

Optimisation of Inter-Cubesat Communication Links

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Objectives of thesis

- To design Cubesat constellation with inter-satellite links (ISL) to act as the backbone communication architecture for continuous global coverage,
- To propose suitable Cubesat constellation architecture for different mission profiles, and
- To ensure Cubesat constellation design is optimised to deliver the highest data rate.

Main research ideas

- Cubesats have changed the communication outlook from long-range, point-to-point propagation to a multi-hop network of small orbiting nodes.
- Cubesats must be deployed in constellations and there is a need to employ ISL to enable continuous coverage over the designated area.

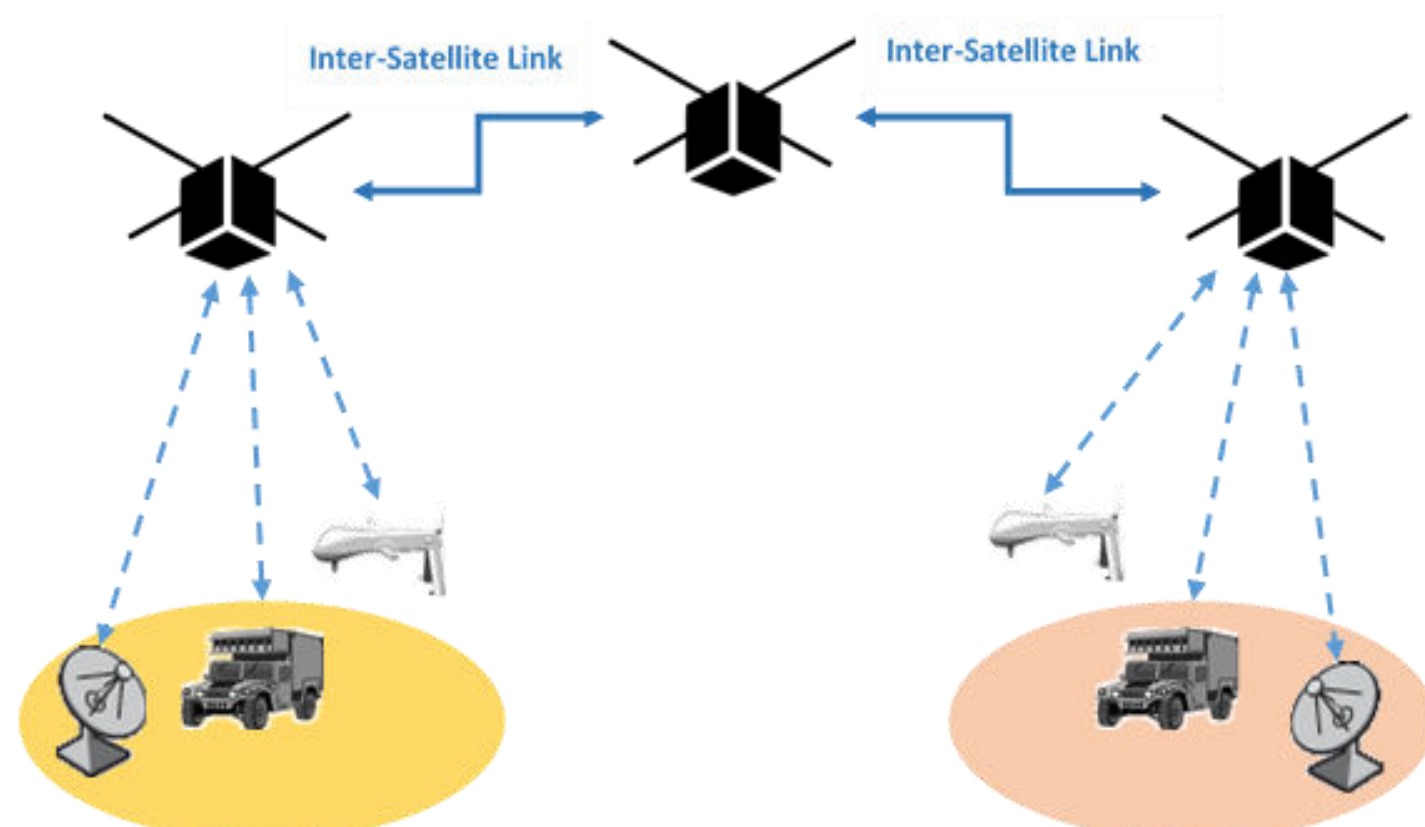


Figure 1. System Overview Using Cubesat with ISL

- Two constellation designs were proposed for different mission profiles.

