Global Positioning System

In the Classroom

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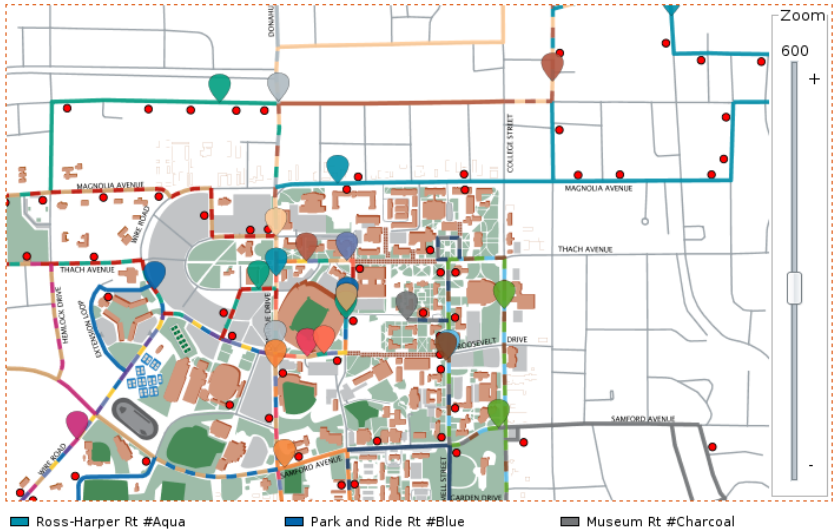
GPS in Everyday Life

The Global Positioning System (GPS) is at use in many places

- Phone
- Vehicle
- Outdoors
- Surveying
- Used heavily as a navigation aide
  - Tiger Transit increasing efficiency
  - `http://auburn.transloc-inc.com/`

Real-Time Bus Location (Made possible by GPS)



GPS Research at Auburn

- Small robotics
- Animal navigation
- Autonomous vehicles
- Advanced GPS receivers

GPS History

Official image taken from

`http://gps.losangeles.af.mil/jpo/images/shield-official.spg`

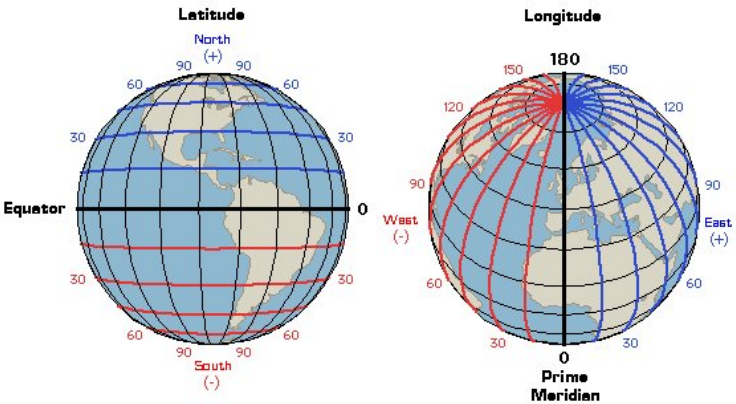
The NAVSTAR Global Positioning System (GPS) is one of a few Global Navigation Satellite Systems (GNSS) in use all over the world.

- Was originally a military system for artillery
- Part of the signals were available to civilians
- This part was intentionally bad until 2000
  - pre-2000 - $>$ 300 ft
  - now - $<$ 10 ft
- Decreasing cost leads to expansion

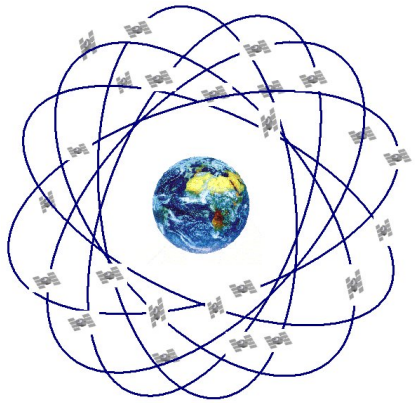
GPS Overview

Tells where a user is

- latitude - angle from Equator
- longitude - angle from Prime Meridian
- altitude - height above sea level



http://www.lakelandsd.com/tutorial/further.html



http:

