*Active PNT in Distributed Architecture using Ephemeral Configuration (aPNT/DAEC)**EC)* *in the Virtual Geo Satellite System*

NASA-PNT Advisory Board
4-5 May 2022

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THE GEO ARC

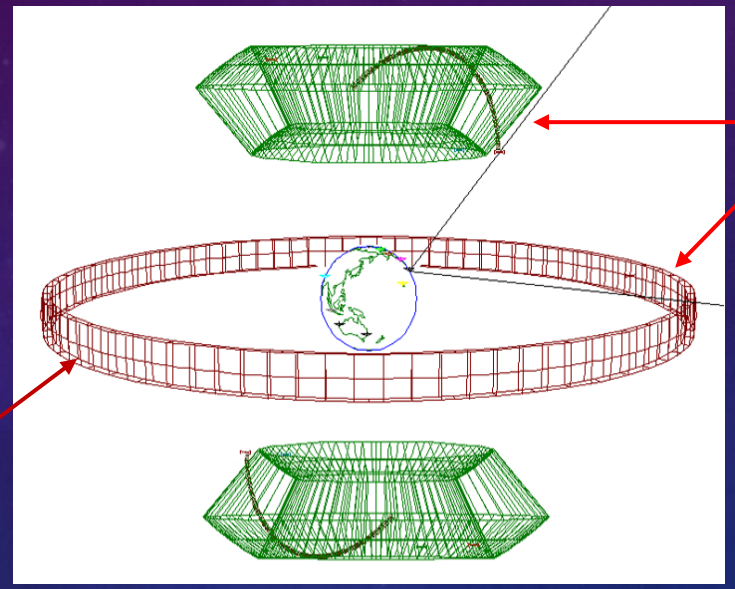
- Extremely Valuable
- Spectrum scarcity and satellite slots saturation limit options

→ US rural broadband is a national priority

→ Several new systems expand into higher bands (Ka)

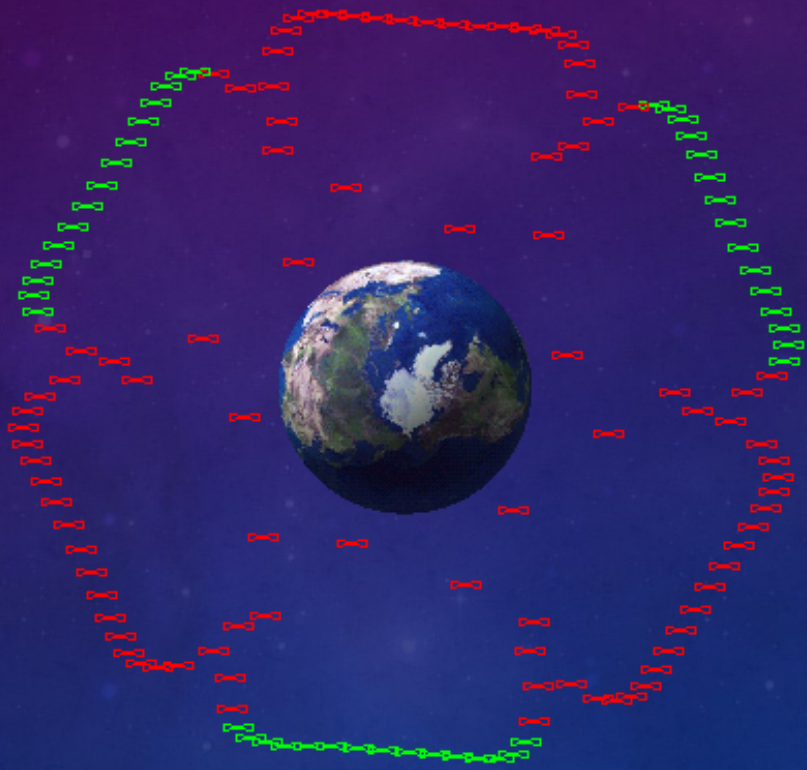
A NEW SPACE FOR BROADBAND

40° of angular separation permits the re-use of all satellite frequencies



- 4,500 MHz in Ku and C bands previously licensed by FCC
- Currently being processed by the US FCC
- Canadian Authorization issued
- Has met all ITU coordination requirements to date

