Geographic Information System (GIS)

IS 454

Lecture 6: Global Positioning System (GPS)

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Learning Outcomes

- Participants will be able to describe the basics of GPS.
- Participants will be able to describe the method GPS uses to calculate your position.
- Participants will be able to list at least three ways that GPS is important to your daily life.

Overview

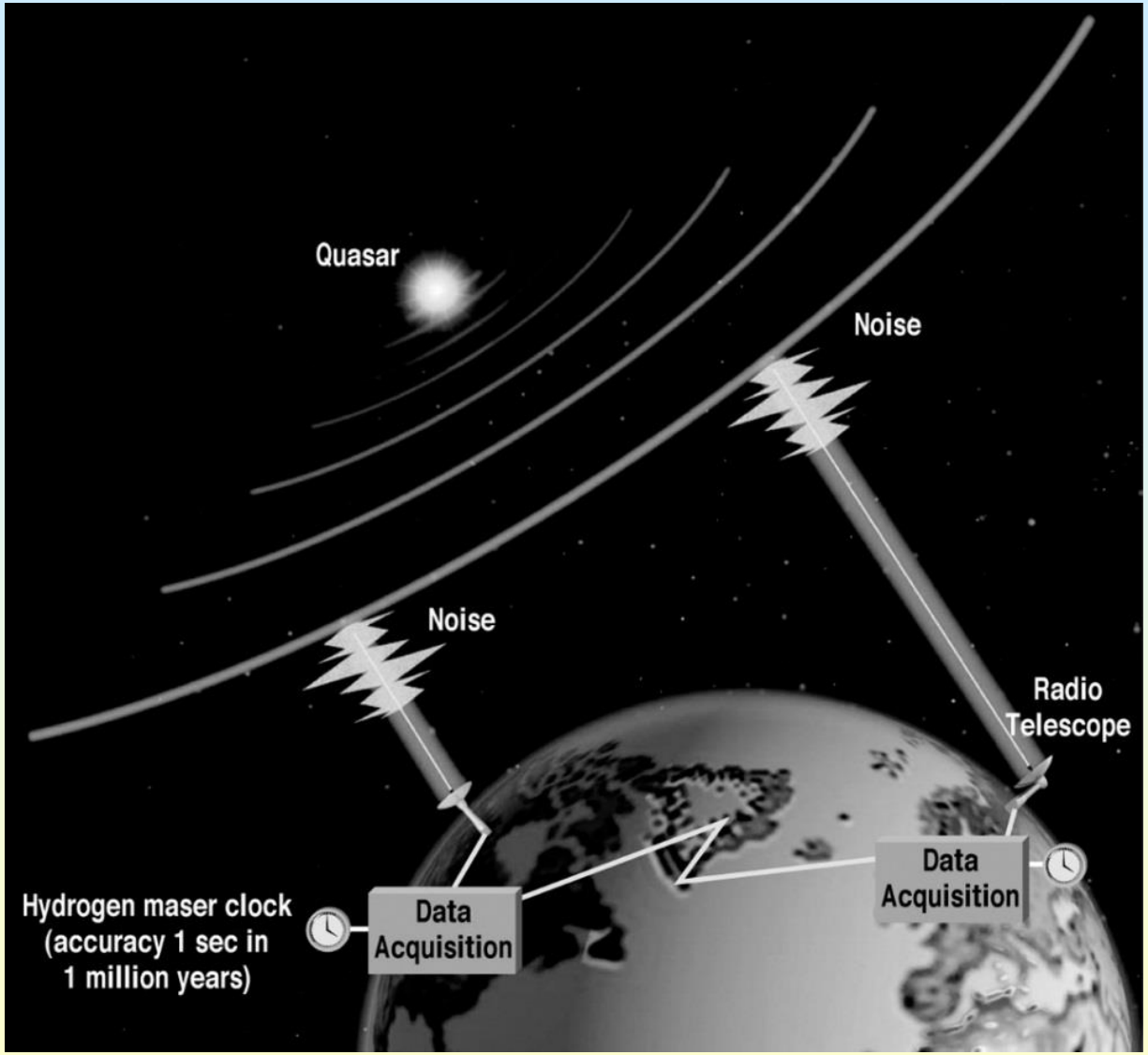
- Part 1: A brief history of positioning
- Part 2: GPS
- Part 3: The amazing new world of precise positioning

Where are we?

