The French Institute of Science and Technology for Transport, Development and Networks

Using GNSS Raw Measurements on Android Devices

TEAM GEOLOC

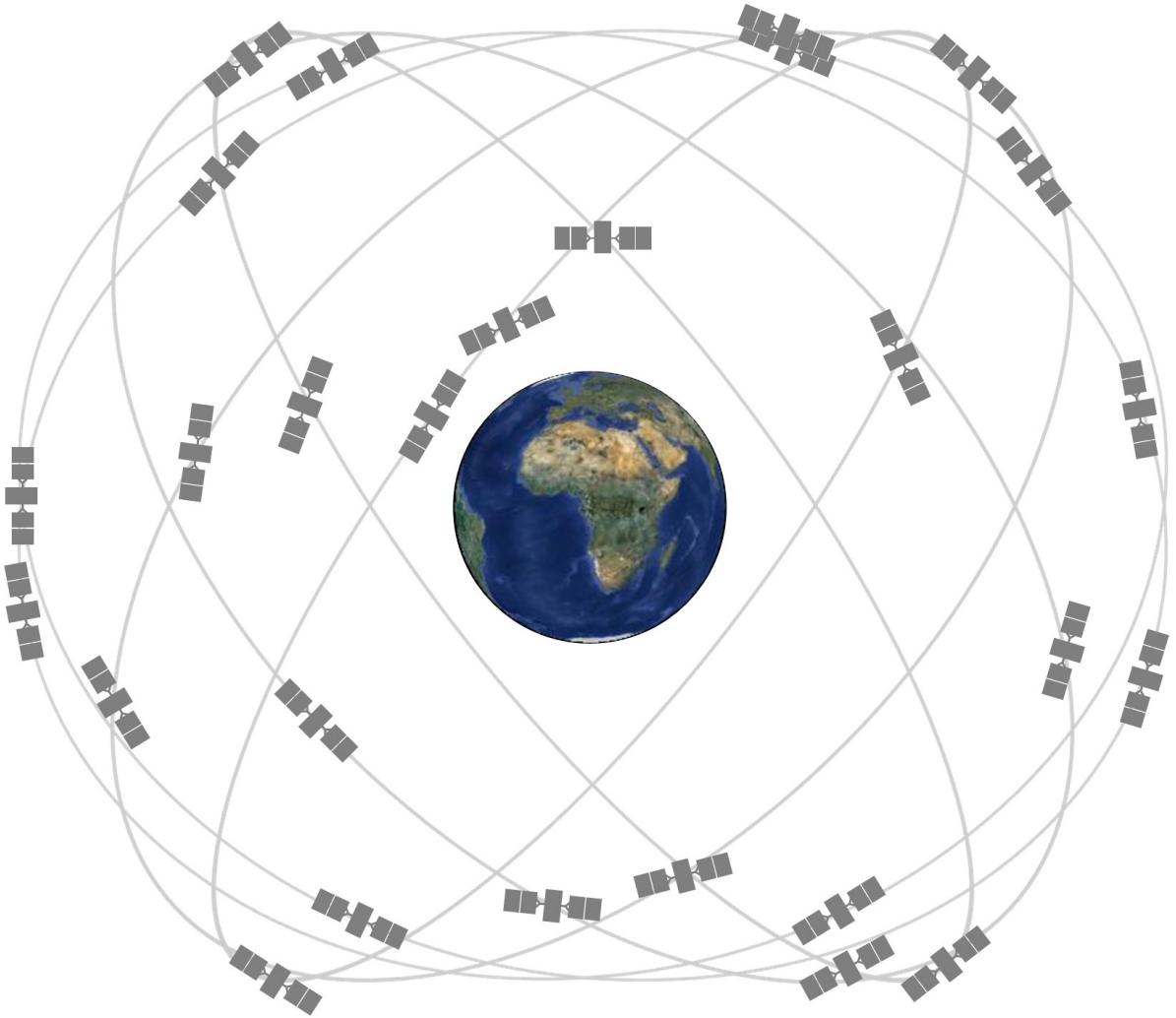
IFSTTAR

José Gilberto Reséndiz Fonseca

GNSS
(Global Navigation Satellite System)