//www.ppcsg.com/mobile/index.php/t88128.html

Based on

- Satellite signals
- Satellite positions
- Ranging to the satellite
- Trilateration

GPS Equipment

Satellite

Image courtesy of NASA

- Currently 31 satellites
- Medium-Earth-Orbit - 12,500 miles
- Traveling over 6000 mph
- Highly accurate atomic clocks

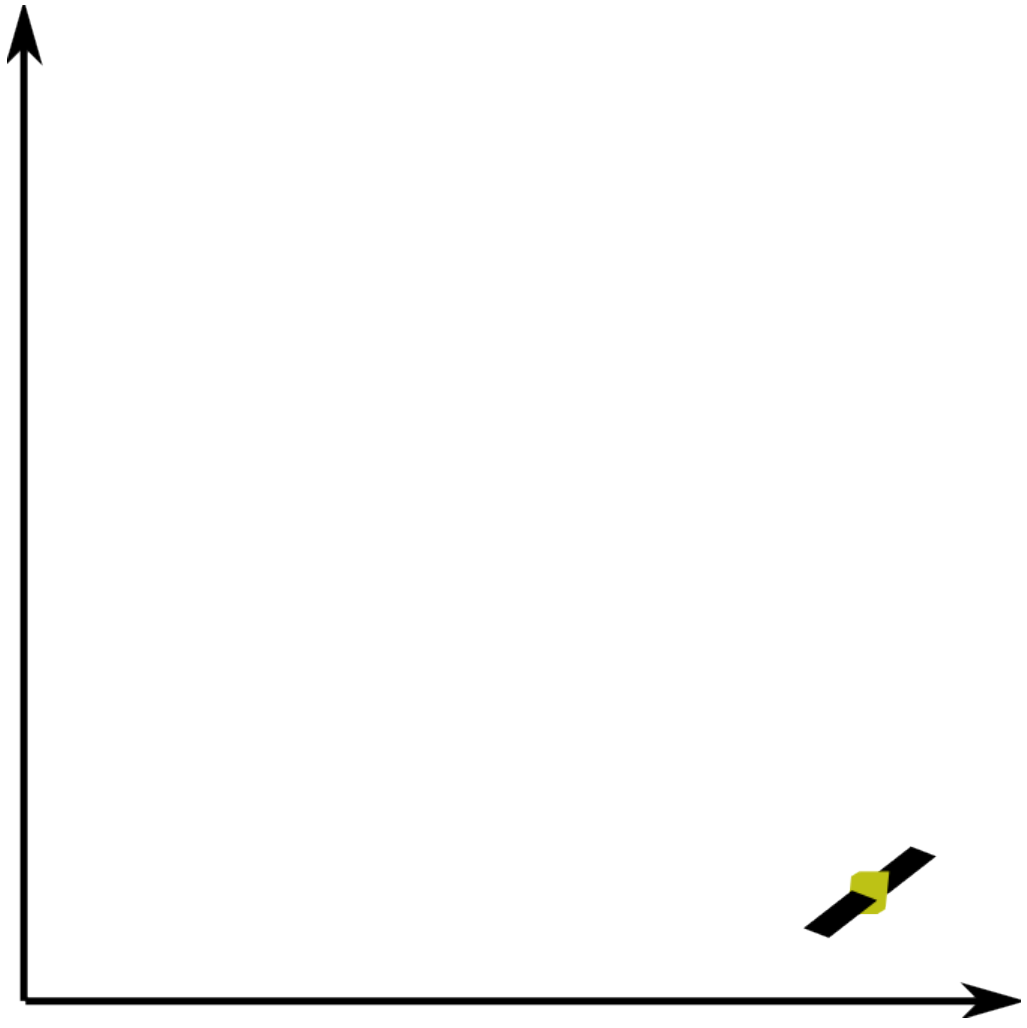
Receiver

Image courtesy of Garmin

- Works all over globe
- Less accurate clock = cheaper
- Decodes satellite signals

