ENHANCING GLOBAL CONNECTIVITY

Measuring Satellite Internet Latency to Support Sustainable Development Goal 9

Project Proposal: Satellite Internet Latency Measurement for SDG 9

Submitted by:

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Introduction

Satellite Internet plays a crucial role in extending connectivity to remote and underserved areas, supporting Sustainable Development Goal 9 (SDG 9) by promoting resilient infrastructure, innovation, and inclusive industrialization. Despite its broad coverage, satellite Internet traditionally suffers from high latency due to the distances signals travel, impacting user experience and limiting its application. This project aims to measure, analyze, and optimize latency in satellite Internet networks to enhance connectivity quality and support SDG 9 objectives.

Objectives

- **Measure end-to-end latency** of satellite Internet using various satellite constellations: GEO (Geostationary Earth Orbit), MEO (Medium Earth Orbit), and LEO (Low Earth Orbit).
- **Analyze factors influencing latency:** satellite type, geographic location, weather conditions, and network load.
- **Develop predictive models** for real-time latency estimation.
- **Propose optimizations** for latency reduction to enhance service quality.

Methodology

Latency Measurement Techniques

Latency will be measured using tools such as **ping** and **traceroute** for basic round-trip time evaluation. Advanced frameworks designed for IP network latency measurement will be employed for comprehensive analysis at scale. Measurements will be taken across different satellite services, including Starlink (LEO) and traditional GEO/MEO providers, to compare performance.

Data Collection

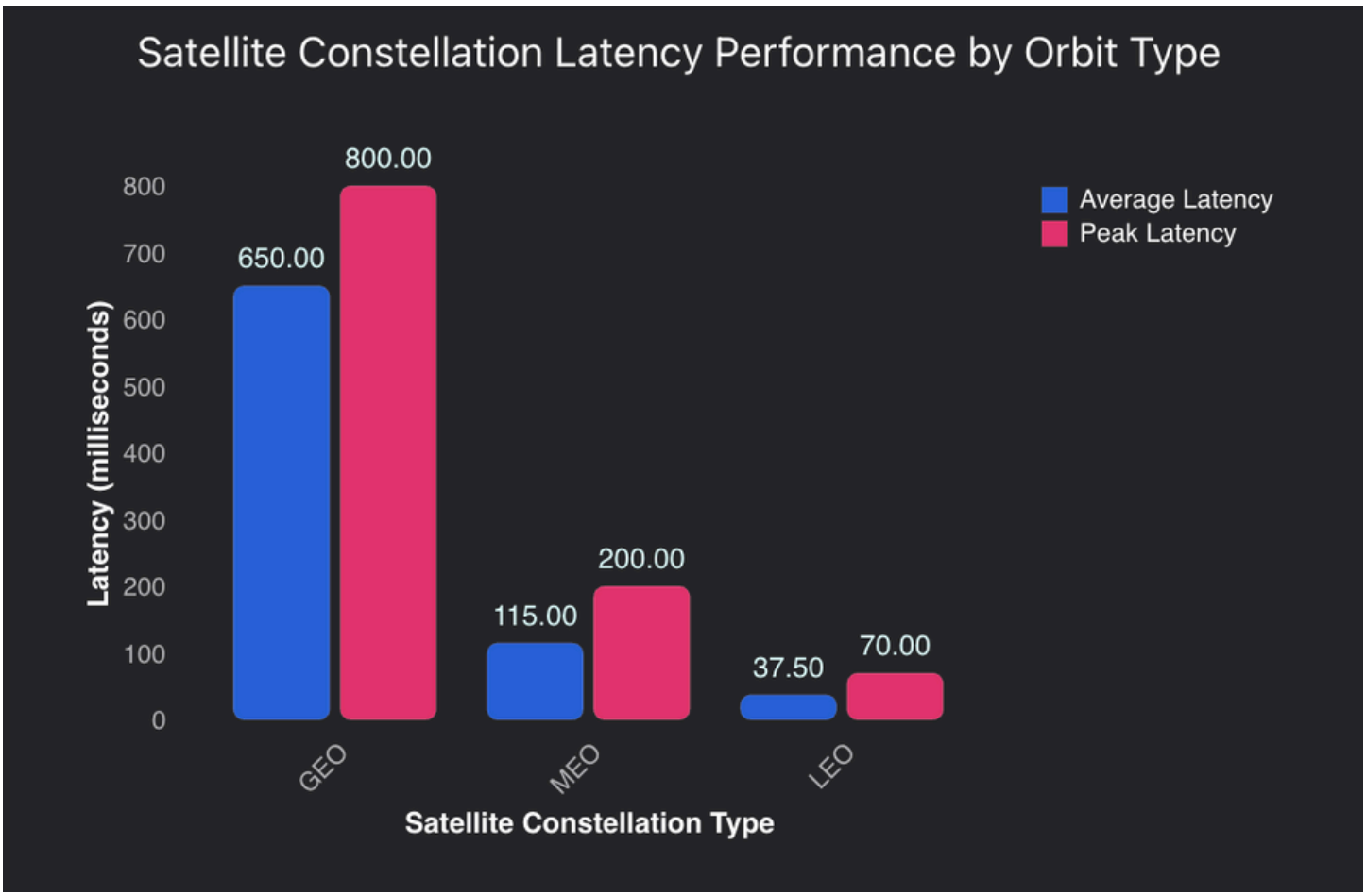
Data will be collected from multiple global regions — both urban and rural — under diverse weather conditions. Parameters include:

