GLOBAL POSITIONING SYSTEM

DEPARTMENT OF GEOGRAPHY

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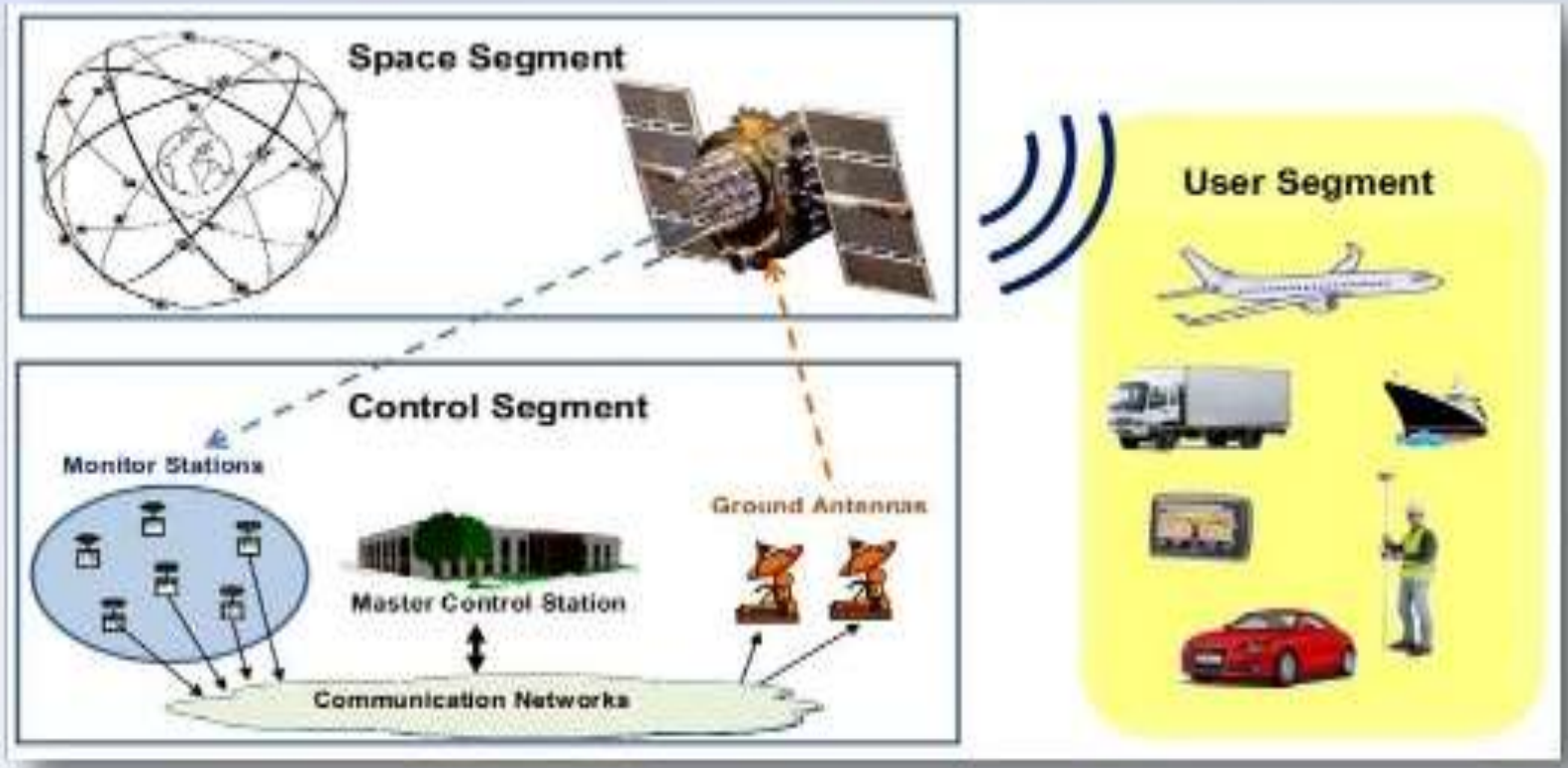
What is GPS

- It is satellite based navigation system.
- Made up of a network of 24 satellites circulating around earth orbit by the U.S. Department of defense (USDOD).
- The first satellite was developed in 1960 to allow ships in the U.S. Navy to navigate the oceans more accurately.
- GPS was originally intended for military applications, but in the 1980, the government made the system available for civilian use.
- GPS permit land, sea, and airborne user to determine their three dimensional position, velocity and time.

