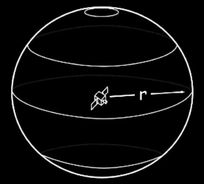
GPS: Satellites

- 24 satellites
  - 4 satellites / orbit
  - 6 orbits
    - 26 km
    - 55° inclination

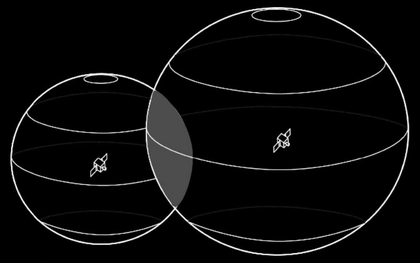


⇒ always > 4 satellites above horizon

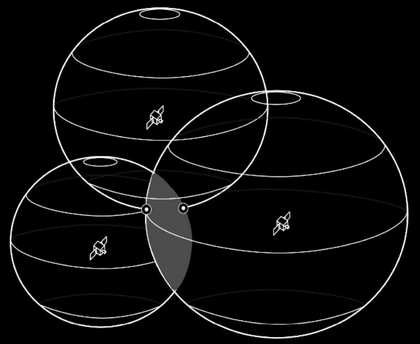
GNSS: How It Works



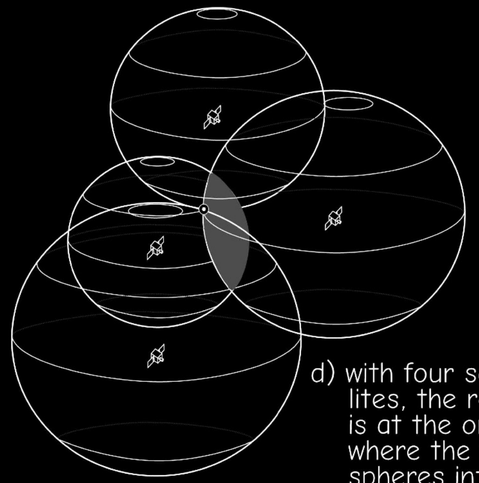
a) with a range measurement from one satellite, the receiver is positioned somewhere on the sphere defined by the satellite position and the range distance, r



b) with two satellites, the receiver is somewhere on a circle where the two spheres intersect



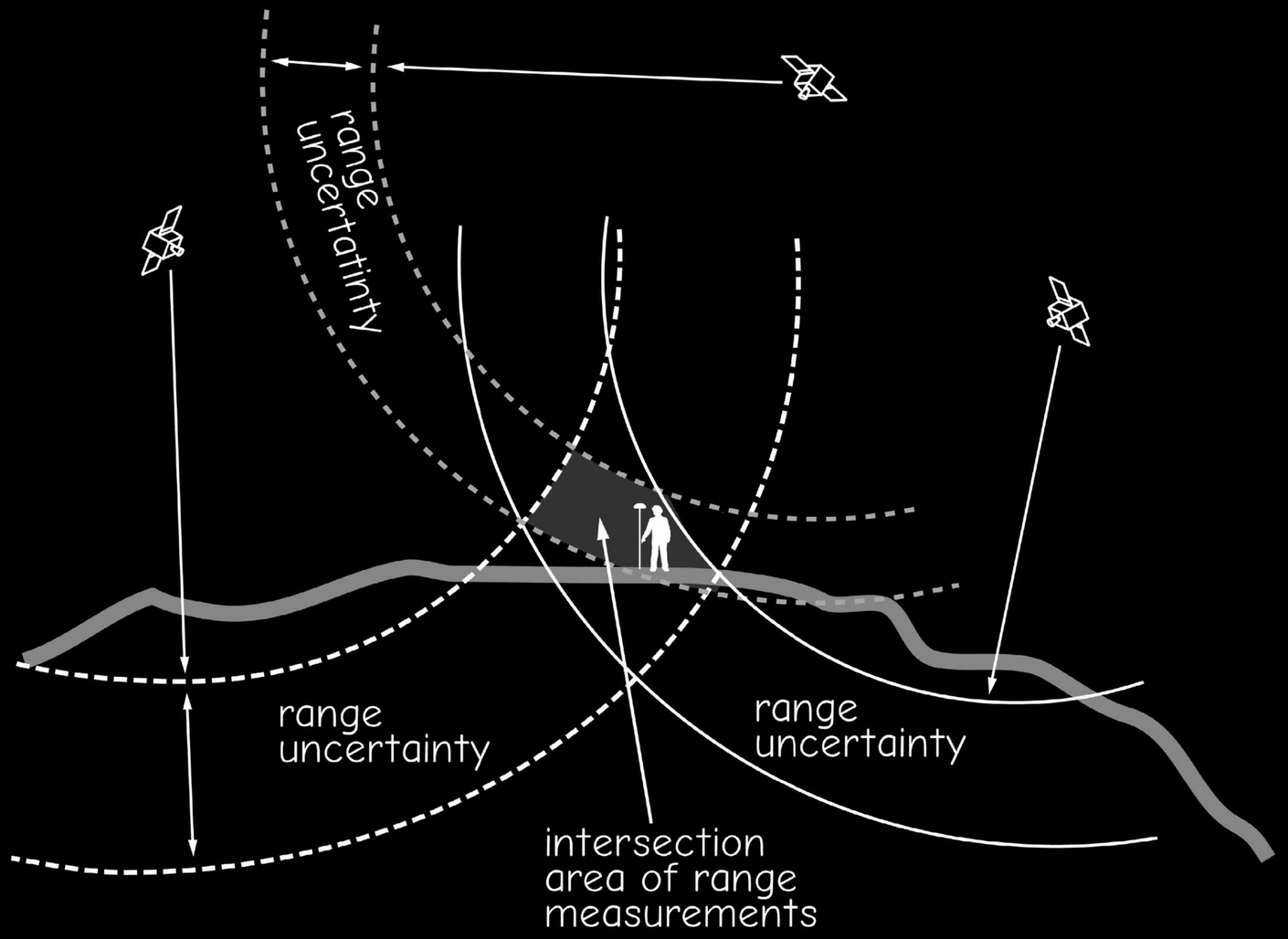
c) with three satellites the receiver is at one of two points where the three spheres intersect