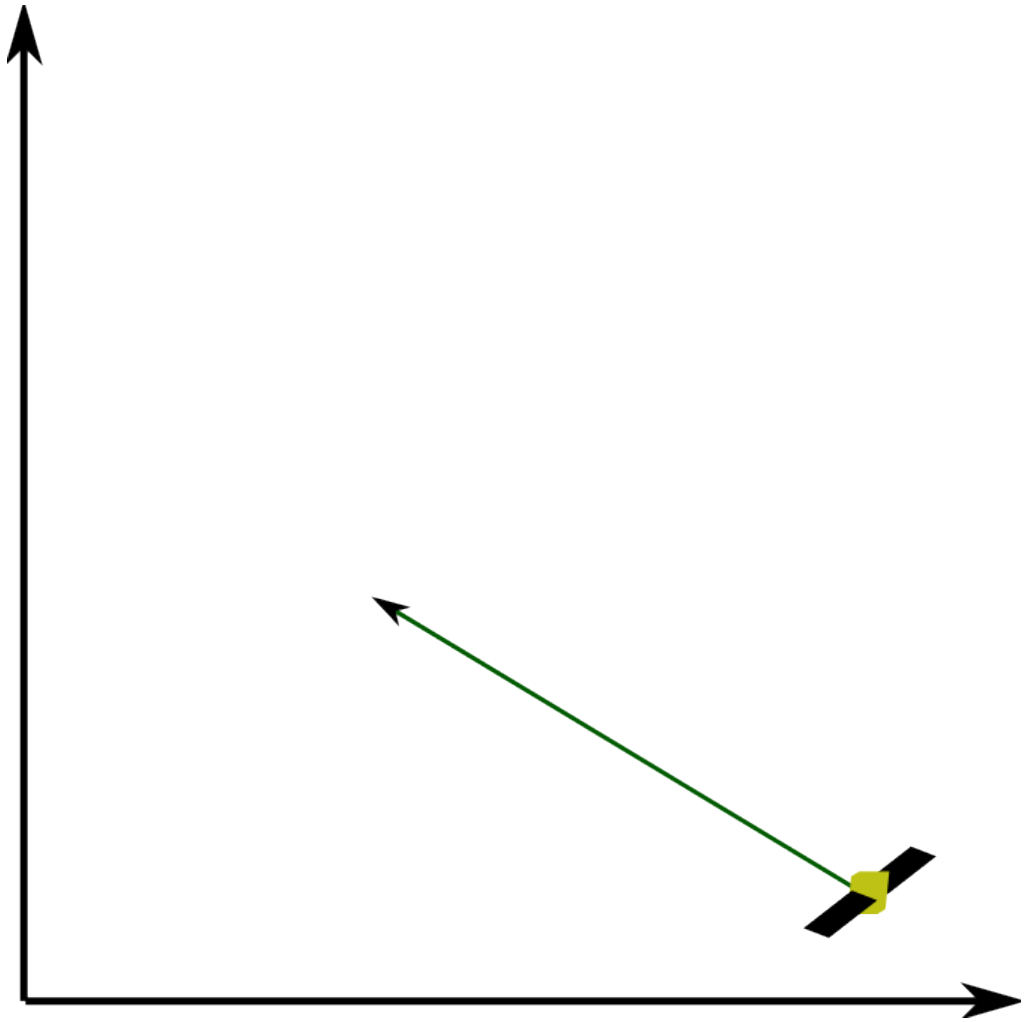
2D Example

- Know where a satellite is



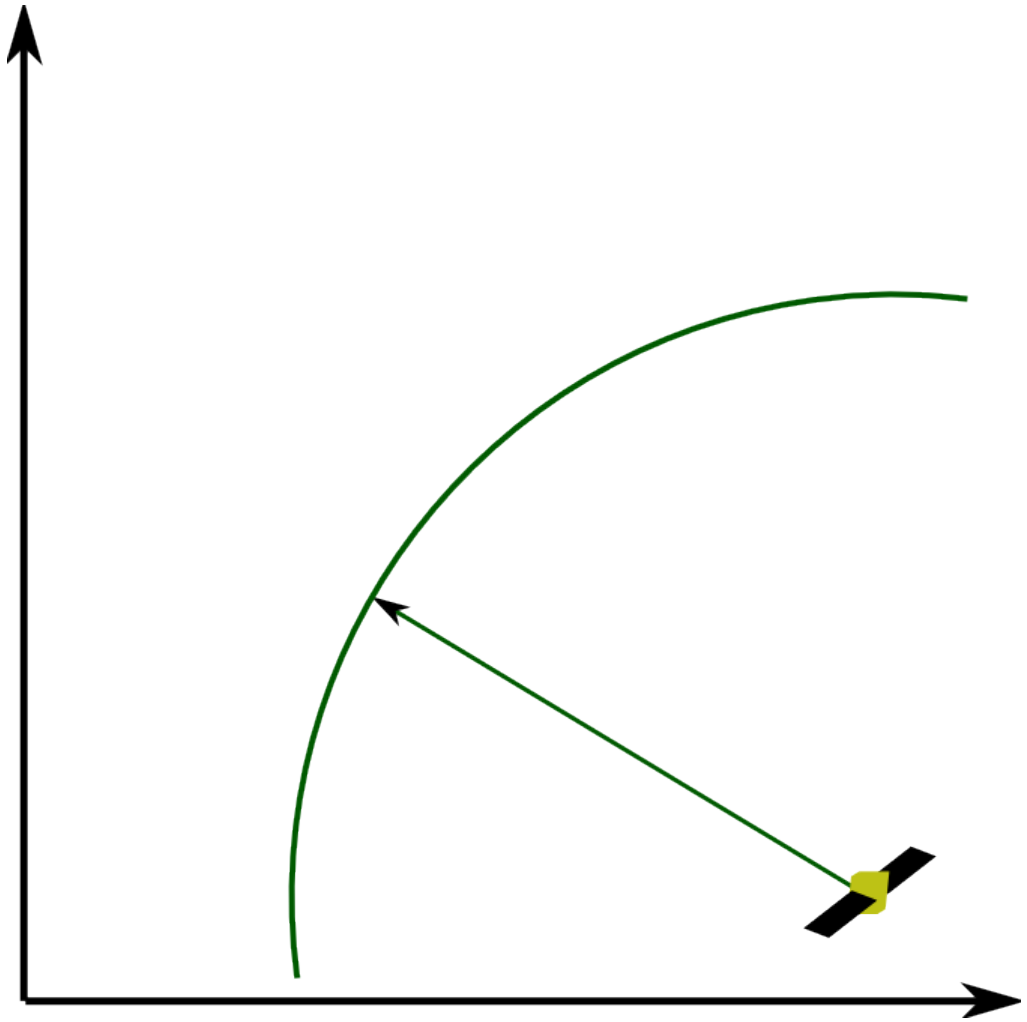
2D Example

- Know where a satellite is