Architecture of GPS:



To run all the system of GPS technology properly, highly advance architecture of GPS has been developed that includes three major segments called the space segment, control segment and a user segment.

Three Segments of GPS

A) Space Segment

- Minimum 24 satellites (currently 32) in orbit around Earth at altitude 20,000 km.
- It transmit radio-navigation signals and store and transmit the navigation message send by the control segment.

B) Control Segment

- Combination of a Master control station, four dedicated ground antennas and six dedicated monitor stations.
- Responsible for the proper functionioning of all the operation of GPS such as changing unhealthy satellite with a healthy one.

C) User Segment

Comprises of thousand of U.S. military users who uses the secure GPS precise Positioning service and millions of civil, commercial and scientific users.

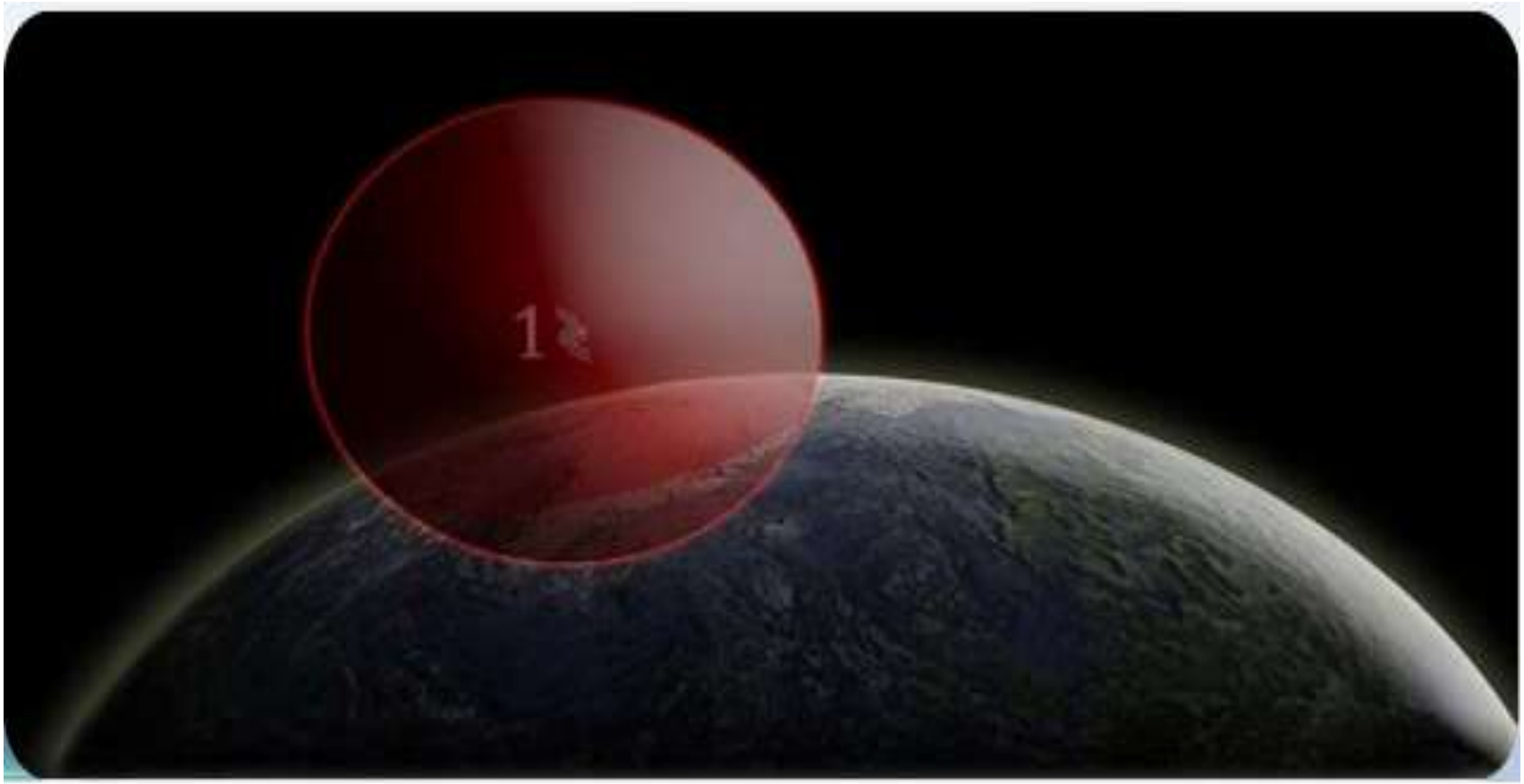
How does GPS works

- Each satellite broadcast radio signals with their location and time.
- GPS receivers receives radio signals, and used these data to calculate its distance from at least four satellites.
- Distance = speed x travel time.
- GPS radio signals are travel at speed of light.
- Both satellite and receiver generate the same psuedocode signals.
- Difference b/w the two signals is the travel time.
- Than the receiver uses trilateration method to define its exact on earth.

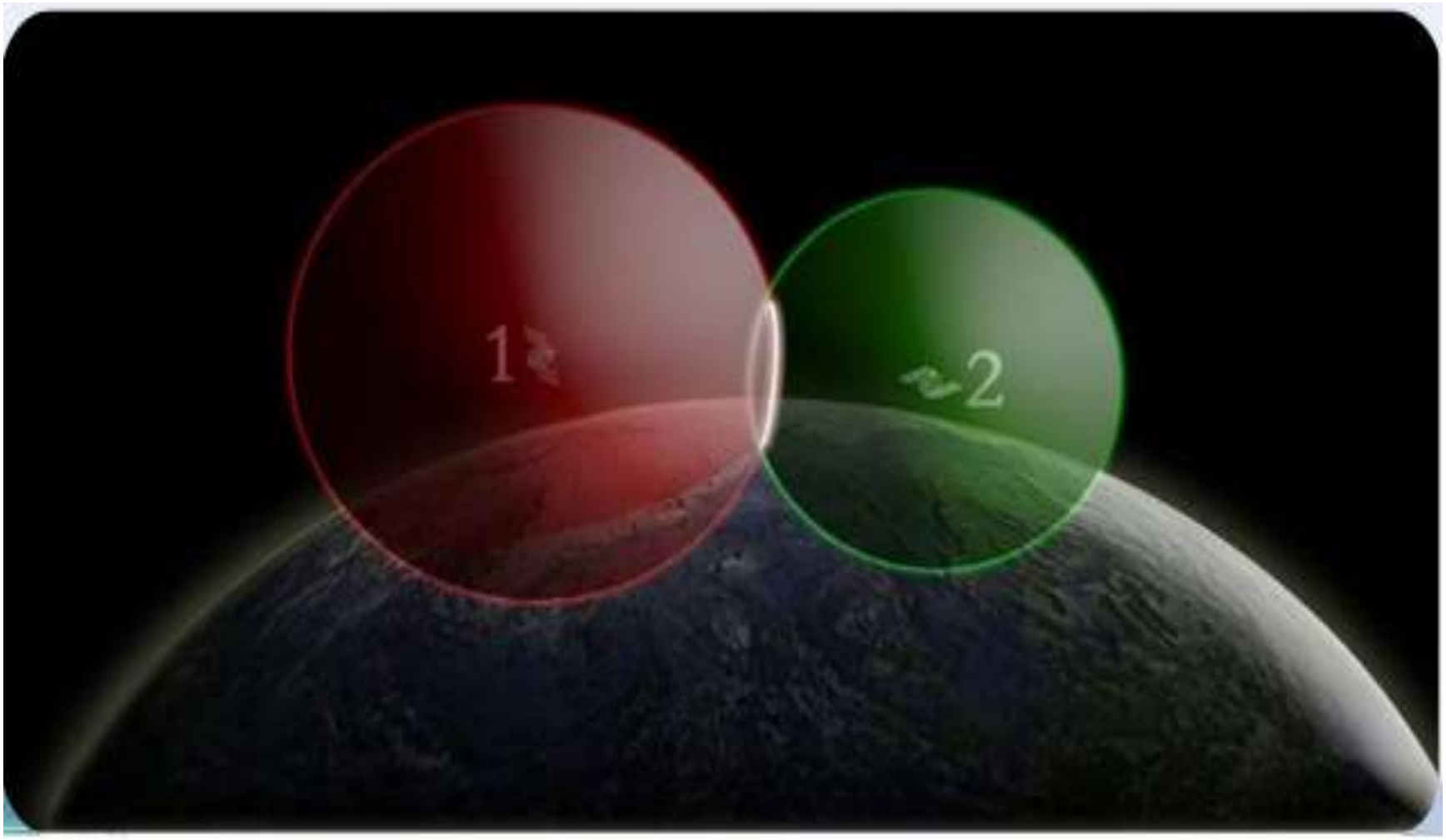
Trilateration Process:

