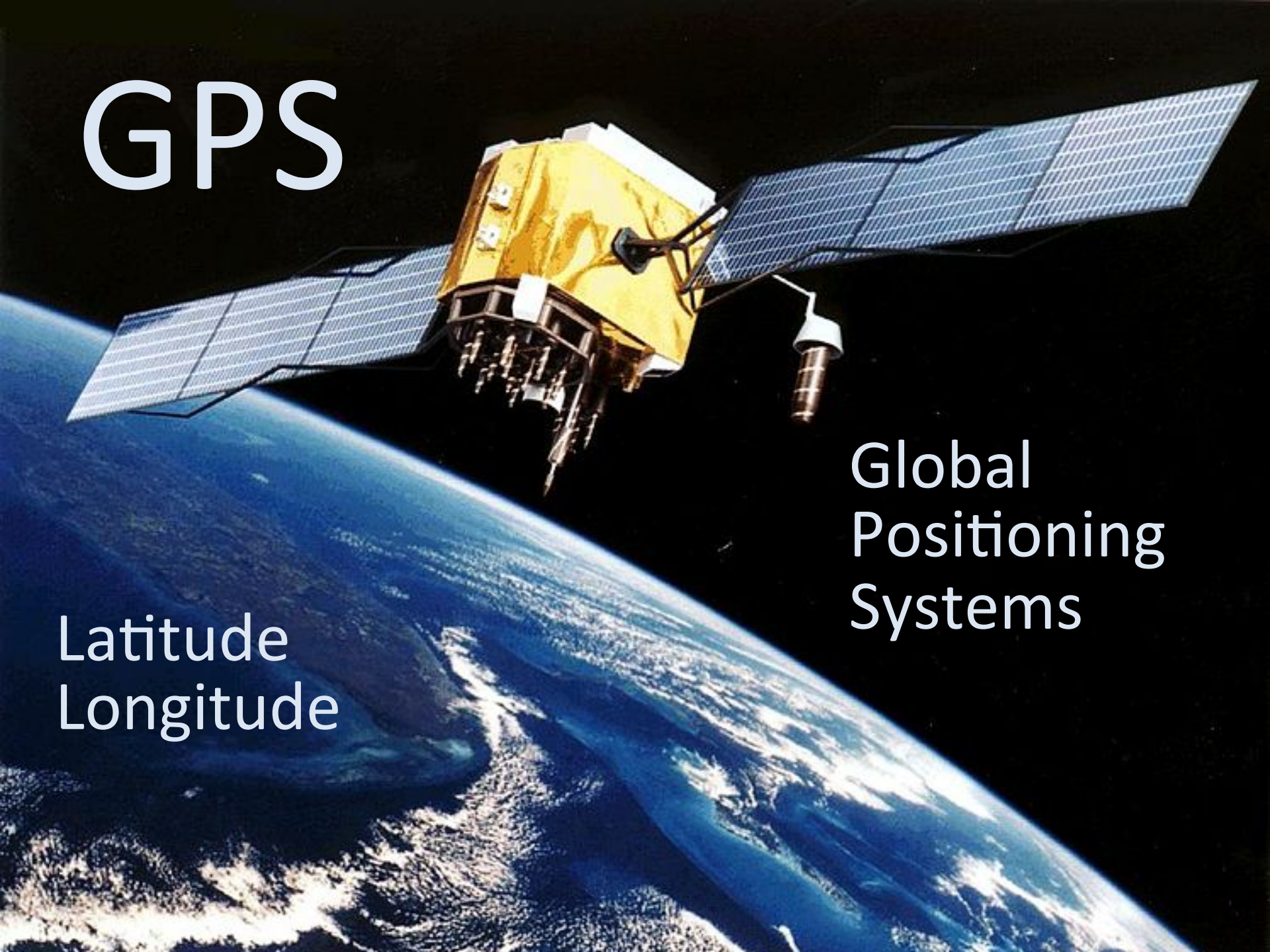
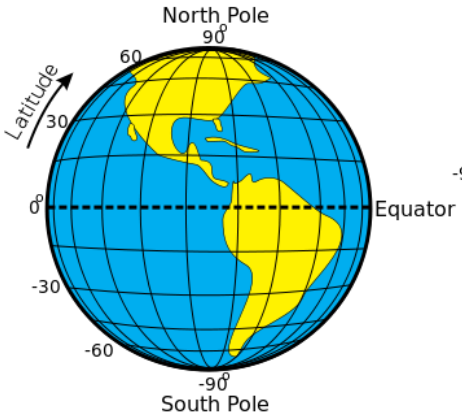
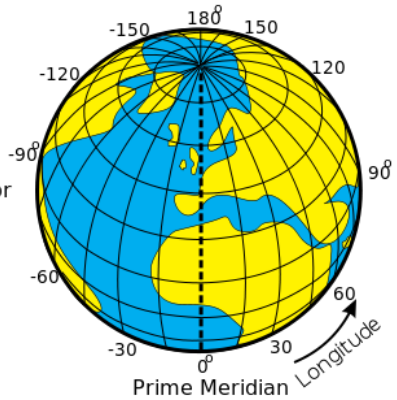

GPS
Global
Positioning
Systems
Latitude
Longitude

Two topics today





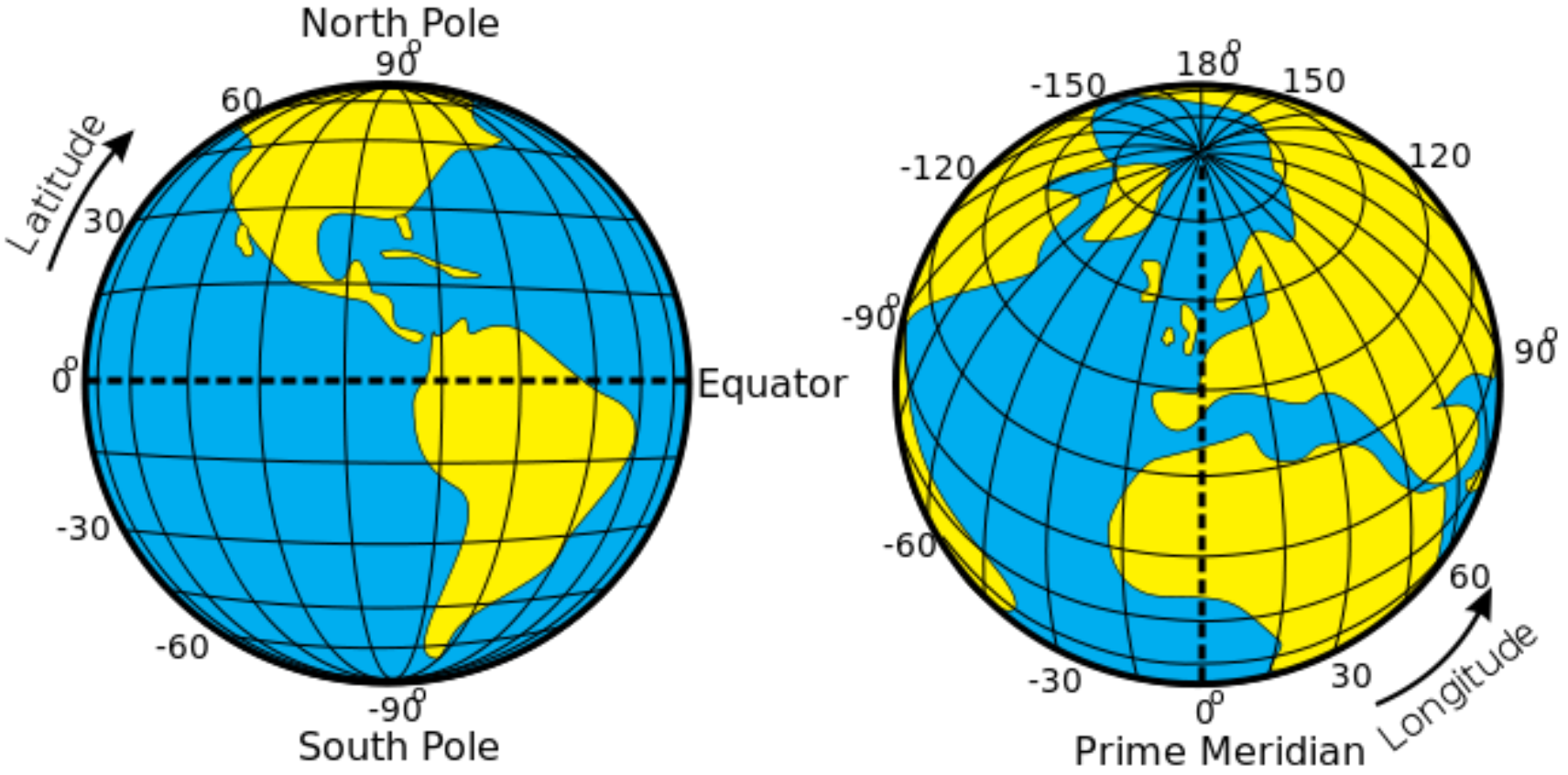
- Latitude and Longitude
  - Locating things on the surface of the earth with coordinates

- GPS – Global Positioning System
  - Using satellites and receivers to find **latitude** and **longitude** (coordinates)

http://upload.wikimedia.org/wikipedia/commons/6/62/Latitude_and_Longitude_of_the_Earth.svg
http://upload.wikimedia.org/wikipedia/commons/b/b1/Nokia_N8_%28front_view%29.jpg

