Constellation Studies for LEO-PNT

(Preliminary Studies)

Babu R , Nirmala S, Sivaraj S

Indian Space Research Organisation

Towards LEO-PNT Realisation

The main goal is to find the viable instruments and techniques to be used, possible gains in comparison to classic GNSS, and the overall capability of LEO-PNT systems depending on distinct positioning approaches

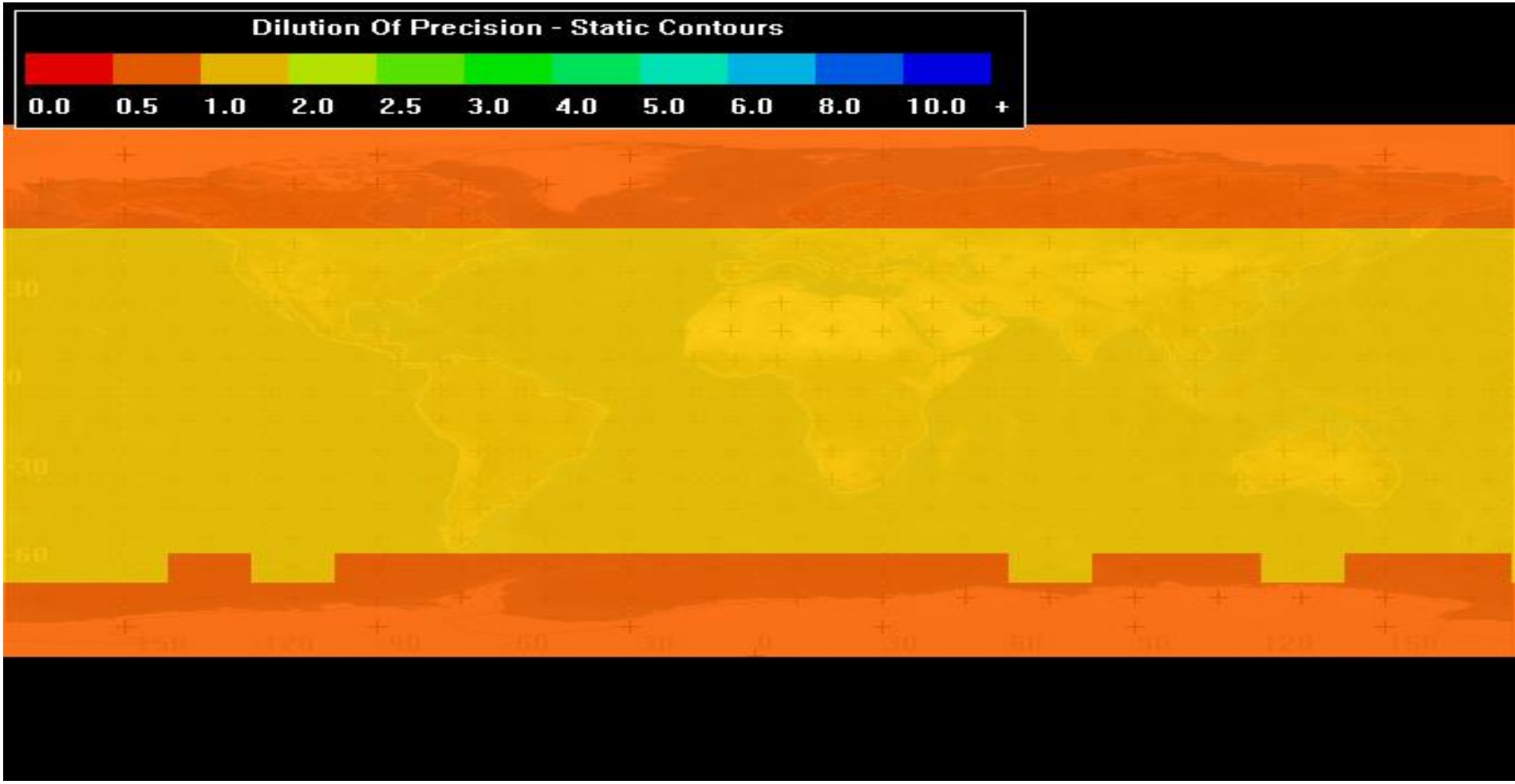
❑ Our studies is being focused on the following topics