- **Satellite type** (GEO, MEO, LEO)
- **Physical distance** from ground stations
- **Time of day** and network congestion
- **Weather effects** (rain, clouds)

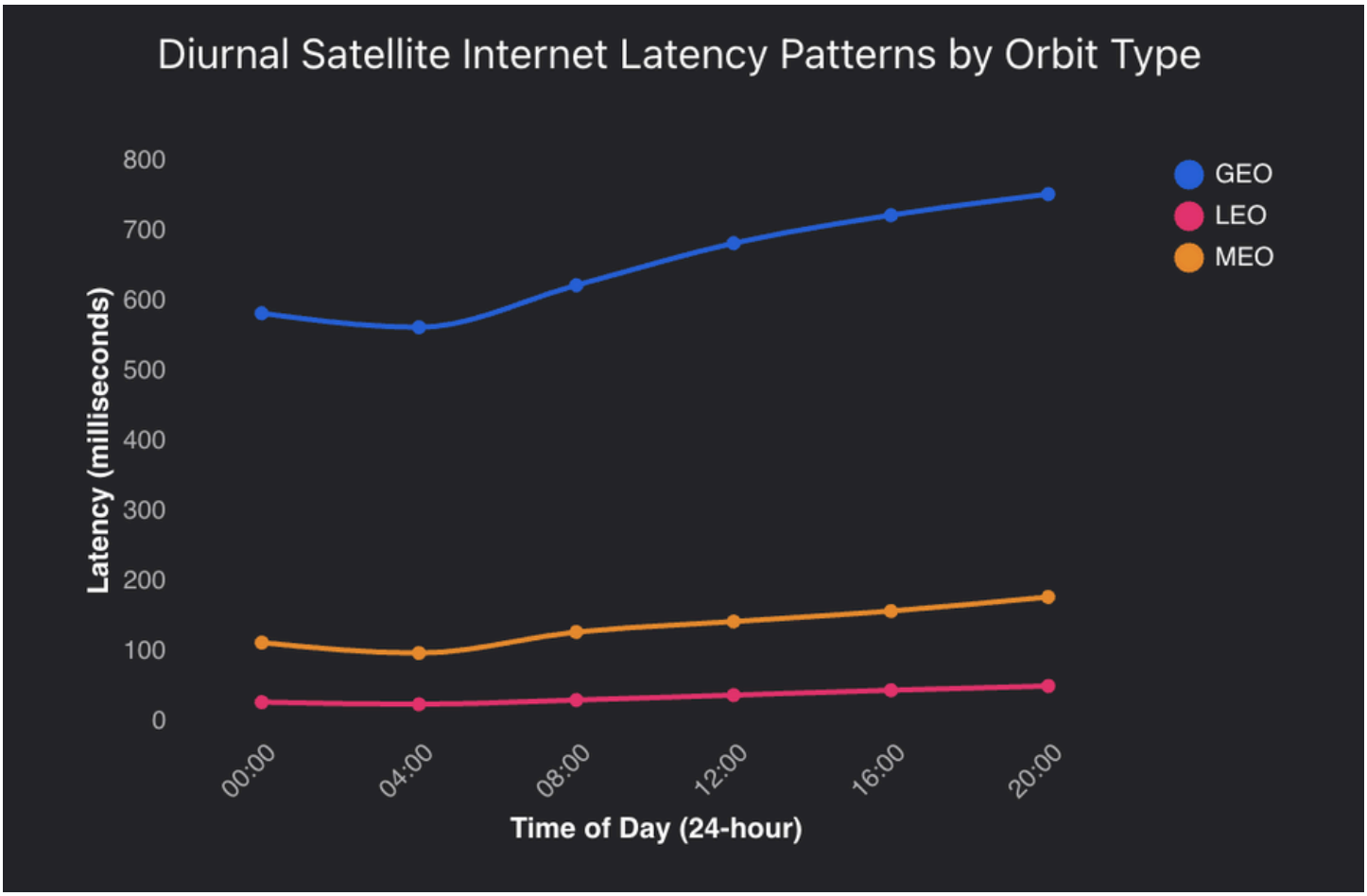
Data Analysis and Visualization