- What is positioning and what is surveying?
- Positioning in the USA (zero meridian)

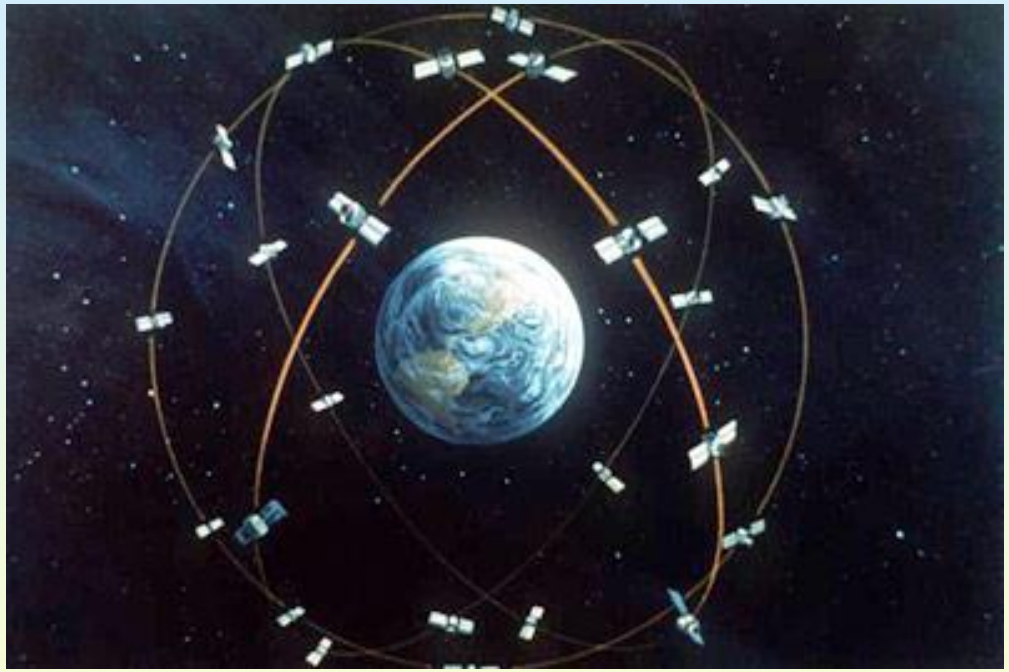
The Importance of Time

- Time has been the limiting factor for a lot of science, including the science of positioning
- Better accuracy requires better clocks


Quasar
Noise
Noise
Radio
Telescope
Data
Acquisition
Hydrogen maser clock
(accuracy 1 sec in
1 million years)
Data
Acquisition

The Launch of GPS

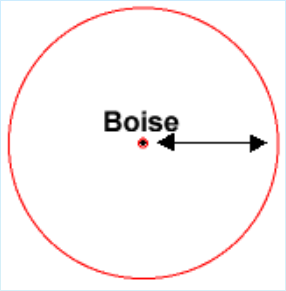
- DOD sponsored project puts satellites into orbit
- First Sat launched in 1978
- 24 Sats by mid 1990s
- 28 Currently in orbit, with more coming
- A fundamental change in how positioning is done
- What GPS has changed?



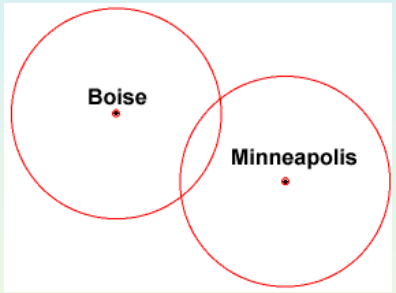
The GPS Receiver

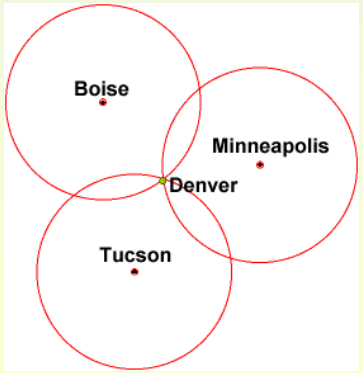
- Who has a GPS Receiver?
- What the receiver does
- What the receiver does NOT

