GLOBAL POSITIONING SYSTEM (GPS)

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Dedicated to Mr.Machata

INTRODUCTION

Examples :

Drone swarm (Naval)

Driverless car (Waymo)

Smartphones

Agricultural robot (Agreenculture)

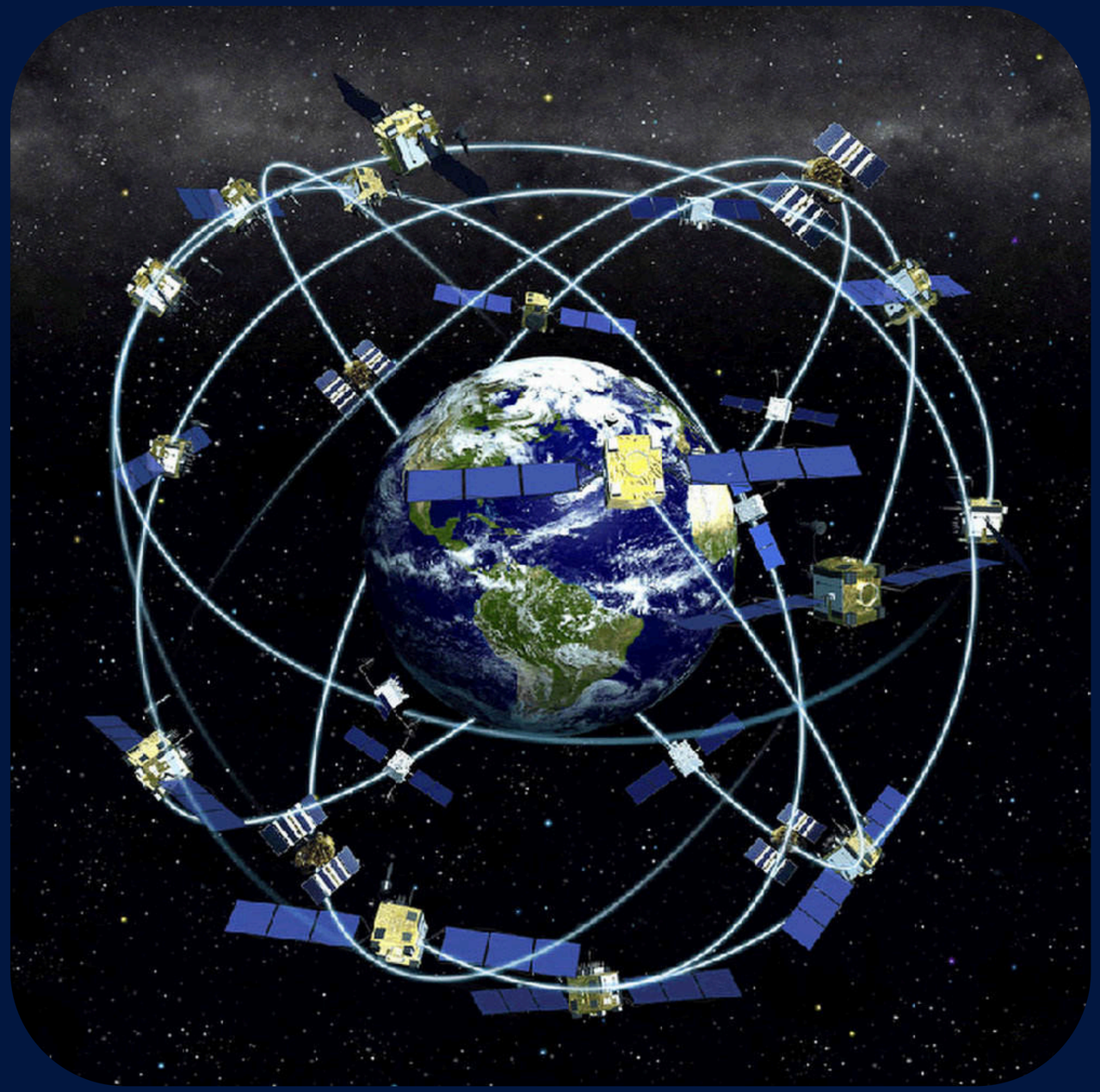
Aviation

Smart Watch

HOW DOES IT WORK?