How do you know where you are on earth ?
Latitude and Longitude

Globes of the Earth



Latitude

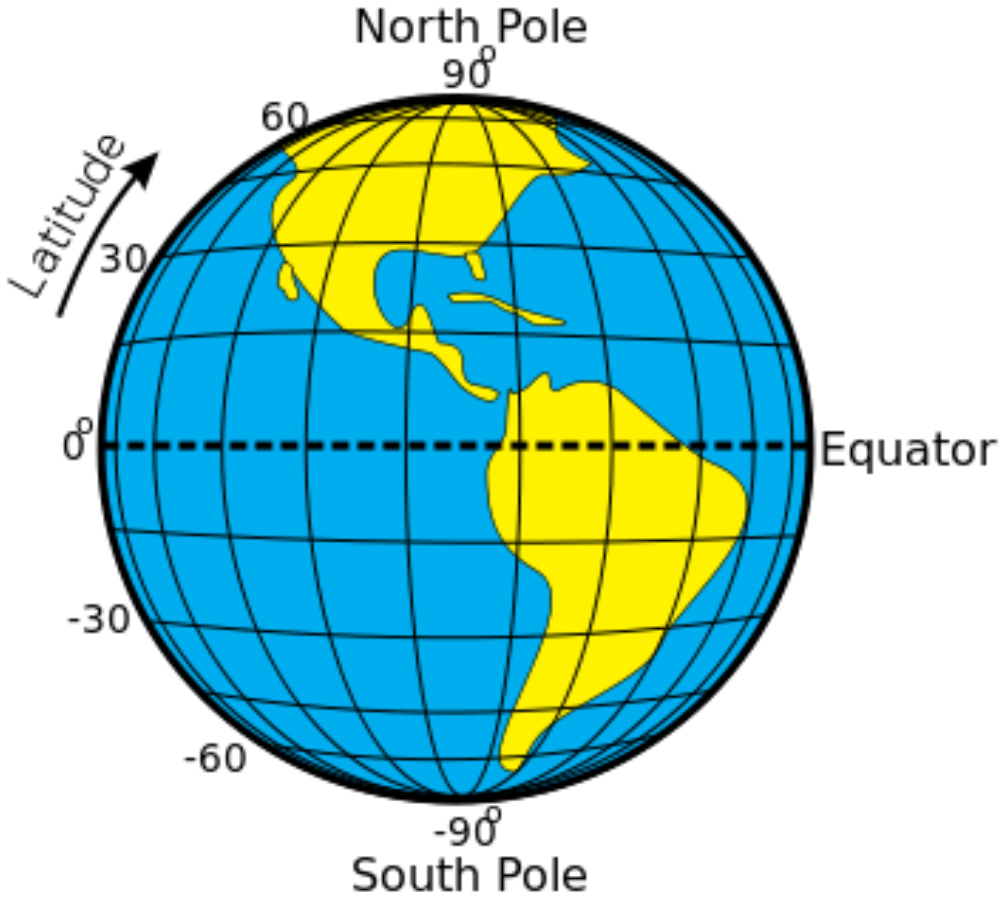
north

Longitude east west

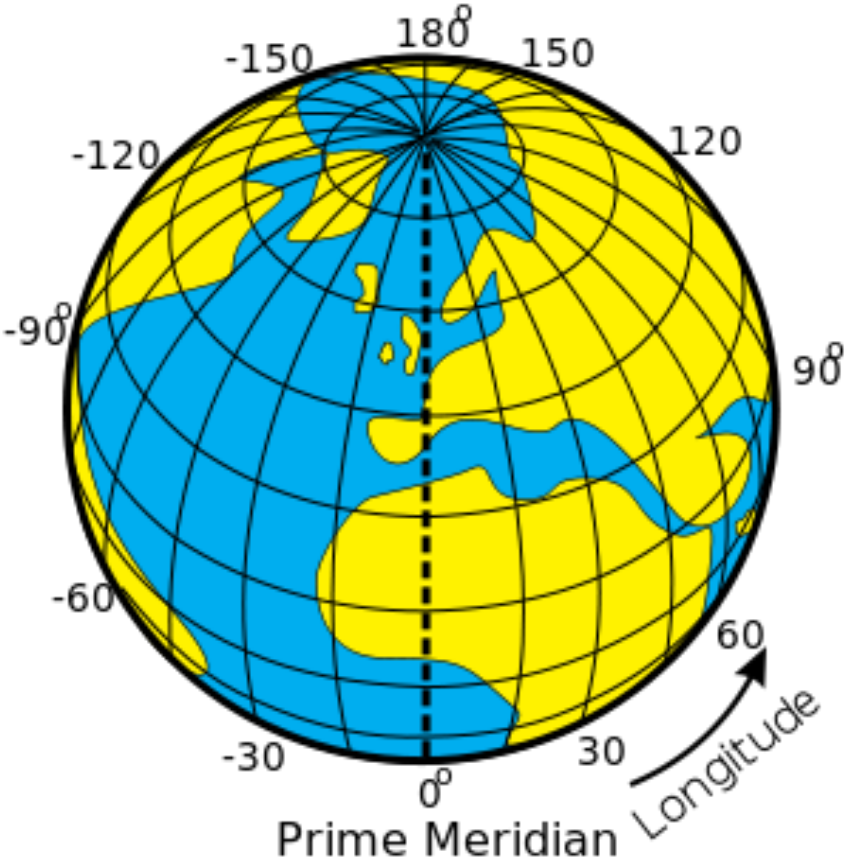
south

Equator

equator- this is the **0° latitude** that divides the earth in half, into the northern and southern **hemisphere**.



Prime Meridian

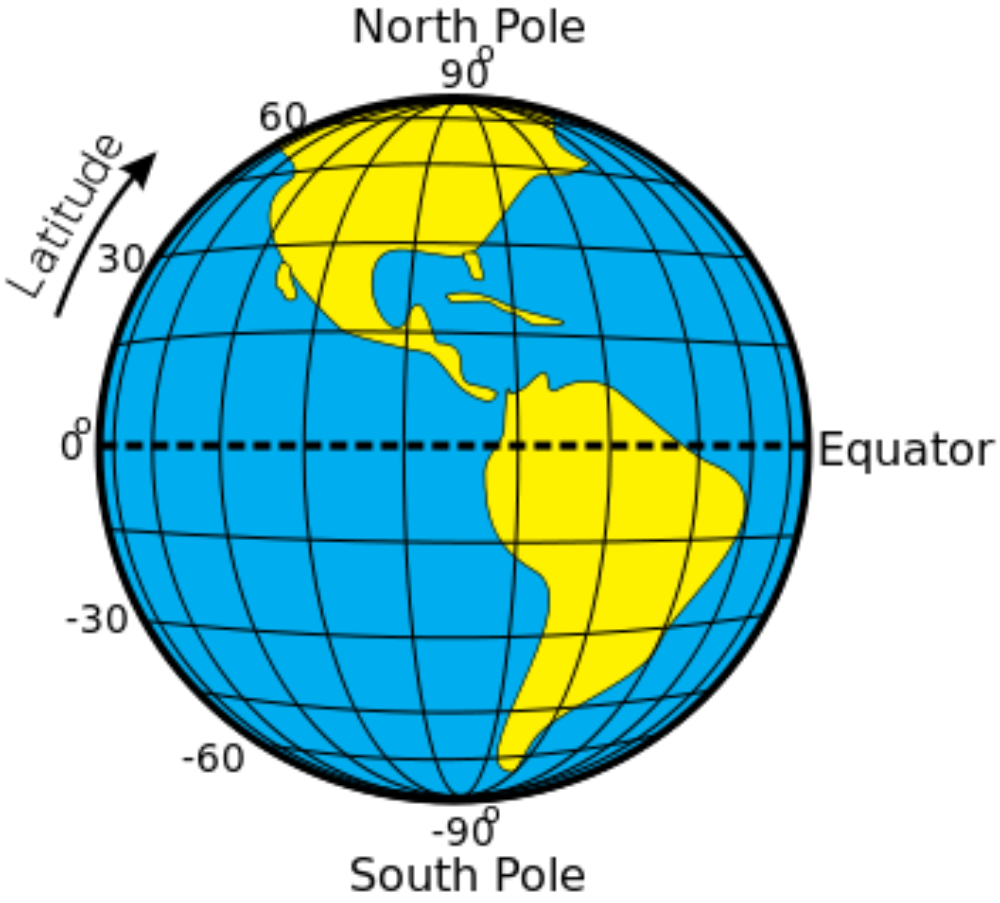


prime meridian- this is **0° longitude** that divides the earth in half, into the eastern and western hemispheres.

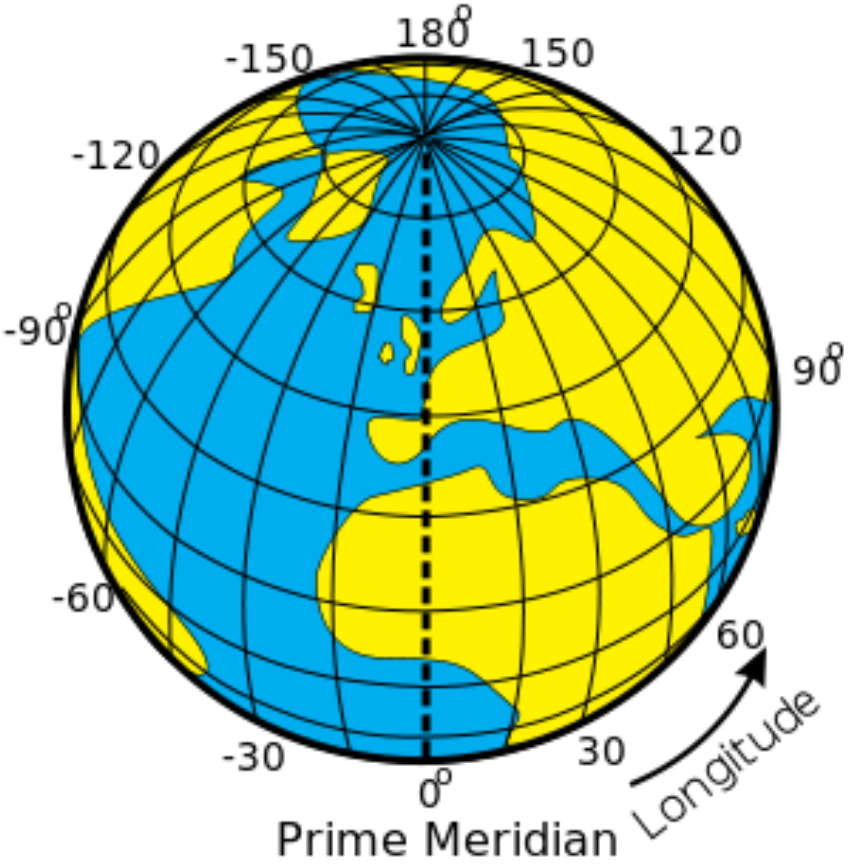
Latitude

latitude- these lines measure how far north or south of the equator a person or object is located.

these run across a globe, left to right

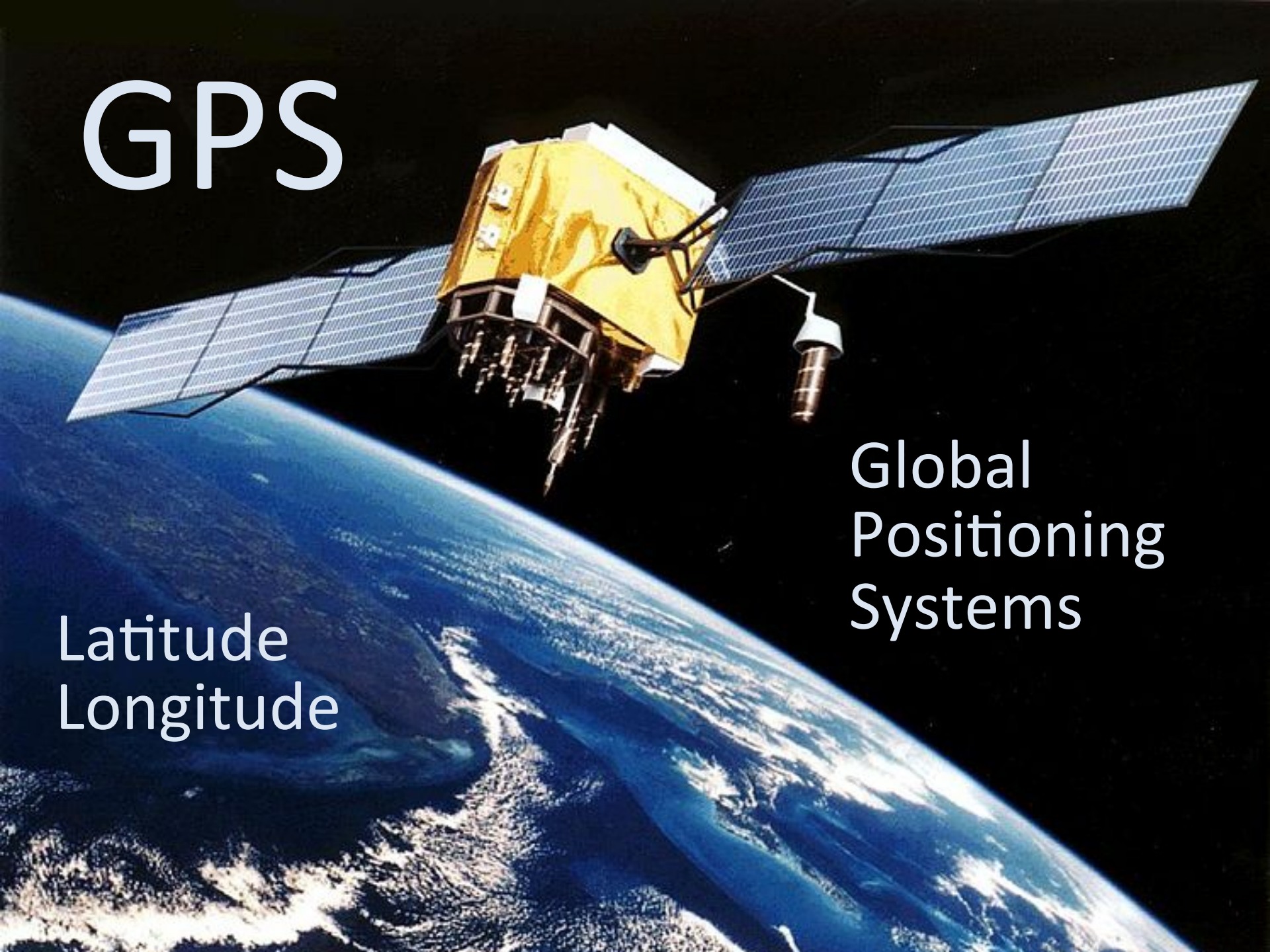


Longitude



longitude- these lines measure how far east or west from the prime meridian a person or object is located.