Basic Trilateration

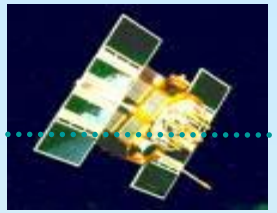


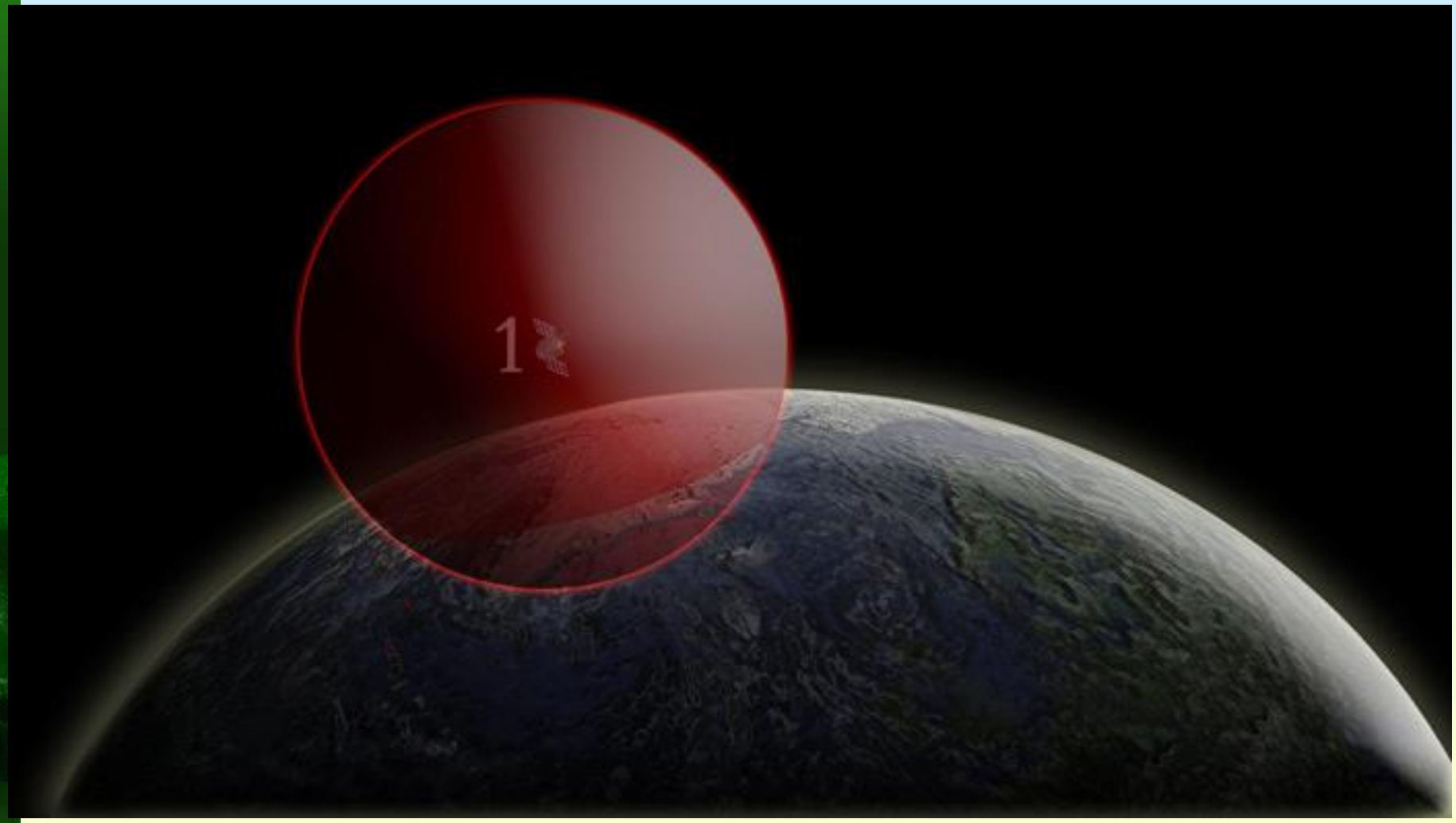
- D=RxT
- Rate is Speed of light
- Time is the key! Technology made it possible
- One you have distance, its “easy”