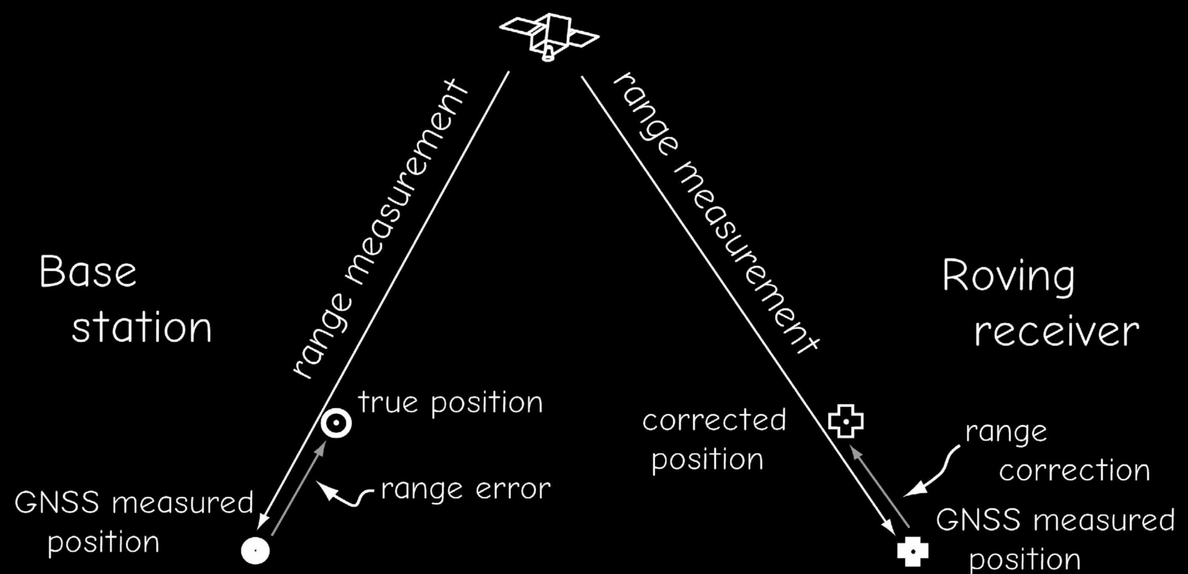
d) with four satellites, the receiver is at the one point where the four spheres intersect.

