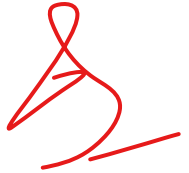
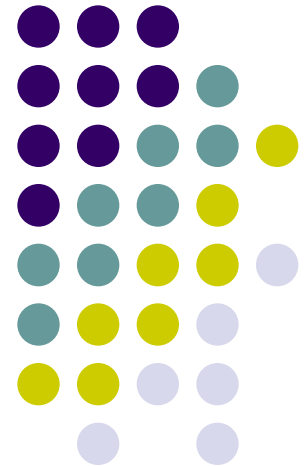


Communication Systems

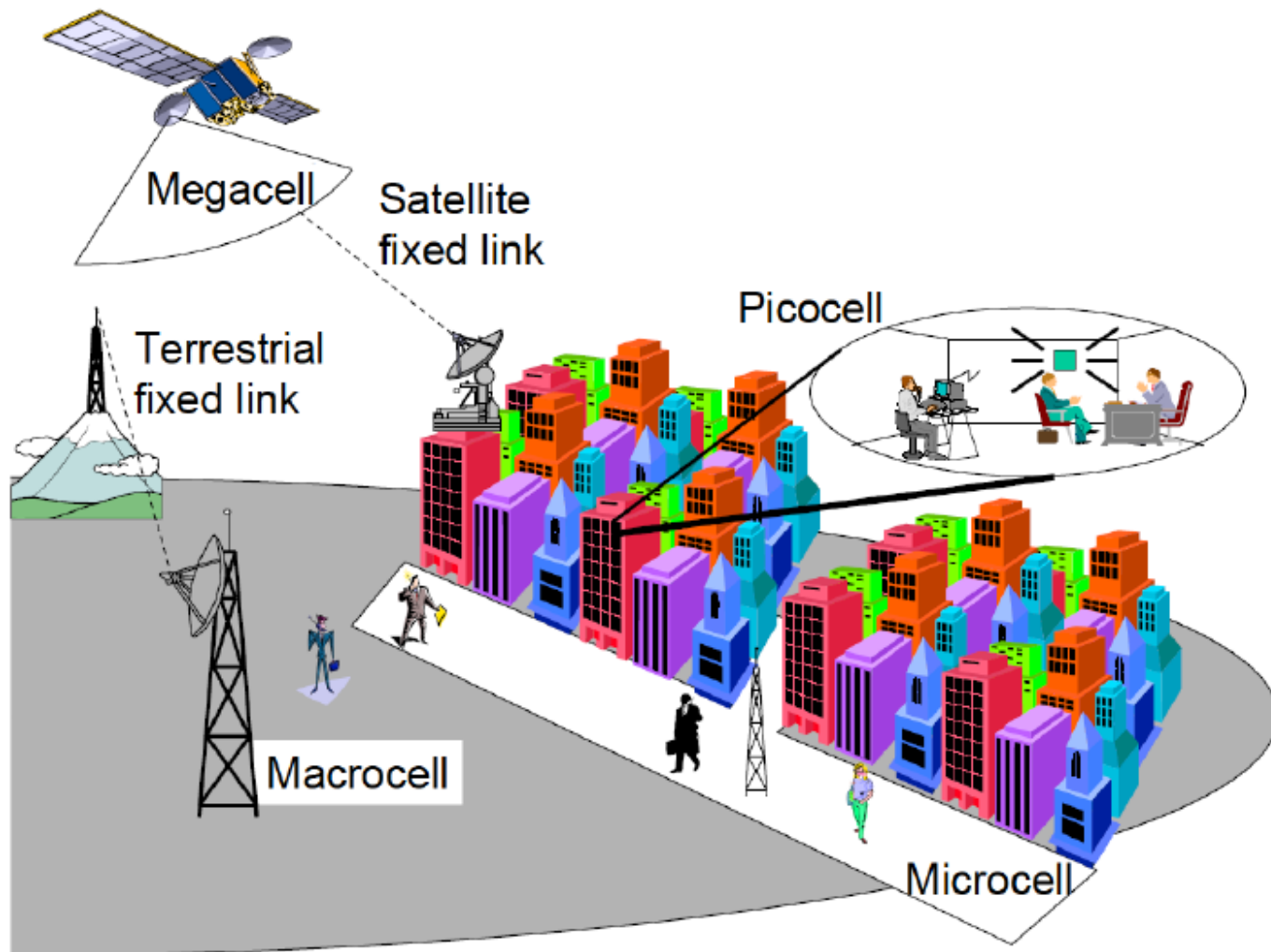
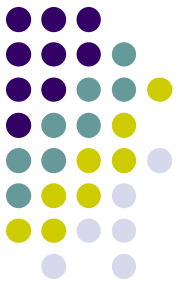


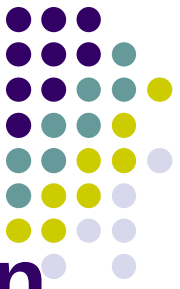
Lecture 2:

Satellite System



Communication Systems

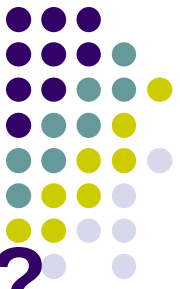




Concerns of Wireless Communication

- Maximum data rate
- Operating range
- Power requirements
- Error rates *→ raise quality*

Wireless systems and markets



Why Microwave and RF are preferred?