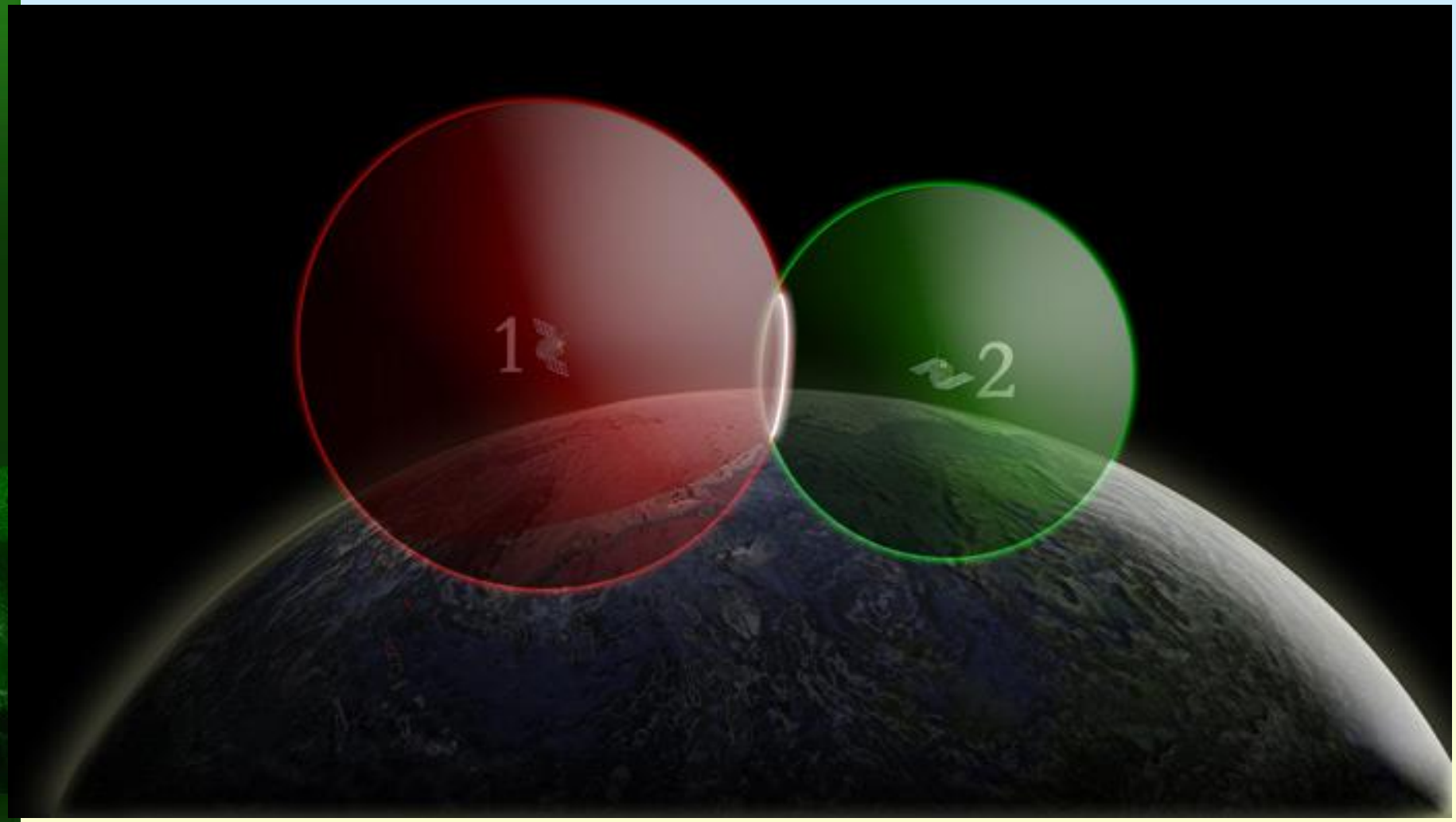


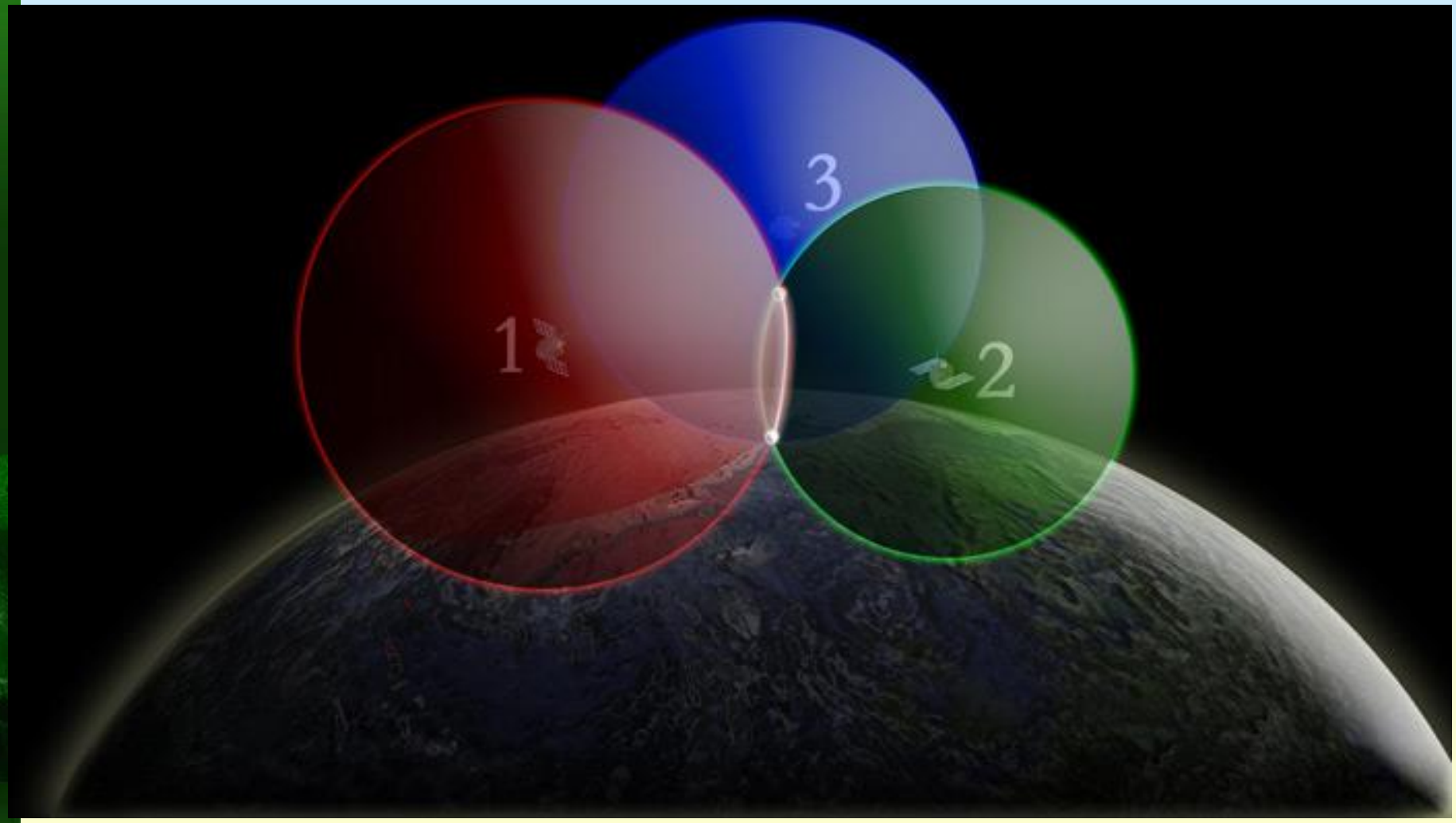


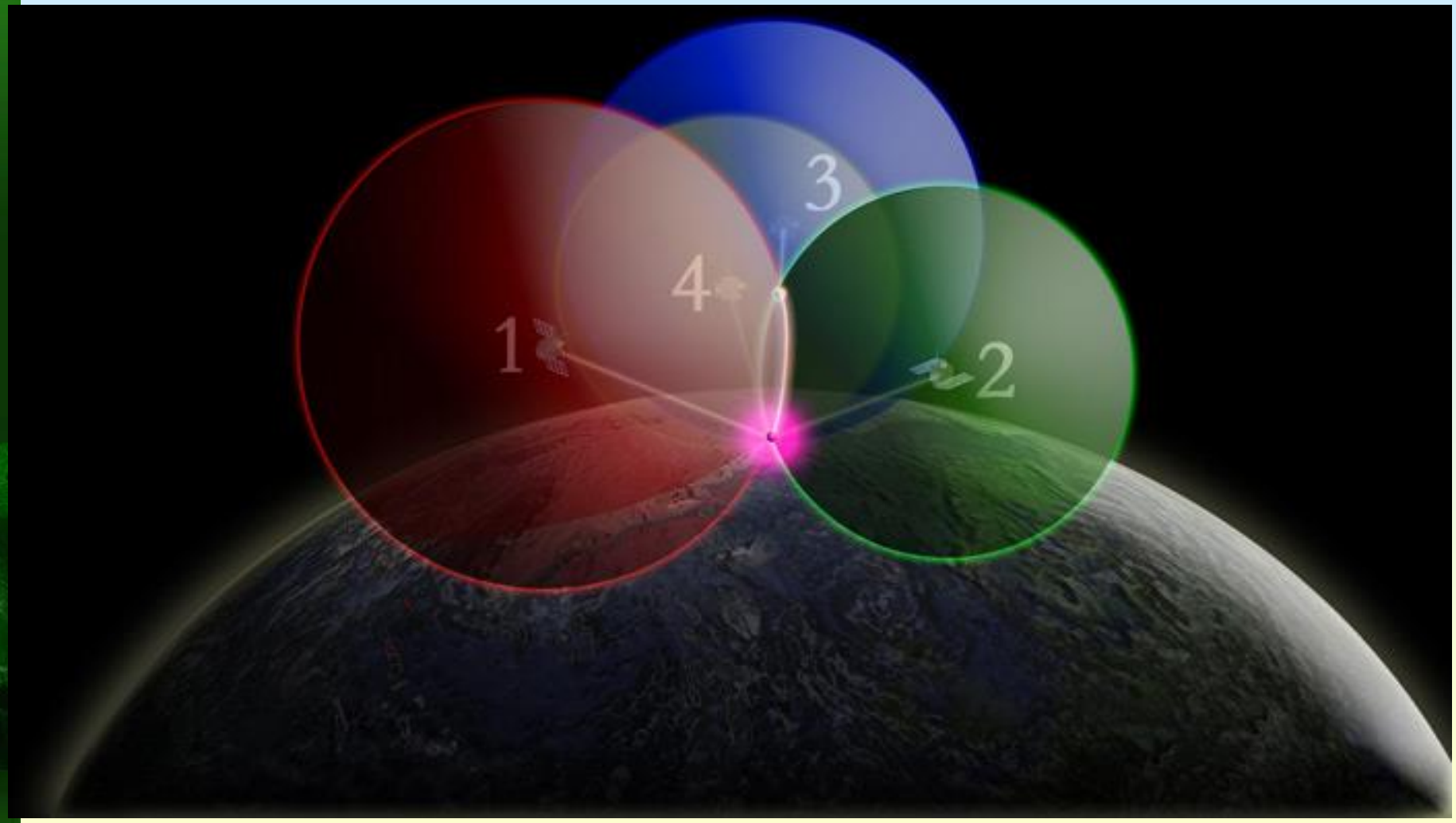
GPS positioning simplified to two dimensions




