GNSS

GNSS

- GNSS stands for global navigation satellite system.
- It is the standard generic term for satellite navigation systems that provide autonomous geo-spatial positioning with global coverage.
- Common GNSS Systems are-

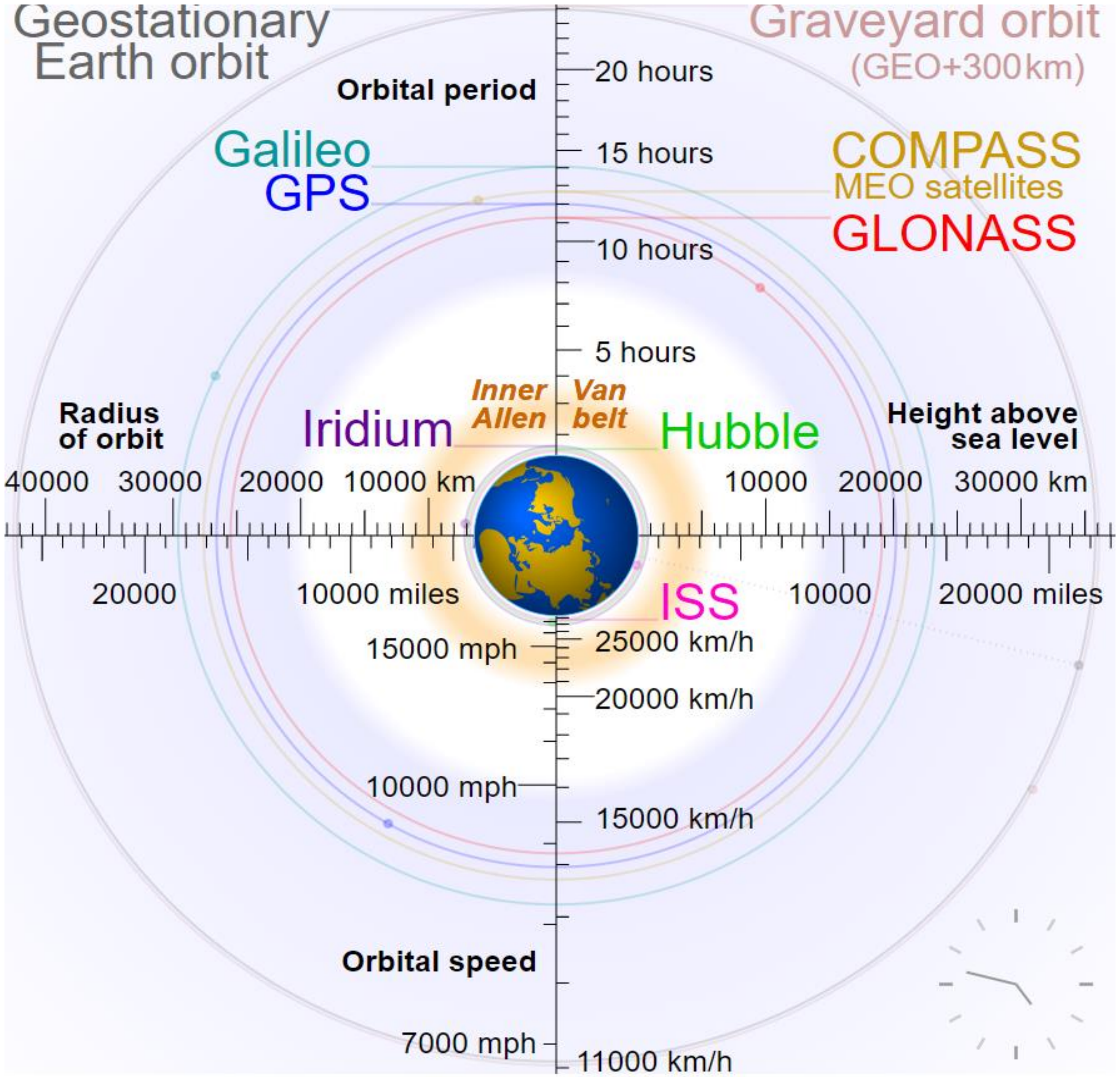
  GPS
  GLONASS
  Galileo
  Beidou
  other regional systems.

GPS:

- The United States' Global Positioning System (GPS) consists of up to 32 medium Earth orbit satellites in six different orbital planes.
- Operational since 1978 and globally available since 1994, GPS is the world's most utilized satellite navigation system.
- It requires minimum of 4 satellite for working.