- **Ultra-sonic signals:** Very low data rates, poor immunity to interference
- **Infrared signals:** Moderate data rates, easily blocked by even small obstructions
- **Optical signals:** Moderate to high data rates, require a line of sight (LOS) path and foliage, fog and dust block signals
- **RF and Microwave:** ranged (100Mhz-30Ghz), with wide bandwidth, can penetrate dust, foliage, even buildings and vehicles.

$$\lambda = \frac{c}{f}$$



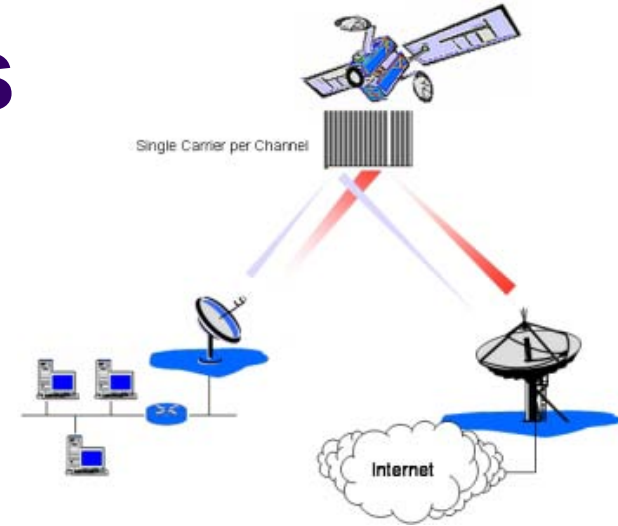
Classification of Wireless Systems

- ◆ Wireless system: communicate between two points without wired connection
- ◆ Sonic, infrared (but is easily blocked by even small obstructions), optical (but require a line-of-sight path), are possible media.
- ◆ Wireless system rely on RF or microwave signals in 100MHz to 30GHz.

the nature and placement of the users

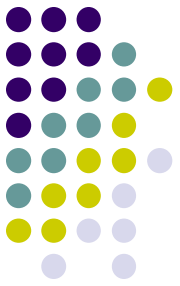
- ◆ Point-to-point: dedicated data communication
- ◆ Point-to-multipoint: broadcast, AM, FM, LMDS
- ◆ Multipoint-to-multipoint: need base stations, mobile phone, WLAN.

Basics: How do Satellites Work



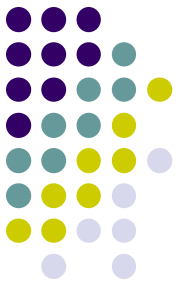
- Two Stations on Earth want to communicate through radio broadcast but **are too far away** to use conventional means.
- The two stations can use a satellite as a relay station for their communication
- One **Earth Station** sends a transmission to the satellite. This is called a **Uplink**.
- The satellite **Transponder** converts the signal and sends it down to the second earth station. This is called a **Downlink**.

Basics: Advantages of Satellites

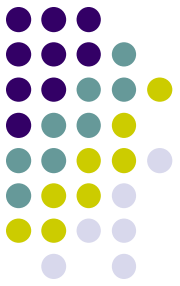


- The advantages of satellite communication over terrestrial communication are:
 - The coverage area of a satellite greatly exceeds that of a terrestrial system (**large area**).
 - Transmission **cost** of a satellite is **independent of the distance** from the center of the coverage area.
 - Satellite to Satellite communication is very **precise**.
 - **Higher Bandwidths** are available for use.

Basics: Disadvantages of Satellites



- The disadvantages of satellite communication:
 - Launching satellites into orbit is costly.
 - Satellite bandwidth is gradually becoming used up.
 - There is a larger propagation delay in satellite communication than in terrestrial communication.

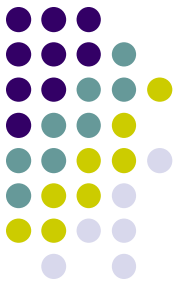


Satellite applications

- DirecTV
- XM and Sirius
- VSAT
- GPS
- Comm. to isolated areas



Ch.8.5 Satellite system (p.566)

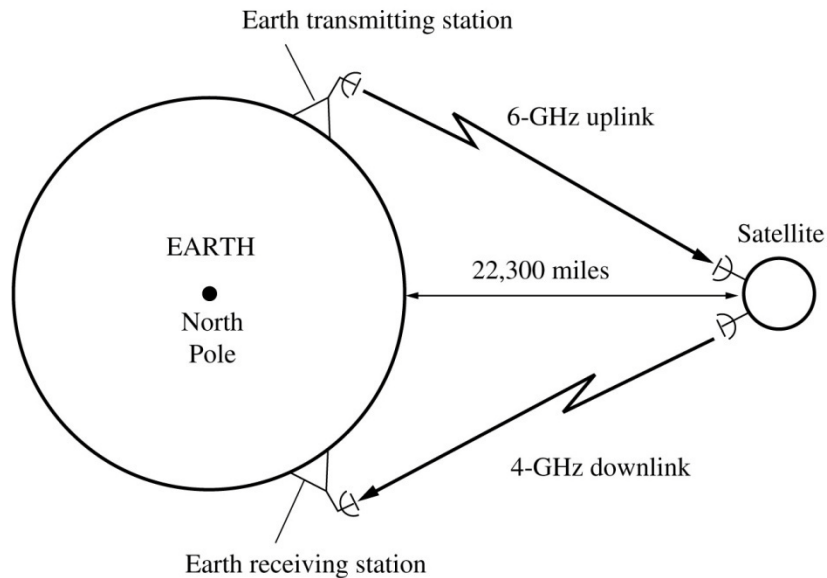
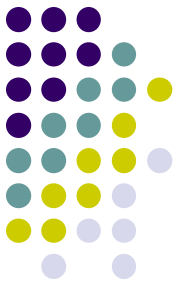


WaveStar fiber optic	6250,000 channels
<u>Intelsat X satellite</u>	170,000 channels

Fiber cost $\ll$ satellite system

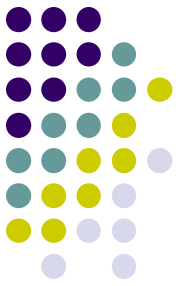
Fiber-optic for broadcast type application;
Satellite for point-to-point communication.