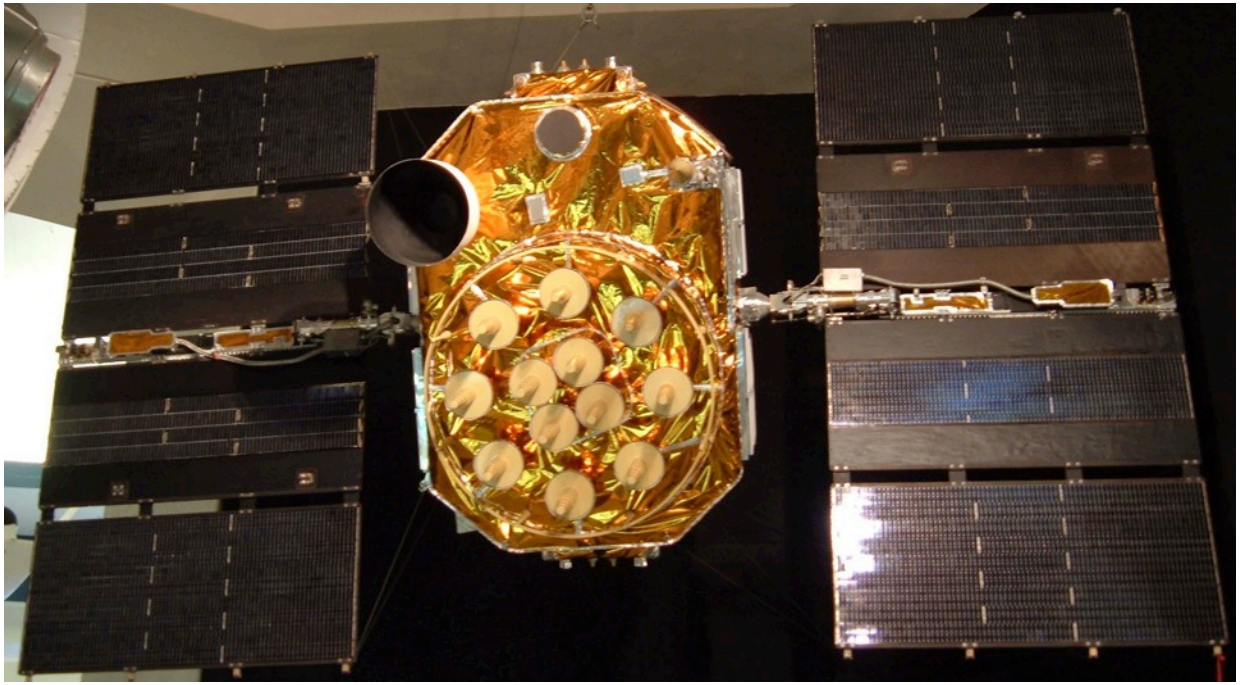
**these run up and down a globe or map, from top to bottom


GPS
Global
Positioning
Systems
Latitude
Longitude

GPS

- System of **GPS satellites** and **GPS receivers**
- Find **latitude** and **longitude** of a position on the earths surface
- Uses **Triangulation** (geometry) to calculate position from satellites

GPS, latitude and longitude



GPS Satellite

http://upload.wikimedia.org/wikipedia/commons/9/96/Global_Positioning_System_satellite.jpg

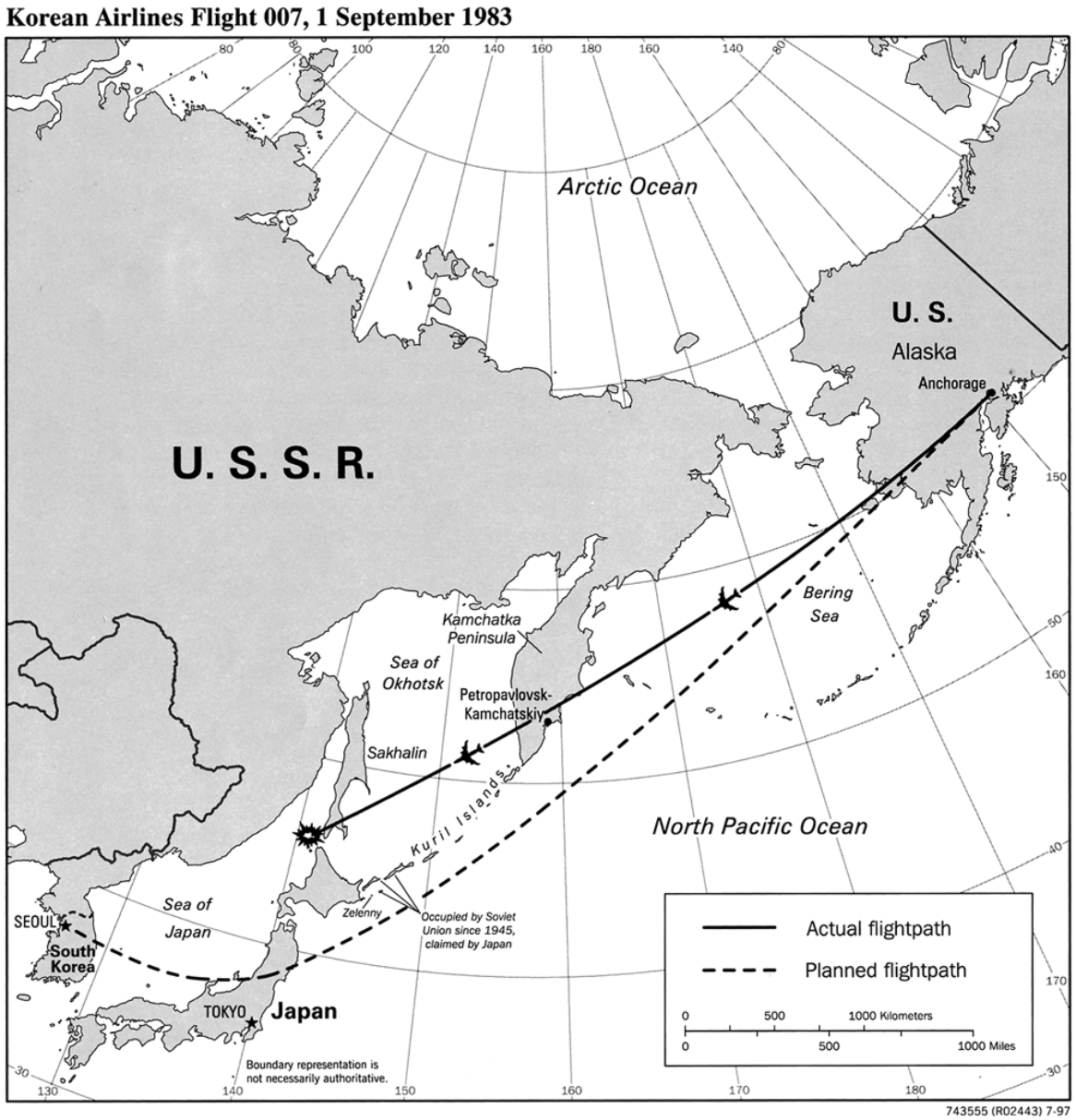
Air force personnel running a checklist on GPS satellite operations

http://upload.wikimedia.org/wikipedia/commons/4/4c/2_SOPS_space_systems_operator_040205-F-0000C-001.jpg

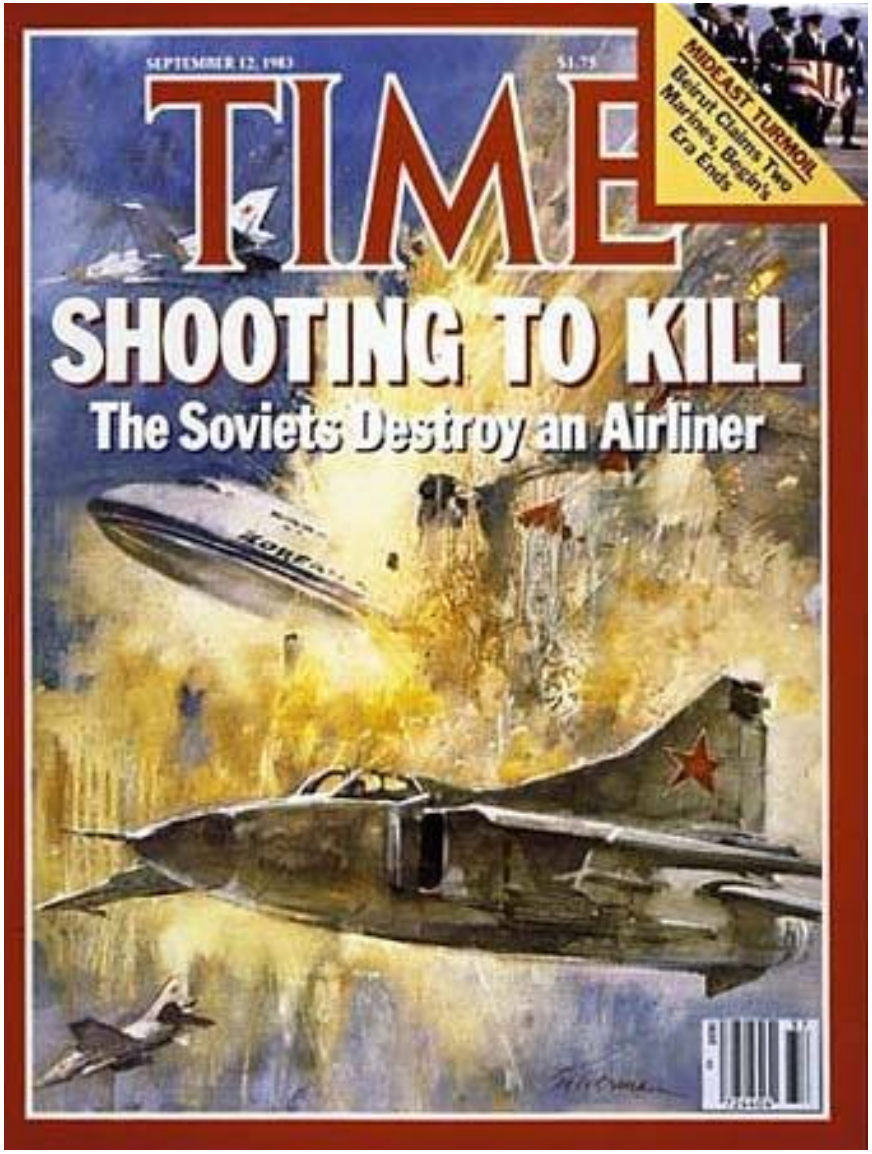
Science History
Global Positioning Systems

- First successful test 1960
  - 5 satellites needed one hour to fix position
  - Used for nuclear submarines and missile control
  - 100 meters accuracy
- First operational in 1978
- Ronald Reagan (president) made public in 1983
  - Airplanes and boats – prevent accidents

– CIA Map
– Flight 007
– Korean Airlines



http://upload.wikimedia.org/wikipedia/commons/7/78/KA_Flight_007.png



– Cold War Drama!!
– Conspiracy??
– Accident??

