Global positioning

Peter Galante

Biodiversity Informatics Scientist

Center for Biodiversity and Conservation

American Museum of Natural History

GNSS

- Global Navigation Satellite System
  - Global Positioning System (GPS)
    - Most commercial GPS units
  - Russian Global Navigation Satellite System (GLONASS)
    - Can be added to commercial units

  - Galileo Positioning System (EU)

GPS

- 1960's US Navy:
  - Satellite positioning of nuclear submarines using Doppler Effect radio shifts

- 1970's Department of Defense:
  - NAVSTAR (Navigation System with Timing and Ranging)
    - 24 Satellite constellation

- 1990's – late 2010's US Air Force:
  - 30 satellites for public use (many retired, dormant)
  - Provides Standard Positioning Service (SPS)
    - Precise Positioning Service (PPS) is reserved for military use

- 2019 US Space Force:
  - Maintain and control operations
    - 24 operational satellites

FORDHAM
THE JESUIT UNIVERSITY OF NEW YORK

GPS

- 1960's US Navy:
  - Satellite positioning of nuclear submarines using Doppler Effect radio shifts

GPS

- 1970's Department of Defense:
  - NAVSTAR (Navigation System with Timing and Ranging)
    - 24 Satellite constellation
    - Completed in 1994
    - At least 5 Satellites in view from most point on earth at any giventime

Block II satellite

GPS

- 1990's – late 2010's US Air Force:
    - 30 satellites for public use (many retired, dormant)
    - Updated to Block III Satellites
    - Provides Standard Positioning Service (SPS)
        - Precise Positioning Service (PPS) is reserved for military use

Block III satellite

FORDHAM
THE JESUIT UNIVERSITY OF NEW YORK

GPS

- 2019 US Space Force:
  - Maintain and control operations
    - 24 operational satellites

GPS

- Future:
  - New civilian signals for improved applications (aviation, safety)
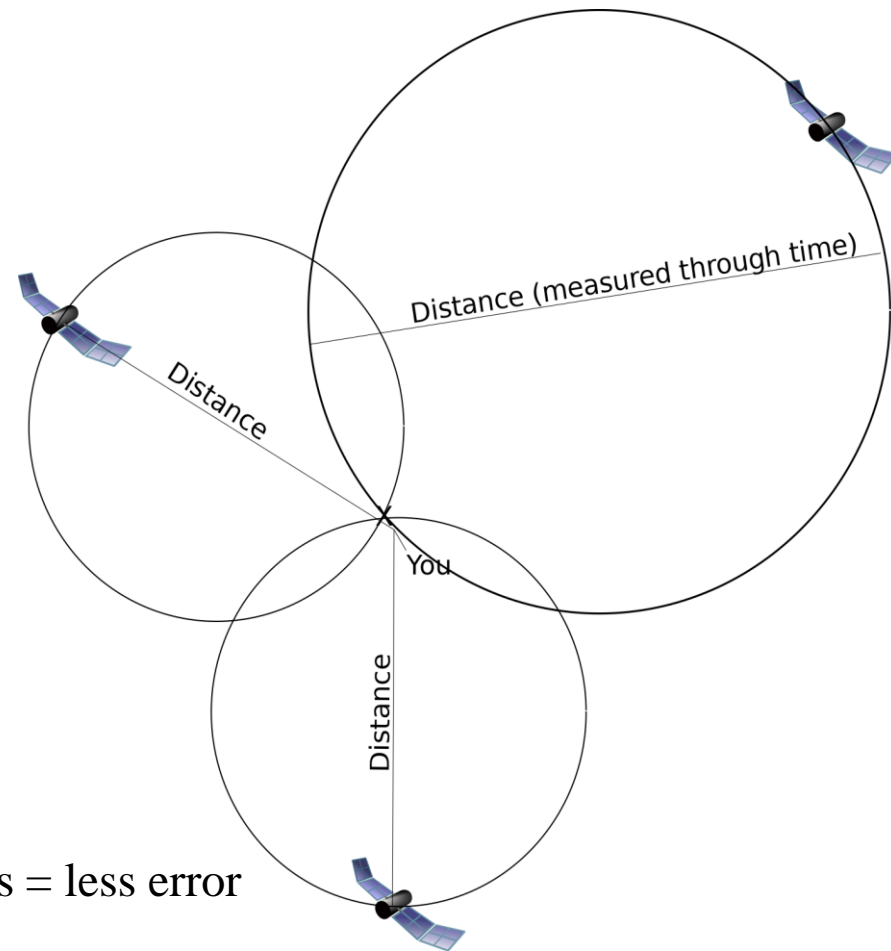 - Private industries
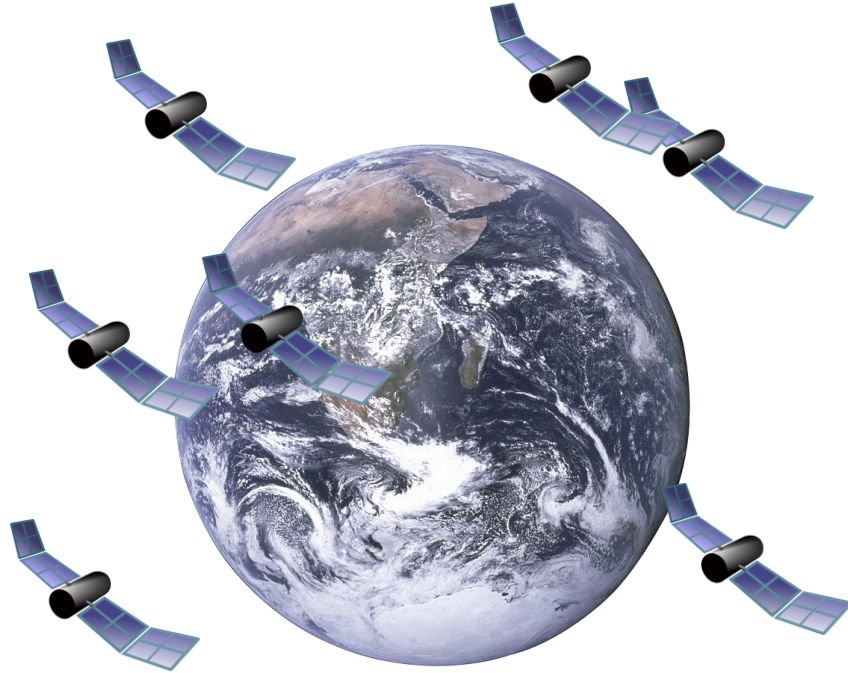
Success

Rough start

  - Regulations?
  - Space junk accumulation

FORDHAM
THE JESUIT UNIVERSITY OF NEW YORK

GPS

Distance (measured through time)

Distance

You

Distance

More satellites = less error

FORDHAM
THE JESUIT UNIVERSITY OF NEW YORK

GPS

- Converting time to distance
  - GPS unit computes its own location using data received from satellite
    - Receiver *must* have a reliable clock
    - Satellite sends *its own* precise location, and an atomically calibrated timestamp
    - Receiver then calculates its distance from that satellite
      - Time received - time sent = time difference
      - Time difference x 299,782,458 meters/second = distance
  - Do this for multiple satellites = accurate 3D location
    - Minimum, 4 satellites

FORDHAM
THE JESUIT UNIVERSITY OF NEW YORK

GPS

Can be used to directly generate vector data
- Point data (long, lat)
- Tracks can be used to create lines (roads/rivers) and polygons
(buildings, fields, forests)