Figure 8–8 **Communications satellite in geosynchronous orbit.**

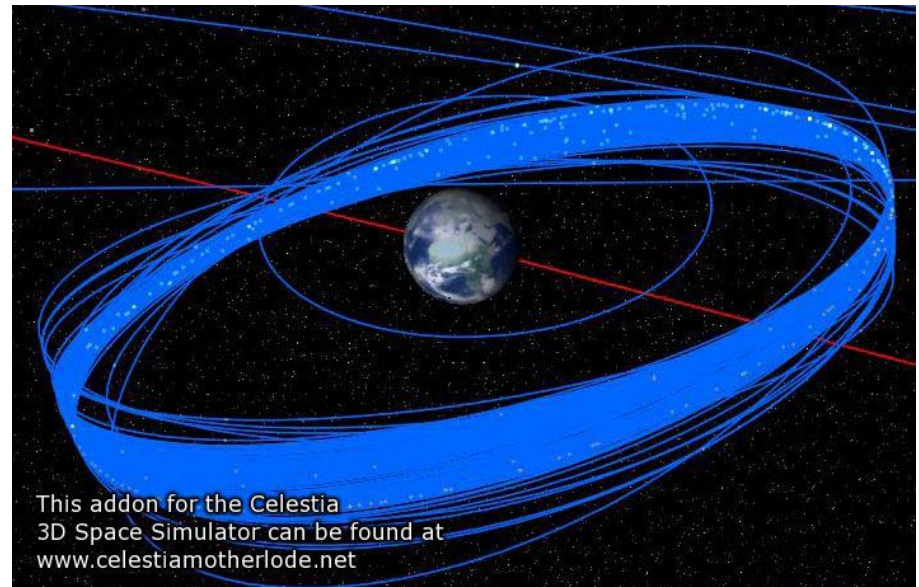


- Appear to be at a stationary point
- Simple antennas, fixed direction
- Up/Down Link: 6Ghz/4Ghz
- Share channels with Microwave Radio

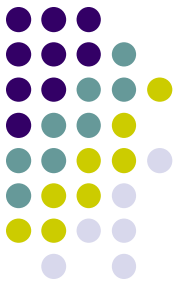
Types of Satellites



- Satellite Orbits
 - GEO
 - LEO
 - MEO
 - Molniya Orbit
 - HAPs
- Frequency Bands

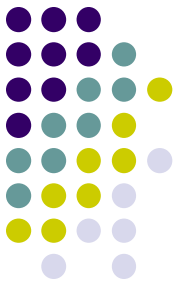


Geostationary Earth Orbit (GEO)



- These satellites are in orbit 35,863 km above the earth's surface along the equator.
- Objects in Geostationary orbit revolve around the earth at the same speed as the earth rotates. This means GEO satellites remain in the **same position** relative to the surface of earth.

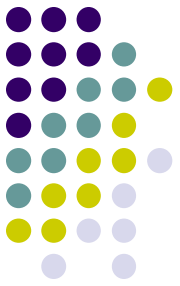
GEO (cont.)



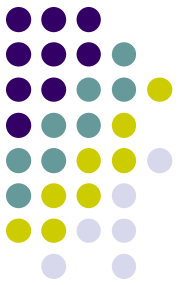
- Advantages

- A GEO satellite's distance from earth gives it a large coverage area, almost a fourth of the earth's surface.
- GEO satellites have a 24 hour view of a particular area.
- These factors make it ideal for satellite broadcast and other multipoint applications.

GEO (cont.)



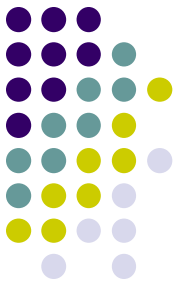
- Disadvantages
 - A GEO satellite's distance also cause it to have both a comparatively weak signal and a time delay in the signal, which is bad for point to point communication.
 - GEO satellites, centered above the equator, have difficulty broadcasting signals to near polar regions



Low Earth Orbit (LEO)

- LEO satellites are much closer to the earth than GEO satellites, ranging from 500 to 1,500 km above the surface.
- LEO satellites don't stay in fixed position relative to the surface, and are only visible for 15 to 20 minutes each pass.
- A network of LEO satellites is necessary for LEO satellites to be useful

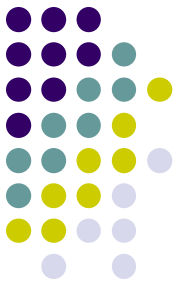
LEO (cont.)



- Advantages

- A LEO satellite's proximity to earth compared to a GEO satellite gives it a better signal strength and less of a time delay, which makes it better for point to point communication.
- A LEO satellite's smaller area of coverage is less of a waste of bandwidth.

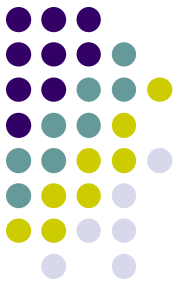
LEO (cont.)



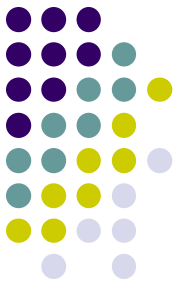
- Disadvantages

- A network of LEO satellites is needed, which can be costly
- LEO satellites have to compensate for Doppler shifts caused by their relative movement.
- Atmospheric drag affects LEO satellites, causing gradual orbital deterioration.

Medium Earth Orbit (MEO)

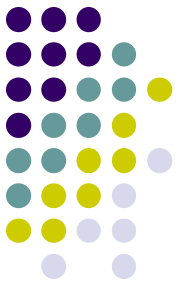


- A MEO satellite is in orbit somewhere between 8,000 km and 18,000 km above the earth's surface.
- MEO satellites are similar to LEO satellites in functionality.
- MEO satellites are visible for much longer periods of time than LEO satellites, usually between 2 to 8 hours.
- MEO satellites have a larger coverage area than LEO satellites.



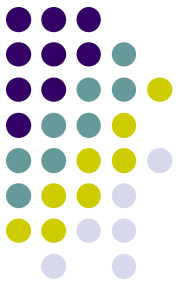
MEO (cont.)