- Know range from satellite



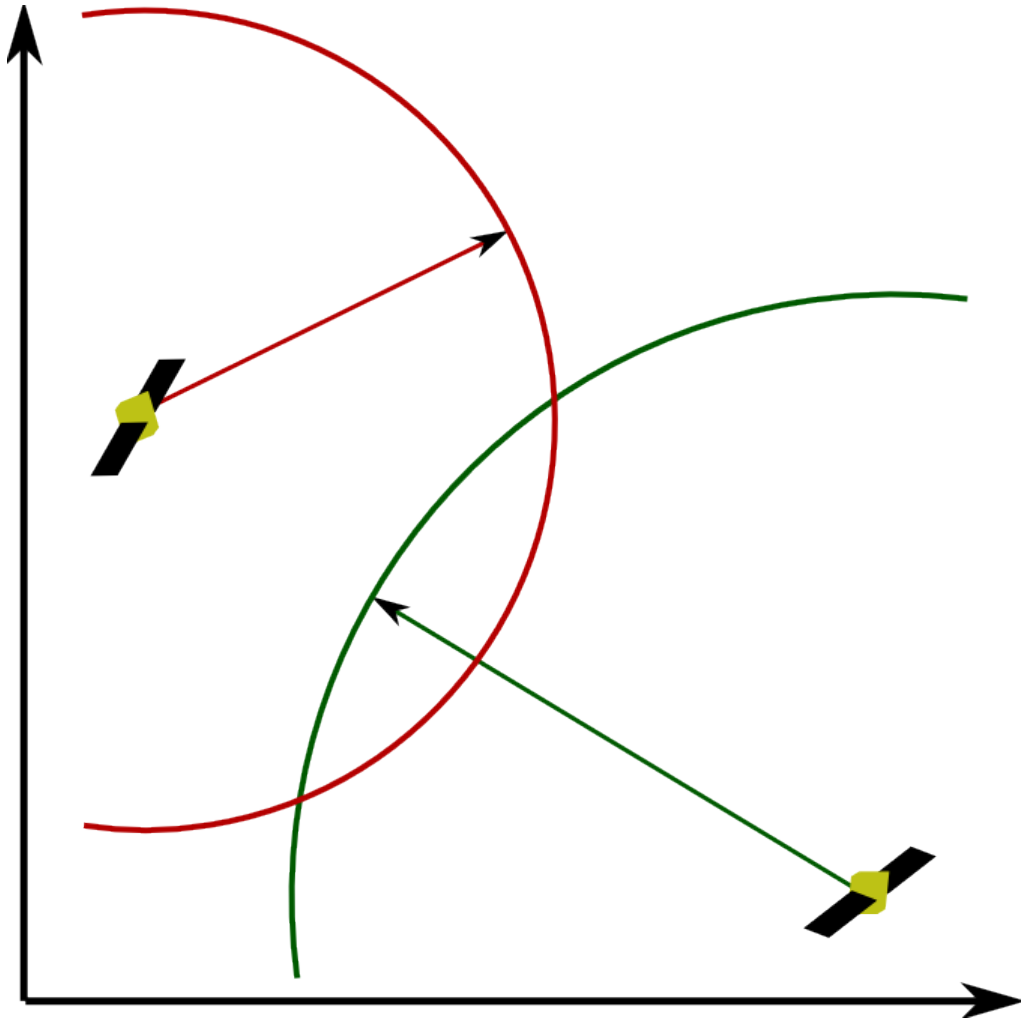
2D Example

- Know where a satellite is
- Know range from satellite
- On a circle around satellite