Transmitter :

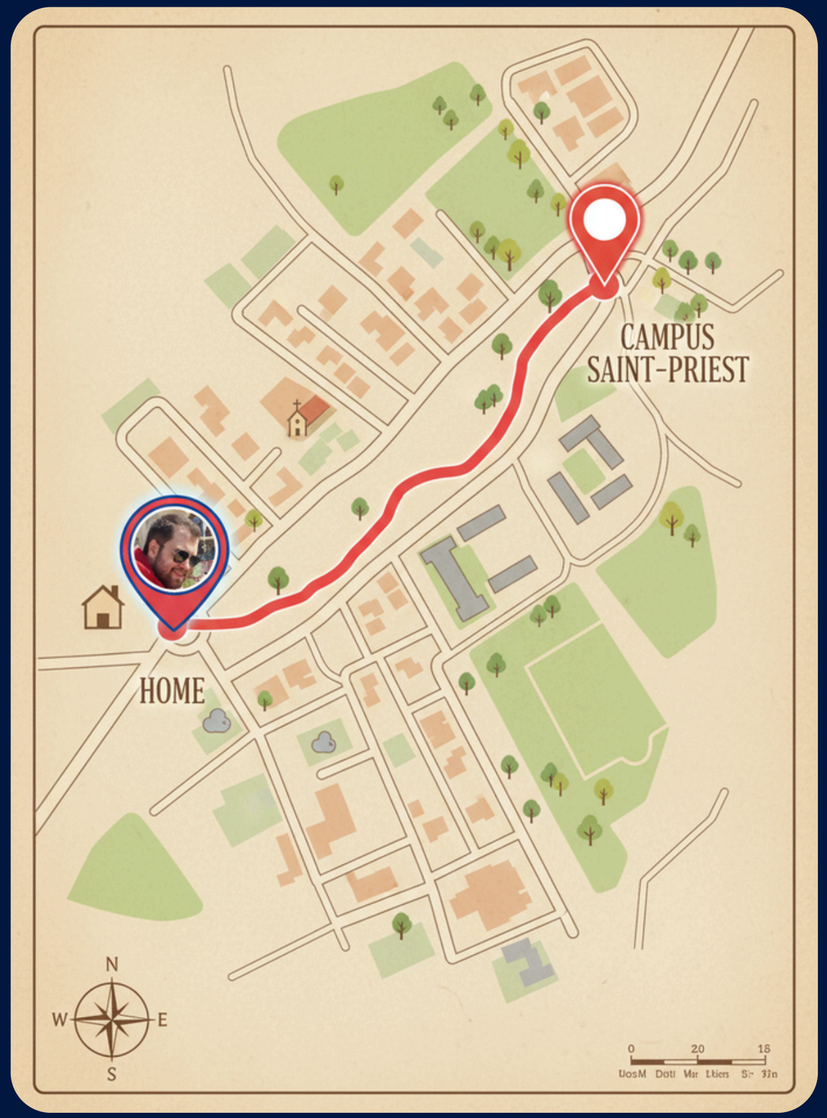
- GNSS Signal