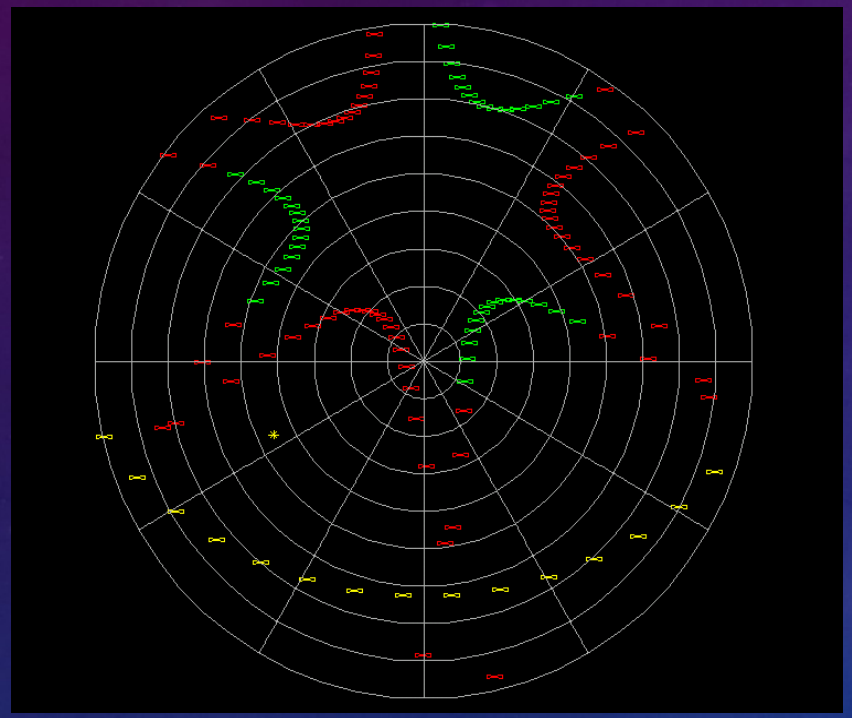
SIMULATION



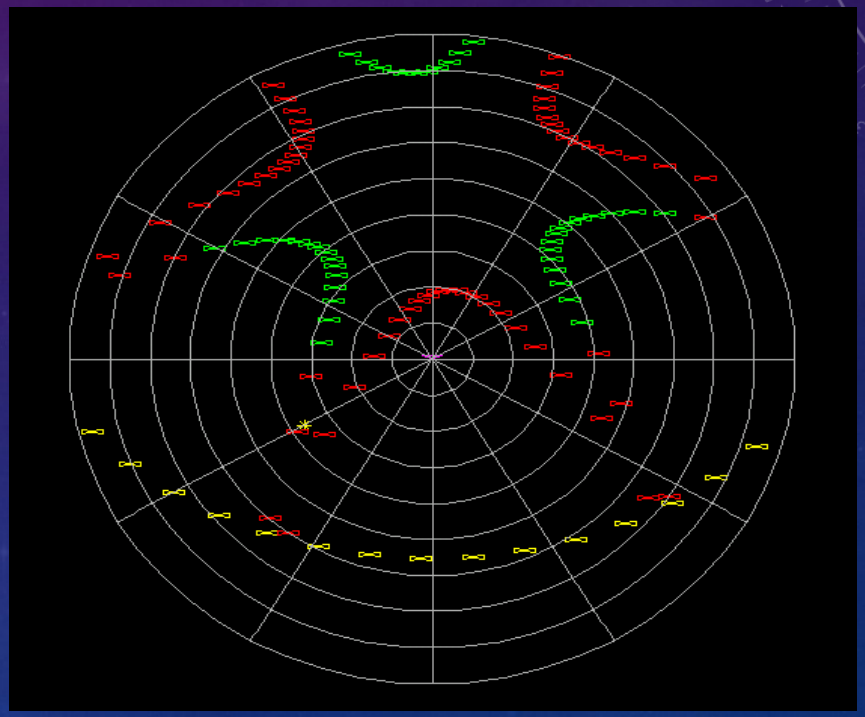
SIMULATION

GLOBAL SINGLE HOP TO THE US

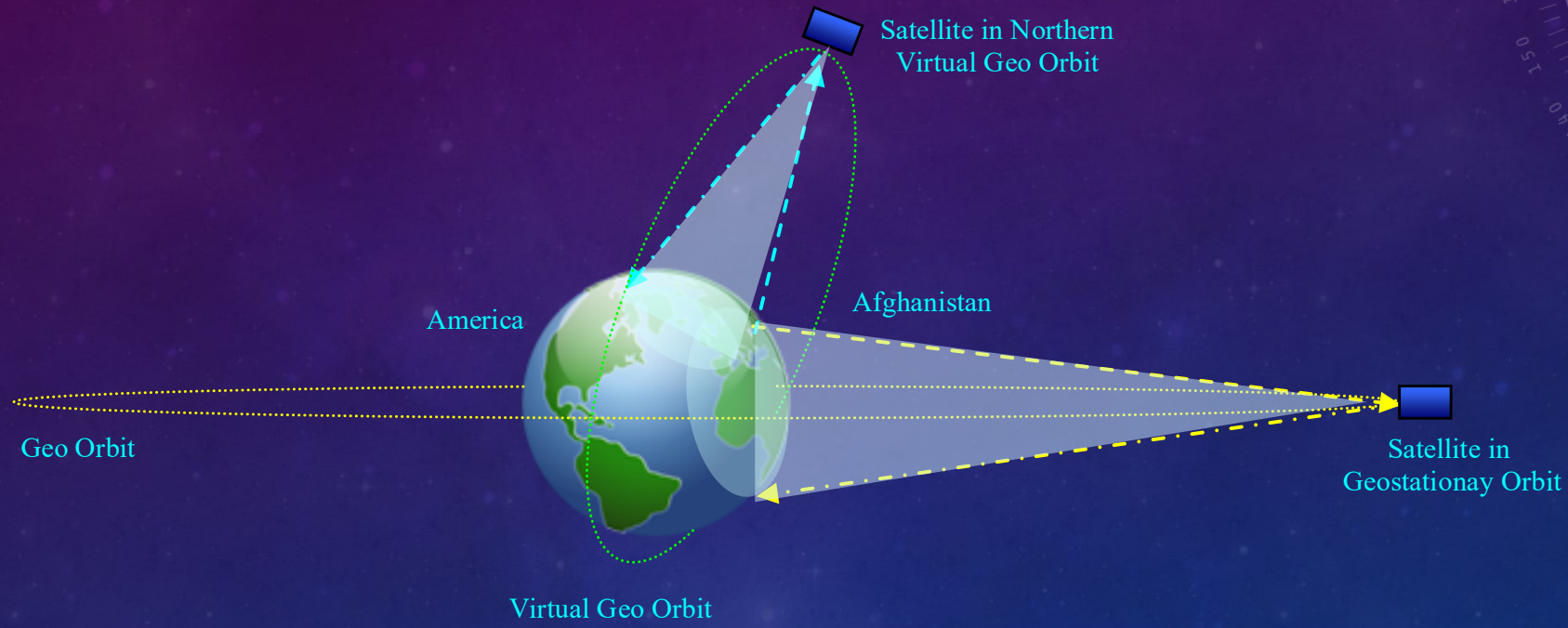
FROM ANCHORAGE, ALASKA



From Springfield, IL



GLOBAL SINGLE HOP



SIMULATION

αPNT (ALPHA PNT)

- Active PNT solution with robustness against any jamming or spoofing
- Flexible to provide position with minimum number of satellites on the horizon
- Provides very accurate geographical position , precise timing and guidance