GLONASS

- The formerly Soviet, and now Russian, ***Glo****bal'naya* ***Na****vigatsionnaya* ***S****putnikovaya* ***S****istema*, (GLObal NAvigation Satellite System or GLONASS)
- GLONASS has full global coverage with 24 satellites.



COMPARISON OF GNSS SYSTEMS

System	BeiDou	Galileo	GLONASS	GPS	NAVIC	QZSS
Owner	China	European Union	Russia	United States	India	Japan
Coverage	Global	Global	Global	Global	Regional	Regional
Coding	CDMA	CDMA	FDMA & CDMA	CDMA	CDMA	CDMA
Altitude	21,150 km (13,140 mi)	23,222 km (14,429 mi)	19,130 km (11,890 mi)	20,180 km (12,540 mi)	36,000 km (22,000 mi)	32,600 km (20,300 mi) – 39,000 km (24,000 mi)[32]
Period	12.63 h (12 h 38 min)	14.08 h (14 h 5 min)	11.26 h (11 h 16 min)	11.97 h (11 h 58 min)	23.93 h (23 h 56 min)	23.93 h (23 h 56 min)
Rev./S. day	17/9 (1.888...)	17/10 (1.7)	17/8 (2.125)	2	1	1
Satellites	23 in orbit (Oct 2018) 35 by 2020	26 in orbit 22 operational 6 to be launched[33]	24 by design 24 operational 1 commissioning 1 in flight tests[34]	31,[35] 24 by design	3 GEO, 5 GSO MEO	4 operational (3 GSO, 1 GEO) 7 in the future