- Atomic Clock



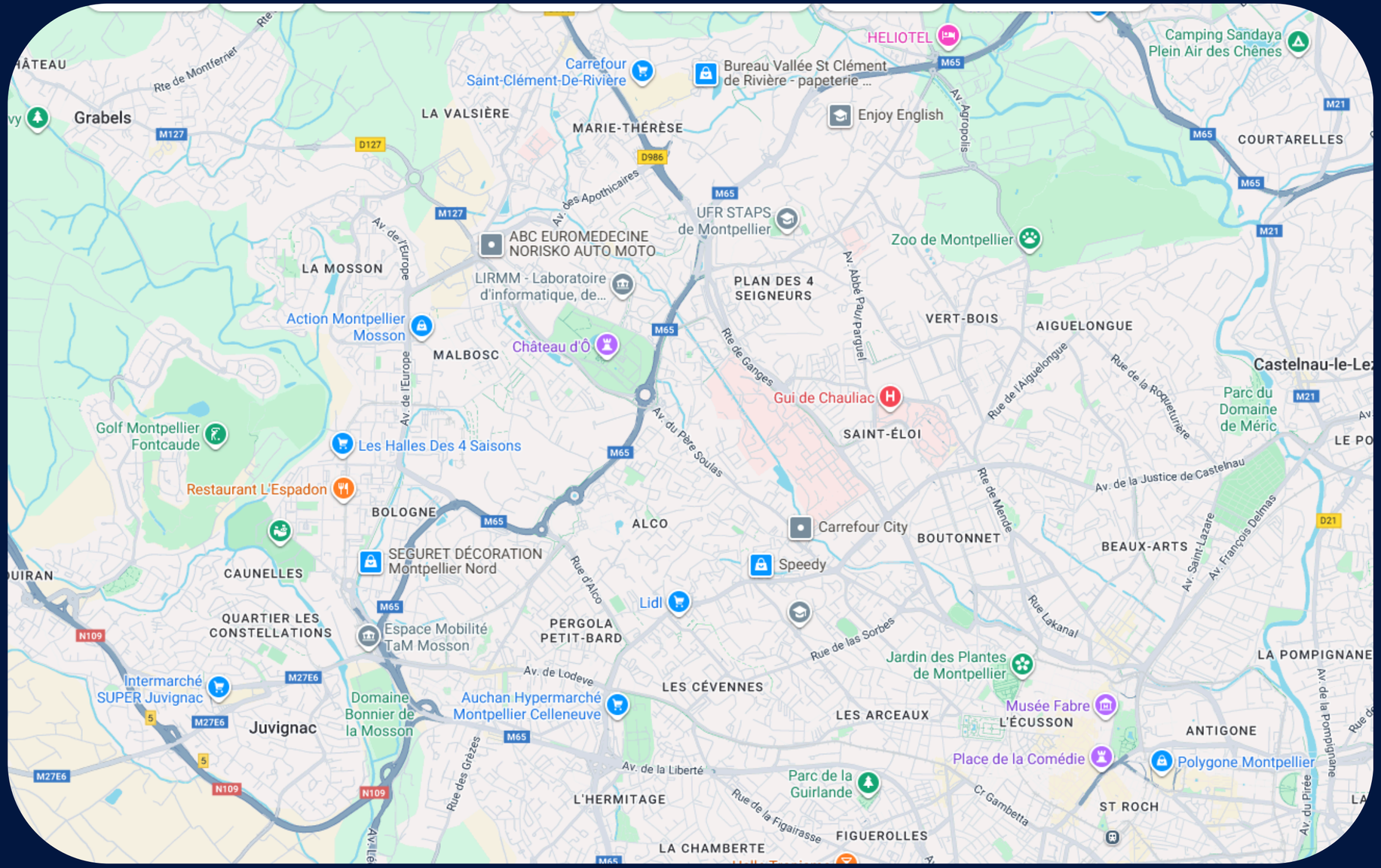
Receivers :