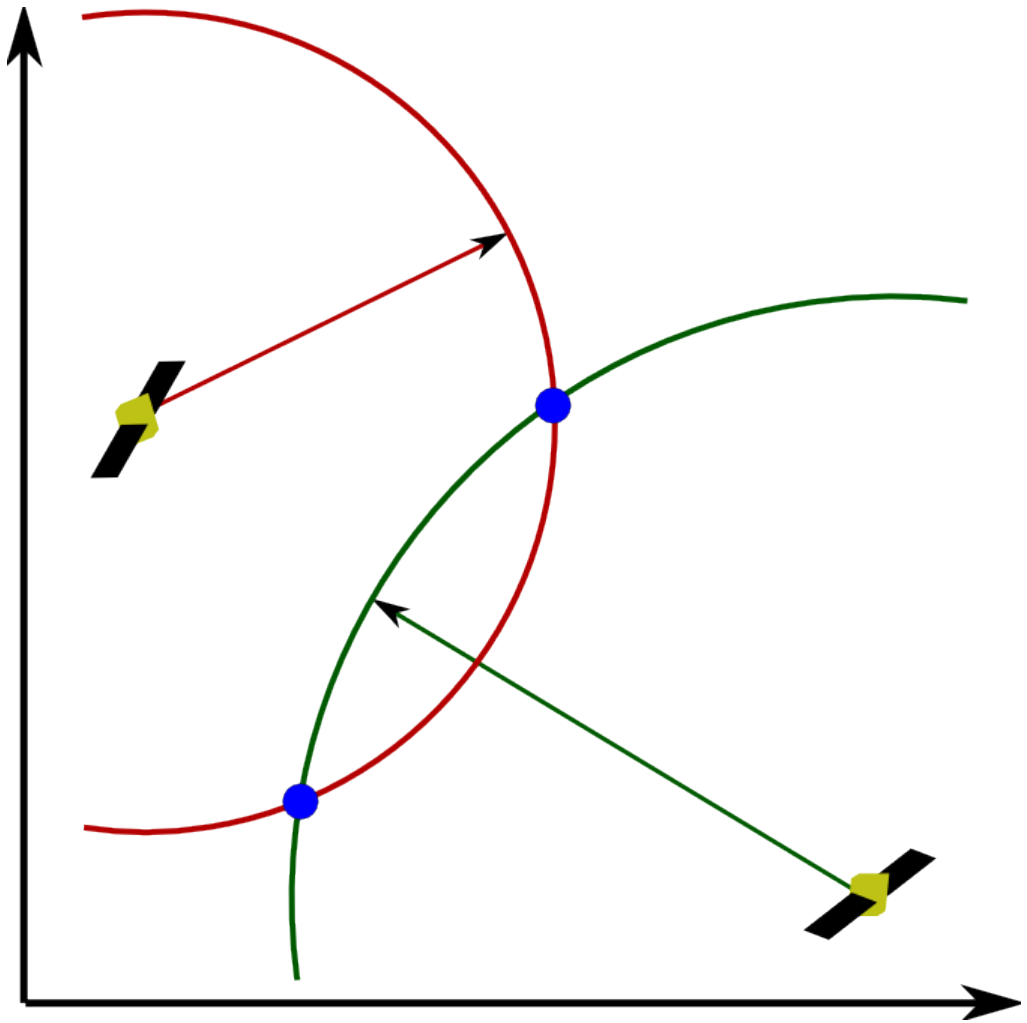
2D Example

- Know where a satellite is
- Know range from satellite
- On a circle around satellite
- Have a second satellite