Collected latency data will be analyzed to identify patterns and correlations. Visual presentations will include:

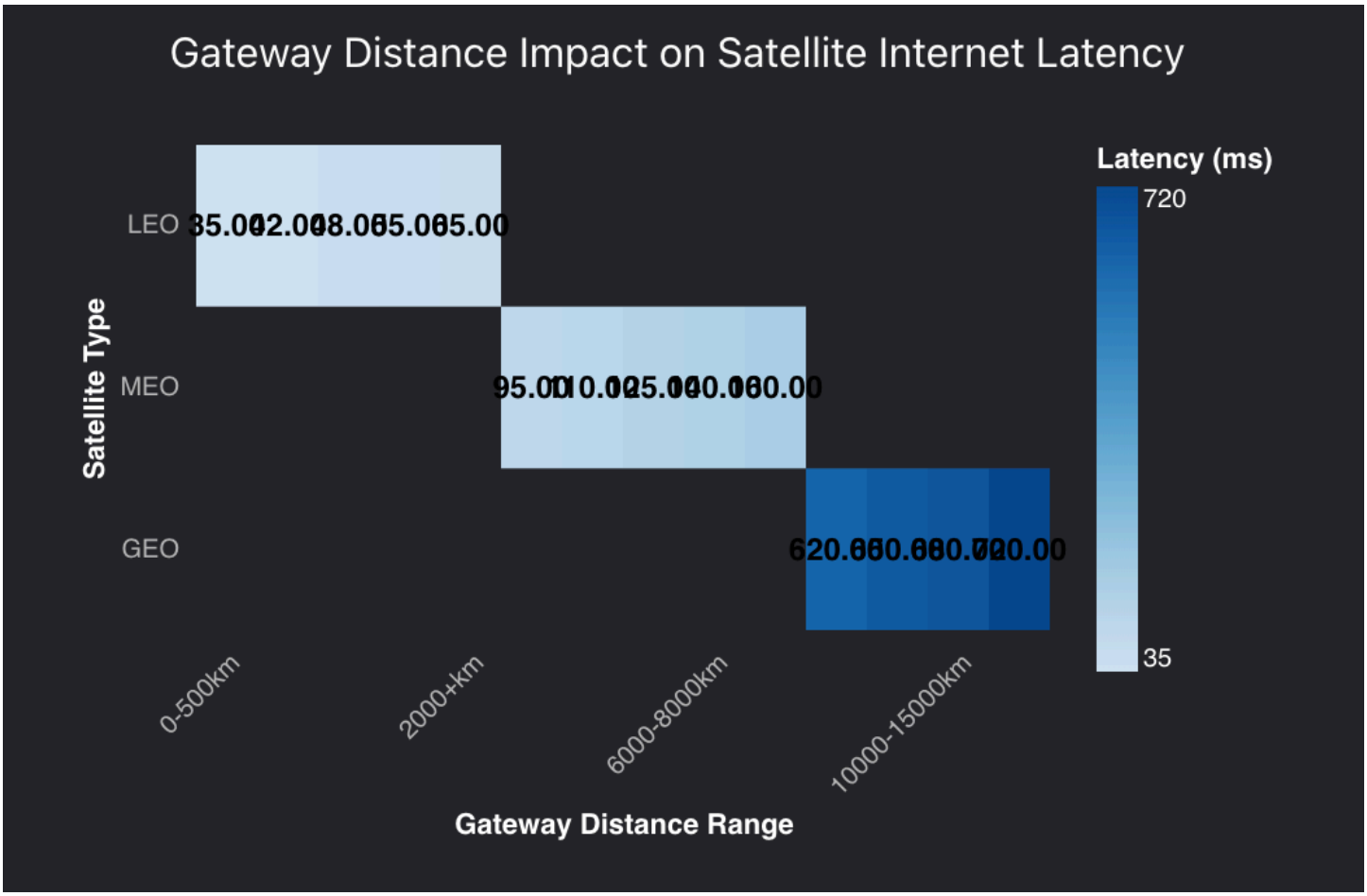
- **Bar charts** comparing average latency per satellite type