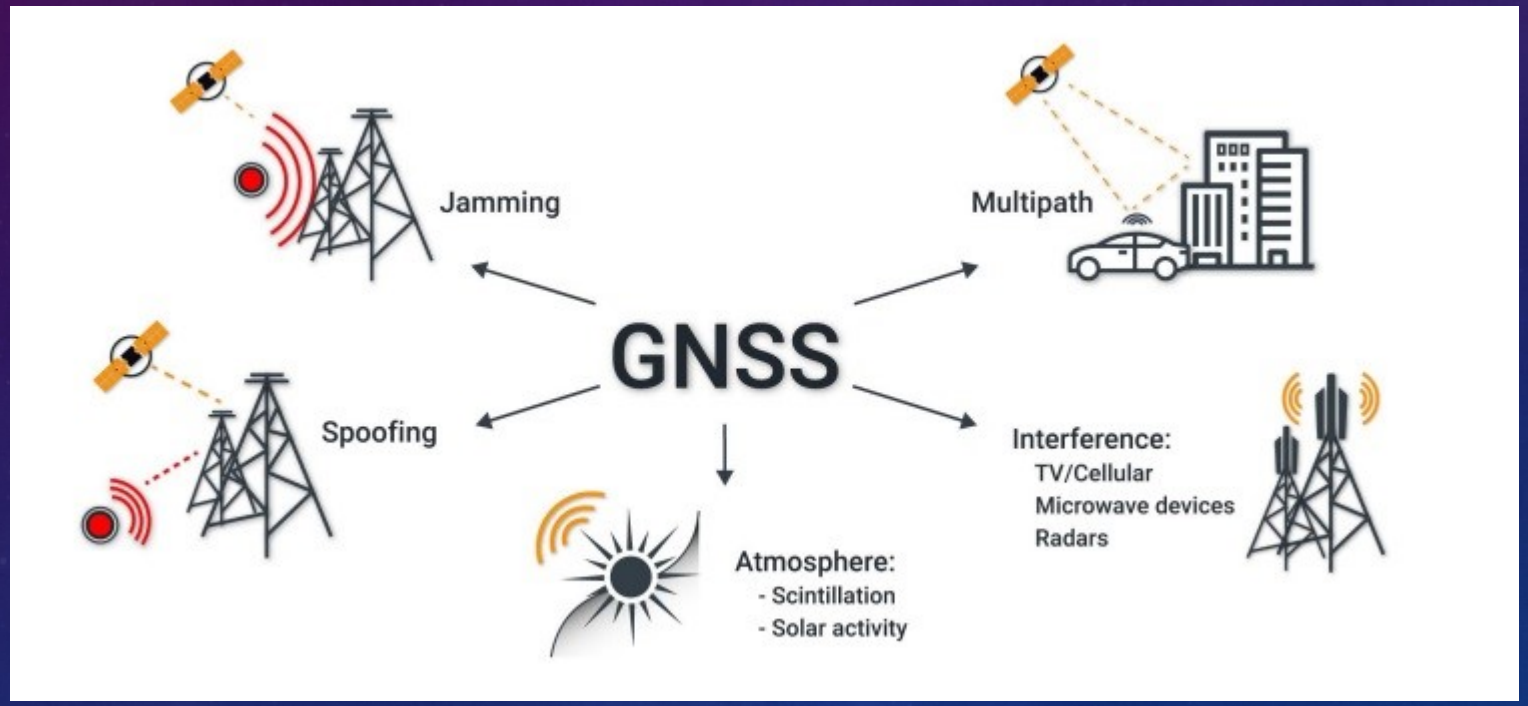
INDUSTRIAL AND GOVERNMENT APPLICATIONS

- **Financial Services** : Based on MiFID II and SEC 613, financial service firms in Europe and the US must comply with the stringent time synchronization requirements. GNSS spoofing attacks can cause a timestamp shift that influences the security and integrity of banking transactions.
- **Airports** : According to ICAO Annex 10 requirements, airports need to implement GNSS monitoring and recording systems to foster a quick response to accuracy inconsistencies and conduct incident investigations.
- **Dangerous Goods Transportation** : Transporting dangerous goods is one of the leading security applications in the transportation sector. GPSPATRON provides real-time detection of intentional GNSS spoofing or jamming attacks.
- **Telecom** : In telecom (3G, 4G, SATCOM, PMR, PSTN), GNSS is utilized for TDMA timing, synchronization of timeslots, and handovers.
- **5G** : Meeting the 5G time synchronization accuracy requirements is the most challenging for the industry. GPSPATRON helps to obtain the mandatory precision from GNSS in challenging interference conditions, and even under spoofing.
- **Marine** : GNSS is applied to diverse marine applications such as navigation, seafloor mapping, underwater exploration, dredging, offshore drilling, and pipeline routing. At the same time, thousands of GNSS spoofing incidents at sea are registered worldwide.
- **Power Stations** : PMU, as the central part of WAMS, requires the exactitude of synchronization to ensure flawless Network Monitoring and Automatic Protection. Time synchronization distortion of PMUs can lead to cascading faults and large-scale power blackouts.

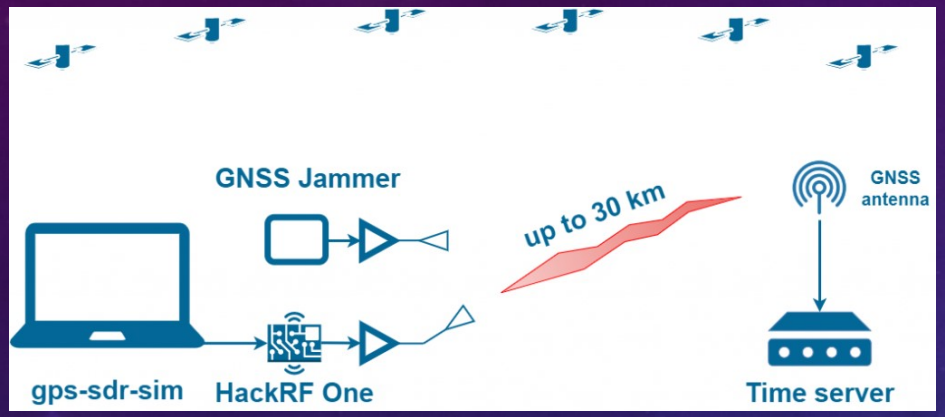
INDUSTRIAL AND GOVERNMENT APPLICATIONS

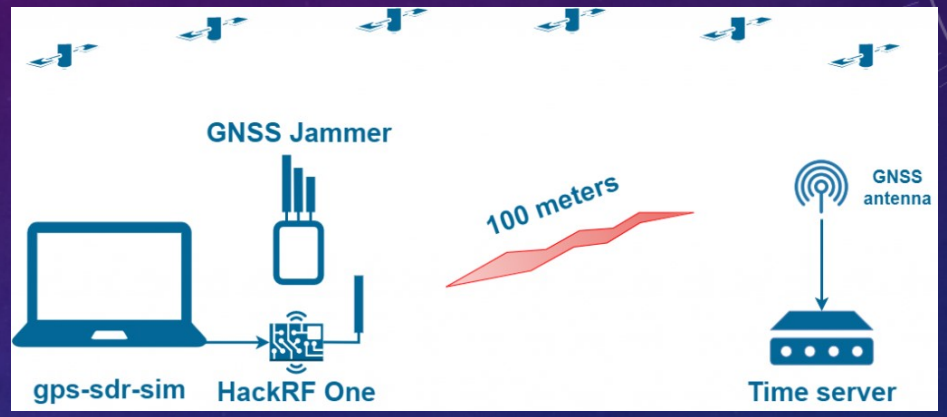
- **Data Centers** : Data centers require sub-millisecond precision timestamping for transactions and distributed data processing, log file accuracy, auditing, and monitoring. GNSS spoofing may cause SSL certificates to fail.
- **Railway**: GNSS is utilized to track trains on low-density line networks. Automatic Train Control Systems use GNSS to determine speed and position. The GNSS should work in all conditions: under a GNSS spoofing/jamming attack, high RF interference.
- **Network RTK** : GNSS RTK network is a critical part of many applications with precise, real-time positioning requirements. Hence, RTK base stations must have reliable GNSS spoofing protection. Spoofing would induce incorrect data, which can be detrimental to thousands of users.
- **Armed Forces** : The armed forces actively use GNSS spoofing during exercises, operations and to protect bases against drones. This activity should be carefully monitored so civilian infrastructures are not impaired.
- **DVB-T/T2** : Digital broadcasting in Single Frequency Networks (SFN) mode like DVB-T/T2, T-DMB, DAB, or DRM requires precise and reliable synchronization. In a case of low accuracy of the PPS phase, the service inevitably fails.
- **Autonomous Vehicles** : The success of autonomous machines requires uncompromised accuracy and reliability of the GNSS. Coordinate or speed manipulations can lead to undesired damages, and even human loses.