- None Atomic Clock

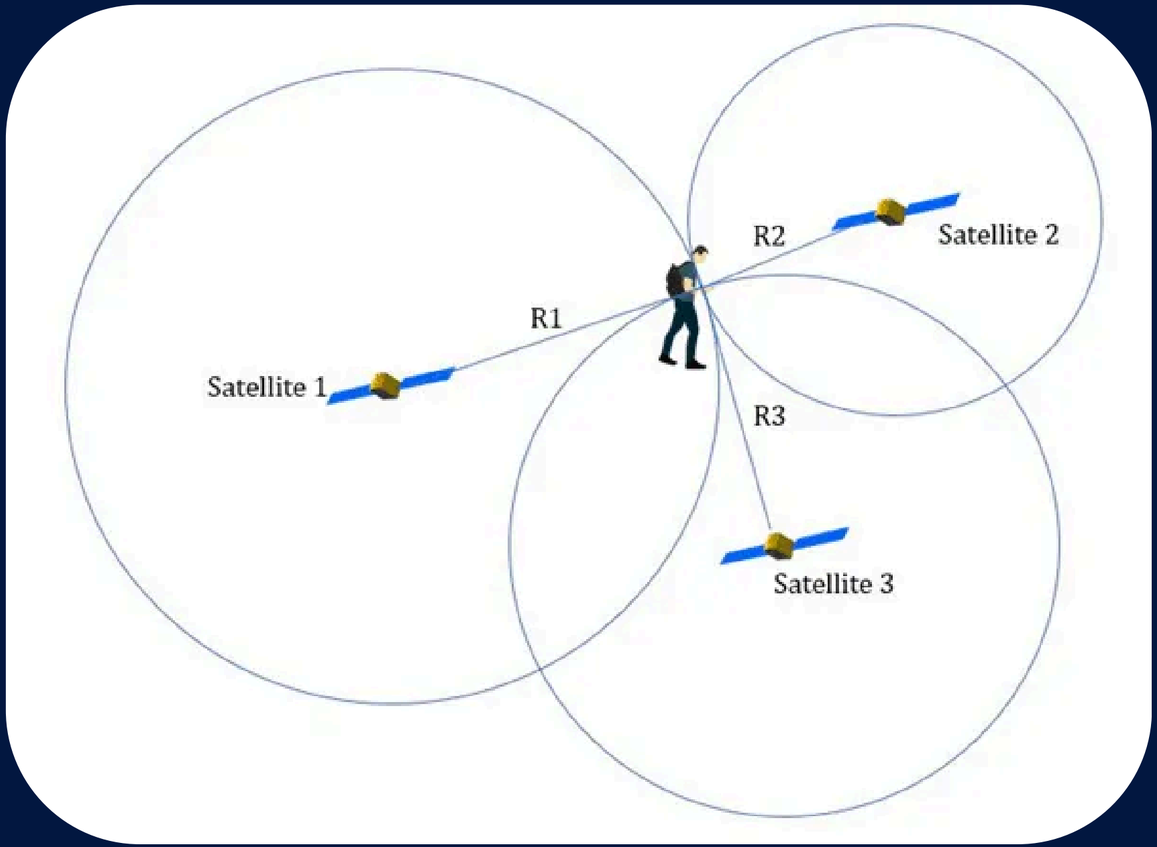
Example :



He has the map but...



TRILATERATION:



Clock : gives the “precise date” of signals to compare the time of emission and time of reception

$$d=c\times\Delta t$$

But life is not that easy...

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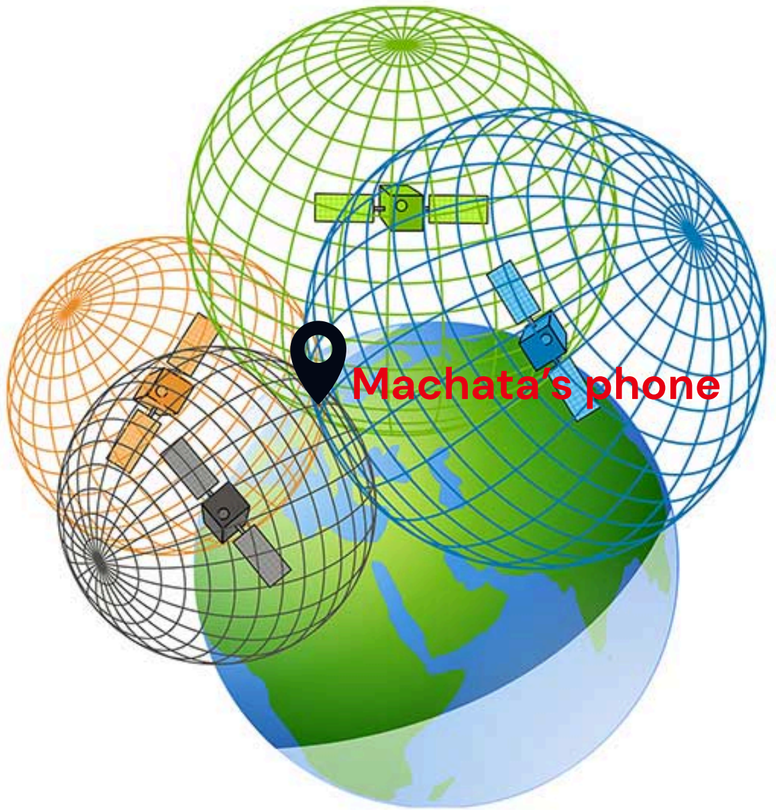
- 3 satellites: In theory you can compute (X,Y,Z)
- Transmitter/Receiver clock: time offset (clock bias)

Huge errors (speed of light)

Fourth unknown (B)

To get B

4 independent equations



The receiver computes both its position and its clock offset at the same time.