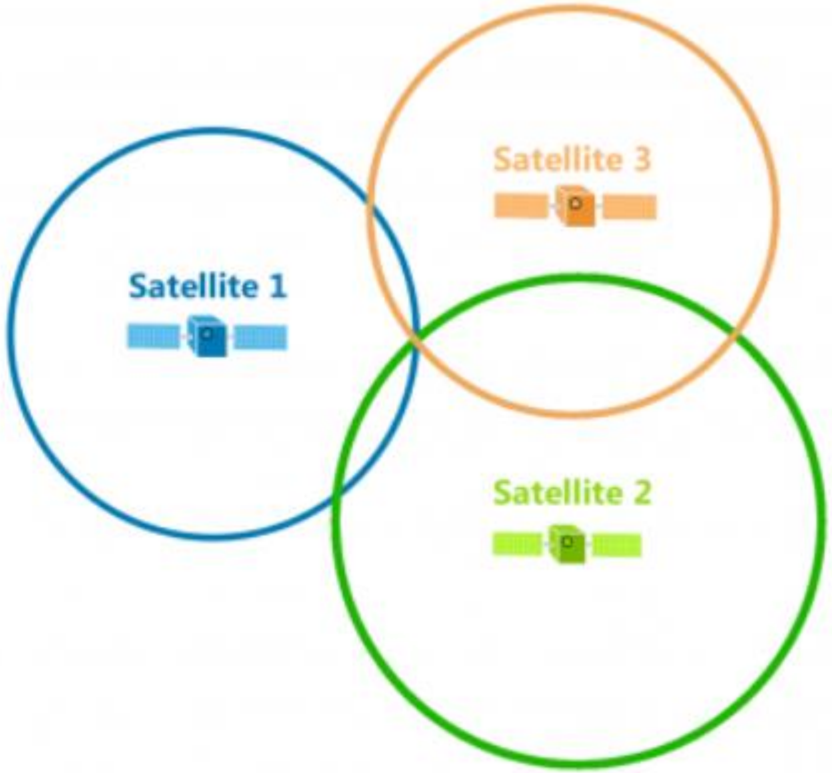
Triangulation

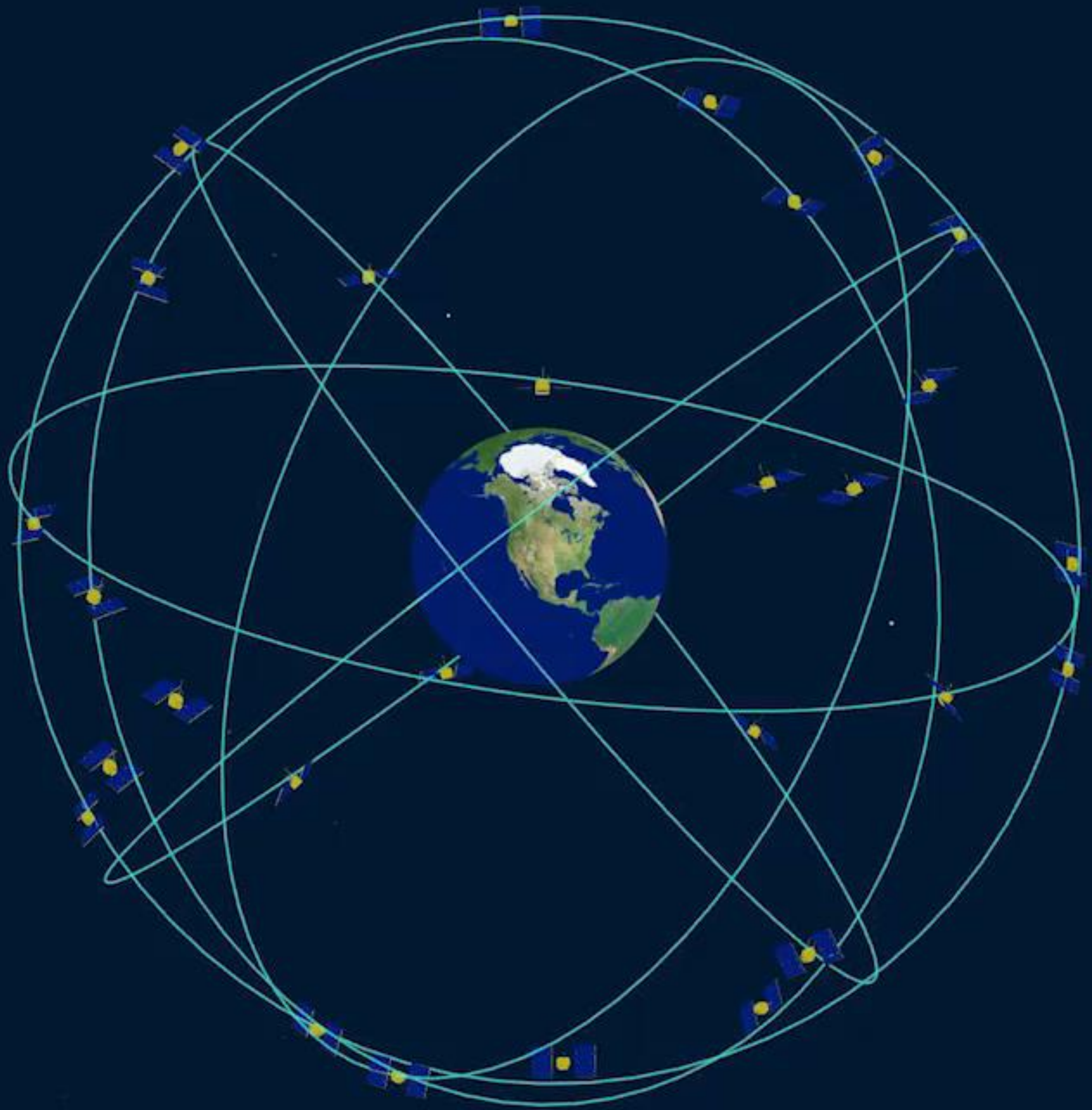
HOW GPS WORKS ?

Distance $d=C*(T_S-T'_R)$

$T'_R= T_R+t$

- GPS uses Trilateration
- It uses 3 satellite for getting the position of the objects
- The 4th satellite is used for correcting the time error of the receiver