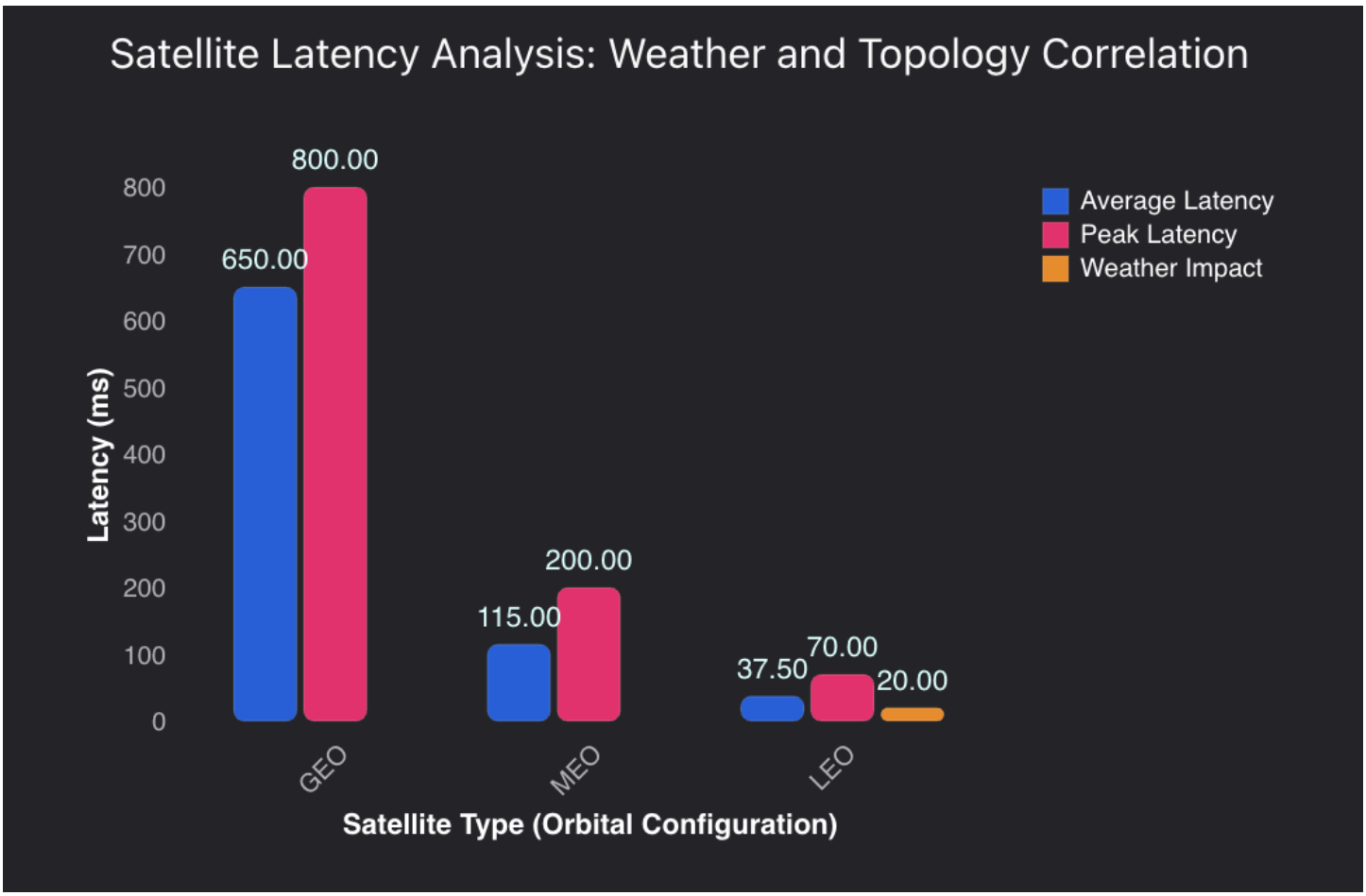


- **Line graphs** illustrating latency fluctuations over time

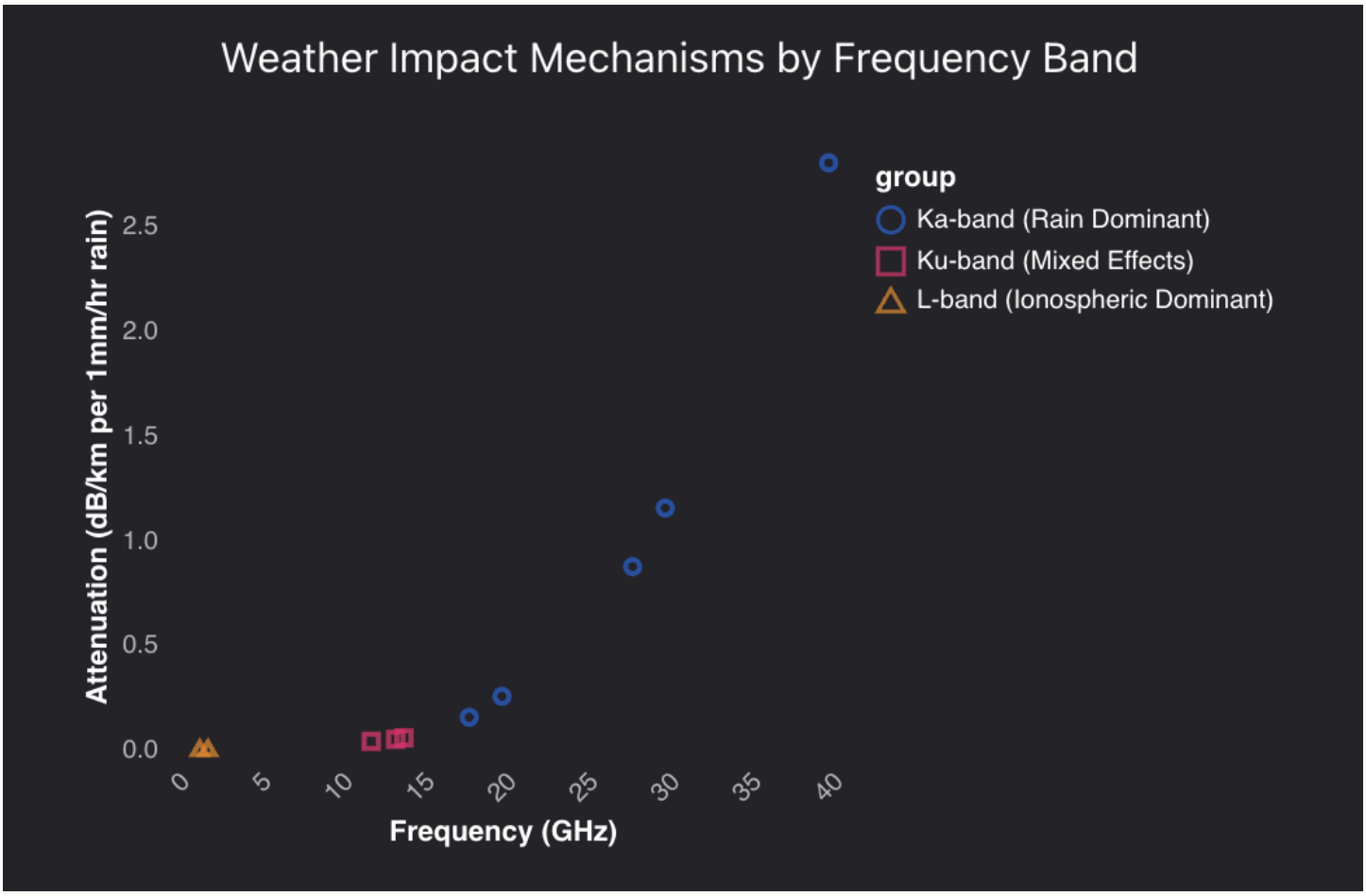


- **Heat maps** showing geographic latency variability


Gateway Distance Impact on Satellite Internet Latency
Latency (ms)
720
35
Satellite Type
LEO
MEO
GEO
0-500km
2000+km
6000-8000km
10000-15000km
Gateway Distance Range


Satellite Latency Analysis: Weather and Topology Correlation
Average Latency
Peak Latency
Weather Impact
Latency (ms)
800
700
600
500
400
300
200
100
0
650.00
800.00
115.00
200.00
37.50
70.00
20.00
GEO
MEO
LEO
Satellite Type (Orbital Configuration)

- **Scatter plots** correlating weather and latency spikes



Sample Latency Ranges Expected for Different Satellite Orbits:

Satellite Type	Average Latency (ms)	Peak Latency (ms)	Weather Impact (ms)
GEO	600-700	800+	+150
MEO	80-150	200+	+50
LEO	30-45	70+	+20

Expected Outcomes

- Verification that **LEO satellites provide significantly lower latency** (~30-45 ms) than GEO satellites (~600+ ms).
- Identification of key environmental and network factors affecting satellite latency.
- Recommendations for **network design and routing improvements** to optimize latency.

- Contribution to SDG 9 by promoting the deployment of innovative satellite infrastructure that delivers low-latency Internet access globally.

Project Significance

This study will provide valuable insights into the real-world performance of satellite Internet, assisting stakeholders in infrastructure development and innovation. By improving latency understanding and prediction, the project supports the expansion of high-quality digital connectivity, vital for economic growth, industrial development, and social inclusion in alignment with SDG 9.

Conclusion

This project integrates rigorous data measurement, advanced analytics, and innovative prediction modeling to tackle the persistent challenge of satellite Internet latency. By focusing on optimization within the satellite communication ecosystem, the project not only advances scientific understanding but also supports the global agenda for equitable digital infrastructure as envisioned in SDG 9.