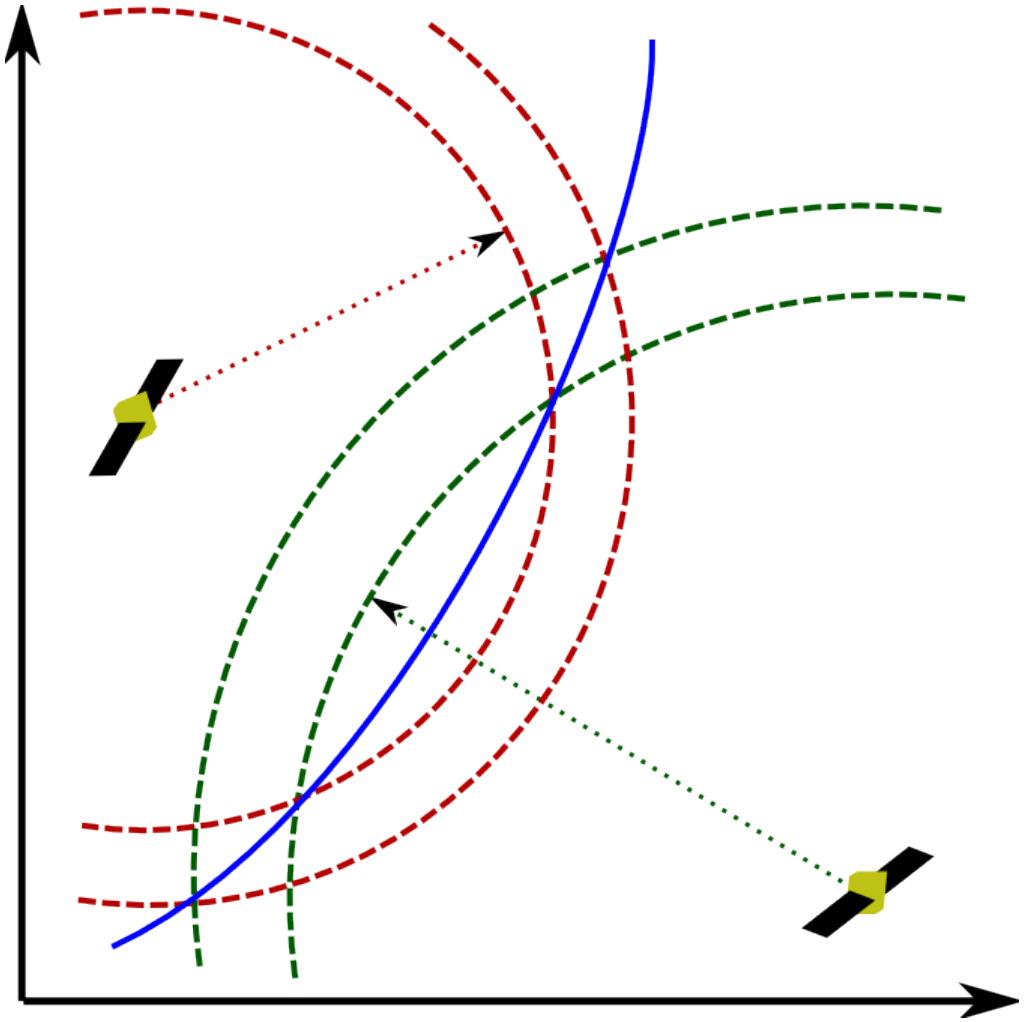
2D Example

- Know where a satellite is
- Know range from satellite
- On a circle around satellite
- Have a second satellite
- At either intersection