More than 4: Reduce noise and errors, and apply filtering to get a stable position.

Thanks to his GPS, he made it to St Priest

DOPPLER EFFECT :

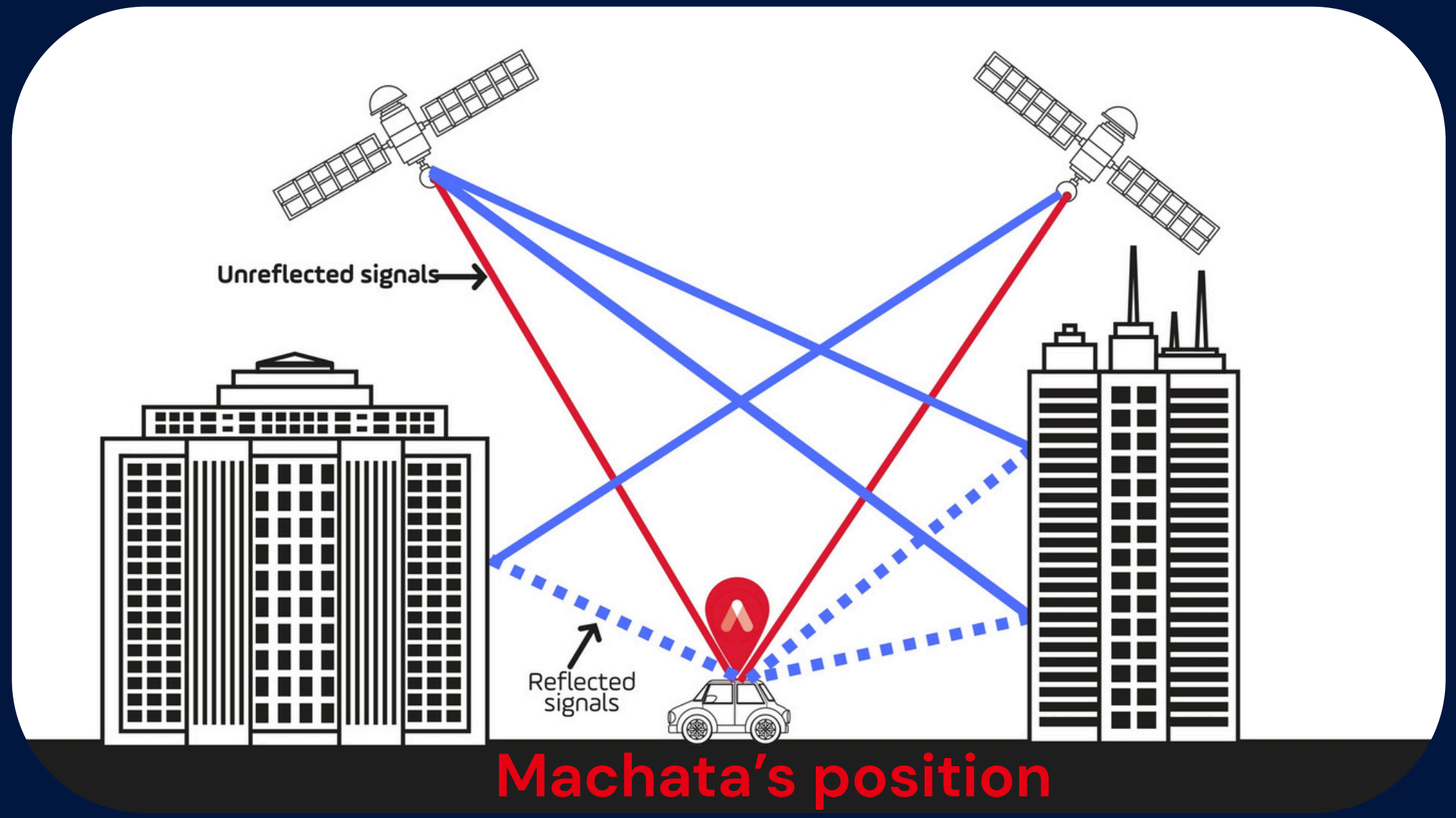
- GPS uses the Doppler effect to measure receiver velocity.
- Satellites send stable frequencies; motion causes a frequency shift.
- Shift $\propto$ relative speed along line of sight.
- Combining shifts from several satellites $\rightarrow$ 3D velocity.
- More accurate than just position change over time.