Public GPS Satellites!!

http://www.conservapedia.com/images/9/9c/Time_magazine.jpg

- Early 1990s first heavy military use in combat
  - Gulf war
- Advanced rapidly after 1995
- US released accurate signals worldwide in 2000
- Now 32 satellites for GPS
  - Approximately 10 meter accuracy within 3-4 minutes
- US Air Force

NAVSTAR

1970s-1992

50th Space Wing

1992 - present

http://en.wikipedia.org/wiki/File:NAVSTAR_GPS_logo_shield-official.jpg
http://en.wikipedia.org/wiki/File:50th_Space_Wing.png

GPS receivers Technological Advance

1991

Manpack global positioning system (GPS) receiver

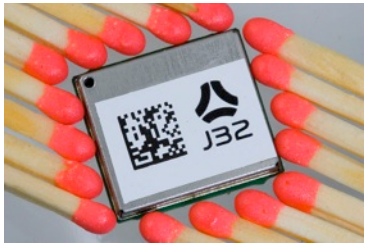
2000

2007

2013

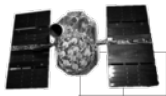
Smart phone

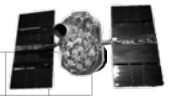
Size of modern cell phone GPS receiver

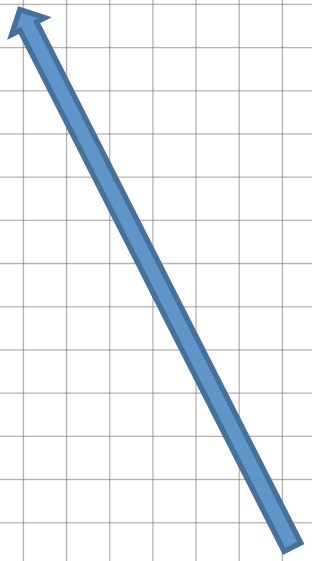


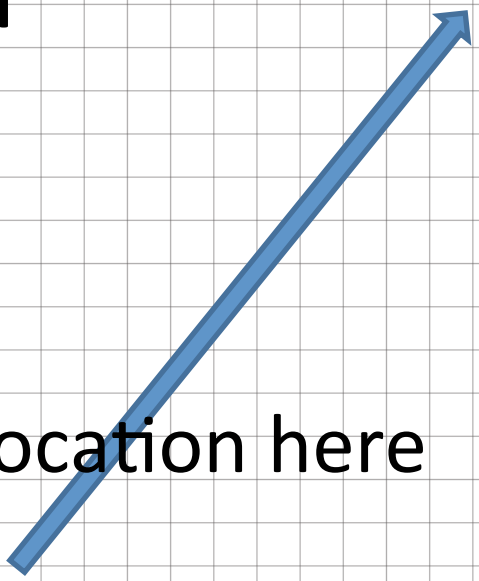
http://amhistory.si.edu/img/collections_xlarge/nmah2002-03037_428px.jpg
http://upload.wikimedia.org/wikipedia/commons/5/59/GPS_Receivers_2007.jpg
http://upload.wikimedia.org/wikipedia/commons/0/05/J32_1_small.jpg
http://www.vagabondjourney.com/travelogue/wp-content/uploads/backpack-trimble-gps-unit.jpg