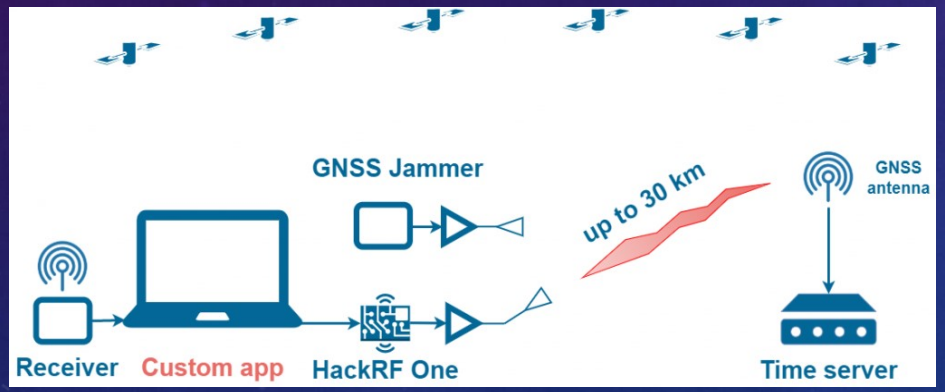
FACTORS THAT IMPAIR GNSS SIGNAL QUALITY

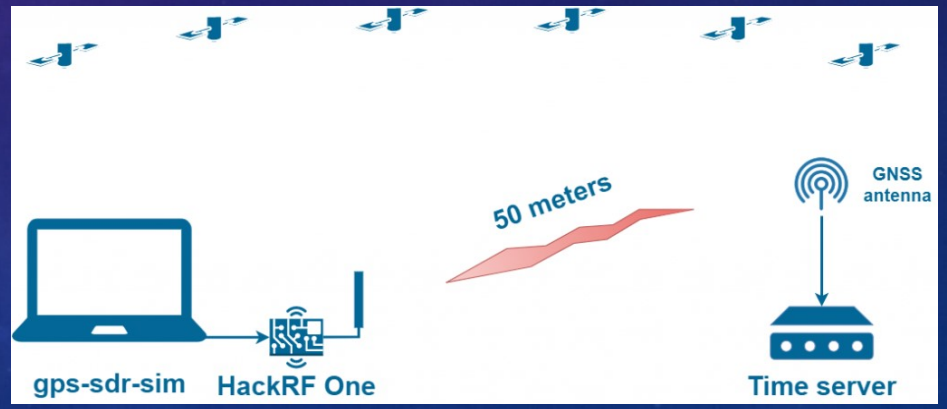


VULNERABILITY OF EXISTING GNSS TO SPOOFING

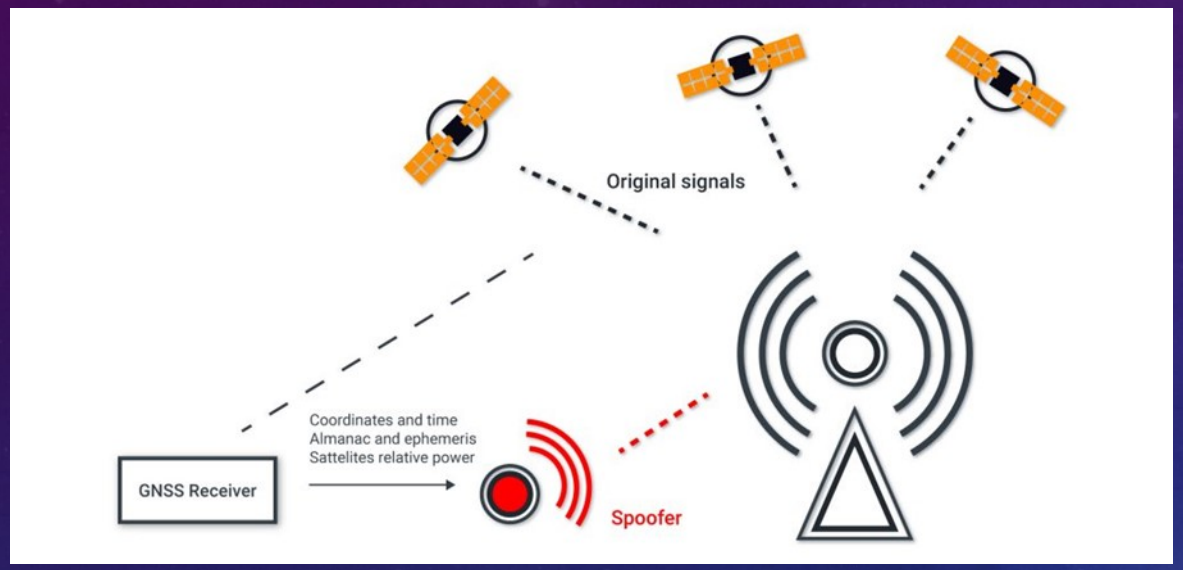