1

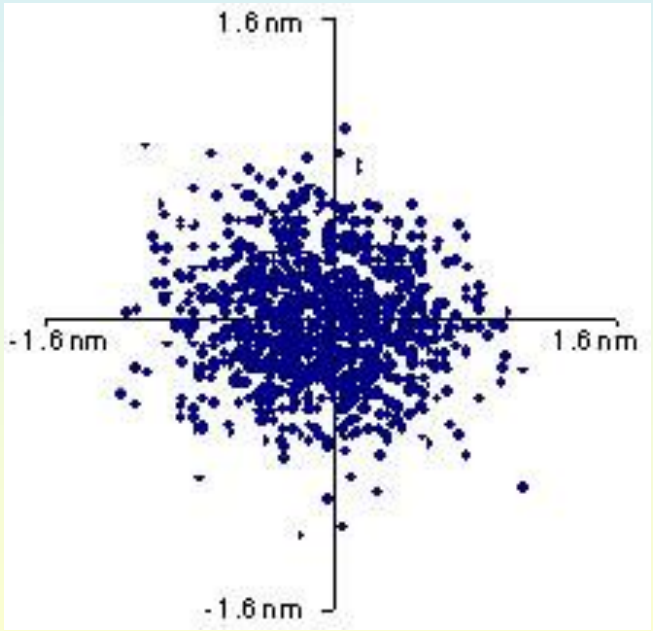

1
2


3
1
2


3
4
1
2

How a GPS receiver works

- Find the satellites
- Know where the satellites are
- Figure out D=RxT
- Trilaterate
- Repeat, repeat, repeat



The limitations of GPS

- Must be able to “see” the satellites
- Requires power
- Multiple sources of error