TECHNICAL LIMITATION

- Multipath Effects
- Ephemeris Errors
- Limited Satellite Visibility
- Power Consumption

TECHNICAL LIMITATION

- Multipath Effects



$$s(t)=s_{direct}(t)+\alpha.s_{reflected}(t-\delta)$$

TECHNICAL LIMITATION

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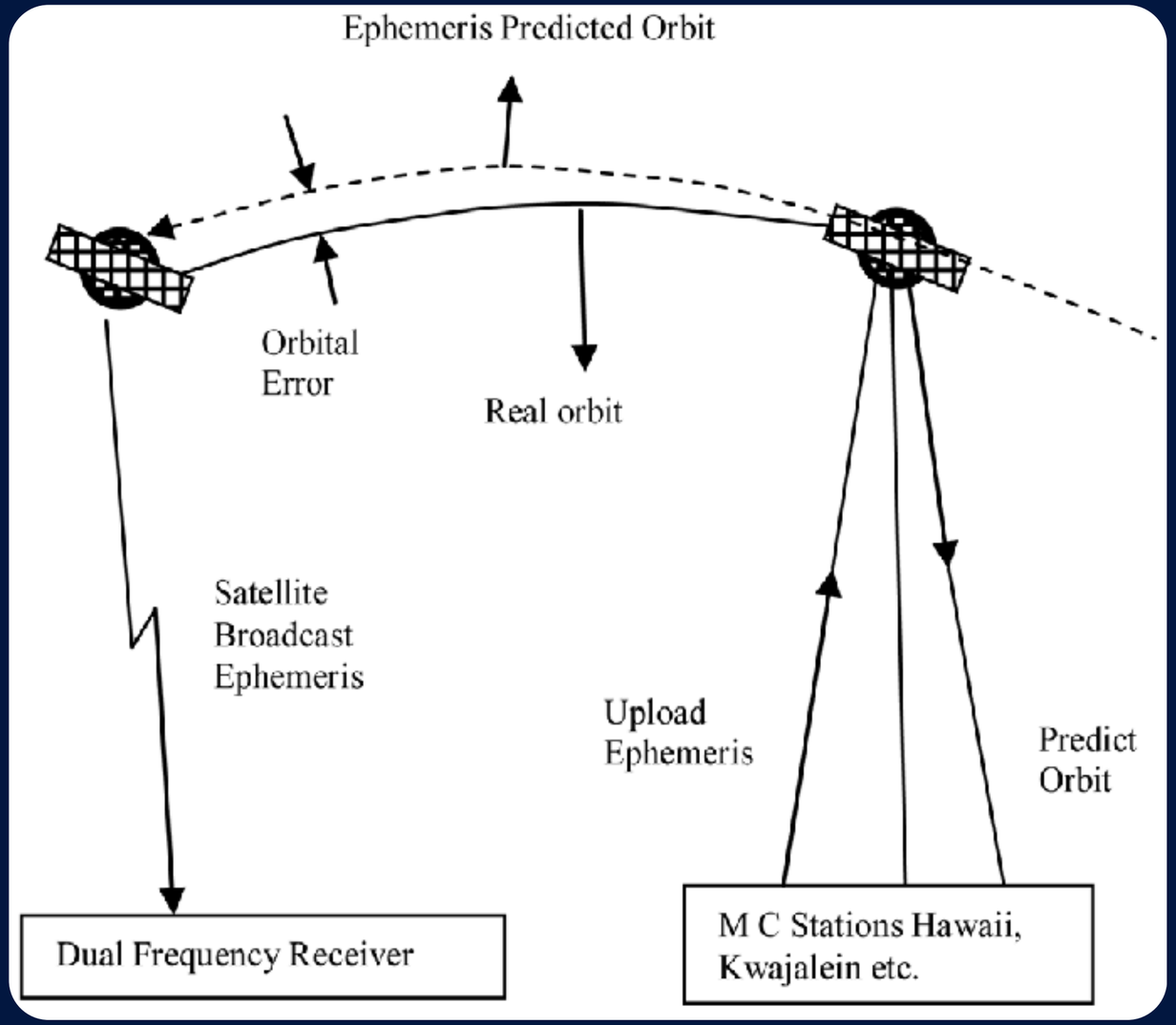