GPS Signal

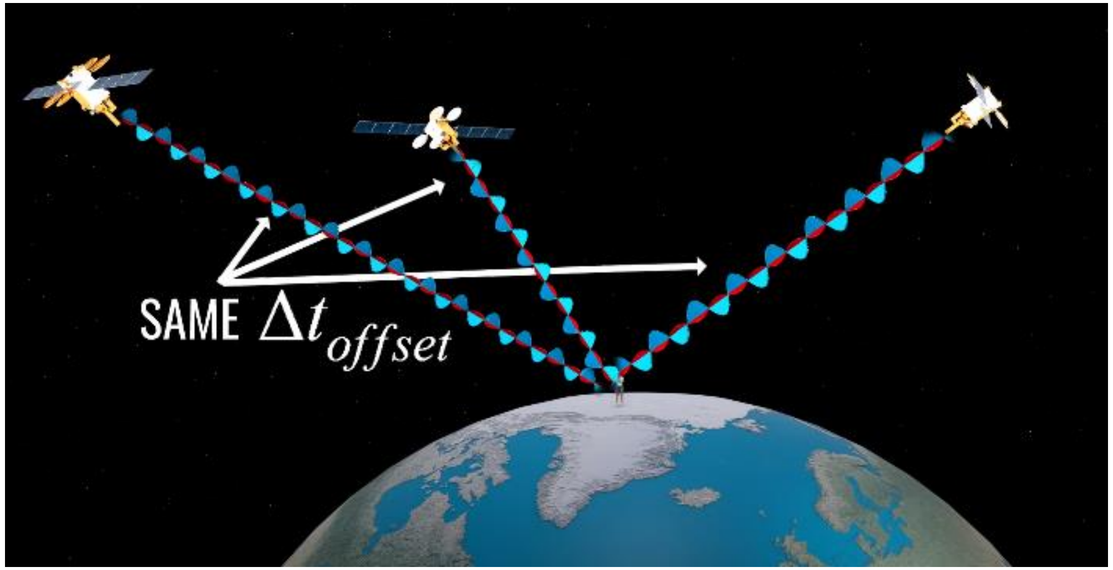
- A GPS signal contains 3 different types of information:
- **Pseudorandom code** is an I.D. code that identifies which satellite is transmitting information. You can see which satellites you are getting signals from on your device's satellite page.
- **Ephemeris data** is needed to determine a satellite's position and gives important information about the health of a satellite, current date and time.
- **Almanac data** tells the GPS receiver where each GPS satellite should be at any time throughout the day and shows the orbital information for that satellite and every other satellite in the system