If we know the distance b/w the satellite and the receiver for:

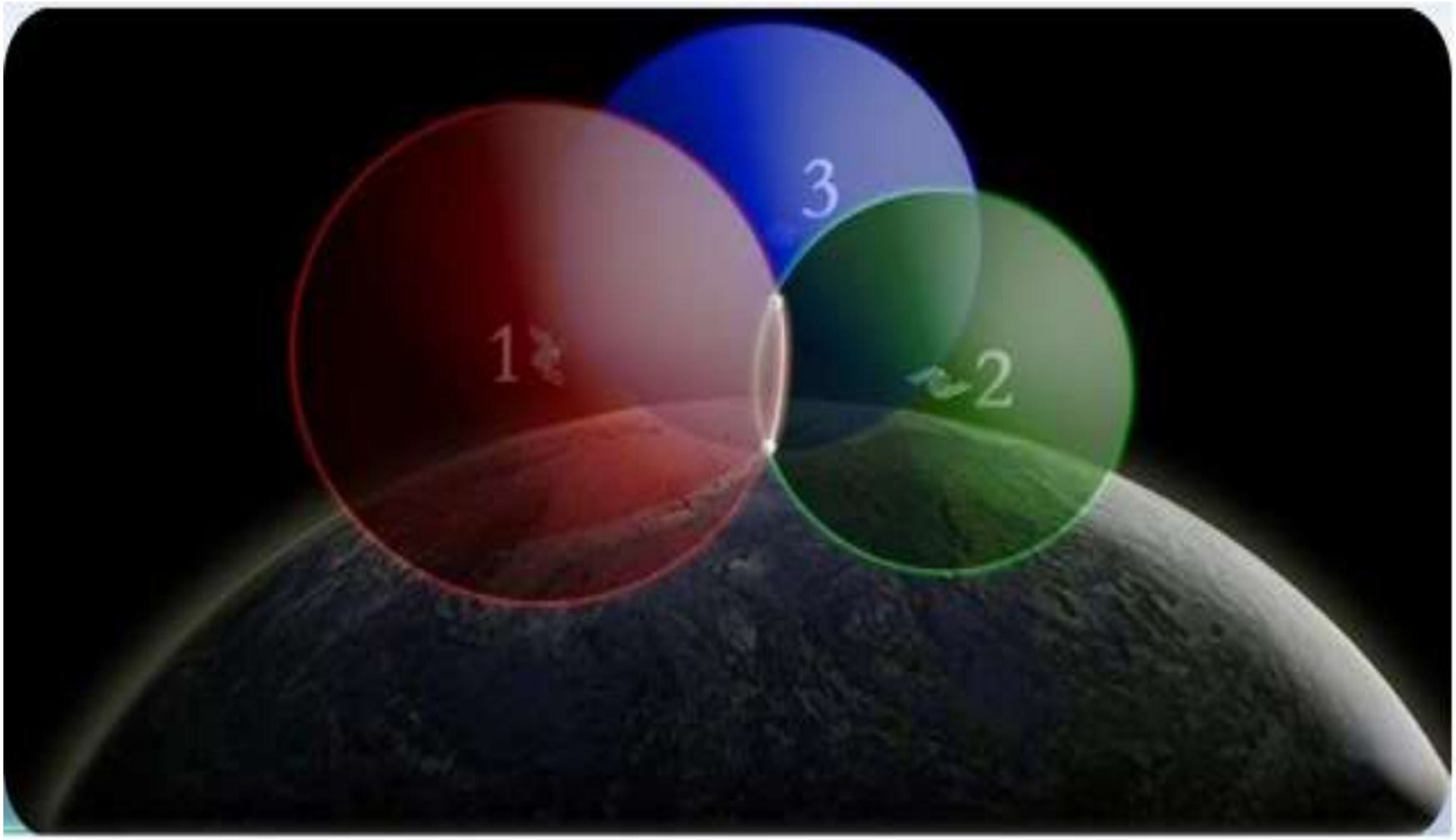
1. satellite the receiver location is known within a sphere