- Advantage
 - A MEO satellite's longer duration of visibility and wider footprint means fewer satellites are needed in a MEO network than a LEO network.
- Disadvantage
 - A MEO satellite's distance gives it a longer time delay and weaker signal than a LEO satellite, though not as bad as a GEO satellite.



Other Orbits

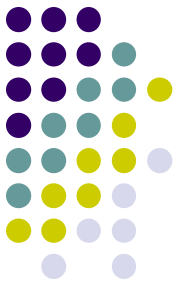
- Molniya Orbit Satellites
 - Used by Russia for decades.
 - Molniya Orbit is an elliptical orbit. The satellite remains in a nearly fixed position relative to earth for eight hours.
 - A series of three Molniya satellites can act like a GEO satellite.
 - Useful in near polar regions.



Other Orbits (cont.)

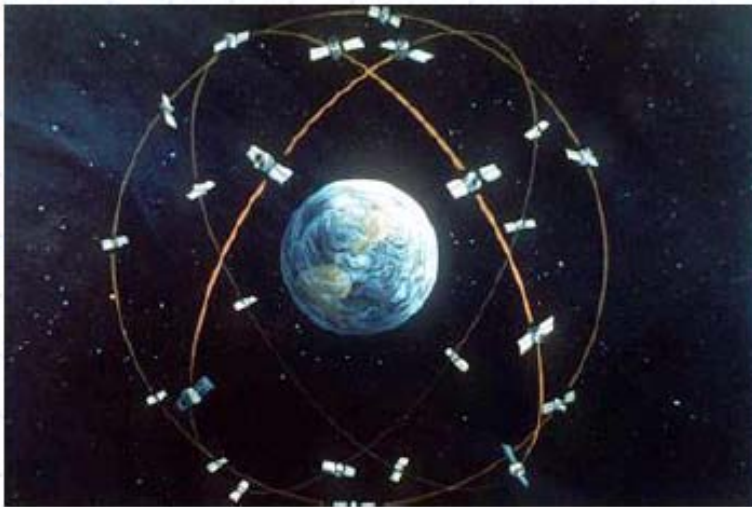
- High Altitude Platform (HAP)
 - One of the newest ideas in satellite communication.
 - A blimp or plane around 20 km above the earth's surface is used as a satellite.
 - HAPs would have very small coverage area, but would have a comparatively strong signal.
 - Cheaper to put in position, but would require a lot of them in a network.

GPS System

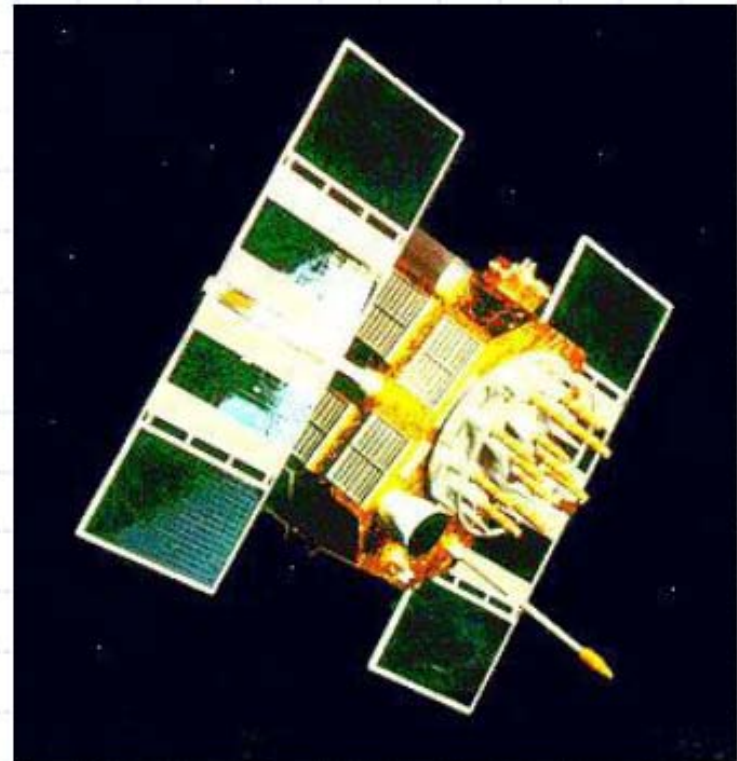


Global Positioning Satellite System

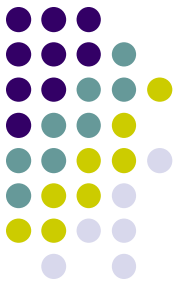
- <http://electronics.howstuffworks.com/gps.htm>



- Built by U.S. Army for military purpose, later allowed for commercial use.