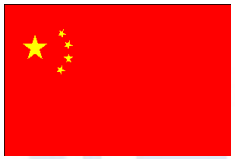
GPS

GLONASS

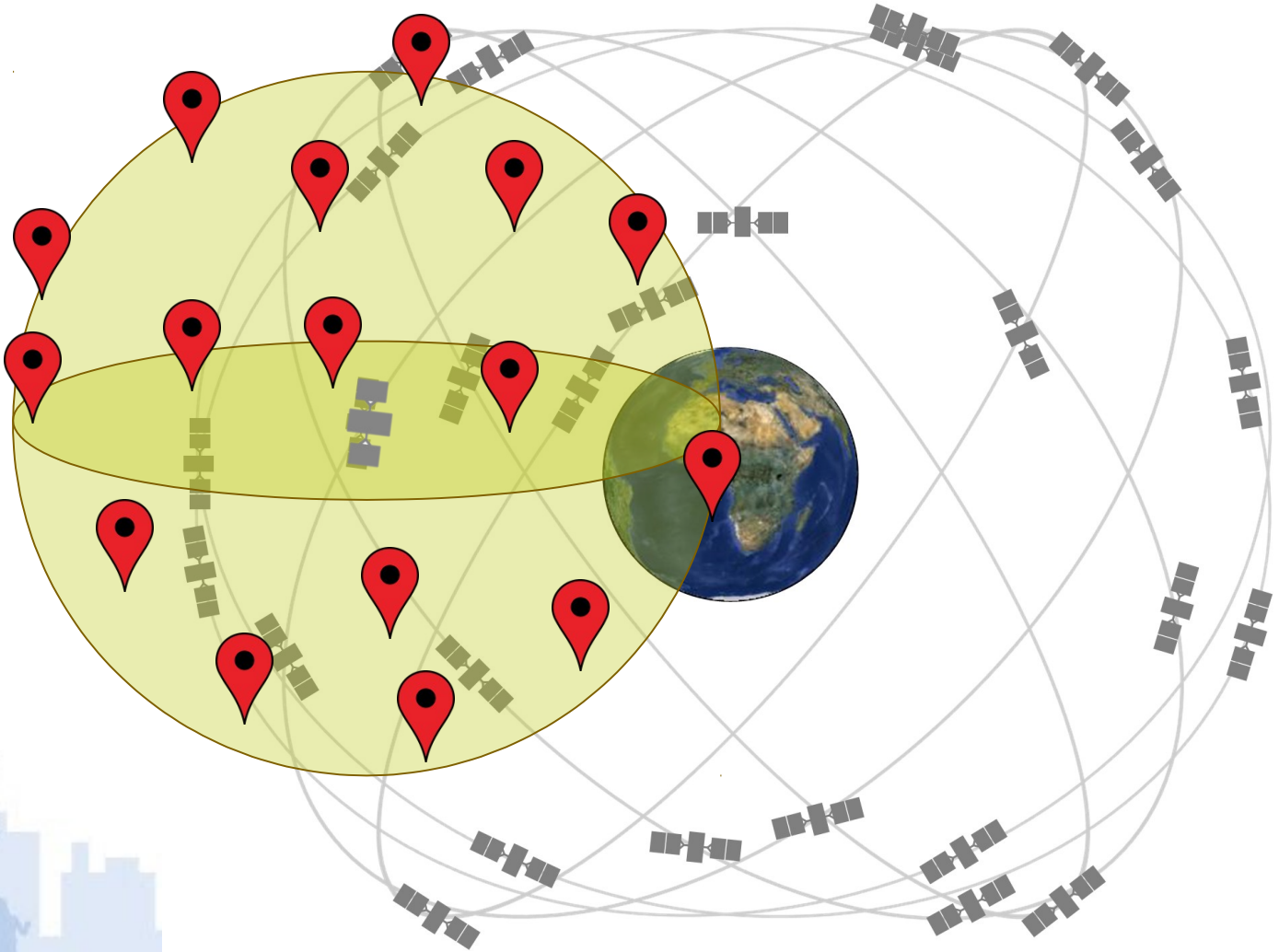


GALILEO

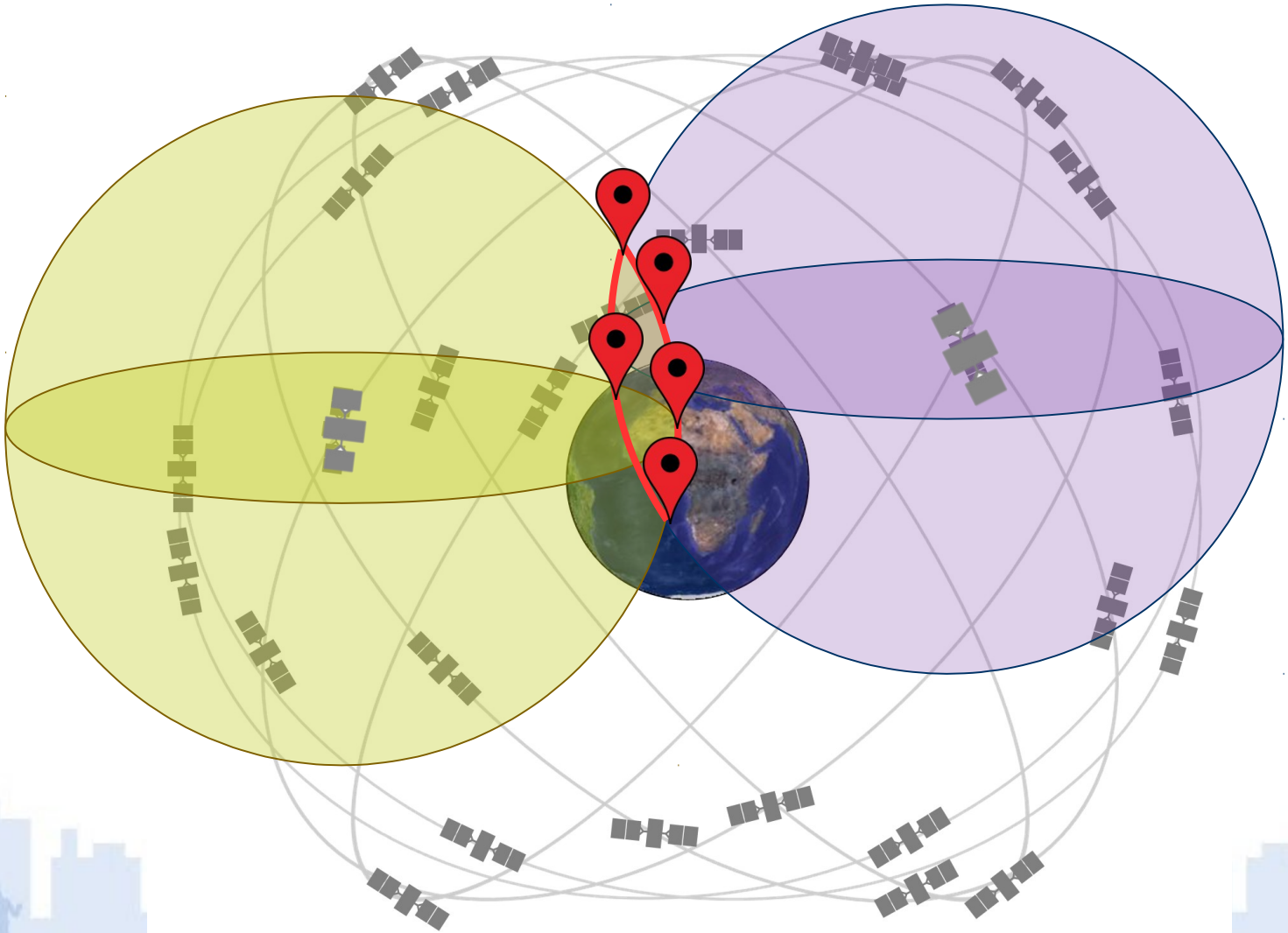
BEIDOU



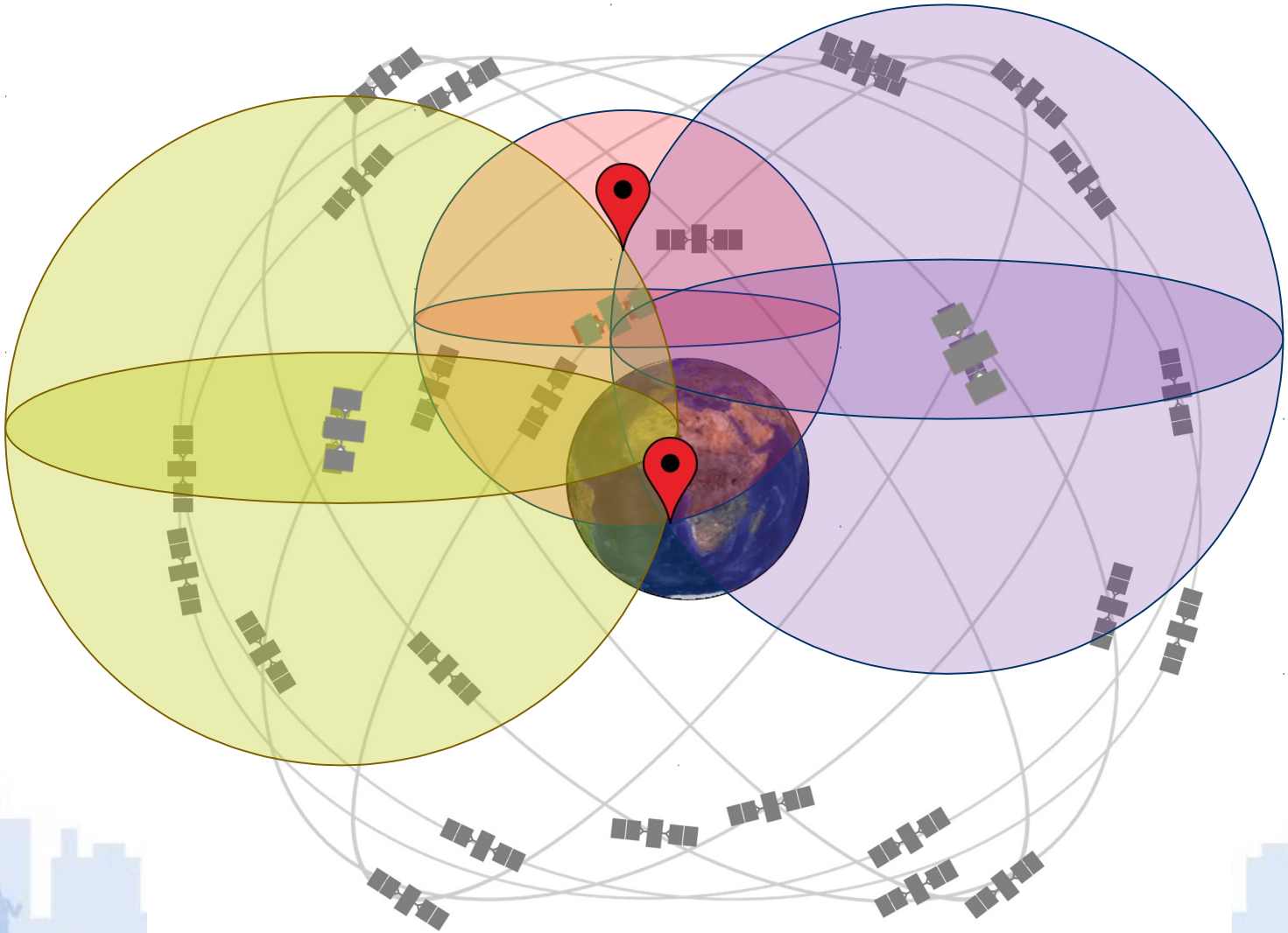
Positioning Principle



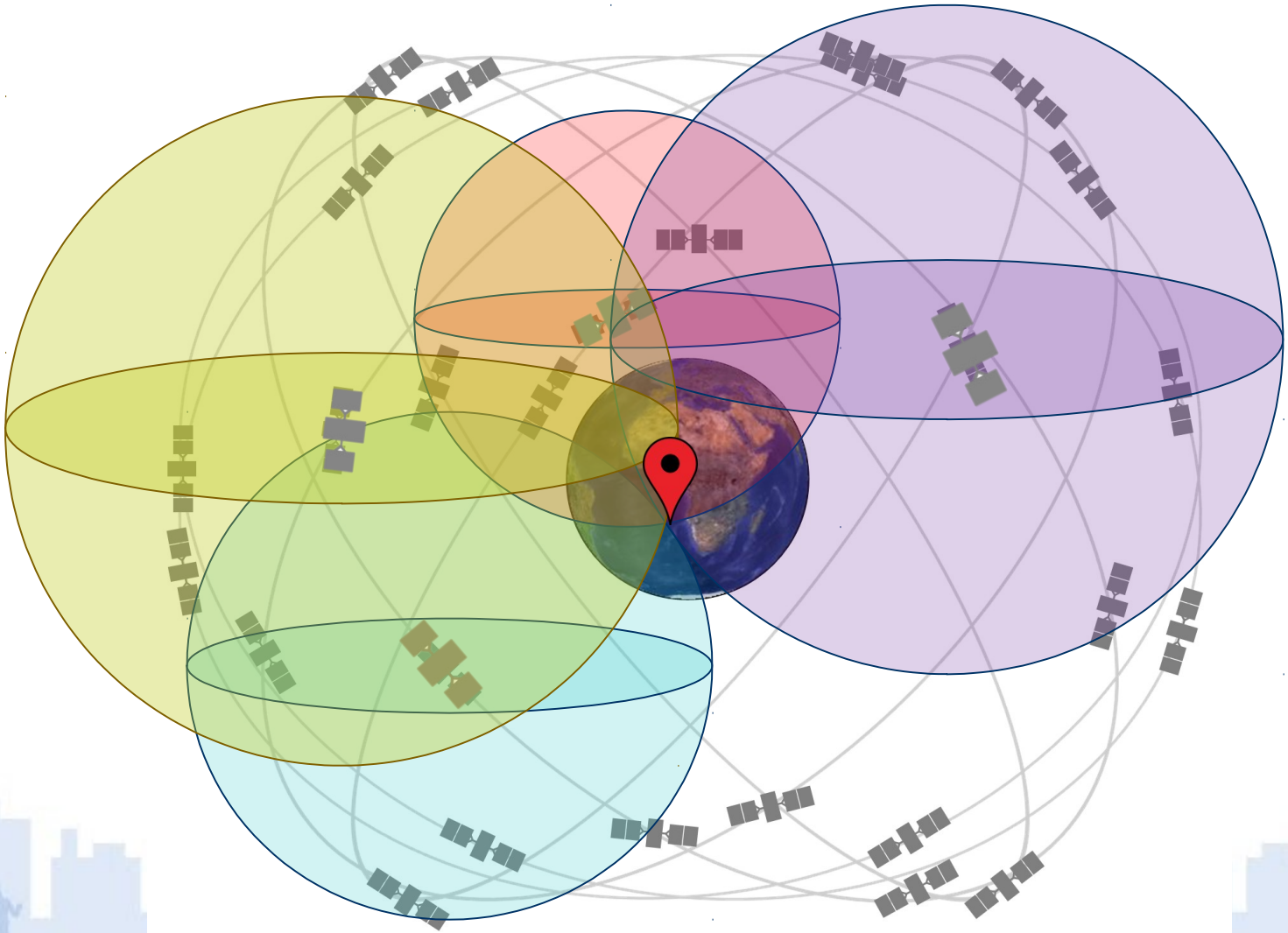
Positioning Principle