- LEO-based positioning systems, methods, and algorithms;
- Various signal design considerations
- Overviewing the parameters of existing and planned LEO constellations
- State-of-the-art positioning algorithms that can be tailored for LEO-PNT systems
- Most suitable receiver architecture to be evolved

Features with LEO-PNT

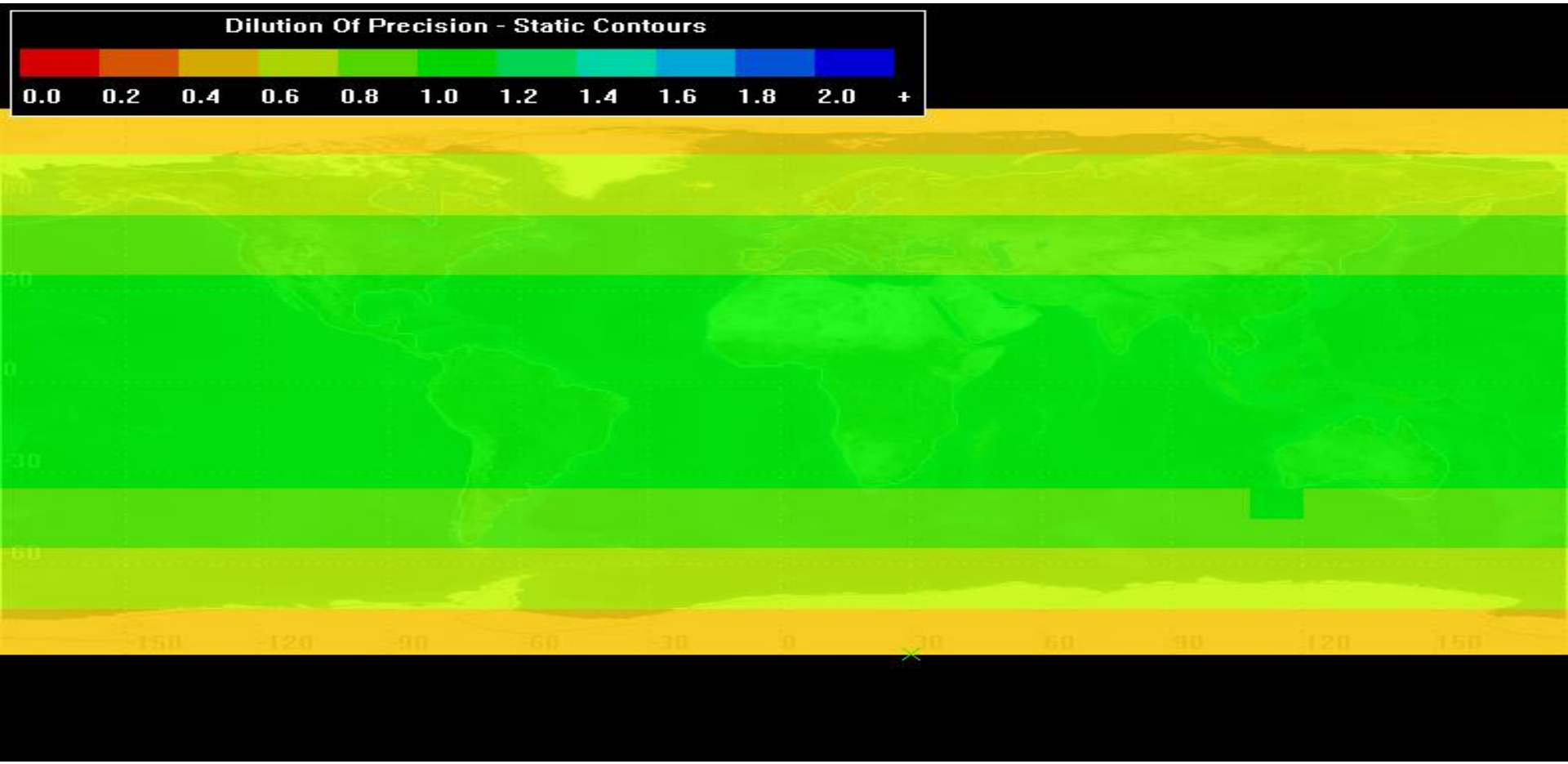
- Minimal Cost & faster deployments
- With more number of satellites , high diversity of geometry
- Low latency & lower altitude reduces space losses
- Strong reduction of static, persistent multipath occurrence
- Accelerate carrier ambiguity resolution
- Higher Robustness against Jammer & Indoor Positioning
- Capability to better fit to rapid changing needs
- Low Energy Positioning (continuous or intermittent Ex: Indoor/ Submarines)