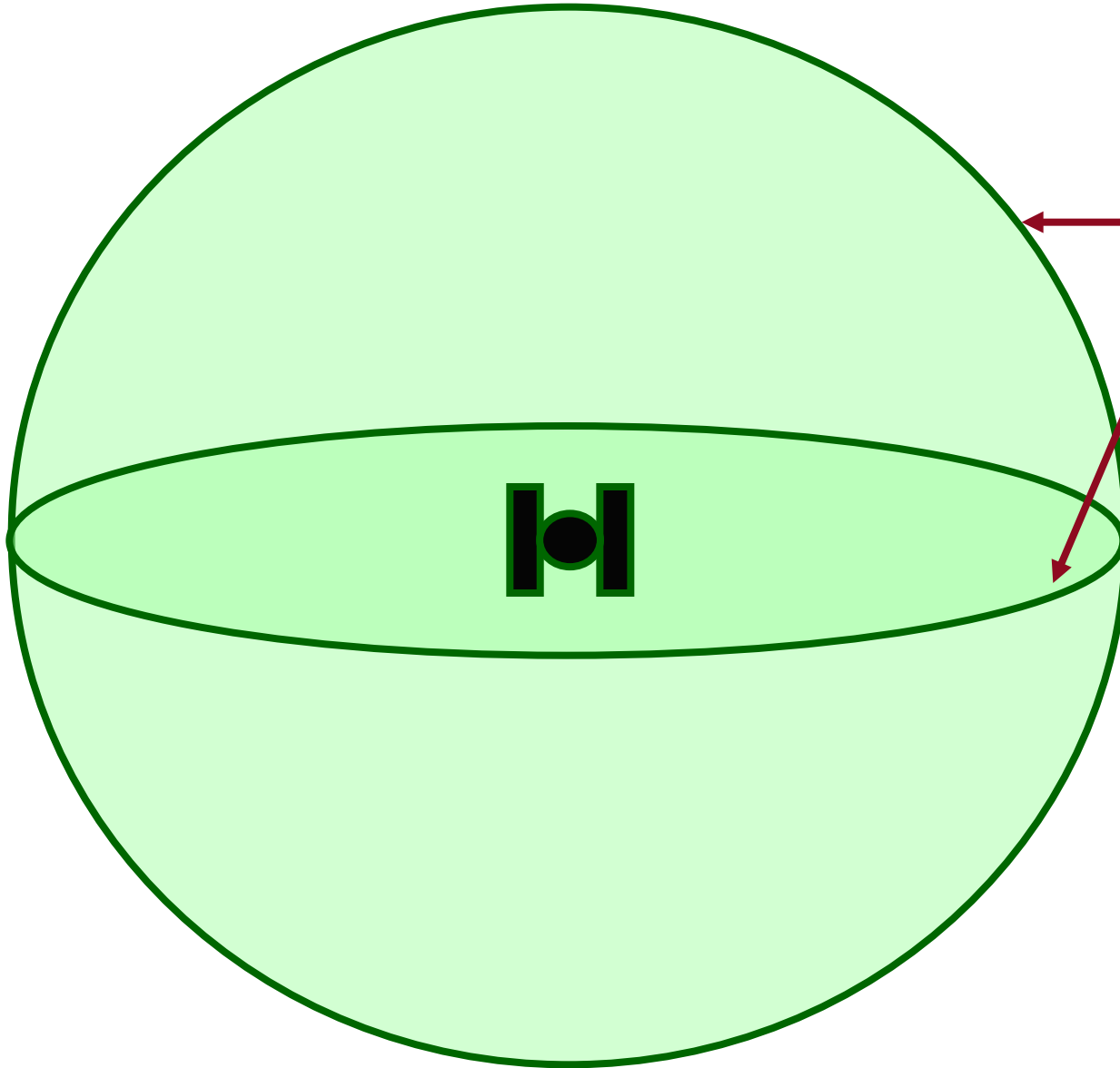
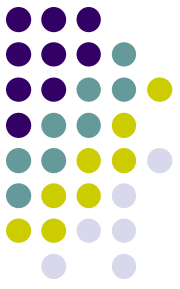


Question

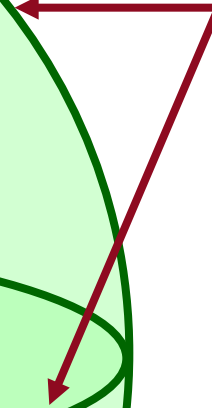


- To locate a moving vehicle on the map, at least how many satellites are needed?

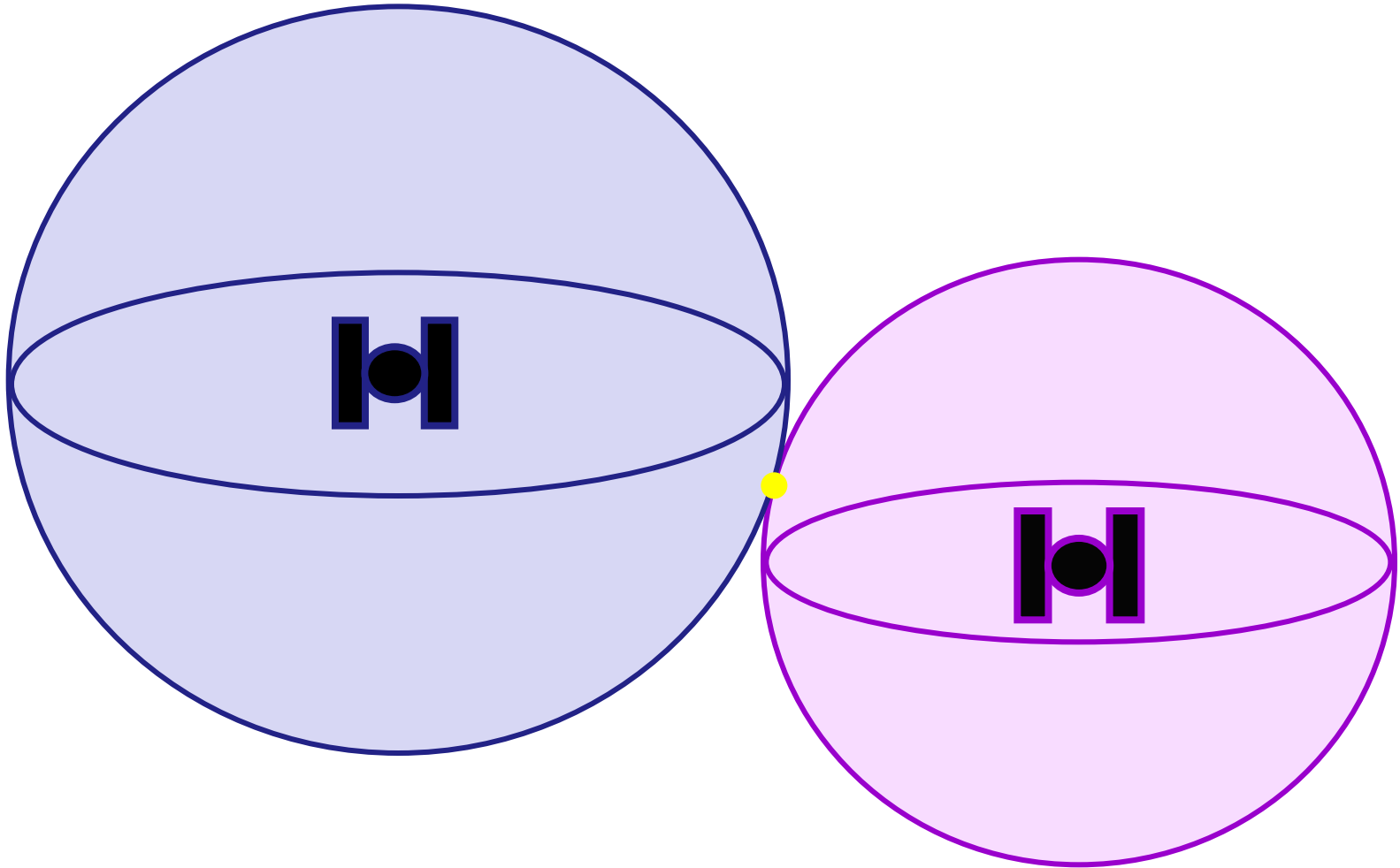
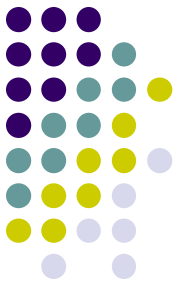
Signal From One Satellite