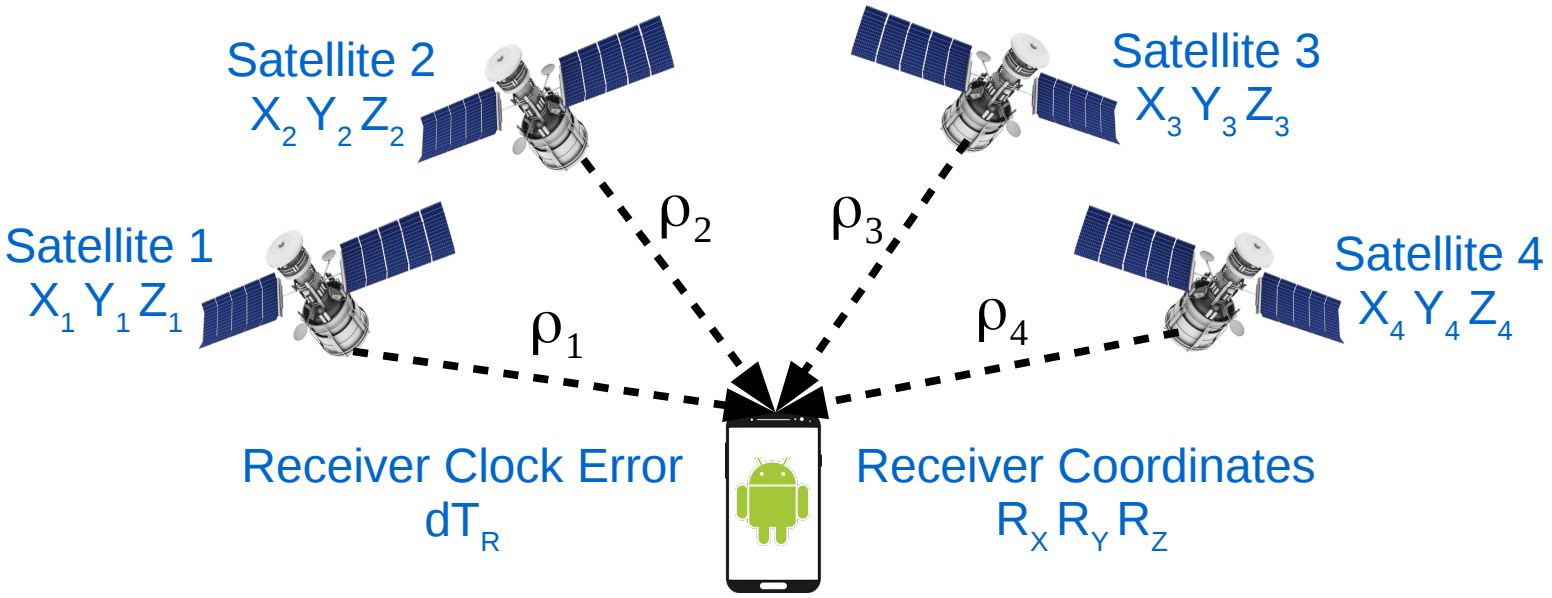
Positioning Principle



Positioning Principle



Navigation Solution



$$\rho_1 = \sqrt{(X_1 - R_X)^2 + (Y_1 - R_Y)^2 + (Z_1 - R_Z)^2} + c(dT_R)$$

$$\rho_2 = \sqrt{(X_2 - R_X)^2 + (Y_2 - R_Y)^2 + (Z_2 - R_Z)^2} + c(dT_R)$$

$$\rho_3 = \sqrt{(X_3 - R_X)^2 + (Y_3 - R_Y)^2 + (Z_3 - R_Z)^2} + c(dT_R)$$