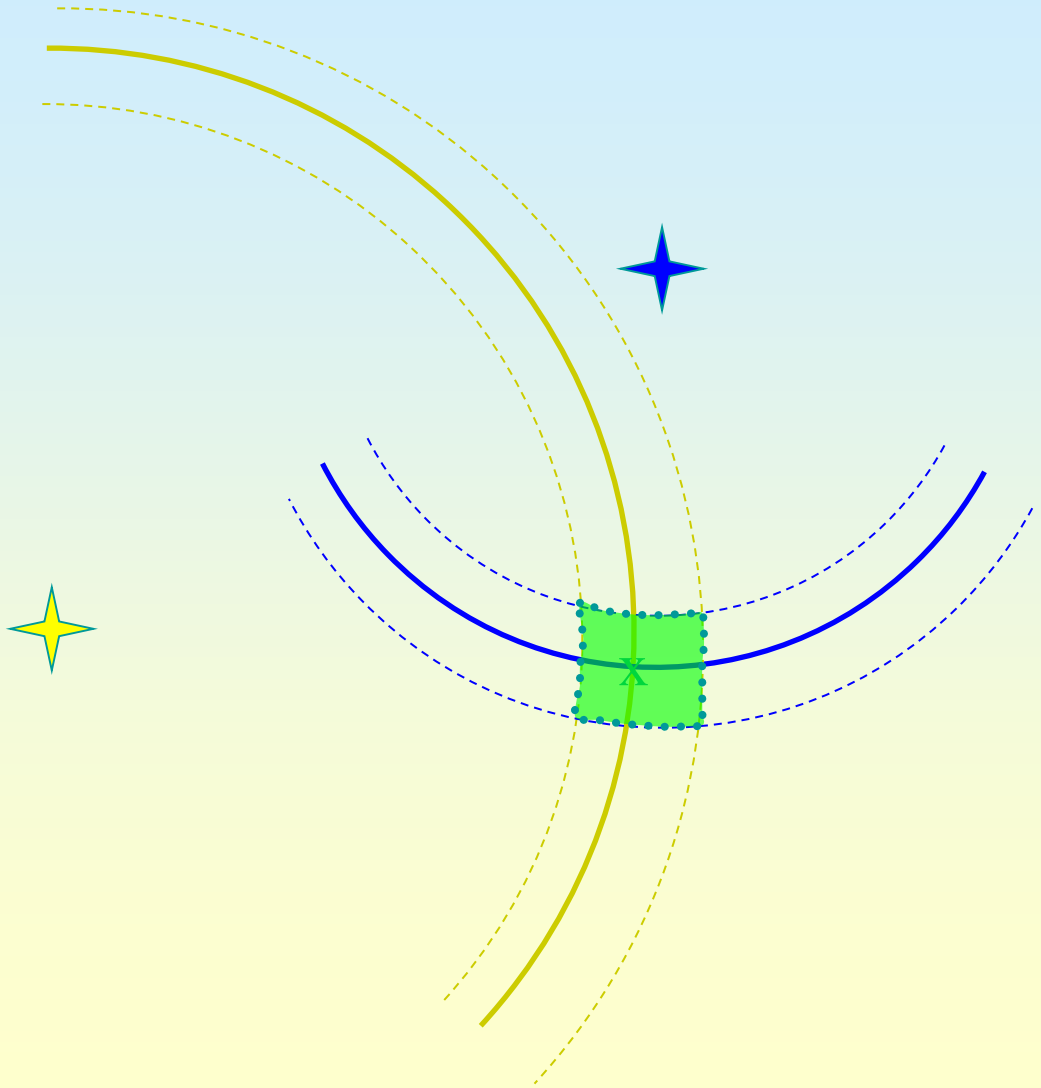
Sources of Error in GPS

- Multipathing
- Atmospheric Delays
- PDOP
- Clocks
- Orbits
- Receiver electronics
- others

PDOP (Position Dilution of Precision) or

"Why the distribution of GPS satellites in the sky affects *how well* I know where I am"

(Simplified to a 2-dimensional model)