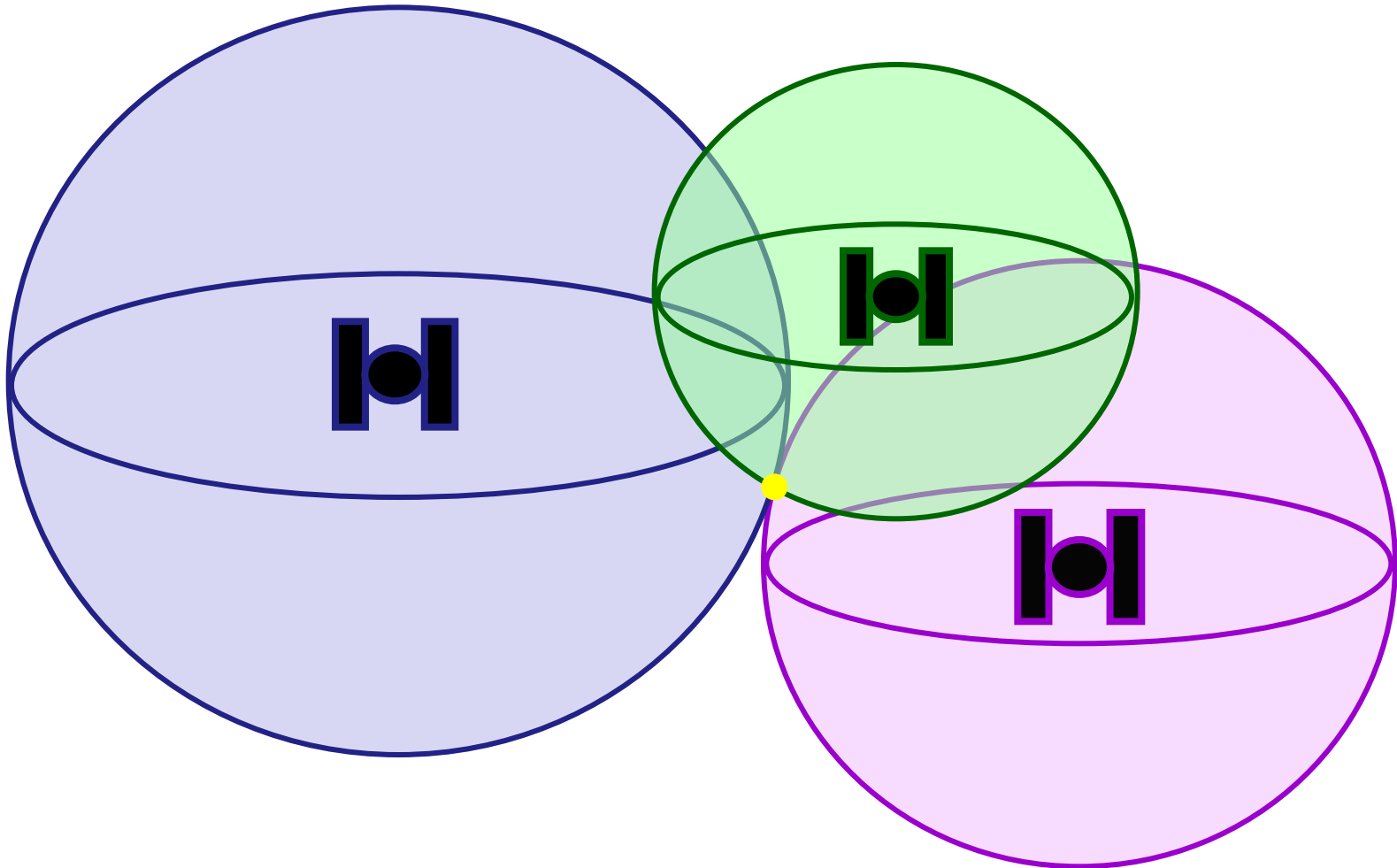
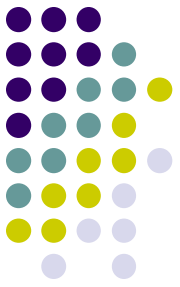
The receiver is
somewhere on
this sphere.