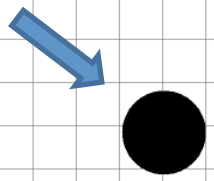
Triangulation review


satellite


satellite

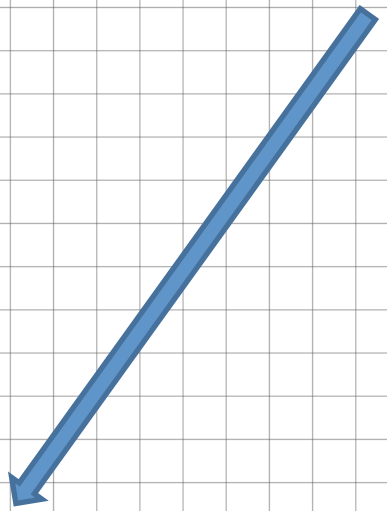


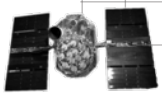


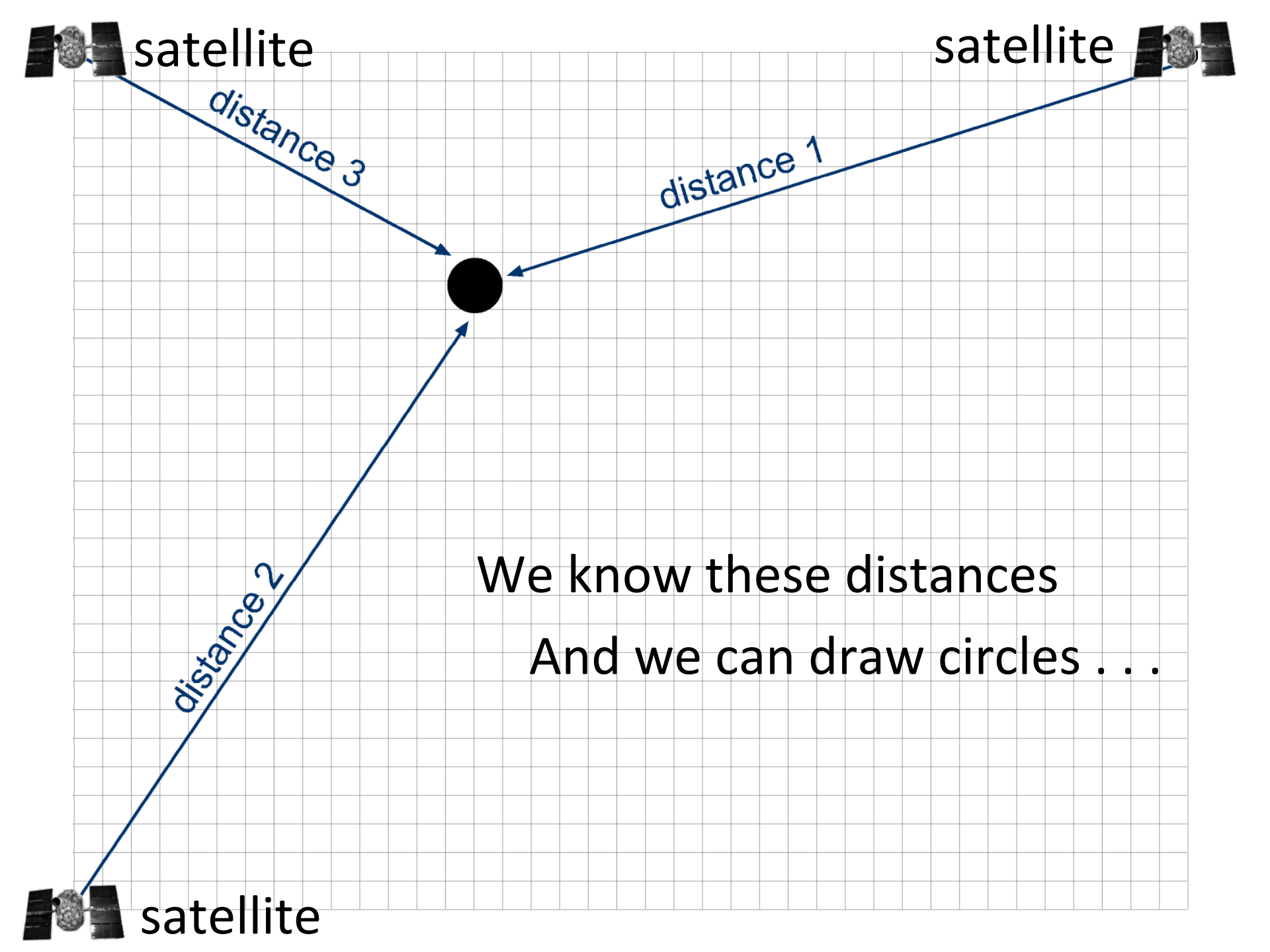


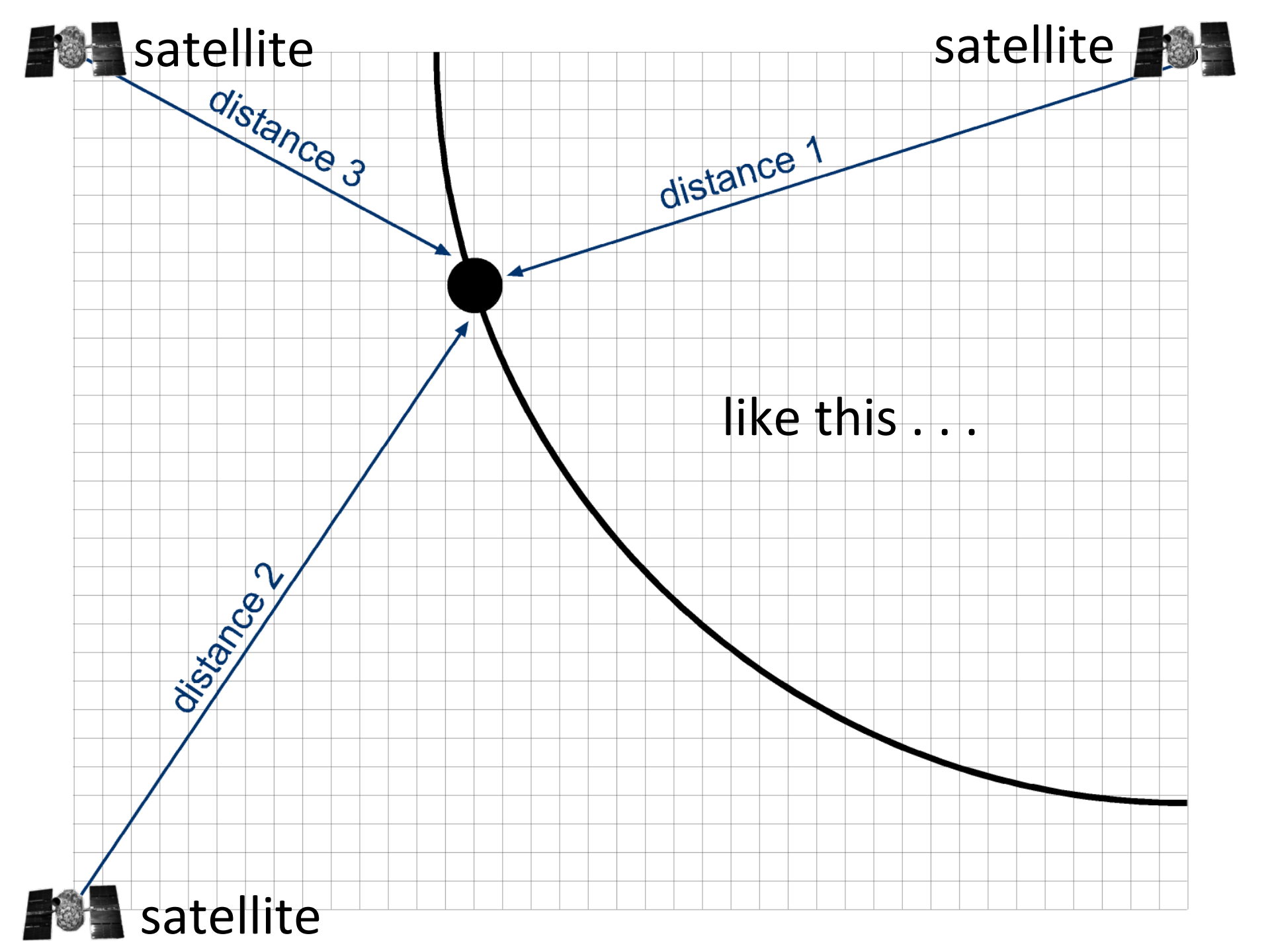
We want to find our location here

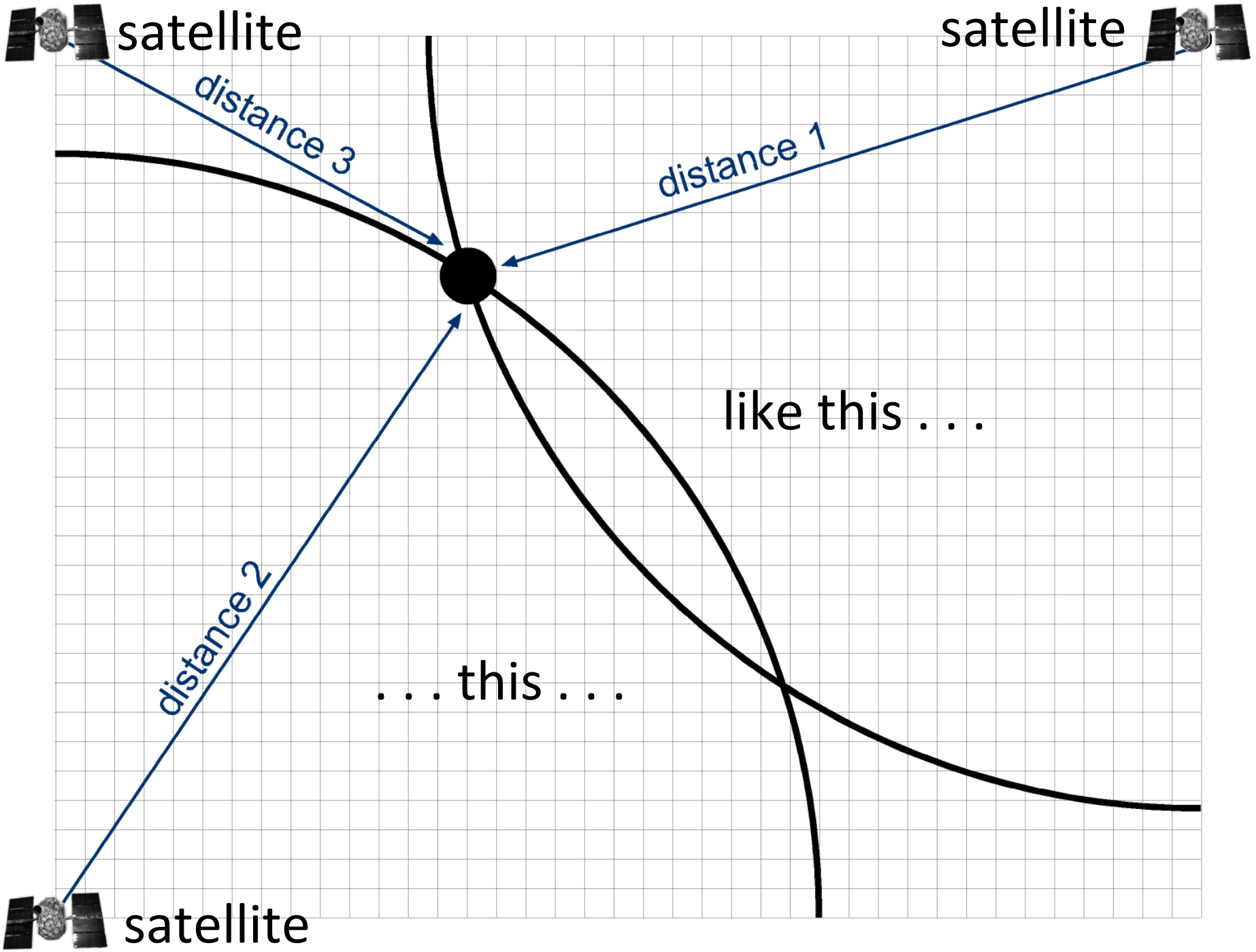
We know the location of these points

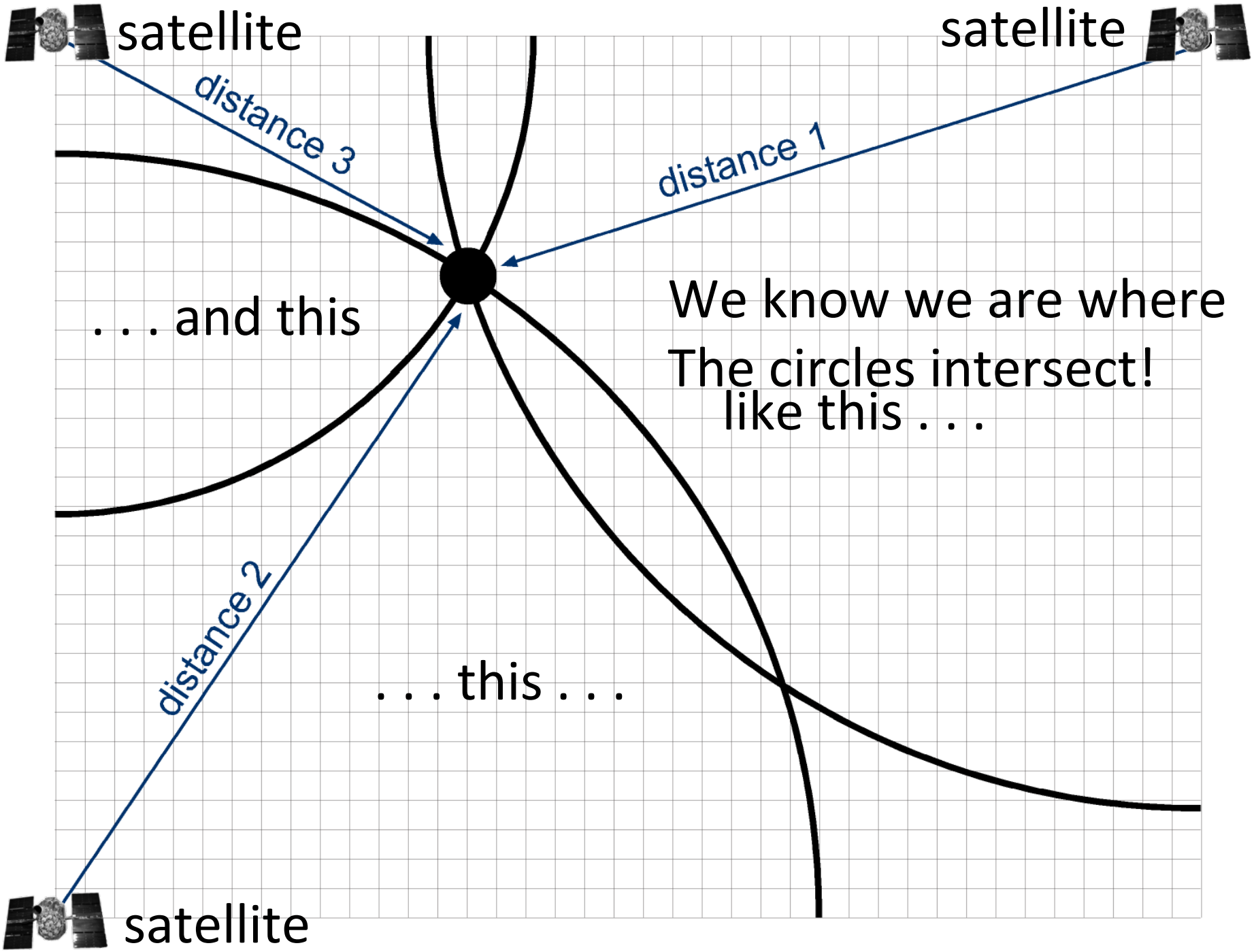



satellite

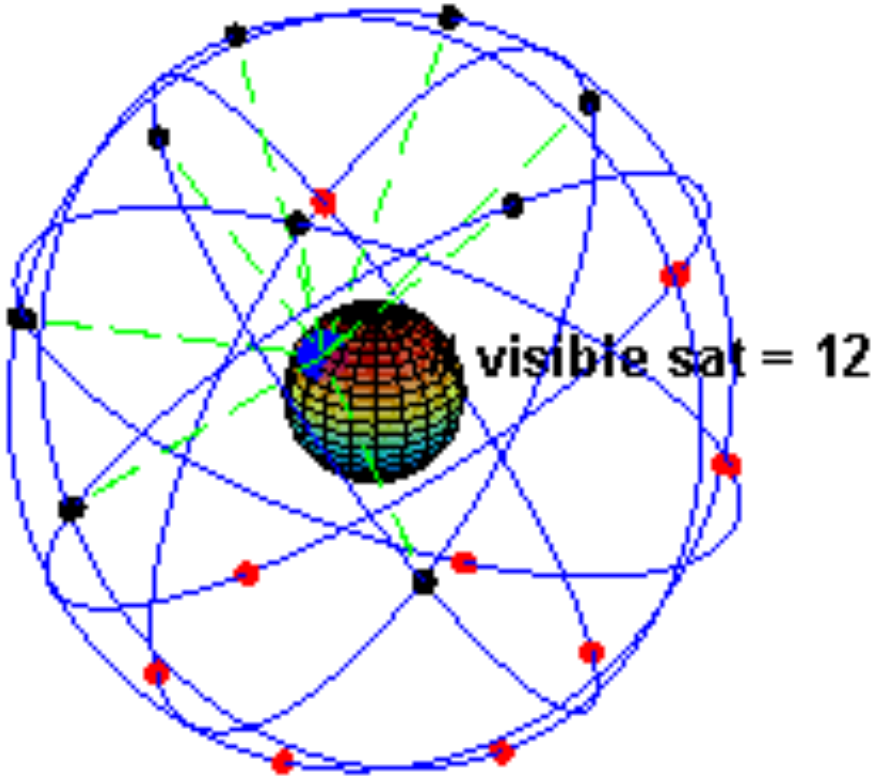

satellite
satellite
satellite
distance 3
distance 1
distance 2
We know these distances
And we can draw circles . . .


satellite
satellite
distance 3
distance 1
like this . . .
distance 2
satellite


satellite
satellite
distance 3
distance 1
like this . . .
distance 2
. . . this . . .
satellite


satellite
satellite
satellite
distance 3
distance 1
distance 2
. . . and this
. . . this . . .
We know we are where
The circles intersect!
like this . . .