$$\rho_4 = \sqrt{(X_4 - R_X)^2 + (Y_4 - R_Y)^2 + (Z_4 - R_Z)^2} + c(dT_R)$$

Android Studio

- Official Integrated Development Environment (IDE) for Android

- Programing languages:
  - Kotlin
  - Java

GNSS on Android Devices

Android 6.0 Marshmallow

- Straightforward location:
  - PVT (Position, Velocity and Time)

Android 7.0 Nougat

- Raw measurements:
  - Reference Times
  - Pseudorange Generation
  - Navigation Message

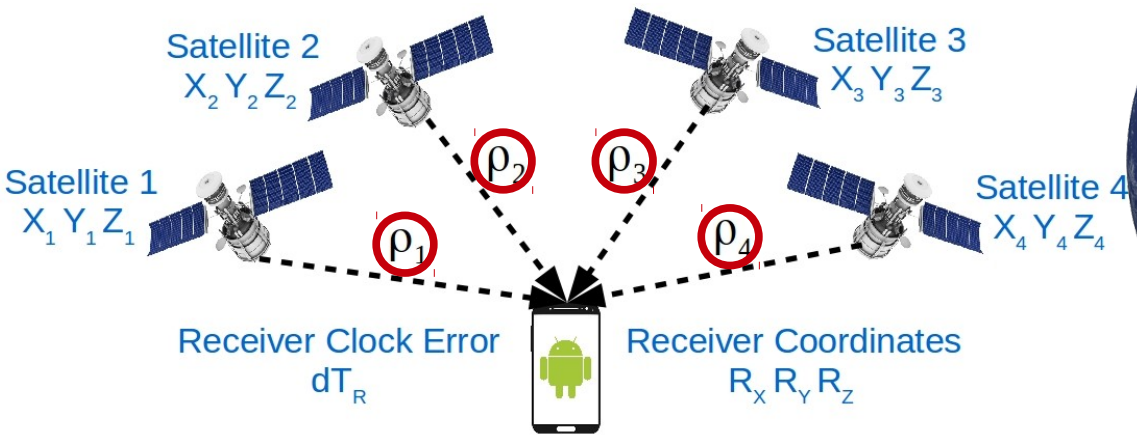
- Advantages:
  - Own algorithms implementation
  - Increase position accuracy
  - Position in harsh environments