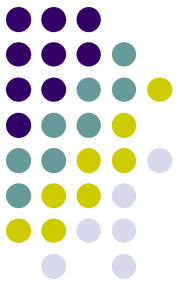


Signals From Two Satellites



Three Satellites (2D Positioning)

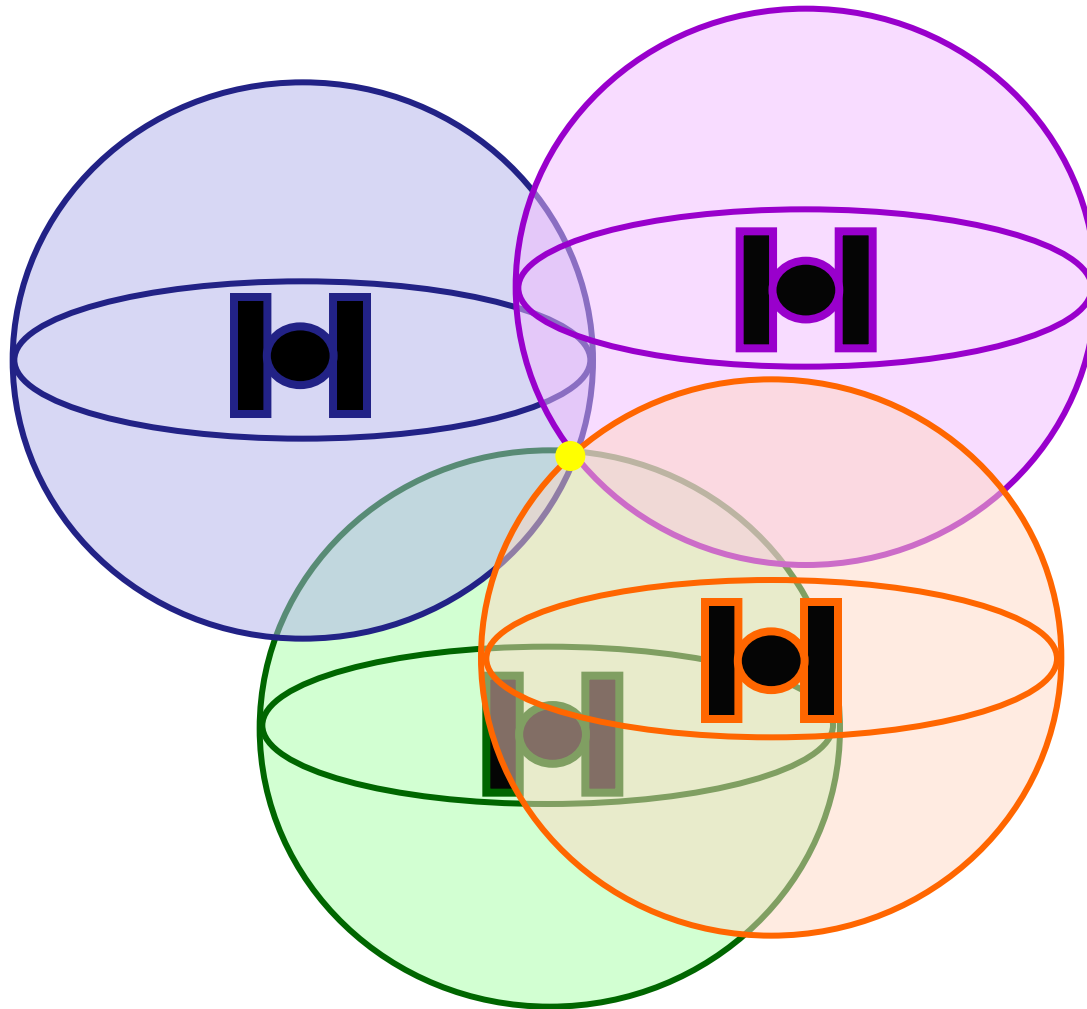




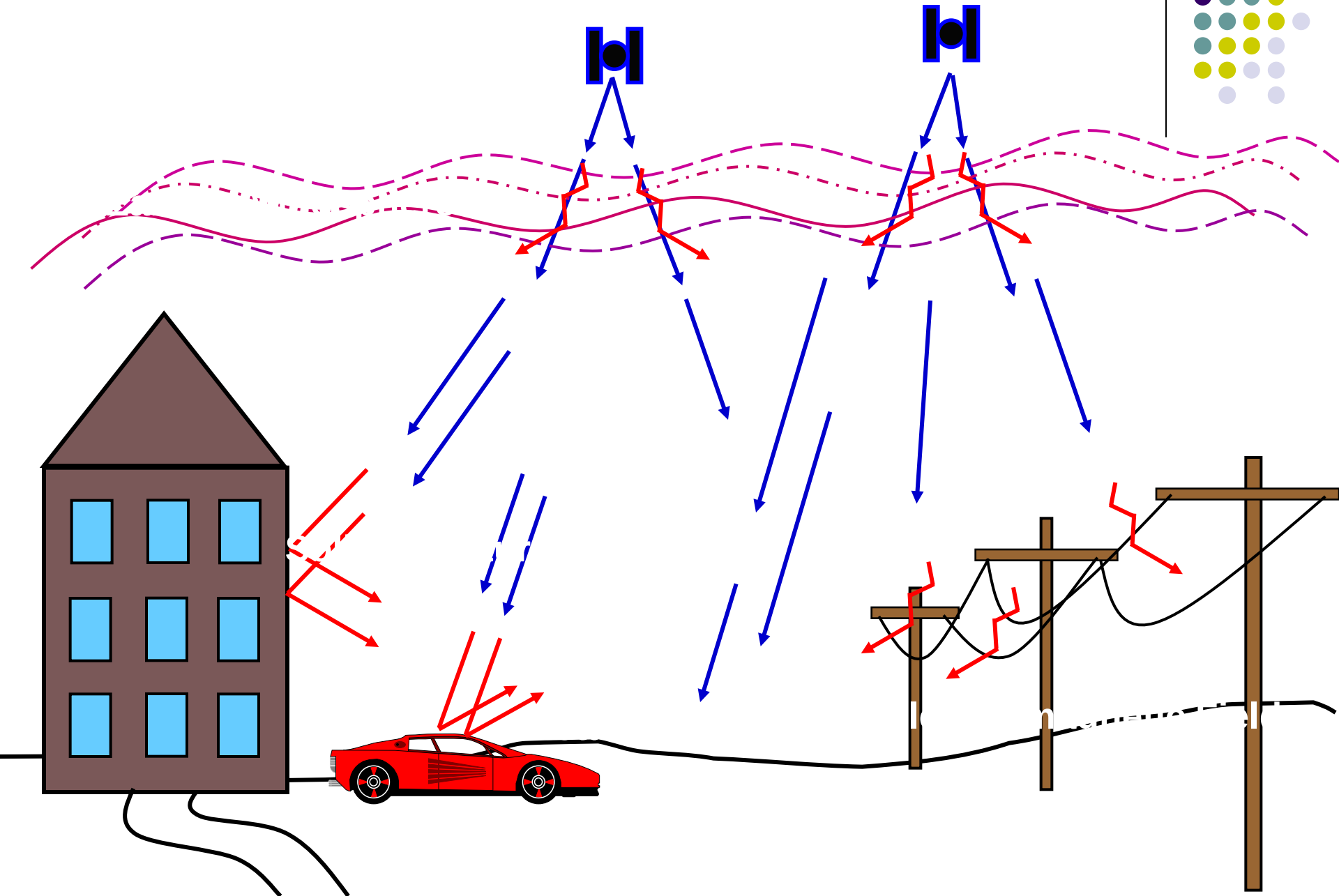
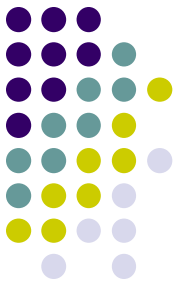
- The talk with the scientist of NASA