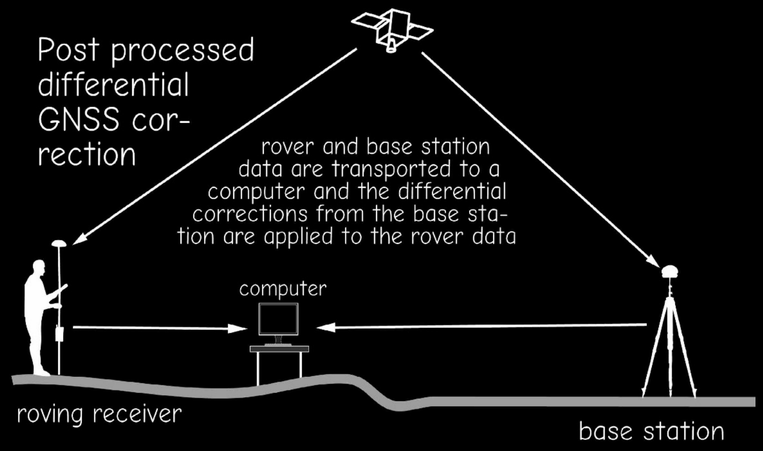
see also: video

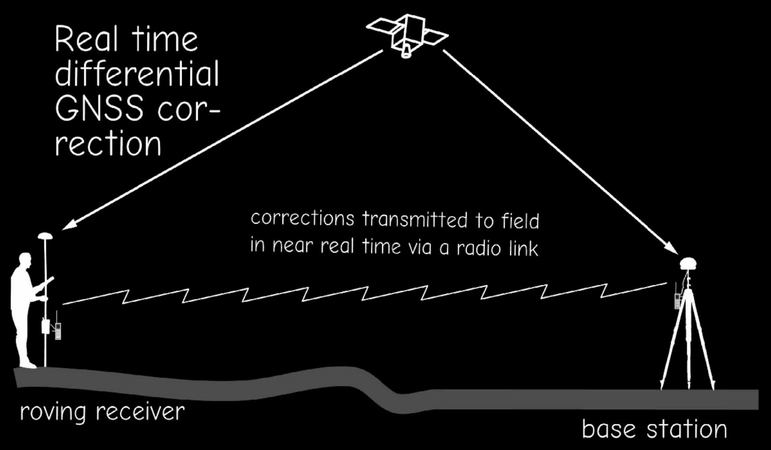
GNSS: It's Not Perfect



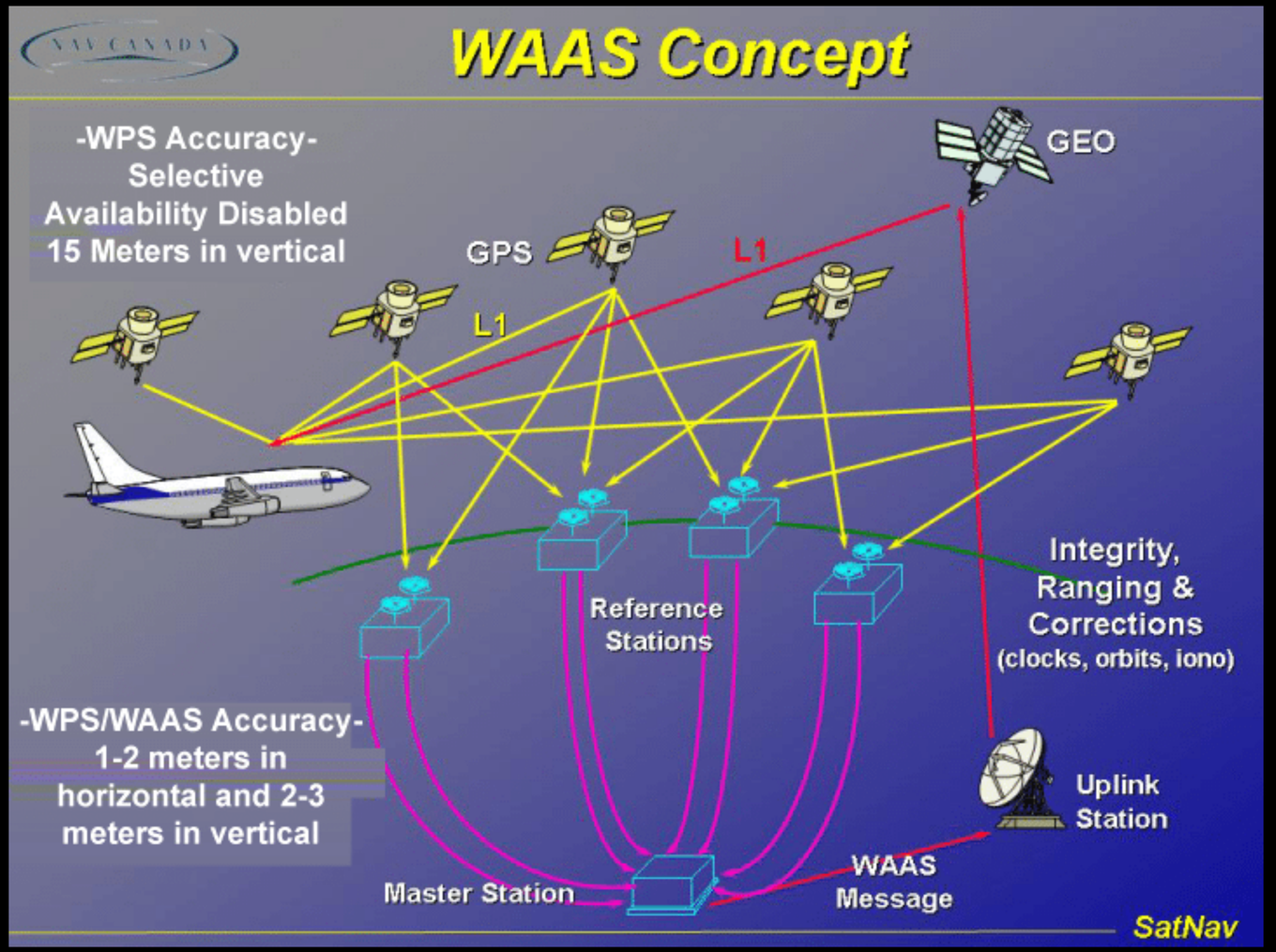
Differential GNSS