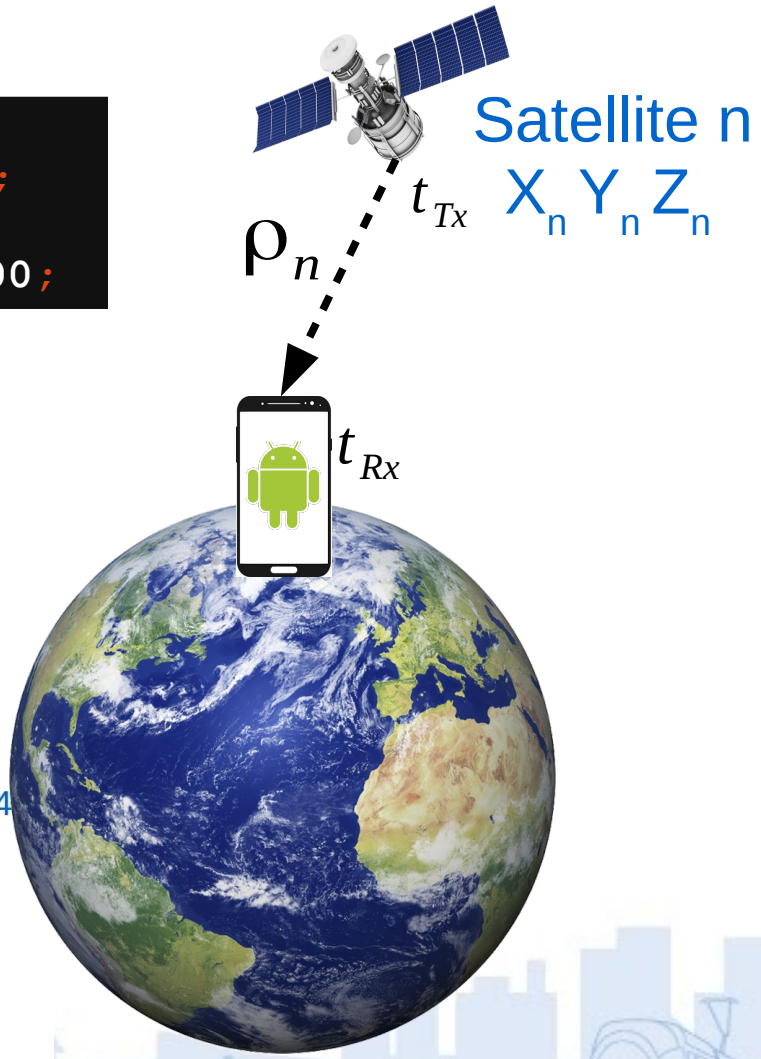
Pseudorange Generation

```
long ttx = getReceivedSvTimeNanos();
double trx = trxGnss - weekNumberNanos;
double pseudoRange = (((trx - ttx) /
    numberNanoSecondsSecond) * c) / 1000;
```

$$\rho_n = (t_{Rx} - t_{Tx}) * c$$

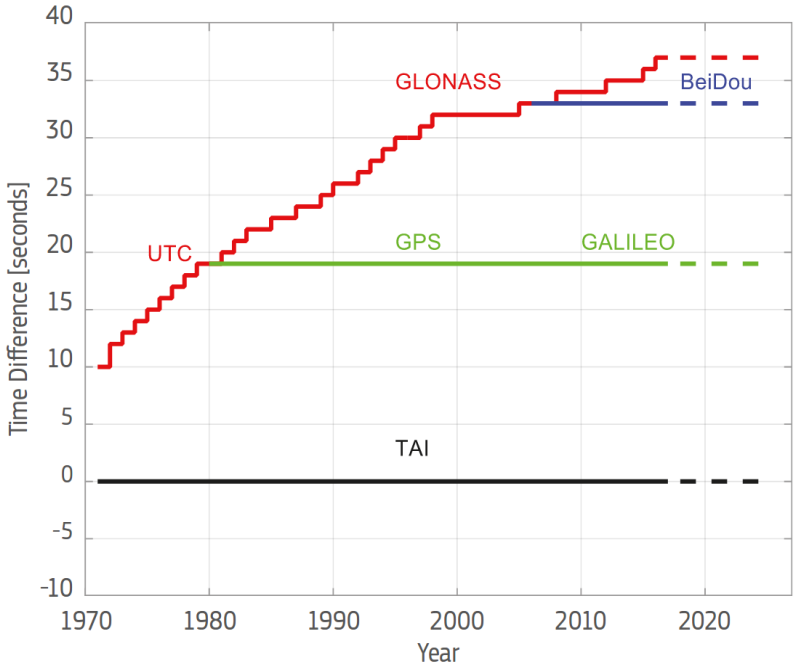
$$\rho_n = \sqrt{(X_n - R_X)^2 + (Y_n - R_Y)^2 + (Z_n - R_Z)^2} + c(dT_R)$$