<http://www.youtube.com/watch?v=PLjld-edVj8&feature=related>

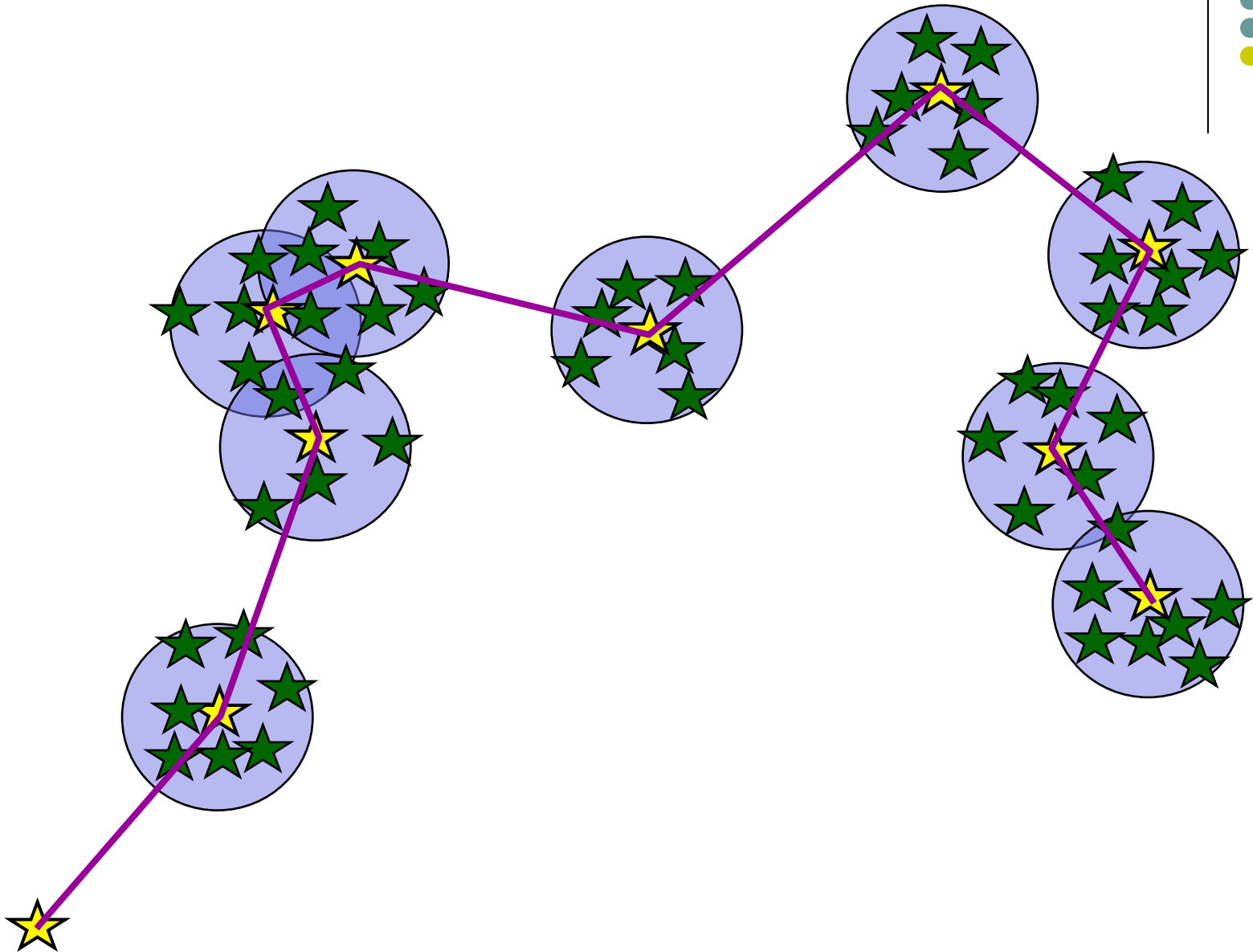
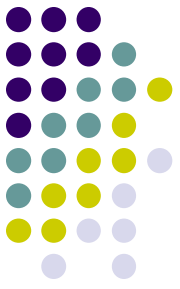
Three Dimensional (3D) Positioning



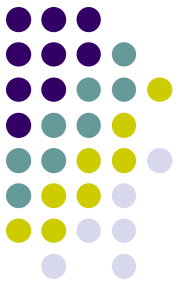
Sources of Signal Interference



How A Receiver Sees Your Route



Satellite Tool Kit



- <http://www.agi.com/products/current-promotions/>

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