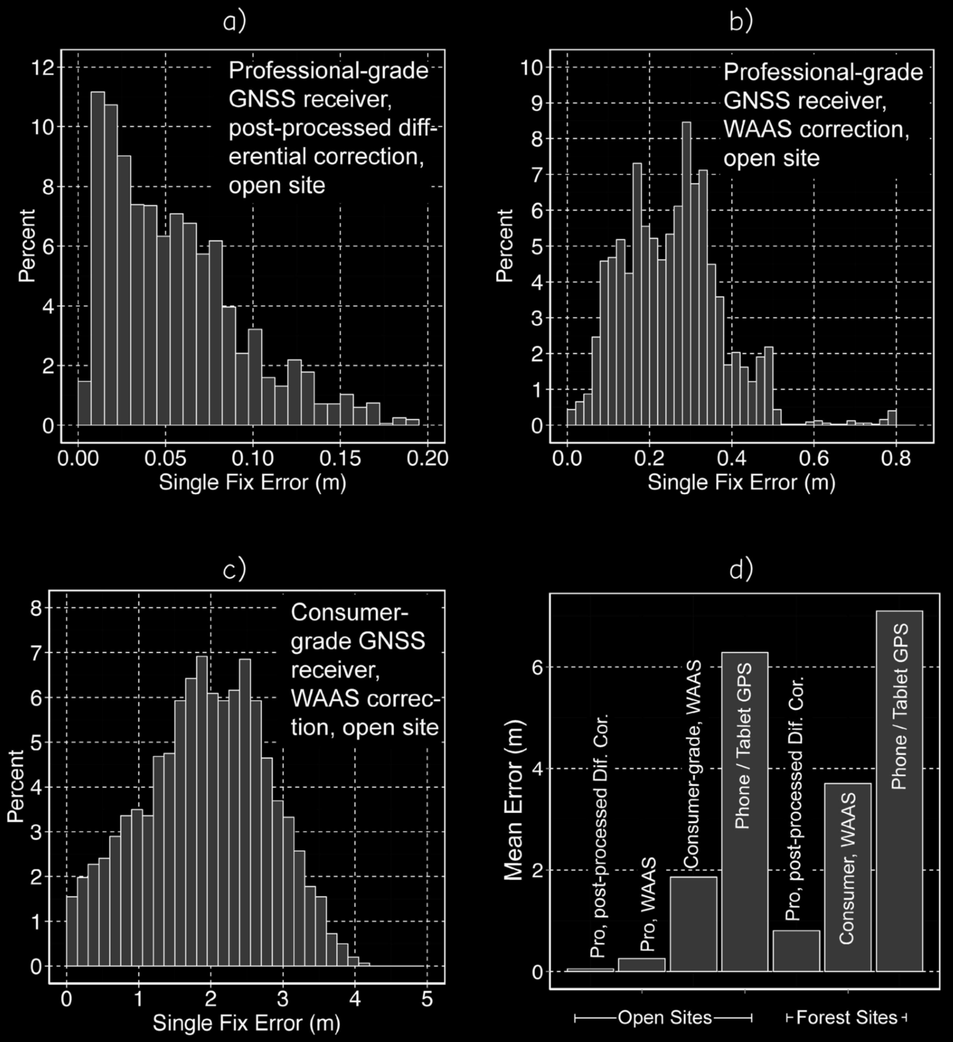




Wide Area Augmentation System



GNSS: Accuracy

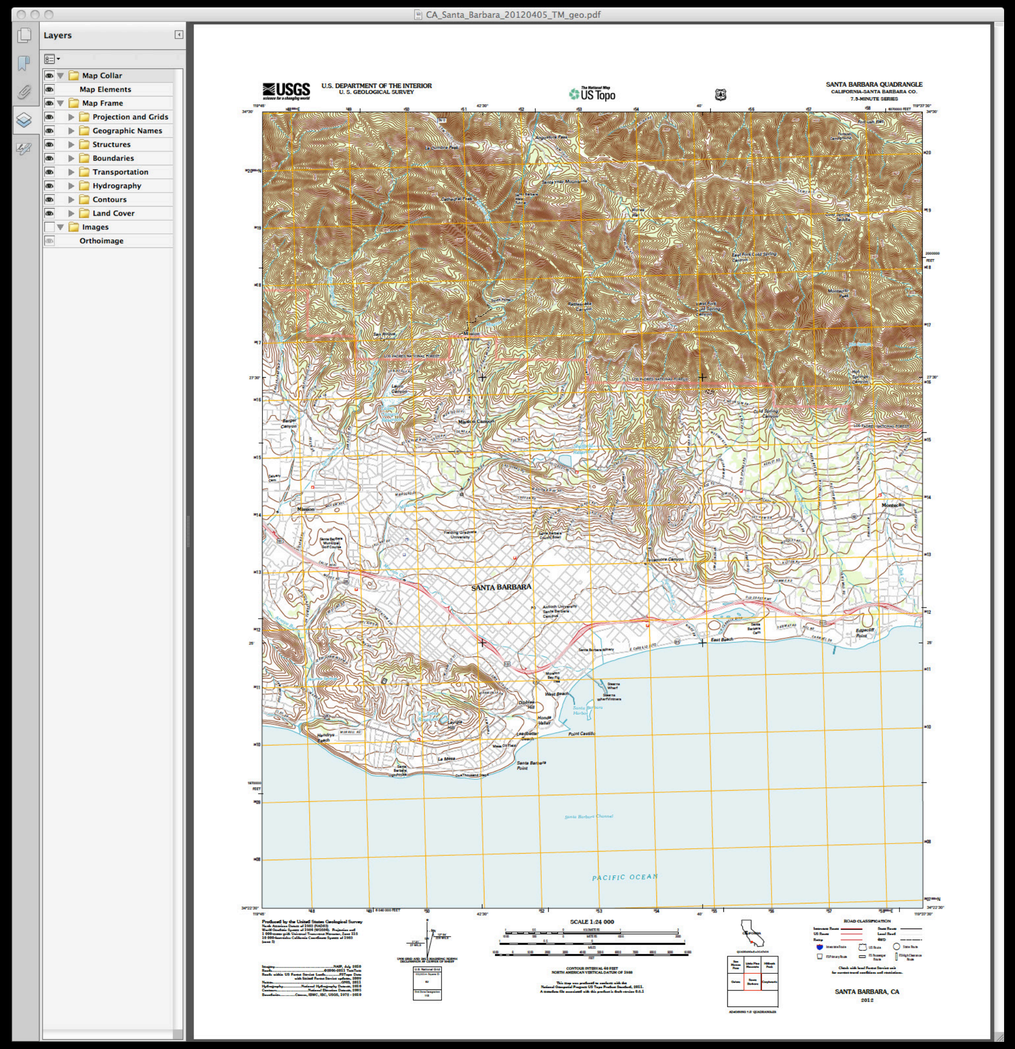


Secondary Data Capture

- Data collected for other purposes can be converted for use in GIS
- Raster conversion
  - Scanning of maps, aerial photographs, documents, etc.
  - Important parameters:
    - spatial resolution (dots per inch)
    - radiometric resolution (bits per pixel)