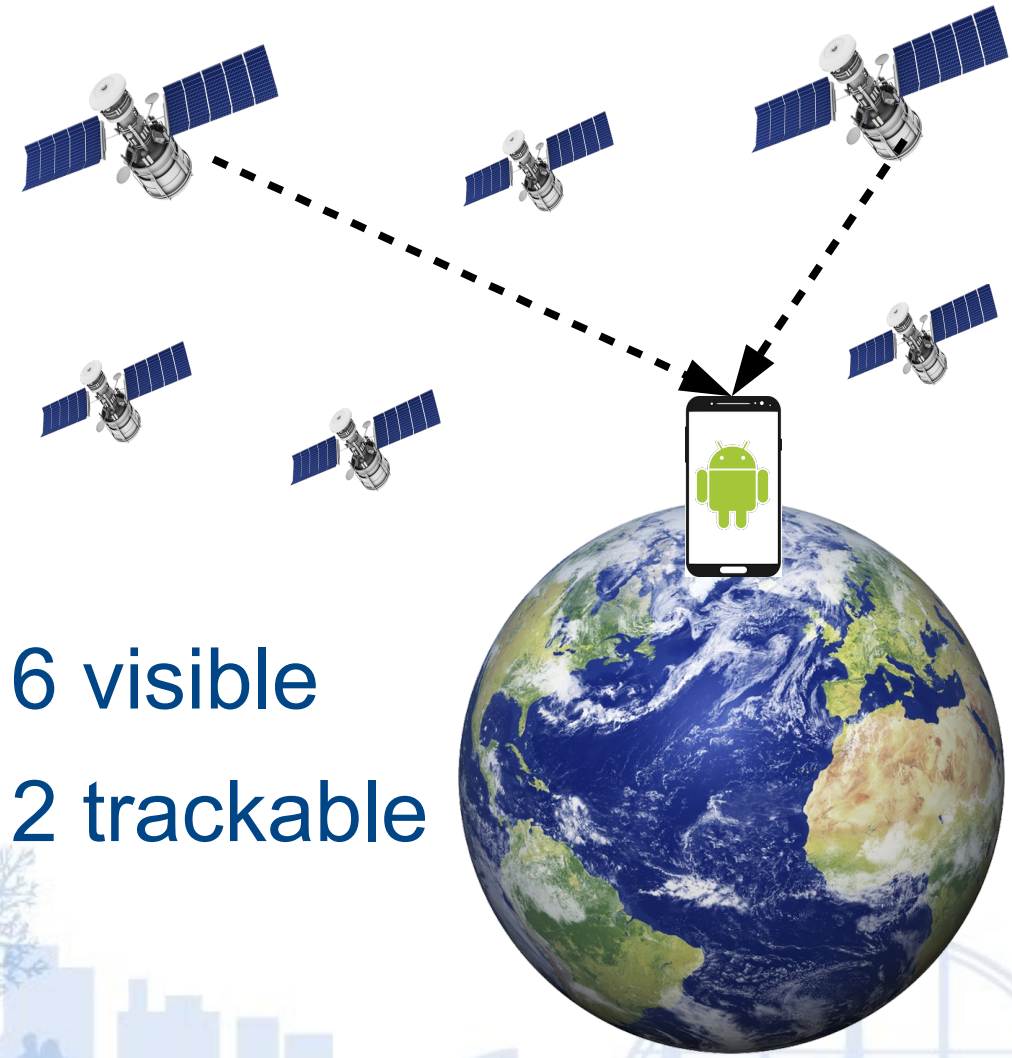


GNSS Reference Times

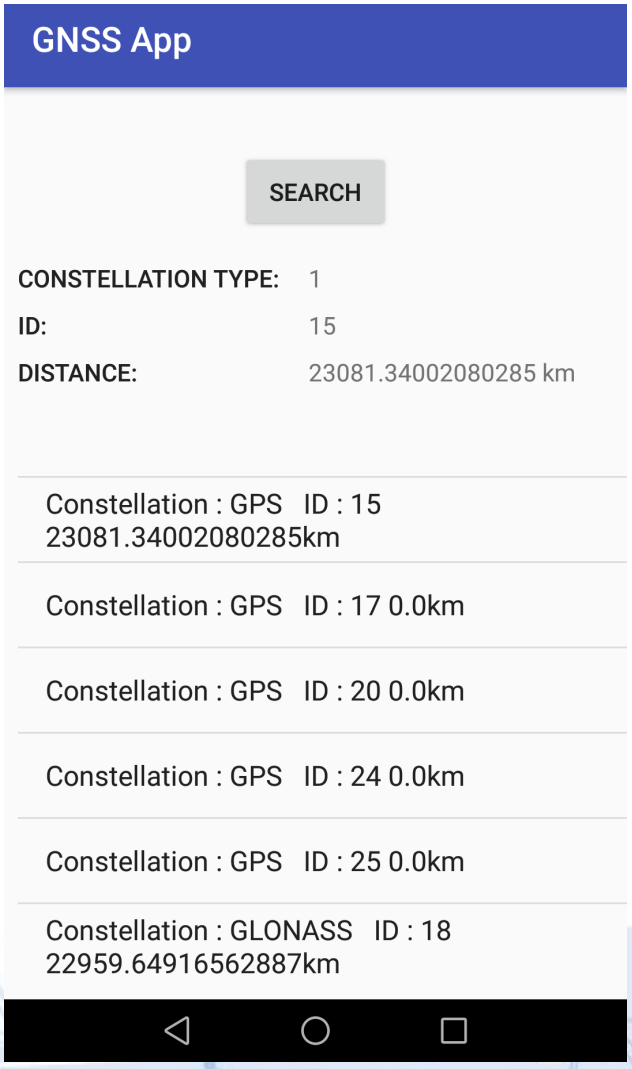
Systems	Relationship
GPST - TAI	TAI = GPST + 19
GST - TAI	TAI = GST + 19
GLONASST - TAI	TAI = GLONASST – 3h + $leapsecond_{UTC-TAI}$
UTC - TAI	UTC = TAI – $leapsecond_{UTC-TAI}$
BDT-TAI	TAI = BDT + 33s



