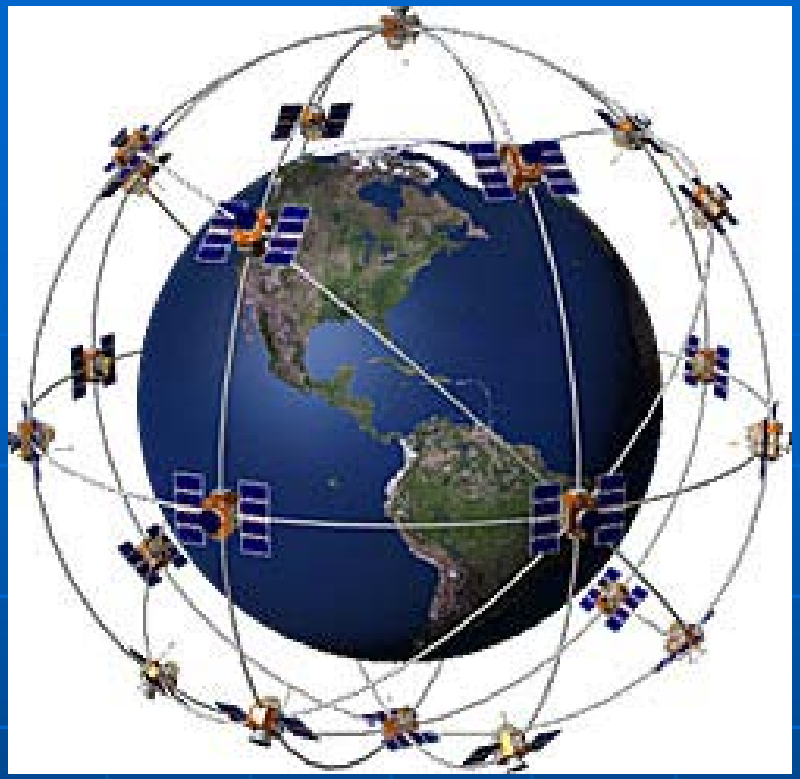
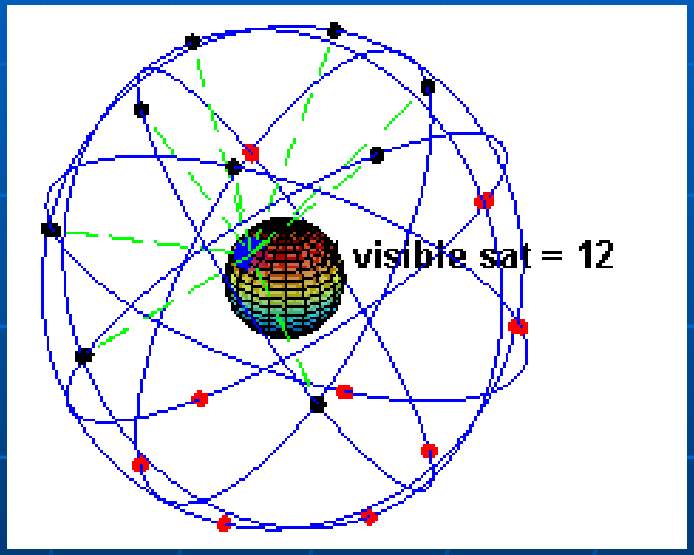


GPS
Global Positioning System

October 27, 2009

What is GPS?

- GPS is the Global Positioning System (originally called the Navstar Global Positioning System
- A space-based global navigation system developed by the US Department of Defense
- First envisioned by the Pentagon in 1973
- First Navstar satellite launched in 1978
- The full network of 24 satellites in low earth orbit operational in 1993

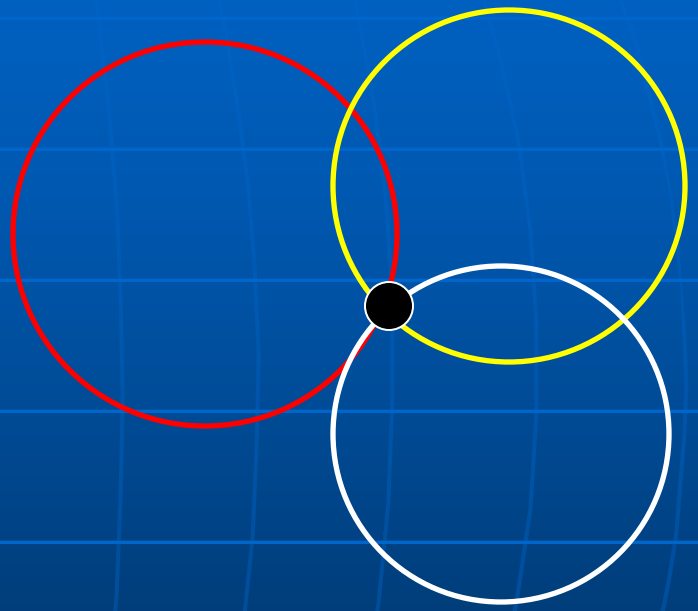


How GPS Works

- Each satellite carries 4 atomic clocks to transmit the time the orbital information was sent
- Satellites transmits an almanac to receivers with expected satellite locations
- Basic location principle – distance between satellites and receiver (you)
- Location by triangulation – distance to at least 3 satellites must be known, 4 visible satellites for 3D position