Scanning Example: US Topo

- USGS topo maps in PDF
  - "GeoPDF" metadata
- New & historical
  - new: multi layers
  - old: single scan
    - cool examples!
- Mix of projections and scan methods



Scanning maps: orientation issues

- Boundaries
  - meridians and parallels
- Projection
  - conformal conic (older)
  - UTM (newer)
  - meridians pinch; parallels curve
- Map sheet
  - quad bounding rectangle
    - not projection-aligned
    - example

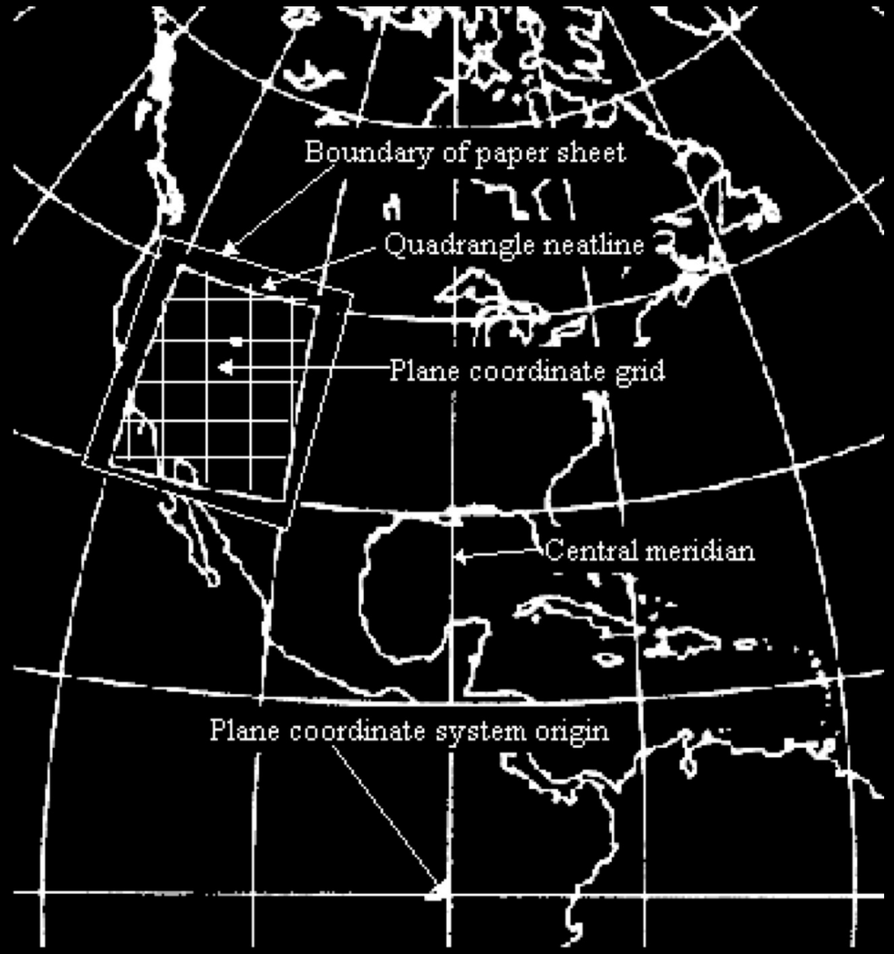


Figure 6. Plane grid, quadrangle neatline, and map sheet relationships.

Vector Secondary Data Capture

- Manual
  - Keyboard
    - transcription
    - "heads-up" digitizing
      - (see also Bolstad ch. 4)
  - Coordinate digitizer
    - Point
    - Stream
- Automatic
  - Scan
    - vector = line_detect(raster)
  - OCR
    - extract placenames or coordinates from scanned text

Figure Credits

- GIS Fundamentals, 6th ed.
  - ISBN 978-1-59399-552-2
- Geographic Information Systems and Science, 2nd ed.
  - ISBN 978-0470870013
- Introduction to Geographic Information Systems, 4th ed.
  - ISBN 978-0-07-305115-2
- Using ArcGIS Spatial Analyst
- Wikimedia Commons
- NASA Landsat Science