Pseudorange Generation



- 6 visible
- 2 trackable



Navigation Message

GPS Navigation Message

6 seconds
300 bits

Words

Subframes	1	2	3-10
1	TLM	HOW	Clock correction GPS week
2	TLM	HOW	Ephemerides
3	TLM	HOW	Ephemerides
4	TLM	HOW	PRN 25-32 Satellite Almanac and Health
5	TLM	HOW	PRN 1-24 Satellite Almanac and Health

Satellite n

$X_n Y_n Z_n$

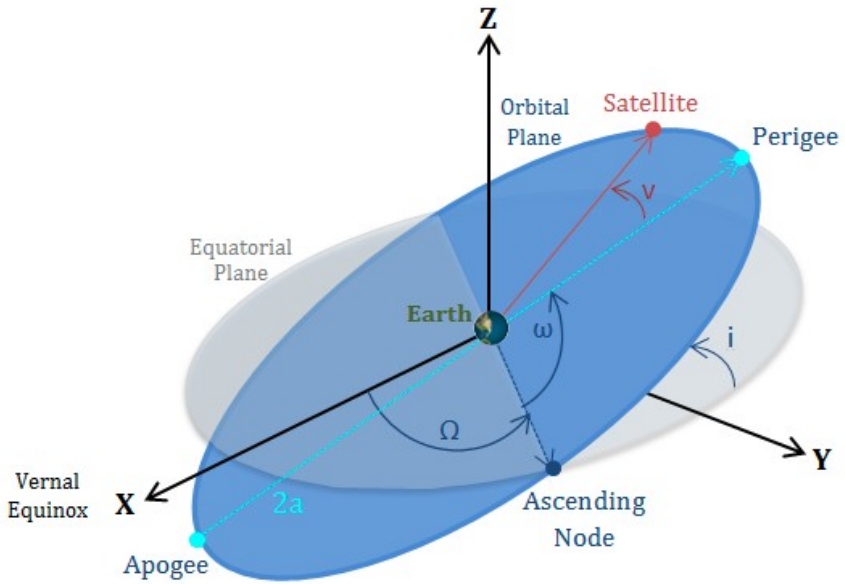
Navigation Message

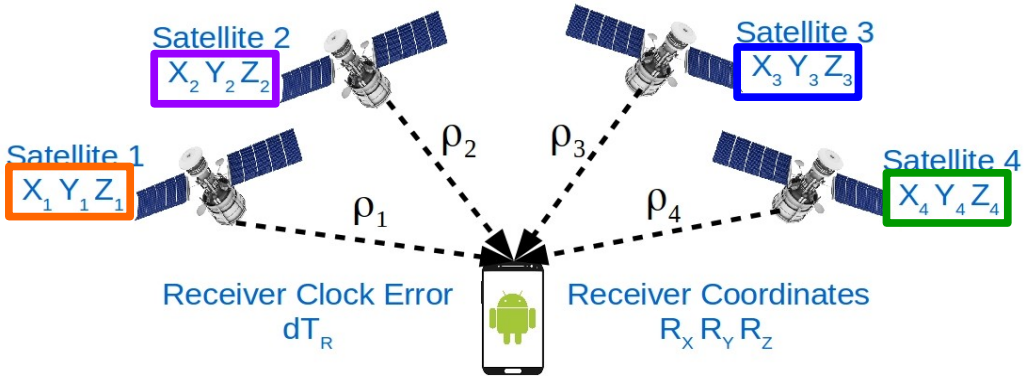
- Time of week
  - 291852 seconds
  - Wednesday 09:04:12

```
public long getTow(){
String tow = words[1].substring(0,17);
return Long.parseLong(tow,2)*6;
}
```

- Week number
  - 978 (mod 1024)
  - 2002 (since Jan 6 1980)

Keplerian Elements





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Future test

- Trace comparison between GNSS receiver and Application made

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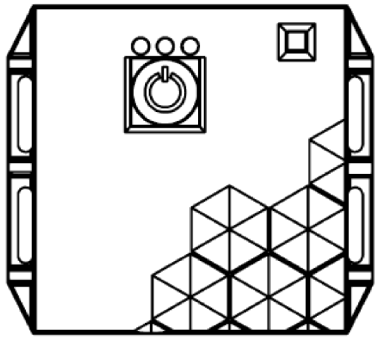
PEdestrian Reference SYstem



Thank you for your attention!