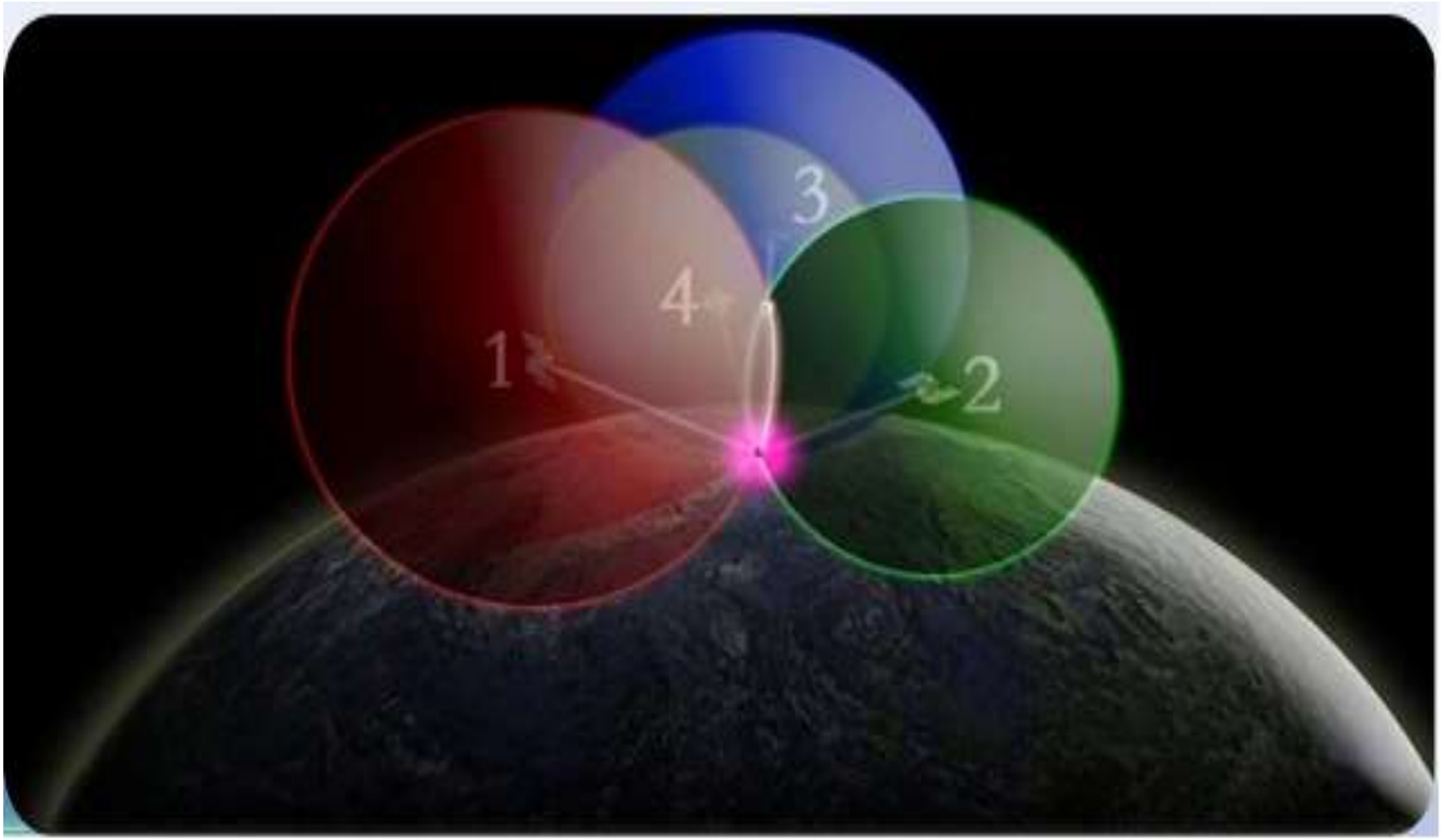
2. Satellite, the receiver's location is known within 3 D ring.