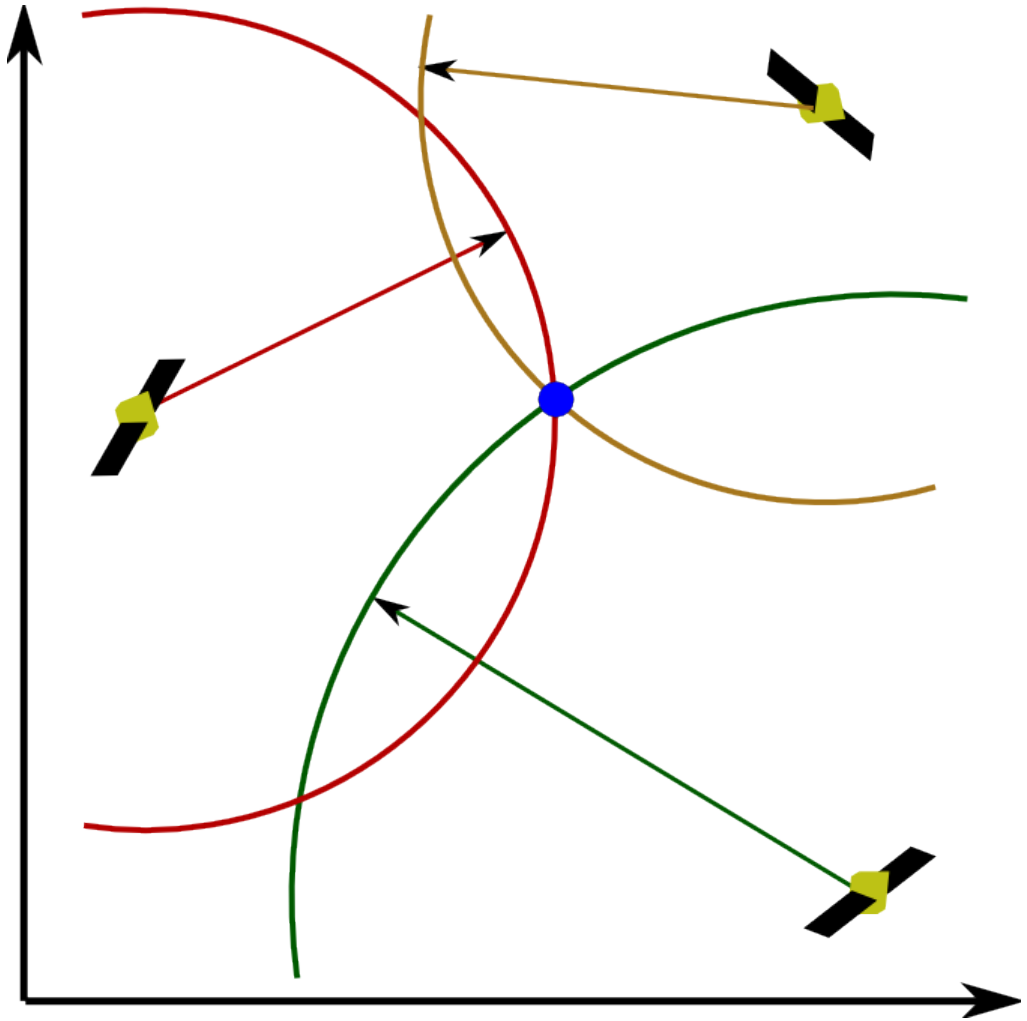
2D Example

- Know where a satellite is
- Know range from satellite
- On a circle around satellite
- Have a second satellite
- At either intersection
- Without good time, along curve