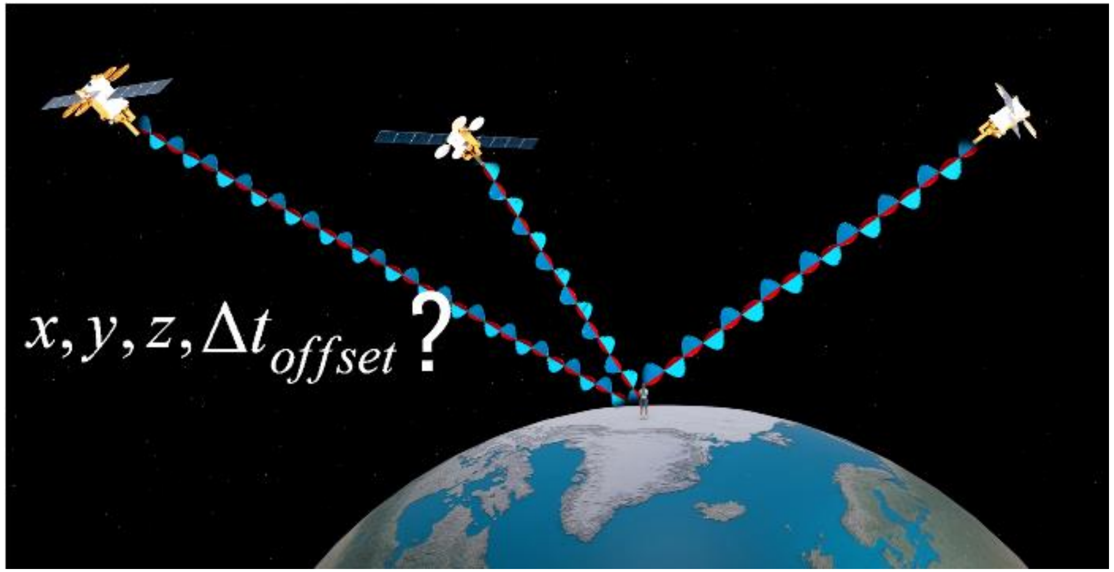
GPS Signal Errors Sources

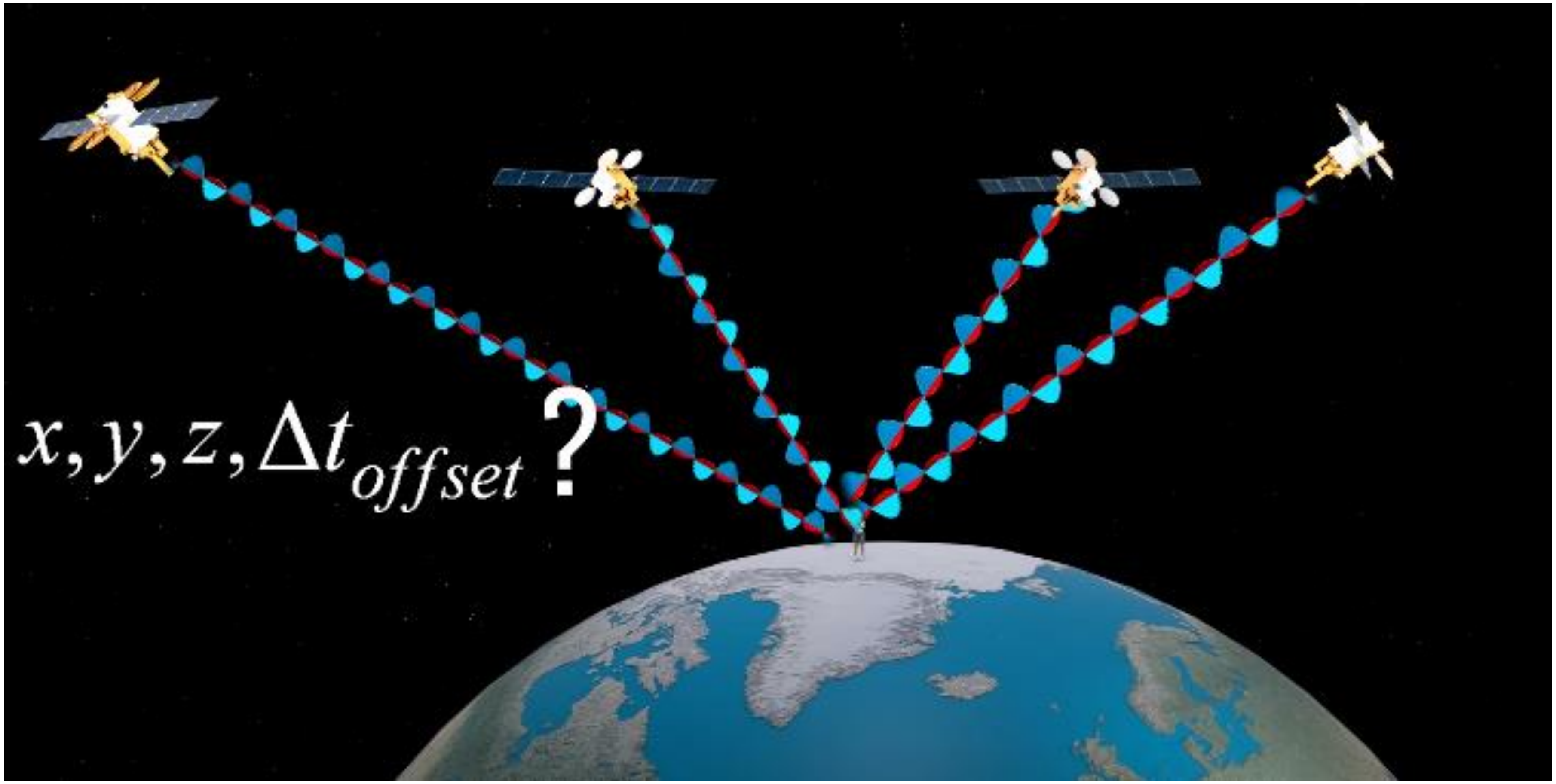
- **Ionosphere and troposphere delays:** Satellite signals slow as they pass through the atmosphere.
- **Signal multipath:** The GPS signal may reflect off objects such as tall buildings or large rock surfaces before it reaches the receiver
- **Receiver clock errors:** A receiver's built-in clock may have slight timing errors because it is less accurate than the atomic clocks on GPS satellites.
- **Number of satellites visible:** The more satellites a GPS receiver can "see," the better the accuracy.
- **Satellite geometry/shading:** Satellite signals are more effective when satellites are located at wide angles relative to each other, rather than in a line or tight grouping.
- **Selective availability:** The U.S. Department of Defense once applied Selective Availability (SA) to satellites, making signals less accurate in order to keep 'enemies' from using highly accurate GPS signals. The government turned off SA in May of 2000, which improved the accuracy of civilian GPS receivers.

Time synchronization

- Remember that both the satellite and the receiver need to be able to precisely synchronize their pseudo-random codes to make the system work
- If our receivers needed atomic clocks (which cost upwards of $50K to $100K) , Nobody could afford it.
- Since any offset from universal time will affect all of our measurements, the receiver looks for a single correction factor that it can subtract from all its timing measurements that would cause them all to intersect at a single point.
- That correction brings the receiver's clock back into sync with universal time
- Once it has that correction it applies to all the rest of its measurements and now we've got precise positioning.






$x, y, z, \Delta t_{offset}$?