Preliminary DOP Analysis



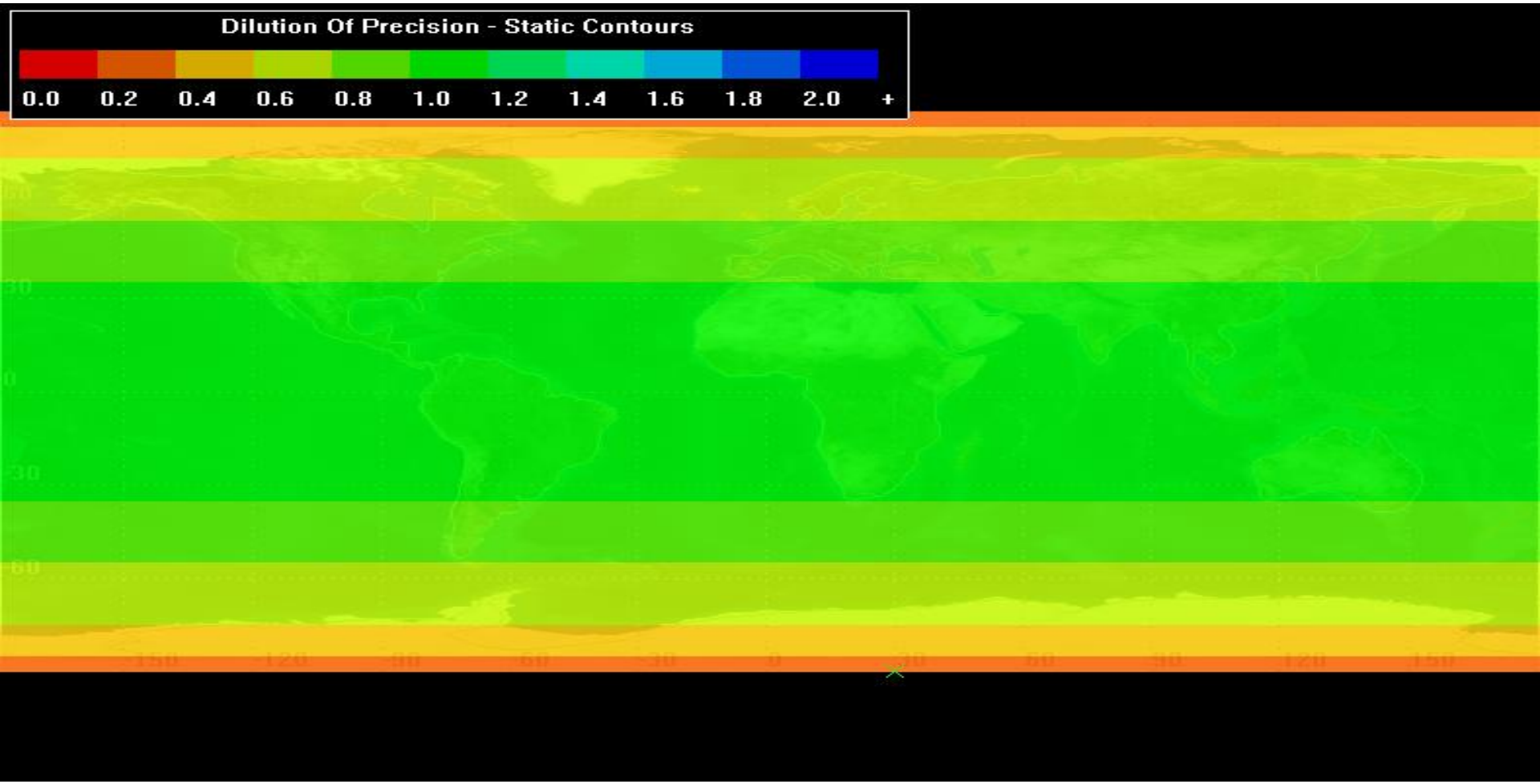
360/18/1; 1200Km , 89°

Preliminary DOP Analysis … Contd



600/30/1; 1200 Km , 89° (95%)

Preliminary DOP Analysis … Contd



1200/60/1; 700Km , 89° (95%)

System Architectures

- Study on three Main Architectures is being looked upon

1. NaVIC/Multi-GNSS Backbone

- "Ideally" no Monitoring Ground Segment: Orbit Determination, Time Synchronization (ODTS), and Nav. Message Generation on-board.
- Prone for "hosted-payload", with minimal footprint on hosting payload, platform

2. Terrestrial Backbone

- Dense Network of Monitoring Stations
- Orbit Determination and Time Synchronization on-ground
- Up-Link Stations in polar regions (~1h revisit time)

3. ISL-Backbone

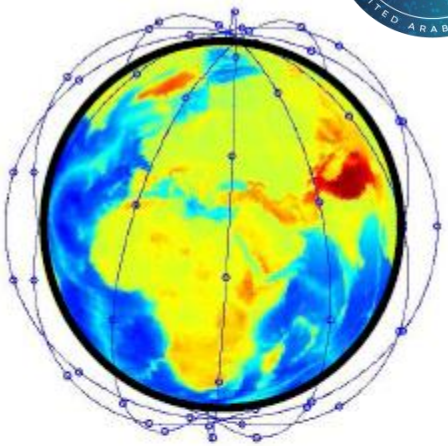
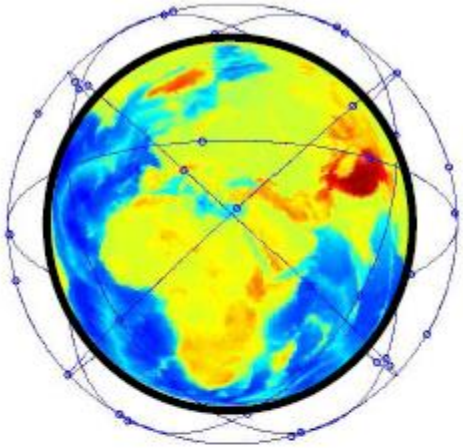
- Reduced Network of Monitoring Stations
- ODTS on ground or on-board (optional)
- ISL too invasive on "hosting platform" may ask for dedicated Constellation
- Enhanced connectivity prone for "Two way Range "

Possible User Positioning Techniques

- With Conventional “Instantaneous” Range-based positioning and timing **(Constant HDOP ~ 0.25-0.35 is achievable, 2-5 times better than MEO-GNSS)**
- With Doppler Based Positioning **(H-DDOP ~100-300) Vs (MEO-GNSS H-DDOP: ~20000)**
- Two way range positioning between user & LEO satellites (**Two-Way positioning offers higher performances than One-Way Positioning, as long as ranging accuracy of Up-Link is not lower than √10 ranging accuracy of Down-Link)**

Summary

- All LEO-PNT related studies and features are being exploited , various plans , pros and cons were being debated to develop a system that provides PNT capabilities

Thank You!