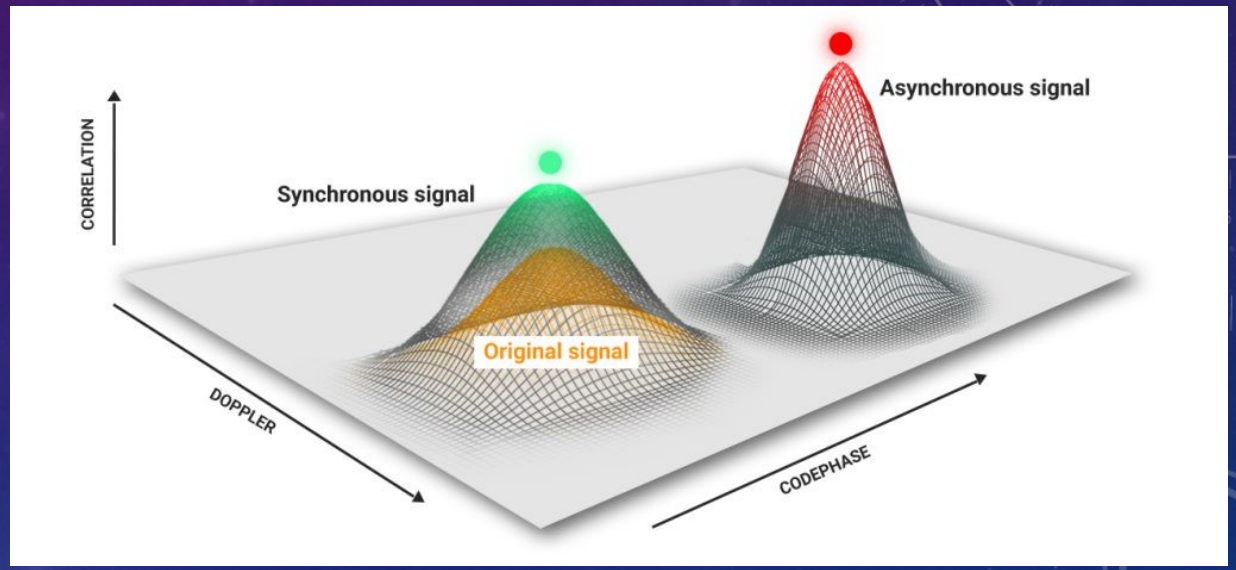




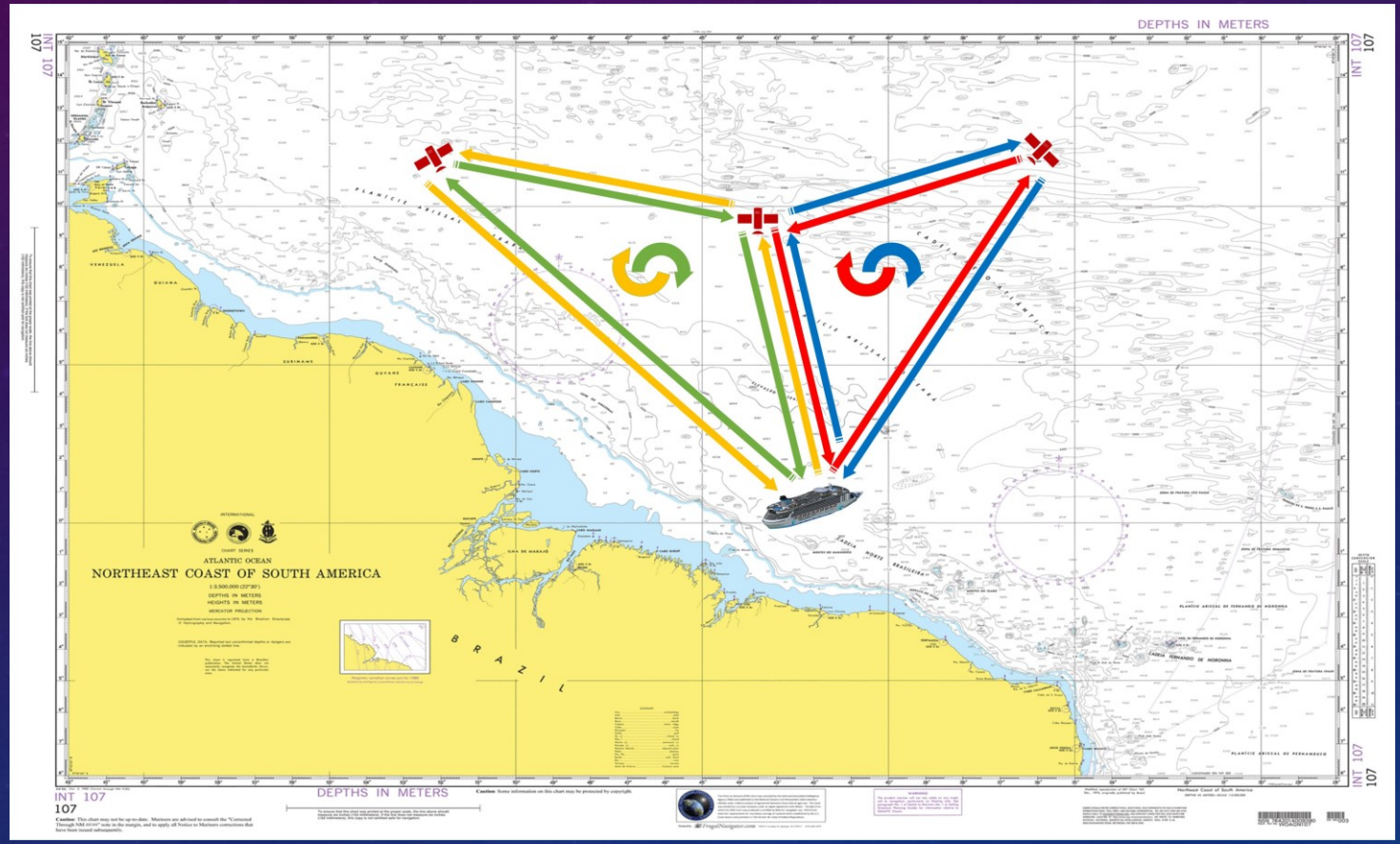


TYPES OF GNSS SPOOFING
ASYNCHRONOUS AND SYNCHRONOUS ATTACKS

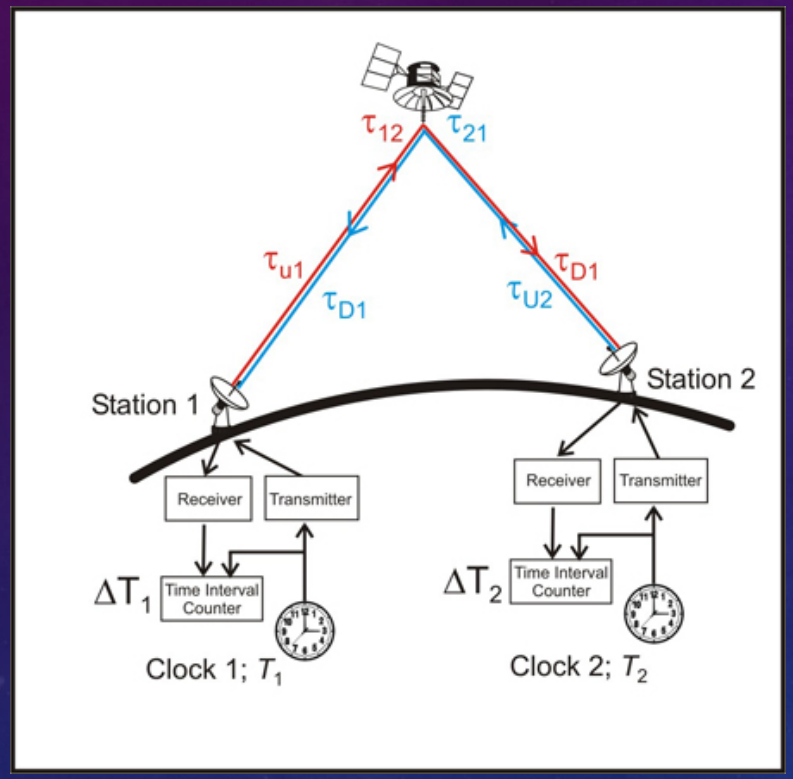


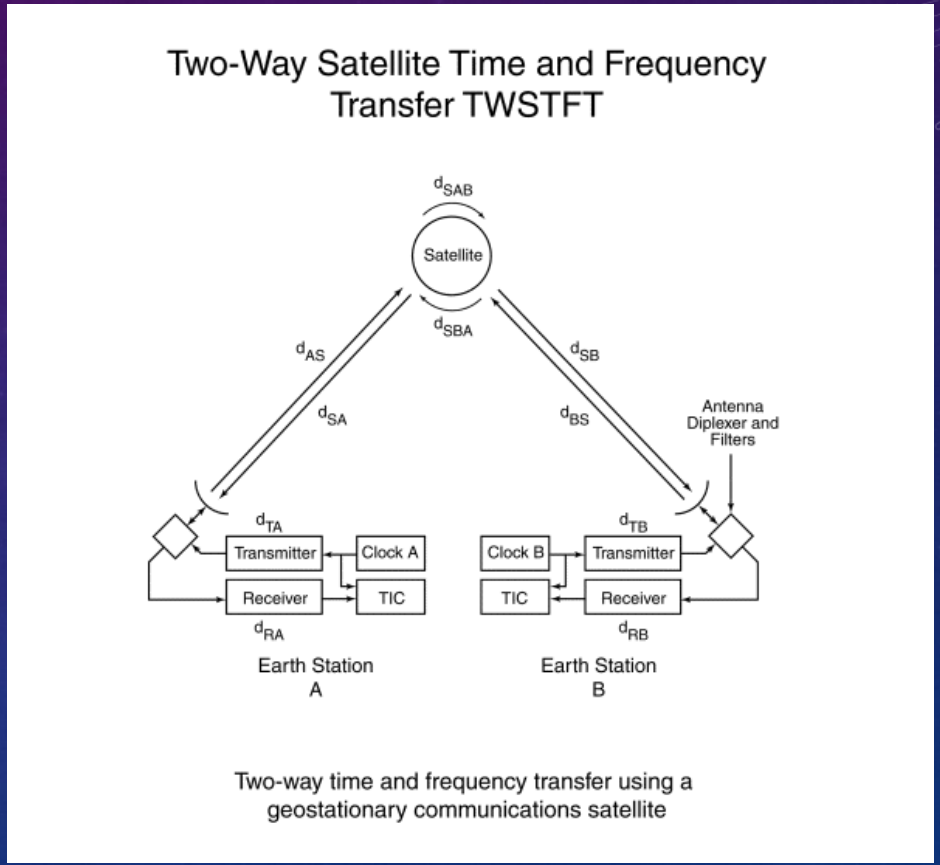