Triangulation from satellites



GPS Triangulation

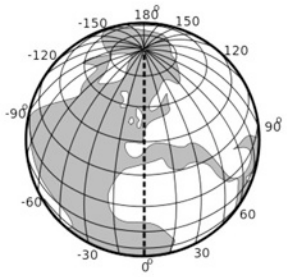
- Distance from satellites to cell phones

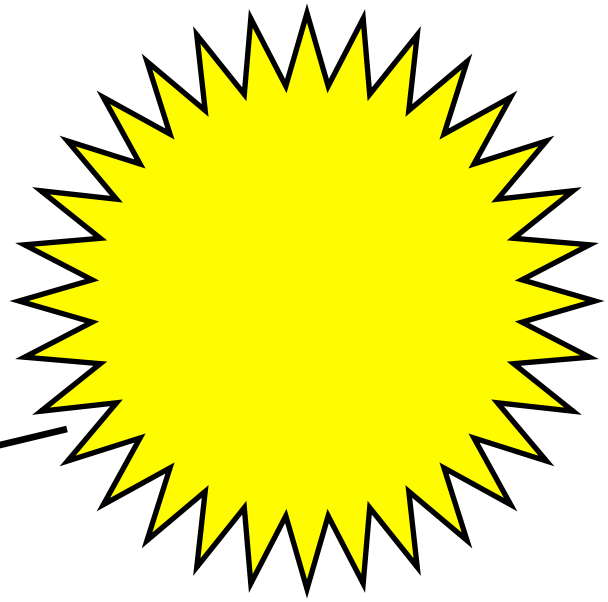
  distance = speed x time

  - Satellite tells the receiver
    - Which satellite is sending the signal
    - What time the signal was sent
      - Need very precise clocks on satellites (atomic)
  - Speed of light ~ $3X10^8$ meters/second (VERY FAST)
    - Same as speed of radio signal (electro-magnetic wave)
  - Simple calculation with above equation in receivers

Speed of Light ~ $3X10^8$ meters/second
VERY FAST

- 186,000 miles / second
- 300,000,000 meters / second
  299,792,458
- 300,000 kilometers / second





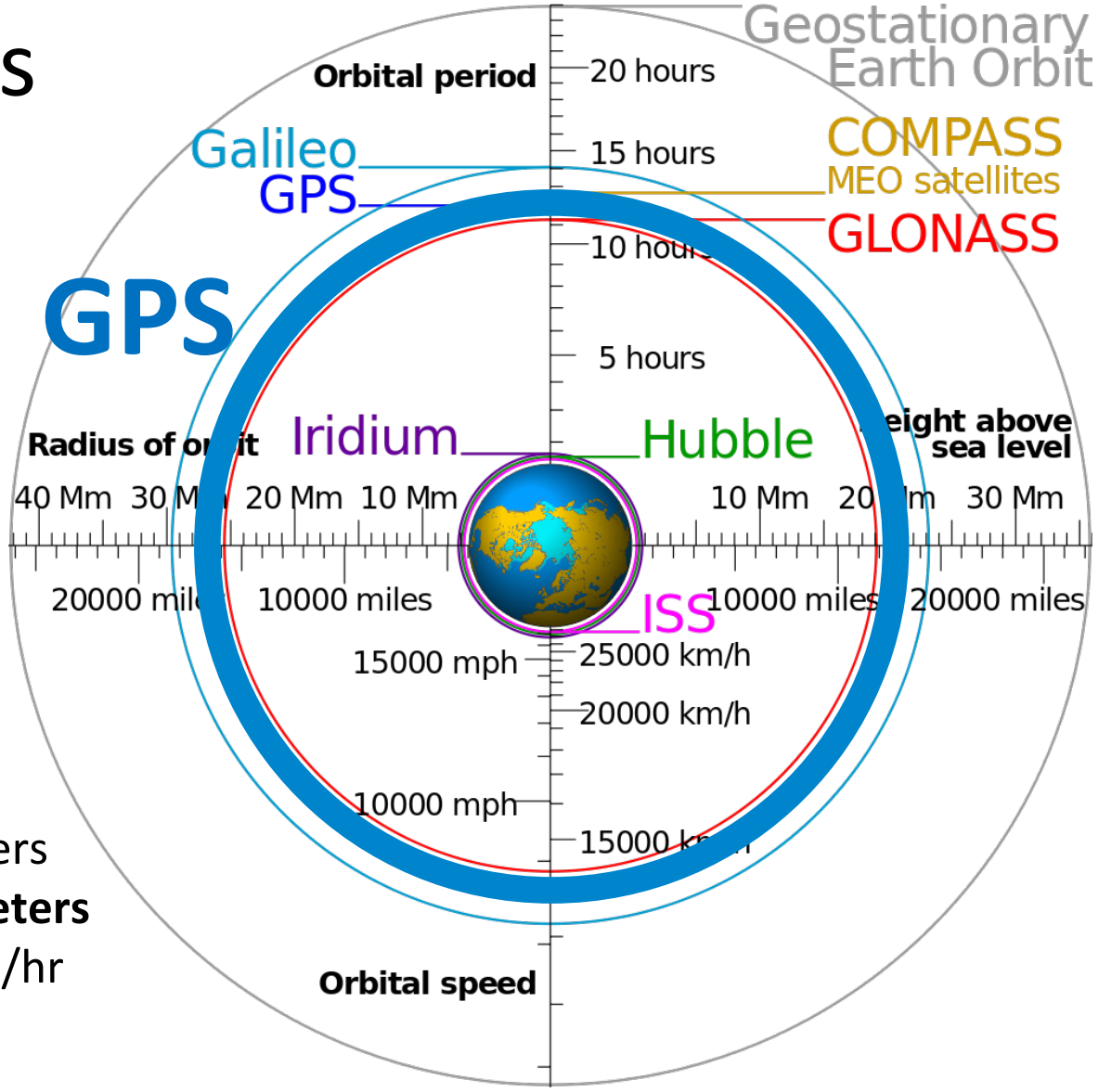
It takes light 8 minutes to travel from the sun to the earth

$15 X 10^7$ km ÷ $3 X 10^5$ km/sec = 500 sec ÷ 60 sec / min ~ 8 min

- LA is 330 miles away, how many times can light travel to LA and back in one second

  186,000 miles / second ÷ 660 miles = 281.81 trips / second

GPS Satellites Orbit Info



Radius: ~26.6 million meters
Altitude: ~20.2 million meters
Speed: ~14 million meters/hr
Period: ~12 hours

https://upload.wikimedia.org/wikipedia/commons/thumb/b/b4/Comparison_satellite_navigation_orbits.svg/1000px-Comparison_satellite_navigation_orbits.svg.png

GPS mapping activity

Now that you have way too much information . . . .

Are you ready to try out this technology???

GPS mapping activity

In groups of two or three you will use a smart phone and a computer to create a map of your high school with *thematic features* of your choice.

Thematic features are simply things that we find on the surface of the earth

birds?

trees?

benches?

people?

flowers?

drinking fountains?

Set up your phone
The GPS Receiver

1. Get into groups of two or three people. Make sure each group has a person with a smart phone.

2. Connect the phone to the WHS wireless network

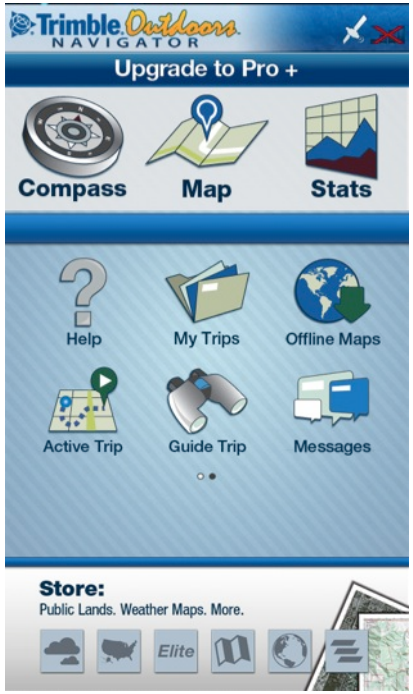
   REMEMBER: while the app is free, the data service is not. Make sure you are connected to the WHS wireless network so you are not charged for data on your cellular plan!!!

