PROBLEM STATEMENT : LEO Satellite Network Topology & Latency Optimization
TEAM NAME : NETWORK CARE
TEAM MEMBERS : Priyanka M
Siddharth K
DR. Electa Alice Jayarani

Problem Description

Low Earth Orbit (LEO) satellite constellations are highly dynamic — their fast orbital motion constantly changes link availability between satellites and ground stations. This creates routing instability, congestion, and unpredictable latency in communication networks. Understanding and modeling these topological changes accurately is essential before implementing optimization techniques.

Solution Proposed

The team developed a **satellite tracking and topology modeling system** that predicts satellite positions using **SGP4 propagation** and constructs a dynamic connectivity graph between satellites and ground stations. This allows real-time visualization of available inter-satellite links (ISLs) and communication paths. The model serves as the foundation for future AI-based routing and latency optimization.

Optimization Proposed by the Team

1. **Efficient Orbit Prediction:** Reduced computational overhead by updating positions only every 5–10 seconds using interpolation between SGP4 epochs.
2. **Link Feasibility Filtering:** Only feasible ISLs (within antenna beam limits and distance thresholds) are modeled, reducing unnecessary computation.
3. **Modular Framework:** Designed the code to integrate easily with the upcoming AI routing and AMC modules.

Solution Architecture and Design

Architecture Flow:

Input: TLE Data

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SGP4 Orbit Propagation

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Position & Velocity Estimation

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Connectivity Graph Construction

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Feasible ISL Identification

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Dynamic Topology Output

Timeline of Delivery

Task
Collect and parse TLE data for chosen LEO constellation
Implement SGP4 orbit prediction in Python
Build dynamic graph structure for satellites + ISLs
Visualize satellite network topology (Matplotlib / NetworkX)

References

1. Orekit & Python-SGP4 Libraries (Satellite Orbit Propagation)
2. Starlink Constellation TLE Data – Celestrak.org
3. IRTF MAPRG 2025 – *A Deep Dive into LEO Satellite Topology Design Parameters*