MULTIPLE TWO-WAY LINKS BETWEEN OBJECT AND SATELLITES FOR PRECISE POINT POSITIONING

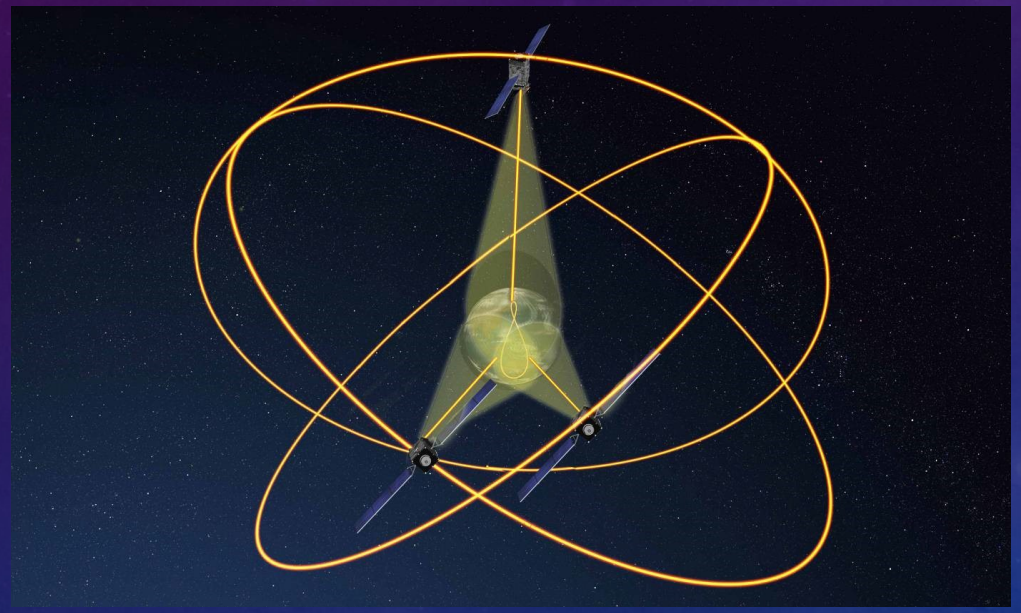


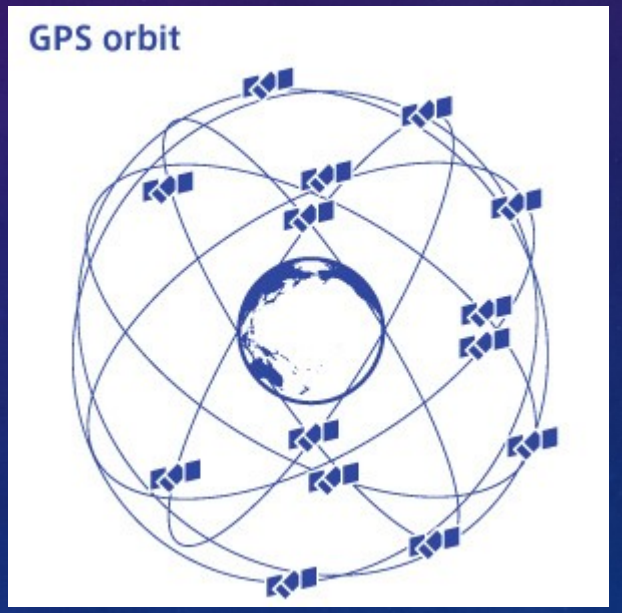
TWO-WAY SATELLITE TIME AND FREQUENCY TRANSFER(TWSTFT)