3. Run the “Outdoor Navigator” app

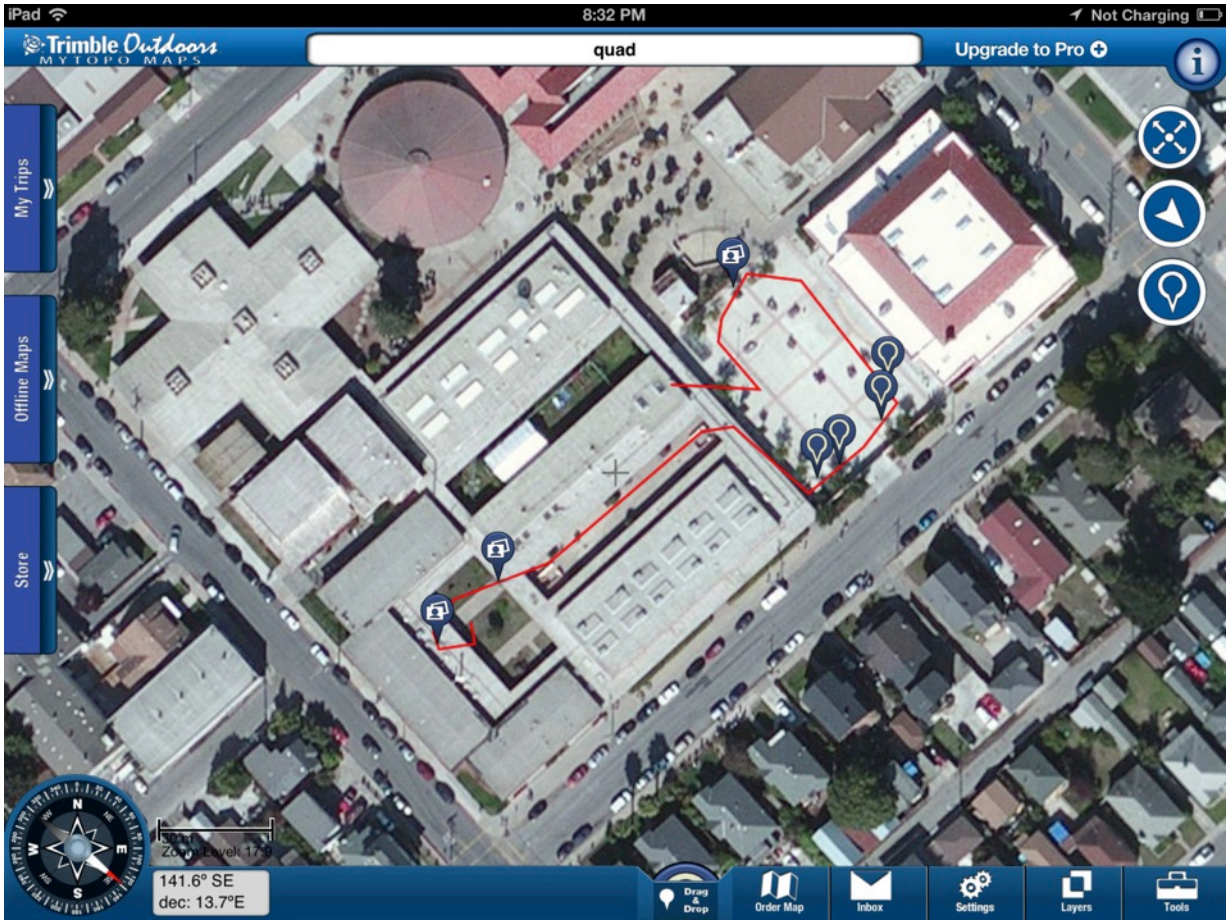
Account Login<> Password <>

You should see this

or this



phone



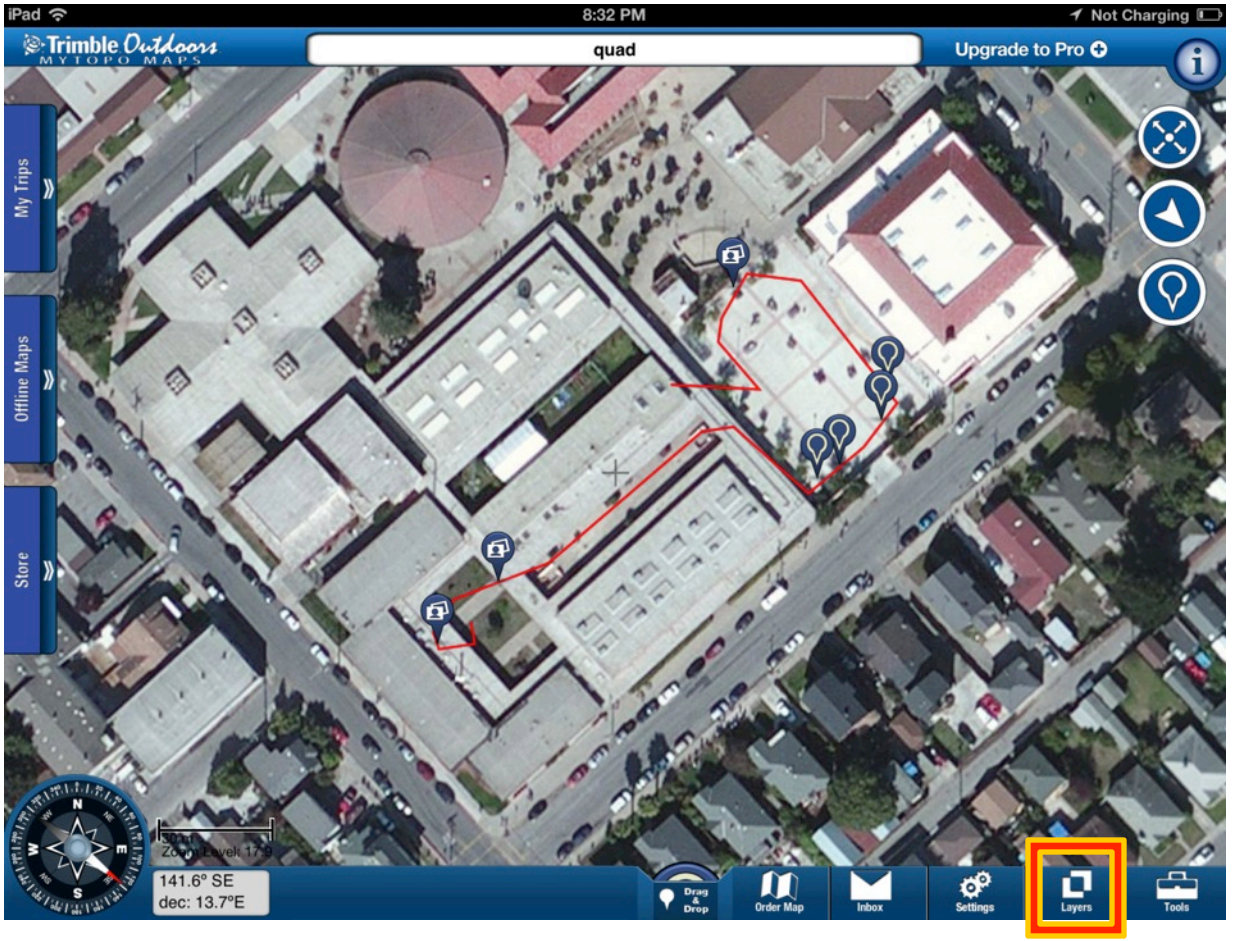
iPad

Find the “Layers” button

phone

Go to “Map”
Then find “Layers”

iPad

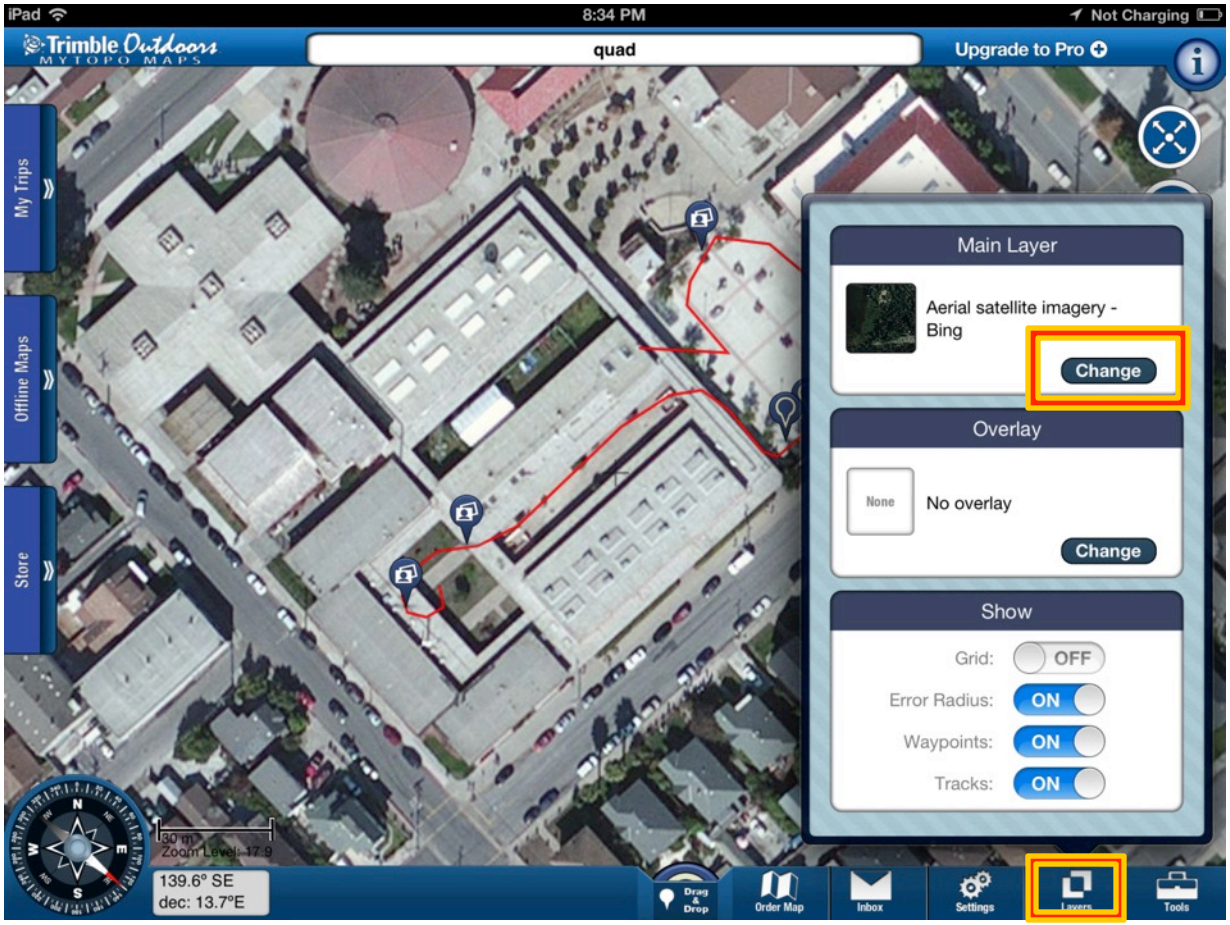


Choose: Aerial Satellite Imagery - Bing

phone

Set “MapType”
To “Aerial – Bing”

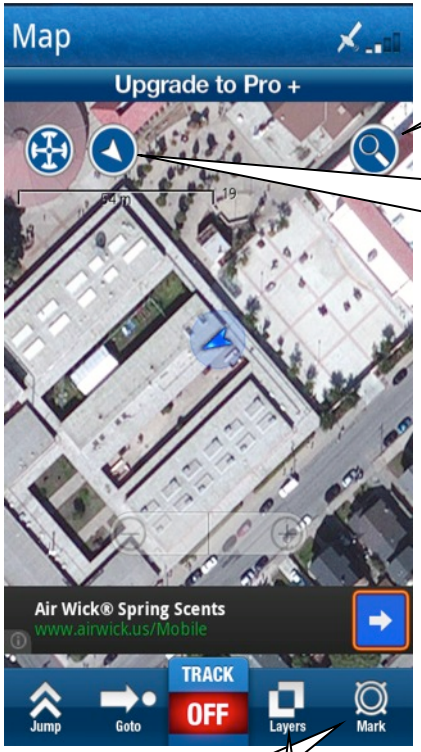
Set “Main Layer” To “Aerial satellite imagery – Bing”



iPad

The map screen

phone



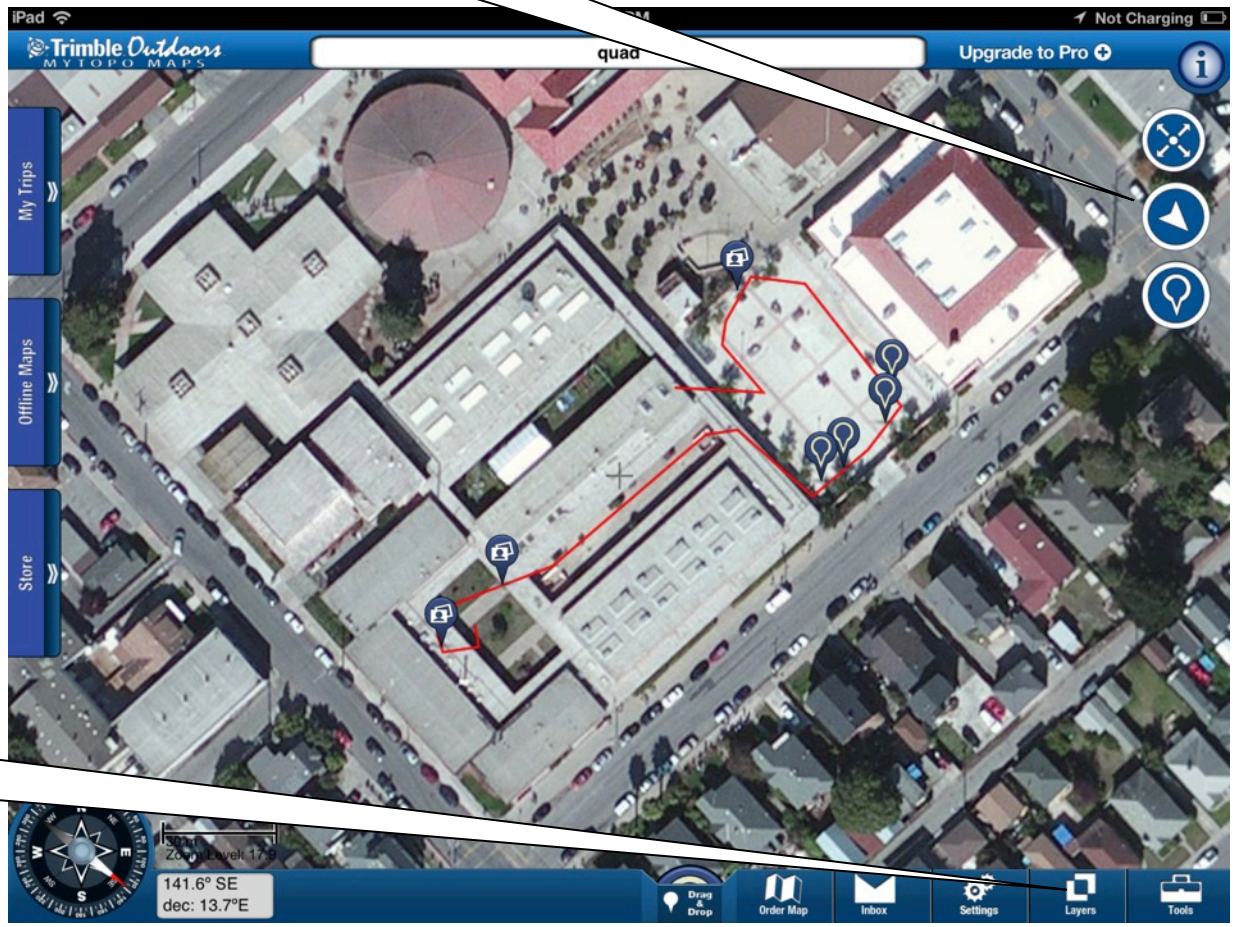
"SEARCH" button

"AUTO_FOLLOW" button. Use this to find your position on the map

"MARK" button for WAYPOINTS and PHOTOS

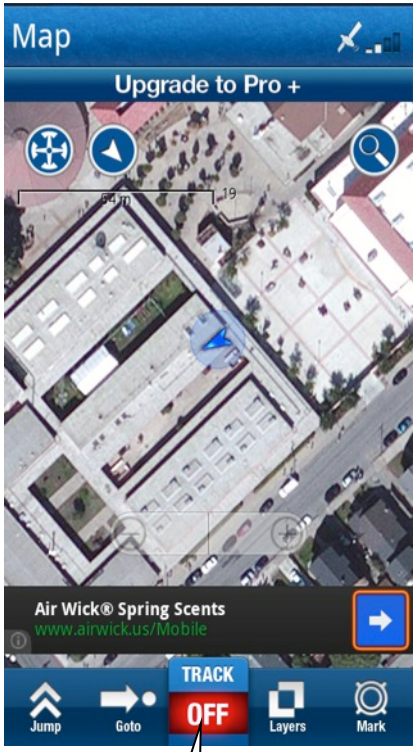
"LAYERS" button to change the style of map