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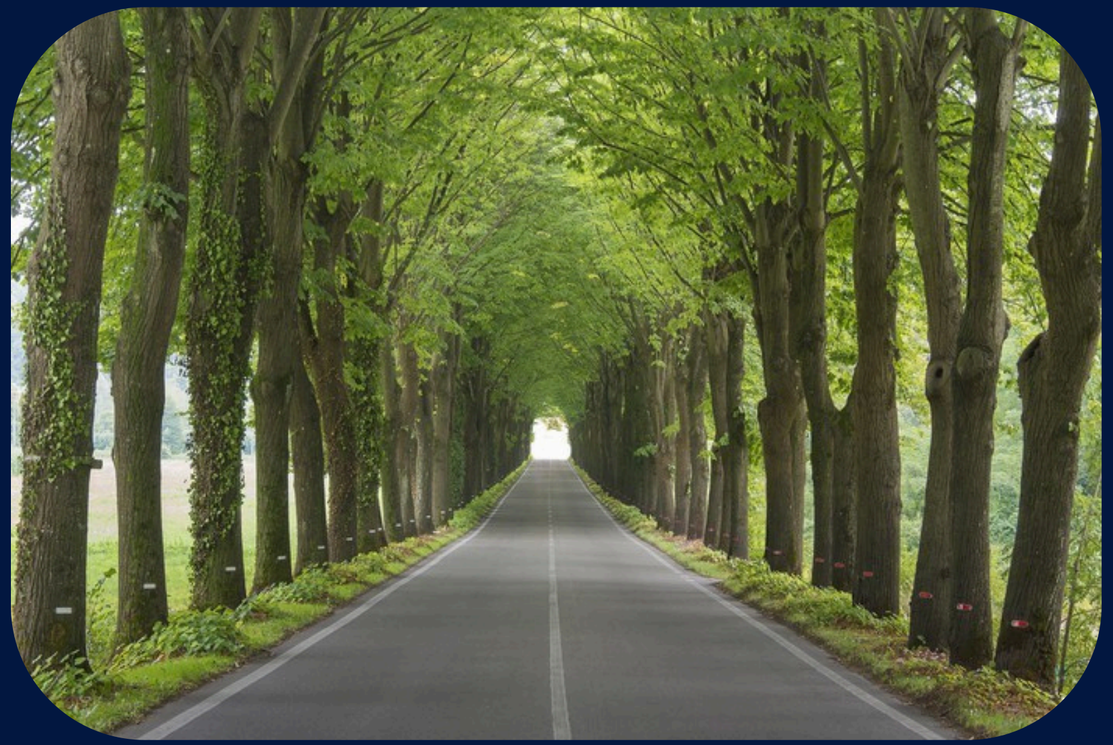

TECHNICAL LIMITATION

- Power Consumption

➡ Example: A phone that has a 4000 mAh battery.

Component	Typical Power (mW)	mAh/h	% battery per hour
Screen (medium brightness)	~800 mW	210 mAh/h	5.3 %/h
CPU / system background	~300 mW	79 mAh/h	2.0 %/h
Mobile data / Wi-Fi (active transfer)	~500 mW	132 mAh/h	3.3 %/h
GPS tracking (continuous)	~250 mW	66 mAh/h	1.7 %/h
Total navigation use	~1850 mW	~487 mAh/h	~12.2 %/h


THANK
YOU