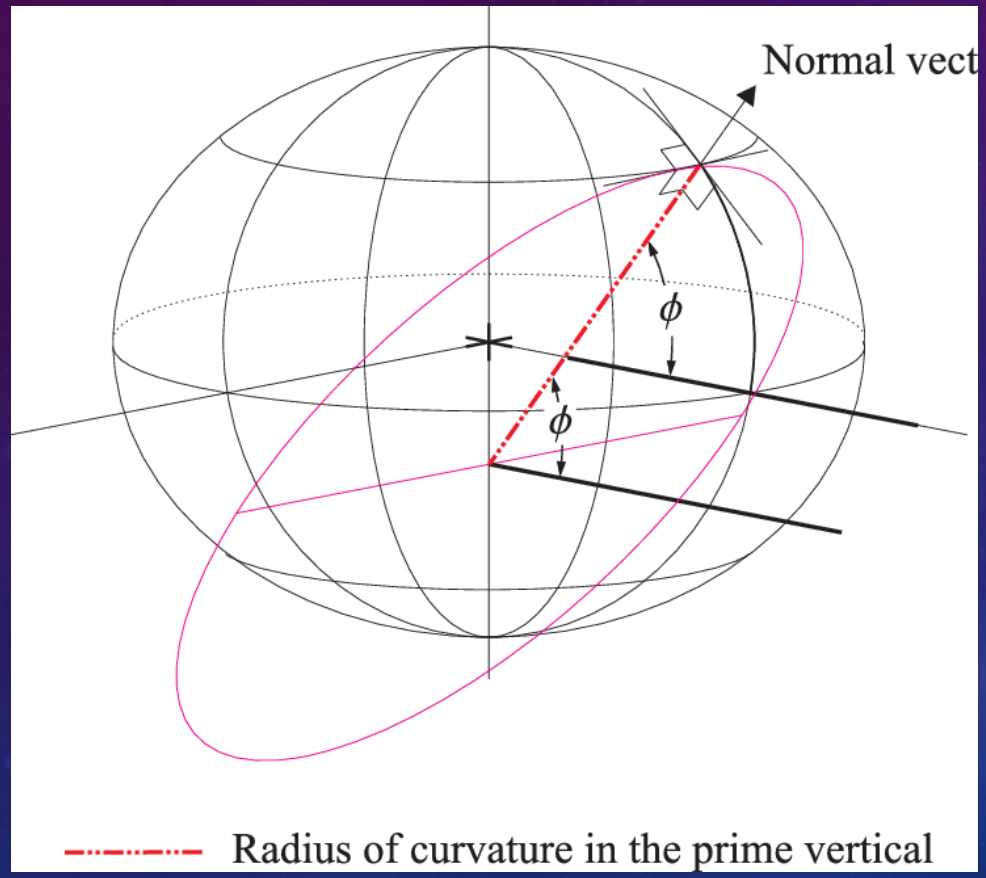


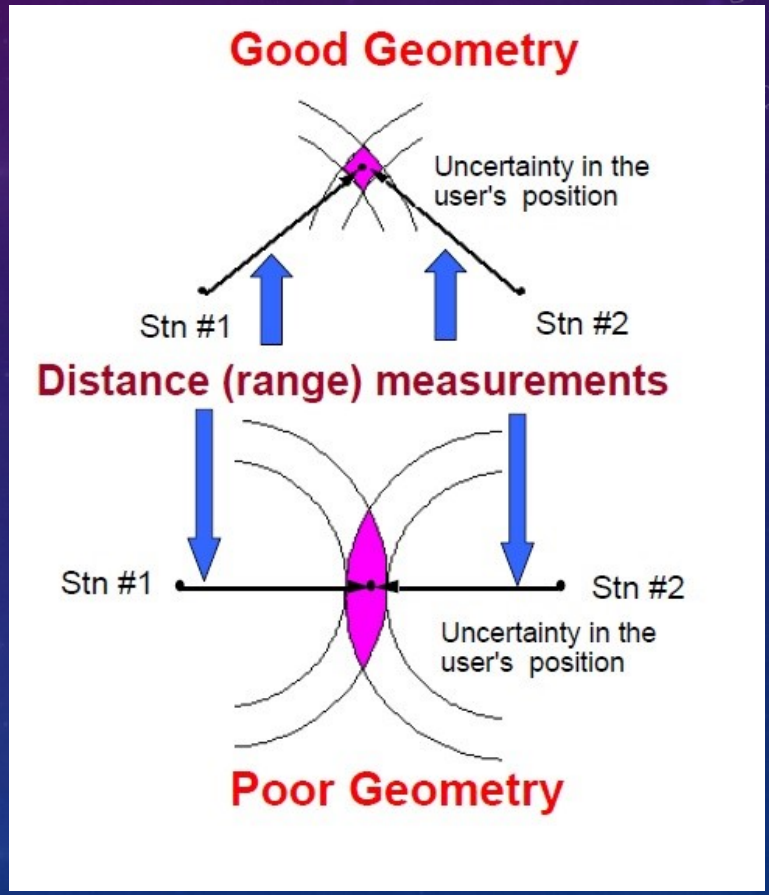
ELLIPTICAL INCLINED ORBIT VS EXISTING CIRCULAR GPS ORBIT