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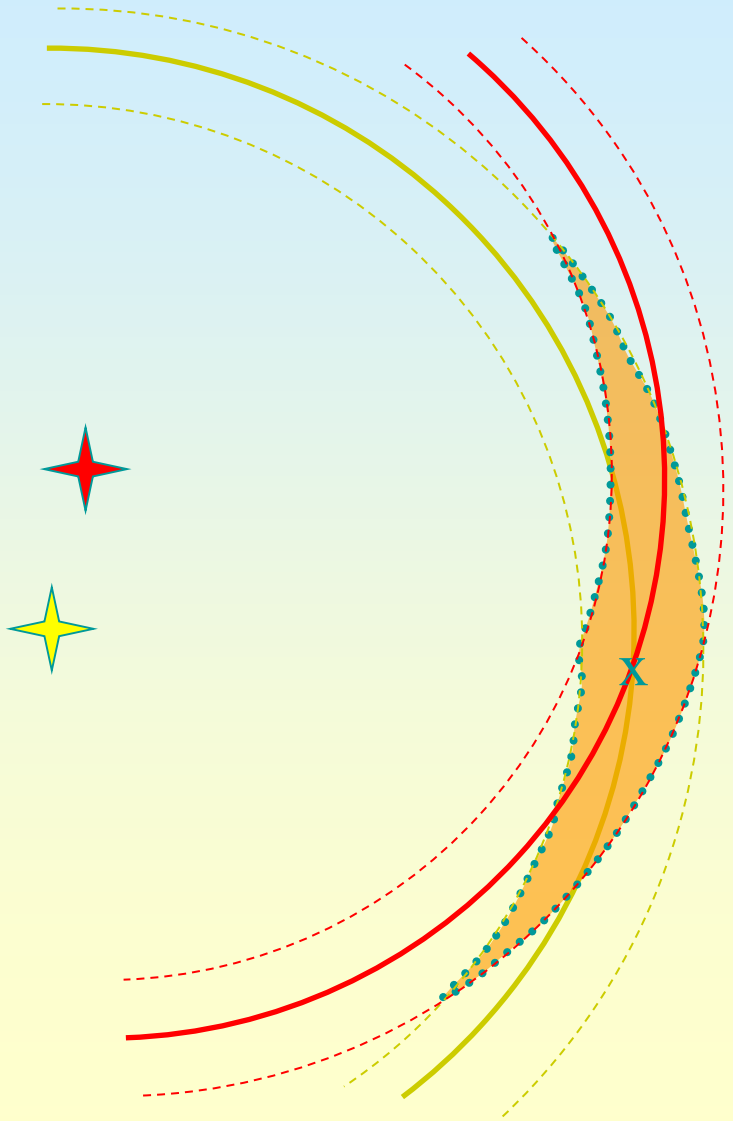


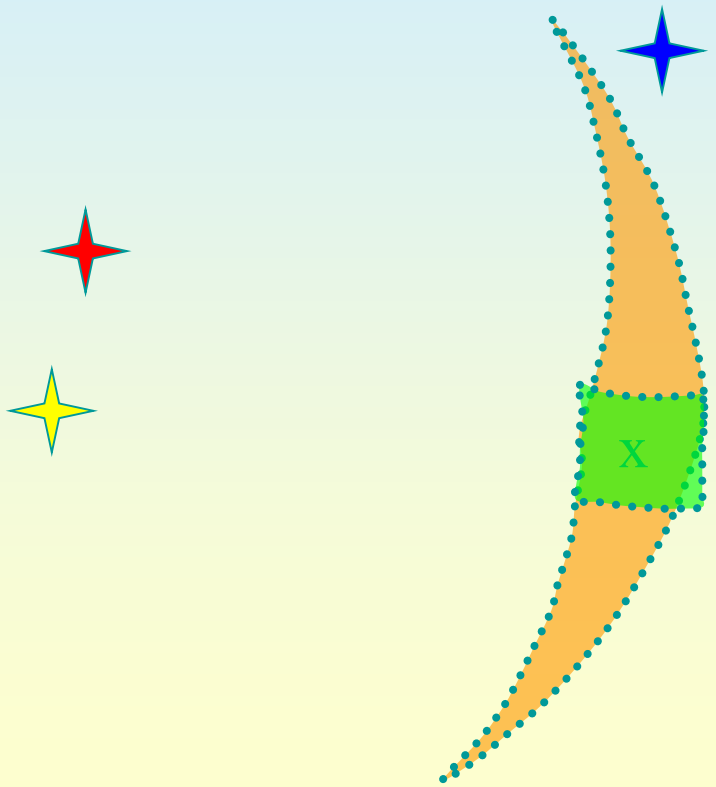
PDOP (Position Dilution of Precision) or

"Why the distribution of GPS satellites in the sky affects *how well* I know where I am"

(Simplified to a 2-dimensional model)

Blue/Yellow have "good geometry" so the (green) error box around "x" is small (PDOP is small)

Red/Yellow have "bad geometry" so the (orange) error box around "x" is large (PDOP is large)



Conclusion and discussion

- GPS completely changed positioning forever
- GPS will continue to improve