

# How does GPS / Wifi-location awareness work.

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Student-Led Presentation

# Outline

- 1 GPS
  - GPS Overview
  - Getting Thine Lat Langs
  
- 2 Wi-Fi Location
  - Think Skyhook

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# Navigation Systems

## History and Overview

- Navstar-GPS, aka GPS, is not the first navigation system:  
[http://en.wikipedia.org/wiki/Global\\_Positioning\\_System#History](http://en.wikipedia.org/wiki/Global_Positioning_System#History)
- 1940s: Ground-based radio navigation systems developed.
- 1960: Satellite system “Transit” tested.
- Labor Day 1973: “Global Positioning System” (GPS) idea synthesized.
- 1983: Reagan announces GPS for “common good” after  
[http://en.wikipedia.org/wiki/Korean\\_Air\\_Flight\\_007](http://en.wikipedia.org/wiki/Korean_Air_Flight_007)
- 1993: Operational.
- Currently: ~ 30 satellites are operational.

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# System Components

- Space
  - 31 Satellites. Nonuniform arrangement for reliability/availability.
- Control
  - Updates Satellites: Synchronize atomic clocks and adjust ephemeris.
- User
  - Receiver: antenna, receiver-processors, clock
  - $10^4$  U.S. & Allied Military Receivers (Precise)
  - $10^7$  civil/commercial/scientific use. (Coarse/Acquisition)

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# Signal Contents

30-second signal with five 6-second long subframes:

Subframe	Contents
1	Satellite clock, GPS time relationship
2-3	Ephemeris (precise satellite orbit)
4-5	Almanac component (satellite network, error correction)

- Overlapping Frequency, different Encoding per satellite.
- Military code 10× faster, but encrypted.
- Good Start here [http://en.wikipedia.org/wiki/Global\\_Positioning\\_System#Communication](http://en.wikipedia.org/wiki/Global_Positioning_System#Communication)

# Signal Contents

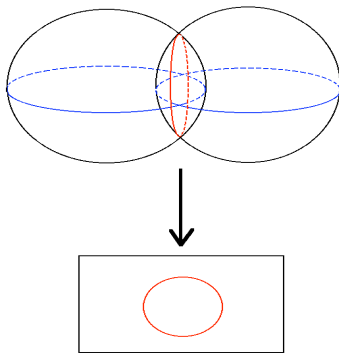
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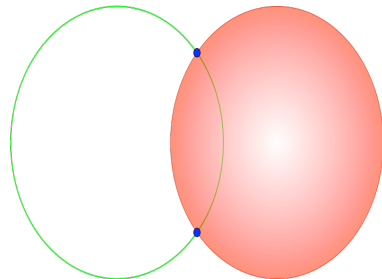
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# Infographic Explanation

## Intersection of Four Spheres is a Point



[http://www.etsu.edu/  
physics/etsuobs/  
starprty/120598bg/  
spheres.gif](http://www.etsu.edu/physics/etsuobs/starprty/120598bg/spheres.gif)



[http://en.wikipedia.org/  
wiki/File:Circle\\_sphere  
\\_2-colour.svg](http://en.wikipedia.org/wiki/File:Circle_sphere_2-colour.svg)

# Some Math (a preview)

Just Kidding No Equations Can fit into this talk...  
Let's discuss sources of error instead.

# Error Sources

Error Type	Inaccuracy ( <i>meters</i> )
Signal Arrival Time	C/A: 3 P: 0.3
Atmospheric effects	5.5
Multipath effects	1
Ephemeris	2.5
Satellite Clock	2
$\sigma_R C/A$	6.7
$\sigma_R P$	6
$\sigma_{num}$	1

$$\sigma_{rc} = \sqrt{PDOP^2 \times \sigma_R^2 + \sigma_{num}^2}$$

where  $\sigma_R = \Sigma(error)^2$  and  $PDOP$  is Position Dilution Of Precision and  $\sigma_{rc}$  is overall standard deviation of error in receiver position

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# Wi-Fi Location

- Remember Ted Morgan's Talk?
- <http://www.skyhookwireless.com/howitworks/>
- Wi-Fi enabled device sends out a signal with its identification info.
- Signal effective distance  $\sim 10^1$  meters.
- A receiver of known position can find Wi-Fi position.
  - How?

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