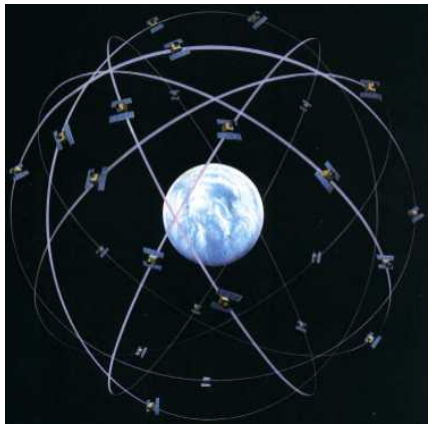


2D Example

- Know where a satellite is
- Know range from satellite
- On a circle around satellite
- Have a second satellite
- At either intersection
- Without good time, along curve
- Third satellite, position



3D Explanation



http://io.uwinnipeg.ca/ vincent/4500.6-001/Cosmology/SpecialRelativity.htm

- Satellites constantly transmit:
  - code to identify satellite
  - parameters to calculate satellite position
  - error monitoring
- To solve for 4 unknowns (3 positions and clock error), need at least 4 satellites

Geographic Information System (GIS)

Perfect Complement to GPS

- Organizes various types of data related by position
  - weather
  - terrain
  - buildings
- Many different packages ranging in price and detail
  - ESRI's ArcGIS - professional grade, $>$ \$1000
  - Google Earth - popular, free and up
- Many online resources (ex. Google Maps - `http://maps.google.com`)

3d View from Google Earth - `http://earth.google.com/tour/index.html`

GPS Equipment

Handheld pros:

- Rugged
- Battery powered
- Light
- Comparatively low-cost
  - $100-1,000

Handheld cons:

- Learning curve to use
- Tedious computer interface

Vehicle GPS

- More expensive ($300-2,000)
- Awquard as a handheld

Bluetooth

- Cheap ($< \$100$)
- Requires other equipment to log and use

GPS Equipment Suggestions

Features (in order of importance):

- Track/Waypoint logging
- High-sensitivity receiver
- Onboard maps
- Alternative sensors (compass/barometer)
- Color screen

Units:

- Garmin Mapping Handhelds

  `https://buy.garmin.com/shop/shop.do?cID=145`

- Magellan eXplorist Series

  `http://www.magellangps.com/products/product.asp?segID=355`

Online Resources

For GPS in Education

- Groundspeak forum - GPS in Education
  - `http://forums.groundspeak.com/GC/index.php?showforum=12`
- GeoQuest
  - `http://members.cox.net/inskeep/GeoQuest/introduction.htm`
- GPS Visualizer - show and convert GPS files
  - `http://www.gpsvisualizer.com/`
- Google Maps
  - `http://maps.google.com/`

Geocaching

Worldwide GPS Treasure Hunt

- Cachers hide caches
- Record GPS coordinates
- Post them online at `http://www.geocaching.com`
- Other cachers download coordinates
- Find the cache (not to be confused with cash)
- Currently 548,636 caches worldwide

Travelbugs

Geocaching Travelers

SS. Water Bug

- Register travelbugs at geocaching site
- Assign a mission
- Place in a cache
- Monitor progress

Geocaching Activity

- Tiger Tracks series of caches
- AU PD
  - http://www.geocaching.com/seek/cache_details.aspx?guid=80cd9491-8b20-4c03-9b4f-c5ebfba3a2c7
- Population 87,451
  - http://www.geocaching.com/seek/cache_details.aspx?guid=af860ff5-ae1b-473e-835f-9a88c4f72331
- Let's get down to Business!
  - http://www.geocaching.com/seek/cache_details.aspx?guid=17f18b00-9f2b-442a-afa3-83b72076be73