Satellite based IoT networks through LEO constellations

Objectives

- To develop satellite-based architectures which suits IoT applications and can harvest the benefits of mega LEO constellations.
- Develop algorithms for random access, resource allocation and beam-hopping in satellite-based IoT networks.

Why satellite for IoT

By end of 2020, 4G will cover (5G similar): 63% of the world population, but only 37% of the landmass. The LEO constellations like *Starlink*, *OneWeb*, *Iridium*, *Telesat* etc. have started a new era of affordable satellite communication.

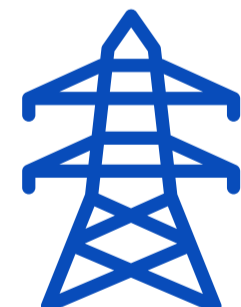**Reachability**   **Resilience**   **Reliability**

Use cases

Satellite-based networks can be used to provide connectivity for eMTC (large scale IoT deployments at remote locations) and eMBB use-case scenarios of 5G.

Pollution Monitoring   **Smart Grid**   **e-Agriculture**   **Communication on-the-move**   **Rural Broadband**

Challenges

Use of satellites for IoT applications has following challenges:

- Topology: Direct-access and indirect access schemes
- Doppler characterization in LEO: Frequency estimation and doppler-based random access
- MAC protocols: Random access in large networks
- Large number of satellites: Optimum resource allocation, on-board processing
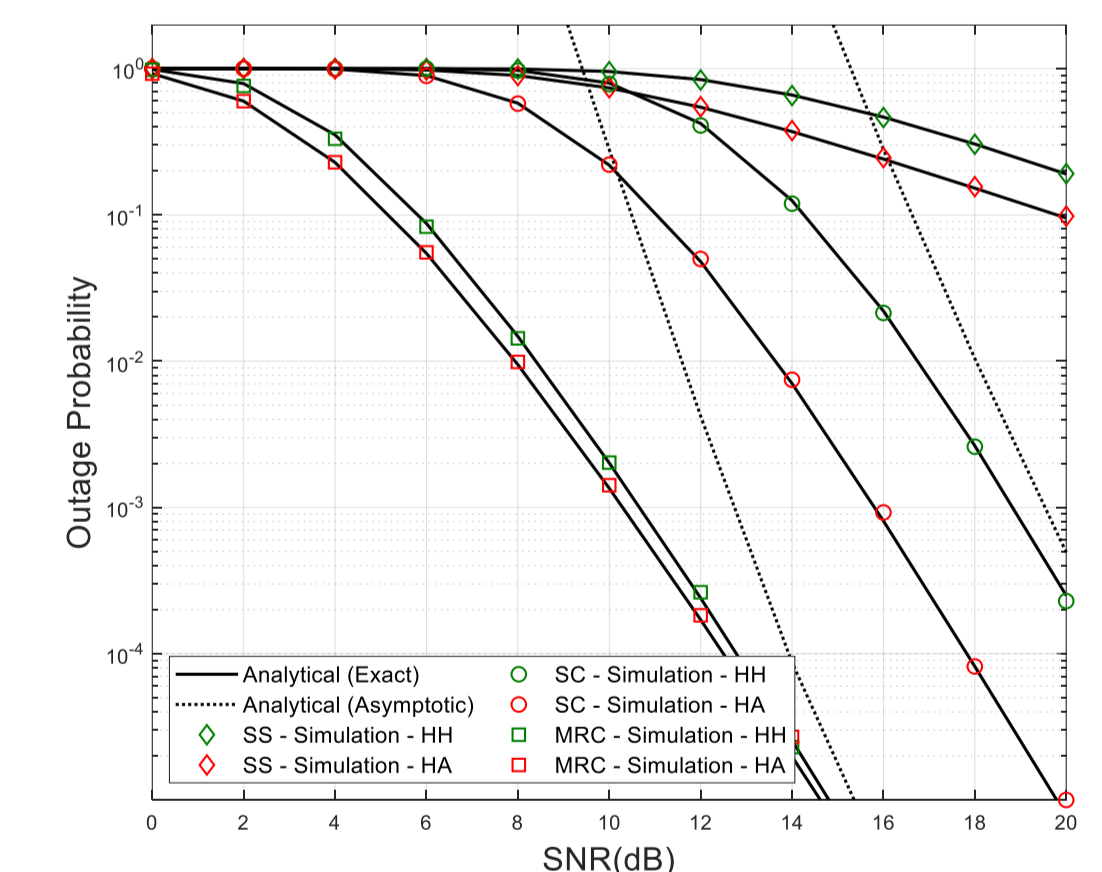
Current Work