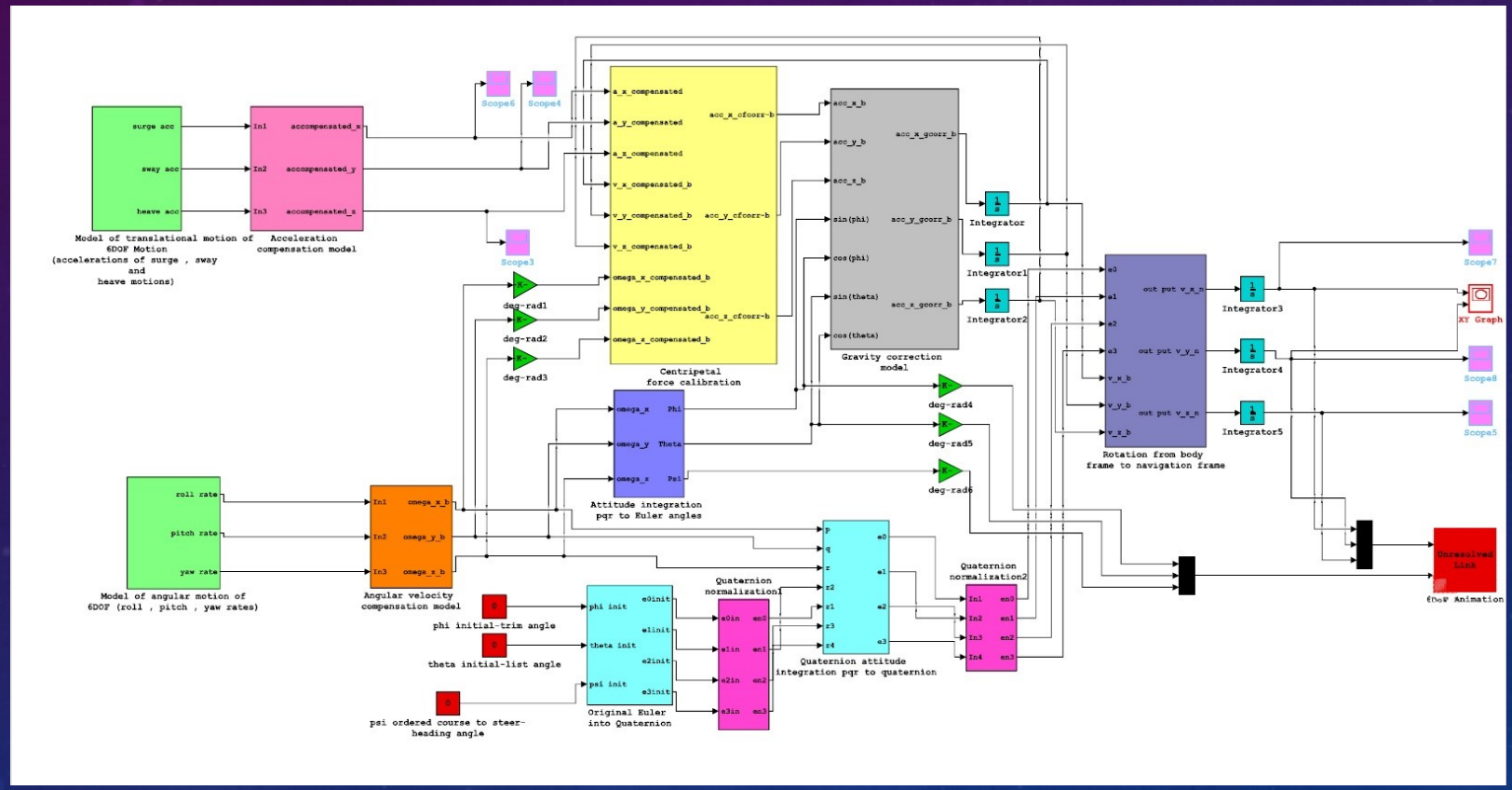


MATHEMATICAL NAVIGATION ANALYSIS

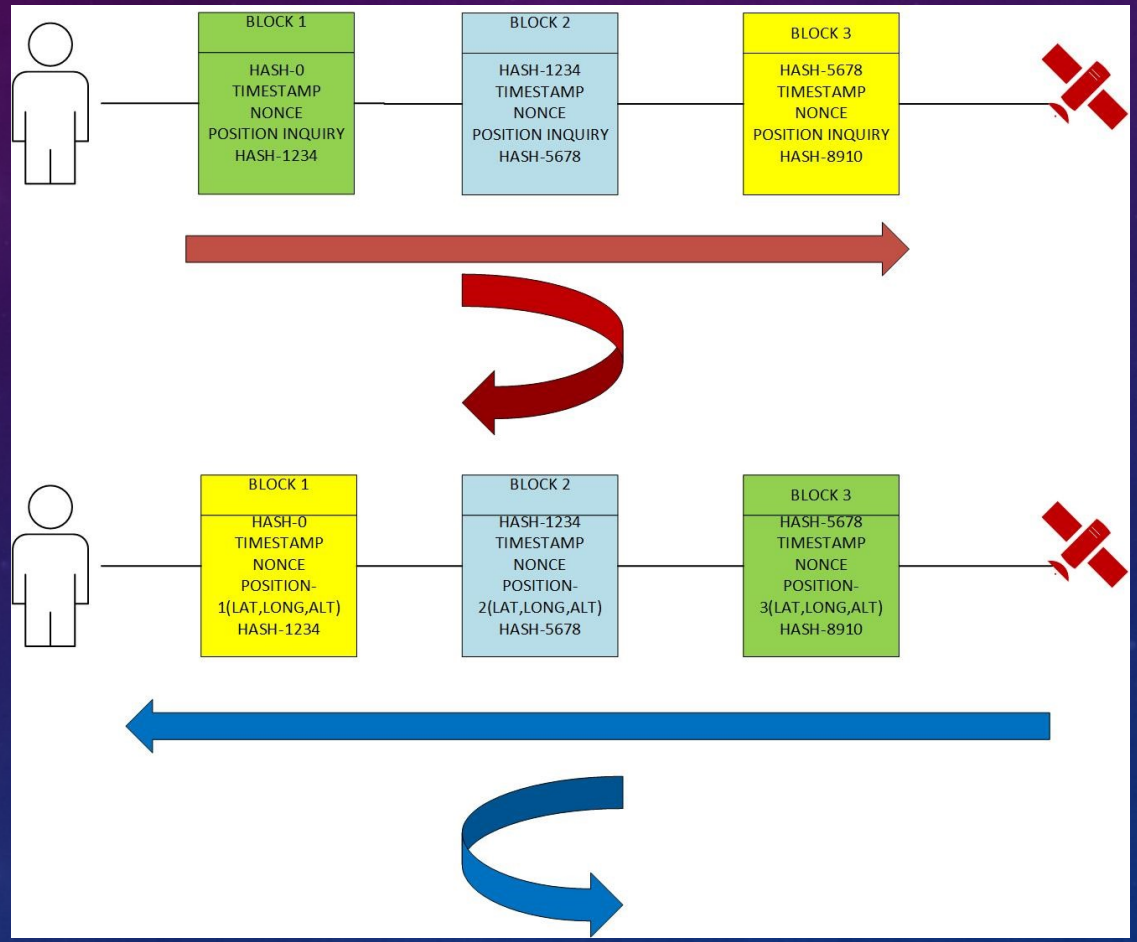




NAVIGATIONAL DYNAMIC ANALYSIS FOR PRECISE POINT POSITIONING



$\beta BLOCKCHAIN$(BETA BLOCKCHAIN)



$\beta BLOCKCHAIN$(BETA BLOCKCHAIN) MAIN FEATURES

- Exclusively integrated with αPNT system
- High scalability with virtual channels created by αPNT satellite constellation
- Very robust and secure with timing and positioning algorithm provided by αPNT system
- αPNT will provide synchronicity for all participating nodes in $\beta BLOCKCHAIN$ system
- $\beta BLOCKCHAIN$ is fully decentralized and integration with synchronized αPNT system it will have high TPS (Transaction Per Second)