3. Satellite, the receiver's location is somewhere on at most 3D regions



4. Satellite, the region gets smaller because of the sphere of new satellite.



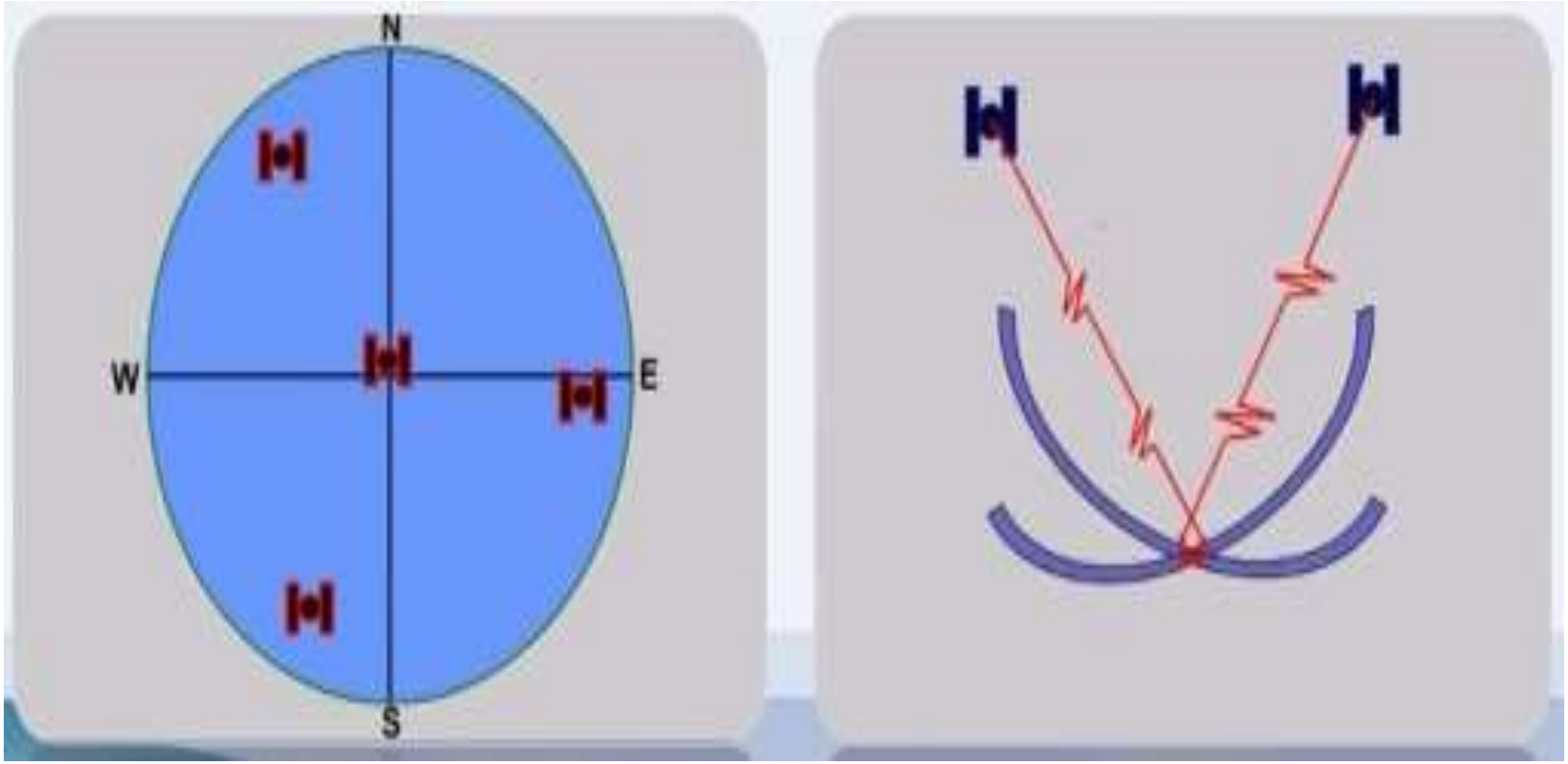
GPS Satellite Geometry:

- Satellite geometry can affect the quality of GPS signals and accuracy of receiver trilateration.
- Position dilution of Precision (PDOP) is the DOP value used commonly in GPS to determine the quality of a receiver's position.
- It's usually depends on the GPS receiver to pick satellites which provide the best position triangulation.

Two types of Satellite Geometry

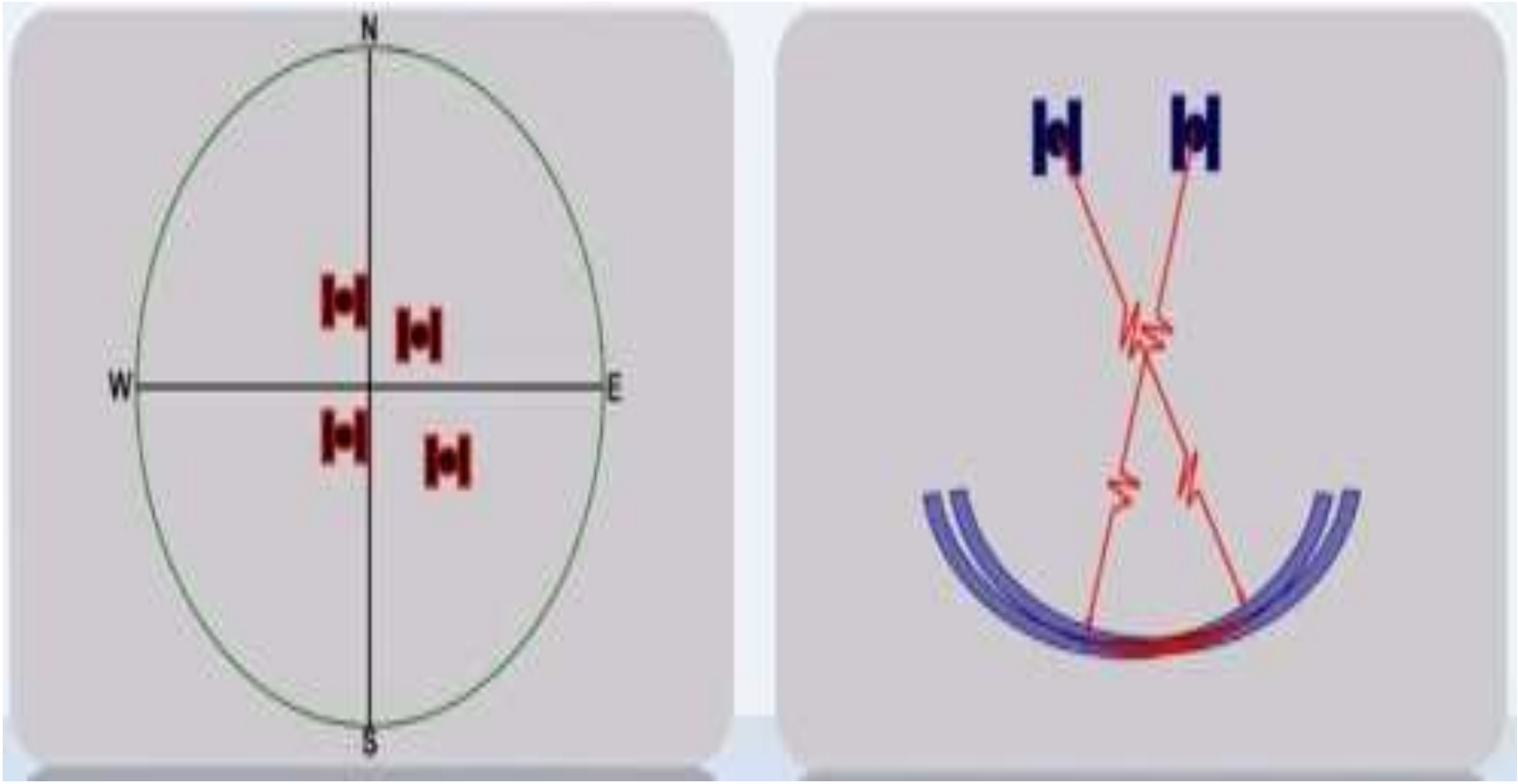
A) Satellite Geometry

If the satellite are will separated equally apart form each other it will from well sphere and give less intersection point and receiver can get an accurate result.



B) Poor Satellite Geometry:

Poor Satellite geometry are formed when satellite are not equally apart to each other and provide more interaction area of receiver's position resulting inaccurate position.



Sources of GPS Error:

Source	Amount of Error
Satellite Clocks:	1.5 to 3.6 meters
Orbitals errors:	< 1 meter
Ionosphere:	5 to 7 meters
Troposphere:	0.5 to 0.7 meters
Multipath:	0.6 to 1.2 meters
Selective Availability:	(depends on USDOD)
Users Errors:	up to a kilometer or more

Other Satellite Navigation System:

- GLONASS: Russia's global navigation system. Fully operation worldwide.
- Galileo: Developed by the European Union and the other partner countries, planned to be operational by 2016 (and fully operated 2020).
- Beidou: People Republic of China's global system, planed to be operational by 2020.
- IRNSS: India's regional navigation system, covering India and northern Indian Ocean: GPS Aided GEO Agumented Navigation (GAGAN).
- QZSS: Japanese regional system covering Asia and Oceania.

Application :

- In – Vehicle Navigation (car, boat, aircraft etc.).
- Weather and Traffic alerts.
- Geologic Research and mining.
- Military Navigation (Intelligence and target locations, Weapon Aiming).
- Mapping and Surveying.
- Precision Agriculture.
- Robotics (Self navigation and autonomous robots).
- Tectonics (motion measurements of earthquakes).
- Recreation (Geocaching, geocaching, way marking and location based mobile games).

Conclusion:

- The applications using GPS are constantly growing.
- More reliable and accurate measurements.
- The cost of the receiver is dropping.
- More affordable and accessible to consumers.

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