- A novel architecture for direct-access LEO satellites based IoT network leveraging benefits of mega-LEO constellations.
- Multiple satellites available in line-of-sight with the IoT node at a given point of time.
- IoT node broadcasts its information to multiple satellites. The signal received at each of the satellites is amplified and forwarded to the ground station for data-processing.
- Simulation based performance analysis: Outage probability of different combining techniques at the ground station under various channel conditions.
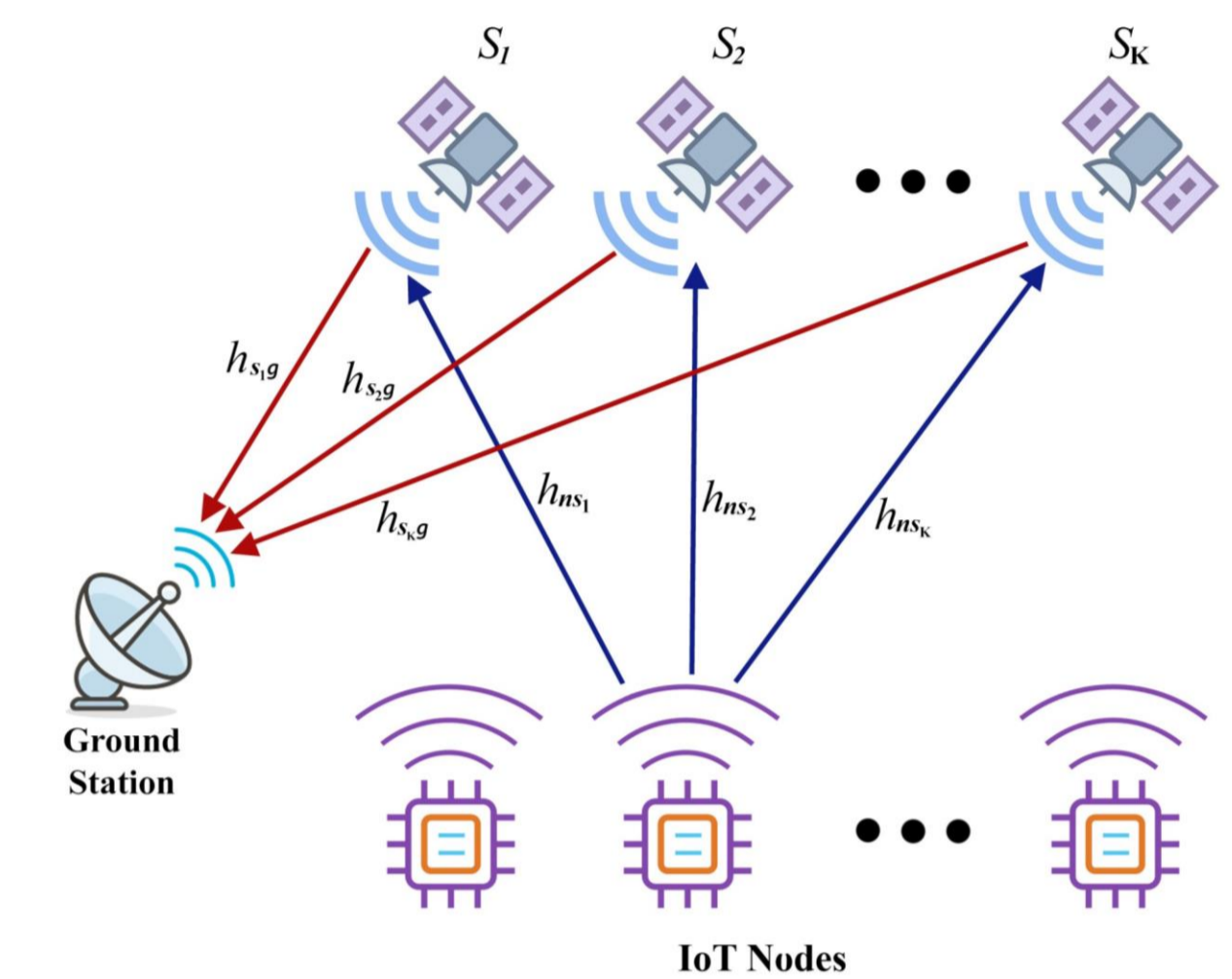
Proposed system model

Results and future directions

- Proposed topology leverages the benefits of multiple satellite: Multiple satellite schemes outperform the single satellite scheme.
- MRC proves to be much more robust towards change in shadowing conditions of satellite-GS channel.
- Future Directions: Comprehensive analysis including random access schemes and LEO orbital-dynamics.

Satellite-based IoT networks have gained attraction at various standardization bodies across the globe.

Outage probability vs SNR for various combining schemes at ground station

Ref: Ayush Kumar Dwivedi, Sai Praneeth Chokkarapu, Sachin Chaudhari and Neeraj Varshney, "Performance Analysis of Novel Direct Access Schemes for LEO Satellites Based IoT Network," accepted in IEEE International Symposium on Personal, Indoor and Mobile Radio Communications (PIMRC), 2018.

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