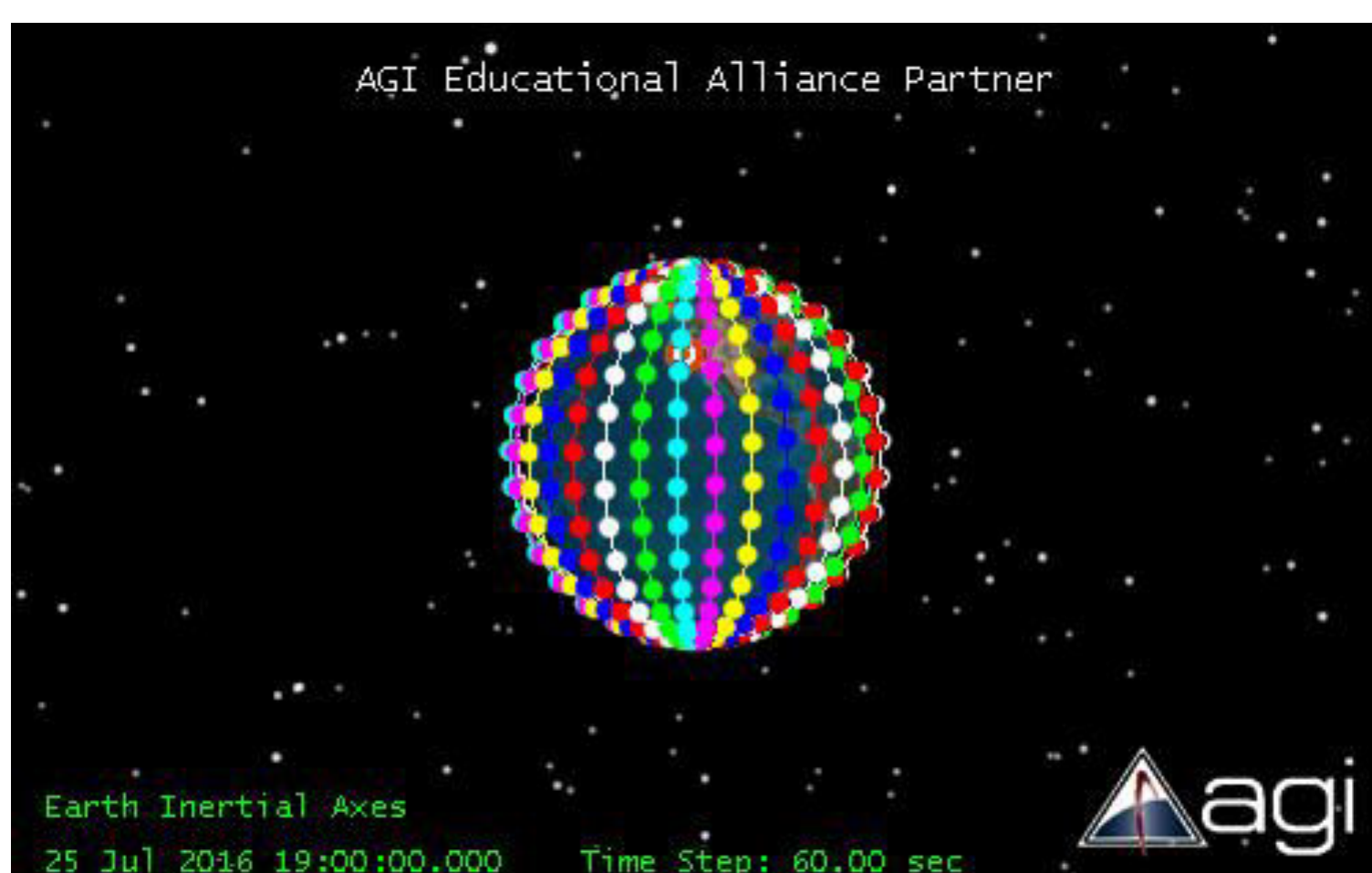


Figure 2. Polar Constellation of 17 Planes with 33 Satellites per Plane

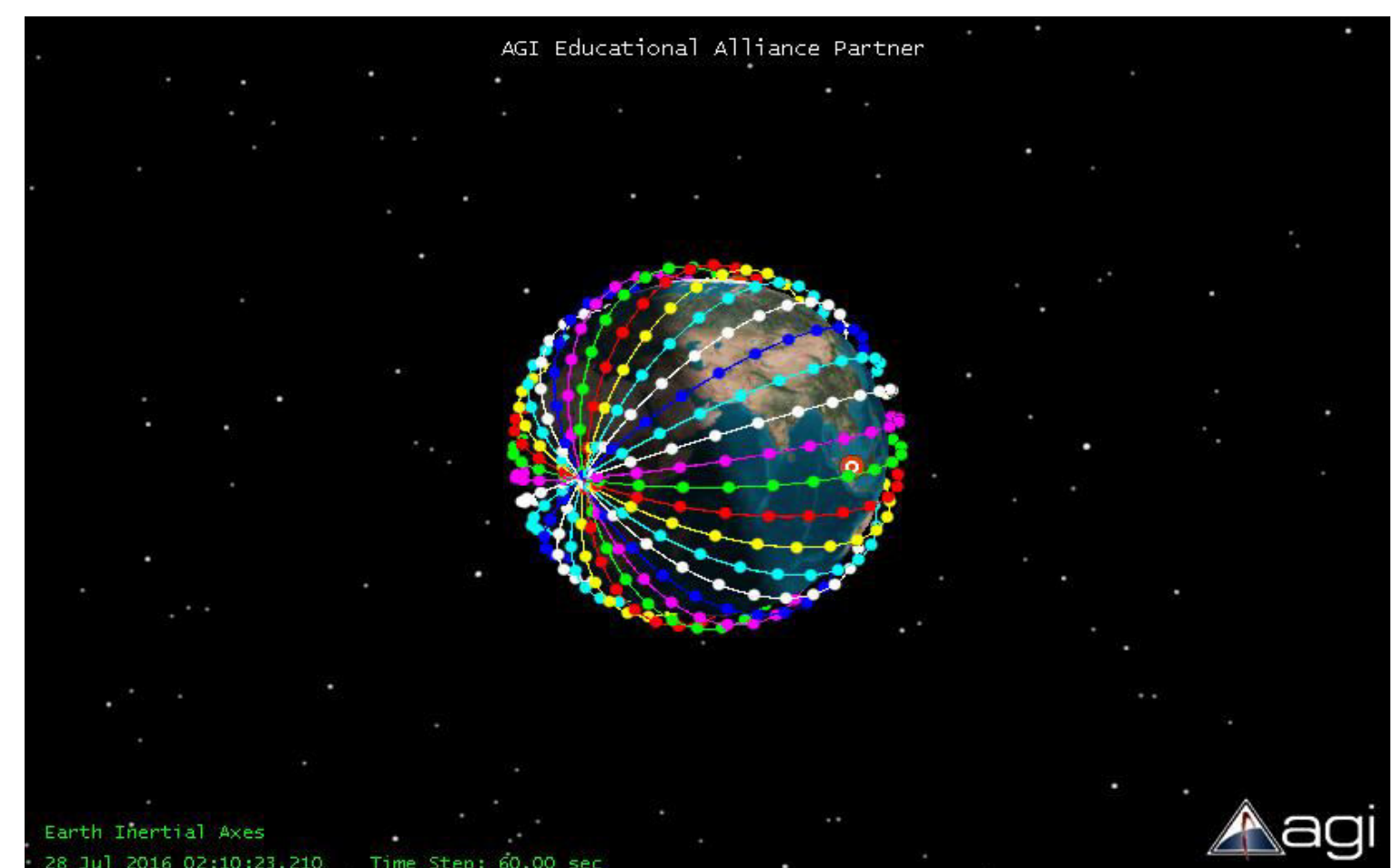


Figure 3. Inclined Constellation of 16 Planes with 30 Satellites per Plane

- A methodology to obtain the optimal number of planes and total number of satellites needed in the Cubesat constellation was determined, and this was verified using the Systems Tool Kit (STK) stimulation program.
- Link budget analysis with link optimisation was performed.
- Propagation time delay of the proposed constellation was analysed to study the network latency.

Research results

- The Cubesat constellation at 450 km was recommended as it required the least number of satellites and also had the longest decay lifespan.
- A theoretical data rate of 11.46 kbps at 450km could be achieved using existing COTS hardware, and this data rate could be further improved to 59.2 kbps through the employment of M-ary code-shift keying.

Benefits/potential applications of the research

- Affirmed that Cubesat constellation can be an alternative communication backbone to achieve continuous global coverage.
- Explored new modulation techniques to improve the data rate.

Follow-up research activities

- To implement the theoretical research work in actual hardware,
- To explore and develop Cubesat transceivers that can support 128-CSK modulation, and
- To integrate the STK simulation of the constellation with Exata stimulation program to study networking protocols and its performance.