iPad



Start a “trip”

phone

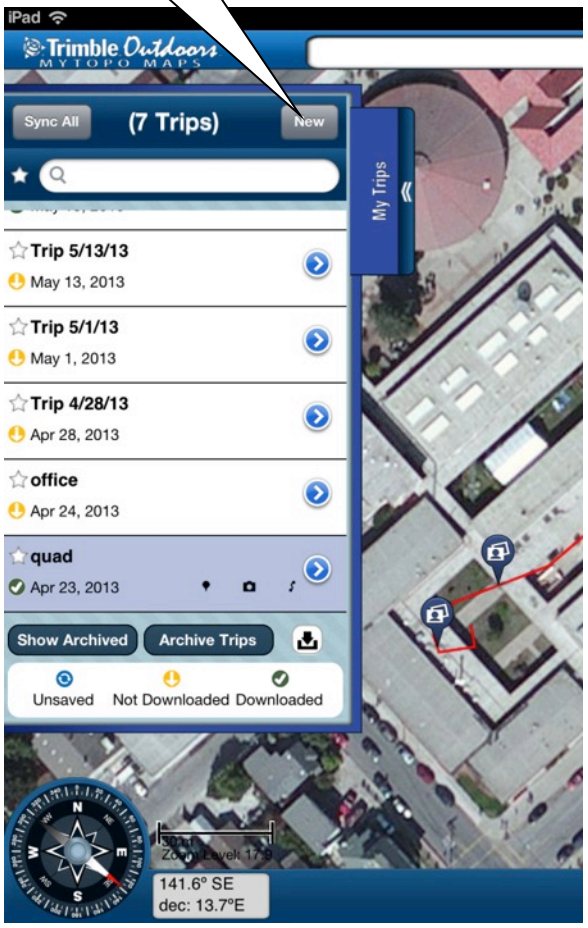


Pull the track button down to “on” and make a good name

Press the “My Trips” tab and then

Press “new” and give it a good name

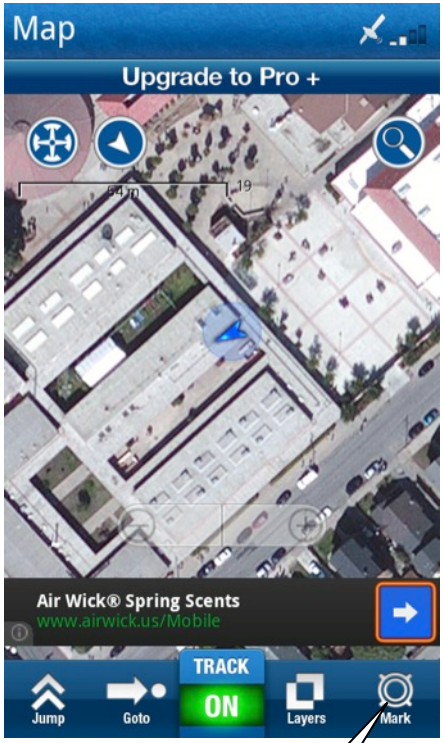
iPad



Mark a Waypoint

Remember: wait a few minutes to get a good "fix" on the location

phone

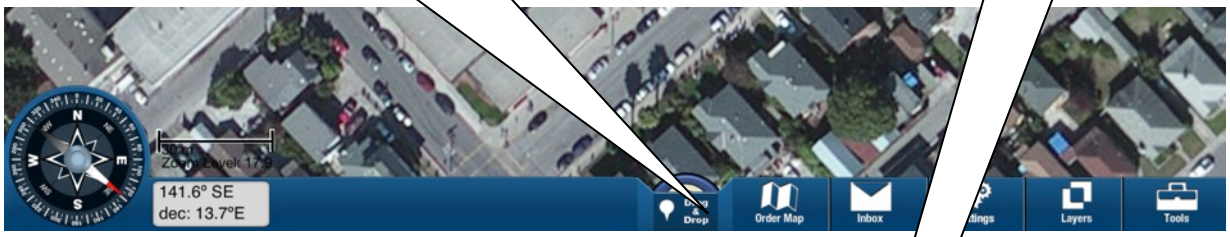


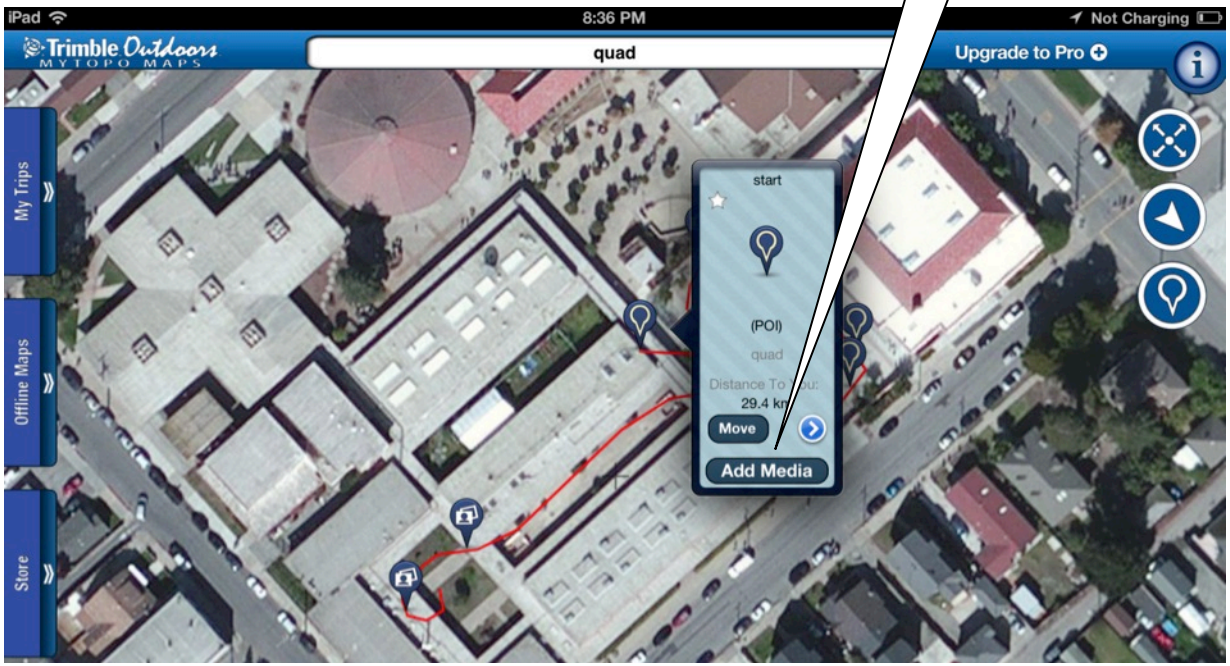
Press "Mark" and choose a waypoint or photo

iPad

Press the "Drag and Drop" button and drag the point to your blue marker

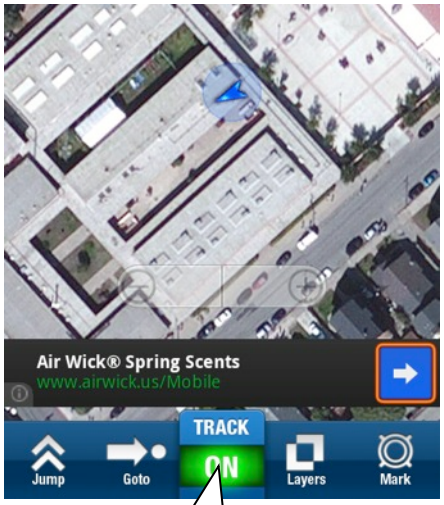
Add a photo if you like





End the “trip”

phone



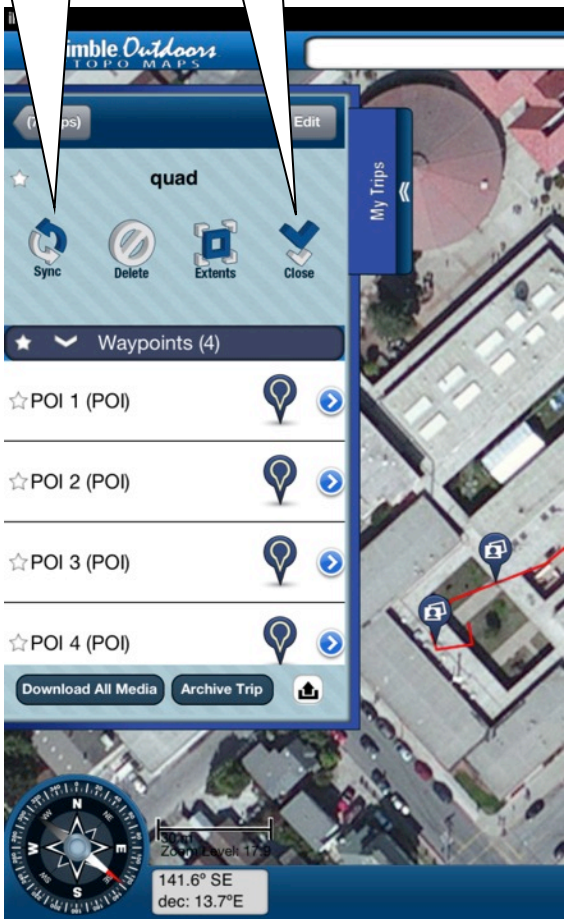
Turn the track off and go to the home screen

Press “My Trips

Then press sync

First press close

iPad



<u>iPhone/Android</u>

1. Go to the “Home” screen
2. Press the “Stop” button
3. When asked, close the trip
4. Choose a sharing option (you do not need to share)

Uses of GPS

- Military
  - Navigation (boats, airplanes, submarines, cars, missiles, bombs)
  - Target acquisition
  - Cartography
  - Rescue
  - Surveillance
- Civilian
  - Navigation (airplanes, boats, cars, etc)
  - Cartography (making maps – any ideas?)
  - Cellular location services
  - Disaster/relief/ emergency services
  - Fleet tracking
  - Geo-fencing (seeing what is near to you)
  - Geo-tagging (like pictures on a camera)
  - GPS tourism (tours, geocaching)
  - Robotics
  - Surveying
  - Plate tectonics