Basic Location

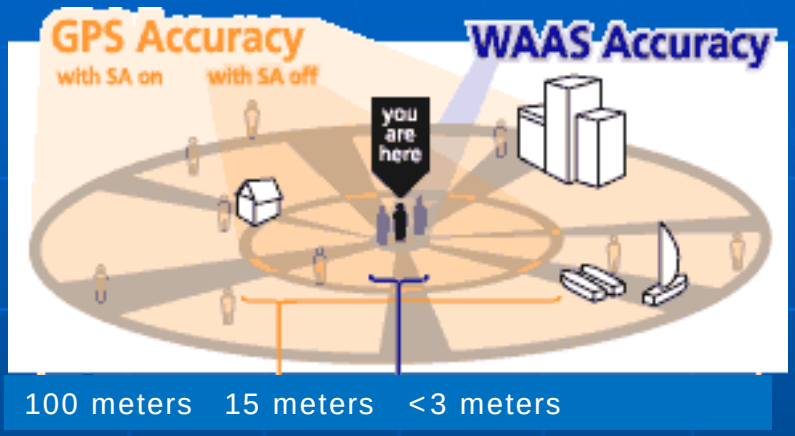
- Speed X Time – Distance
  - Satellite 1 - 0.09 seconds to reach receiver (186,000 mps X 0.09 seconds = 16,740 miles
  - Satellite 2 – 0.08 seconds to reach receiver (186,000 mps X 0.08 seconds = 14,880 miles
  - Satellite 3 – 0.07 seconds to reach receiver (186,000 mps X 0.07 seconds = 13,020 miles



Note there will be two locations possible, but one is located in space and will be discarded by the GPS receiver

GPS Accuracy

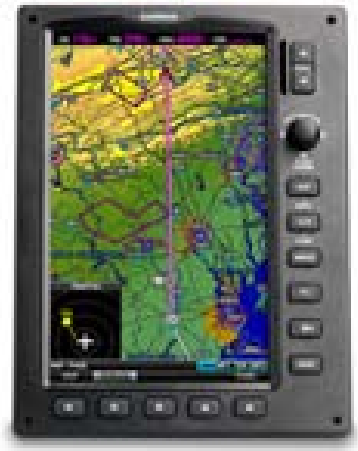
- Initially, two accuracy levels were transmitted, military (most accurate) and civilian (less accurate)
- Selective Availability degrades accuracy for civilian use to around 10 meters horizontally, 40 meters vertically



- Due to shortage of GPS receivers during Gulf War, US temporarily turned off SA
- By Presidential Order, SA was turned off on May 1, 2000, but could be turned back on if needed
- Wide Area Augmentation System (WAAS) added to GPS constellation to improve accuracy to better than 3 meters in North America

GPS Receivers

- Many types – Handheld, Automotive, Aviation, OEM/Embedded
- Handheld has maps, coordinates, elevation
- Automotive has maps, “go to” features, POIs
- Aviation mounts in airplane avionics, integrates other functionality, navigation, approaches
- Embedded devices in cellphones, laptops, OEM devices



GPS In The Field

- Basic needs
  - Location – Latitude, Longitude, Elevation
  - Maps
  - Datum (typically WGS84 or NAD 83)
- Latitude – 0 to 90 degrees north or south of equator (34° N)
- Longitude – 0 to 180 degrees west or east of Greenwich meridian
- Location format
  - Complete – Degrees, Minutes, Seconds (DDD °, MM', SS.SS")
  - Decimal minutes – Degrees, Minutes (DDD °, MM.MMMM')
  - Decimal degrees – Degrees (DDD.DDDD °)

Coordinates Defined

- Latitude
  - Degrees – 0 to 90
  - Minutes – 0 to 60 (60 minutes in 1 degree)
  - Seconds – 0 to 60 (60 seconds in 1 minute, 3600 seconds in 1 degree)
- Longitude
  - Degrees – 0 to 90
  - Minutes – 0 to 60 (60 minutes in 1 degree)
  - Seconds – 0 to 60 (60 seconds in 1 minute, 3600 seconds in 1 degree)

Converting Coordinates

- From decimal degrees to DMS – 34.94033

Degrees = 34

Minutes .94033 x 60 = 56(.4198)

Seconds .4198 x 60 = 25.188

34° 56’ 25.2”

Converting Coordinates

- From decimal minutes to DMS –

  34 ° 56.4198’

Degrees	=	34
Minutes	=	56
Seconds .4198 x 60	=	25.188

34° 56’ .25.2”

Converting Coordinates

- From DMS to decimal degrees –

  34° 56’ 25”

Degrees	=	34
Minutes 56 ÷ 60	=	.93333
Seconds 25 ÷ 3600	=	.006944
		34.9402773

Converting Coordinates

- From DMS to decimal minutes –

  34° 56’ 25.2”

Degrees	=	34
Minutes	=	56
Seconds 25.2 ÷ 60	=	.42
		34° 56.42’

Just to Confuse Things…

- GALILEO is a project of the European Union (EU) and the European Space Agency (ESA) to be operational by 2013
- GLONASS is the Russian system operational since 1995, but has fallen into disrepair
- COMPASS (Beidou-2) is being developed by China

GPS Calculators & Links

- boulter.com/gps/
- www.roadnotes.com/gpscalc.htm
- iPhone App – iGCT (Geocaching Toolkit)
- DegMinSec program on GwinnettARES Yahoo Files section (downloadable)

- www8.garmin.com/aboutGPS/
- www.gps.gov
- en.wikipedia.org/wiki/Global_Positioning_System