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LEO Satellite Networks Simulator Reproduction and Study of Various LEO Satellite Routing Topologies

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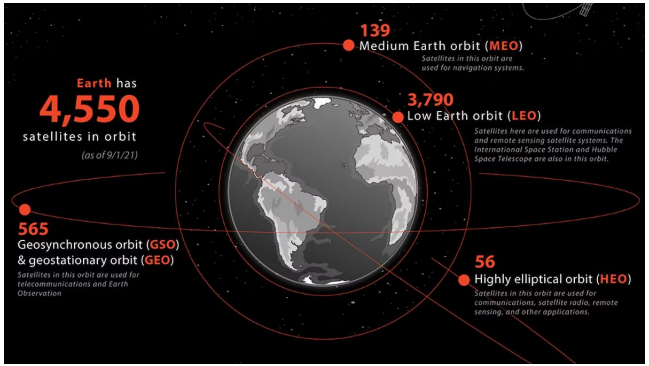
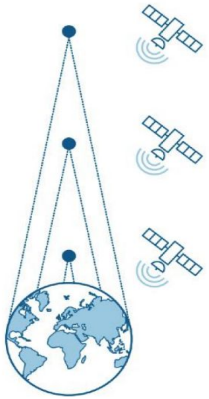
Contents

Overview

- Low Earth Orbit(LEO) satellites orbit between 2,000 and 160 kilometers above the earth. LEO satellites are commonly used for communications, military reconnaissance, spying and other imaging applications.
- LEO satellites move at approximately 7,500 m/s and are within the operational range of terrestrial ground stations for only minutes at a time





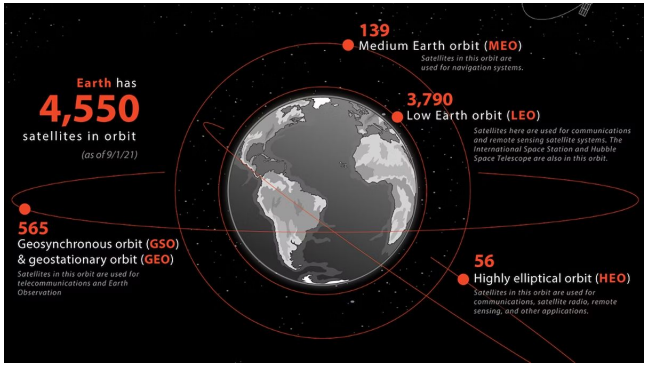
GEO satellites at altitudes of 35,786 km
Full orbital period of 24 hours
Latency (round trip) of approximately 477 ms

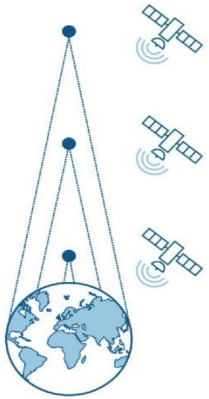
MEO satellites at altitudes of 2,000–35,786 km
Full orbital period of 127 minutes to 24 hours
Latency (round trip) of approximately 27–477 ms

LEO satellites at altitudes of 160–2,000 km
Full orbital period of 88–127 min
Latency (round trip) of approximately 2–27 ms

Motivation

- The consistent connection of satellites presents challenges due to their high mobility.
  - Satellite to Satellite, and Satellite to ground station
- And LEO satellites are not reachable for us, How can we emulate the communication traffic?





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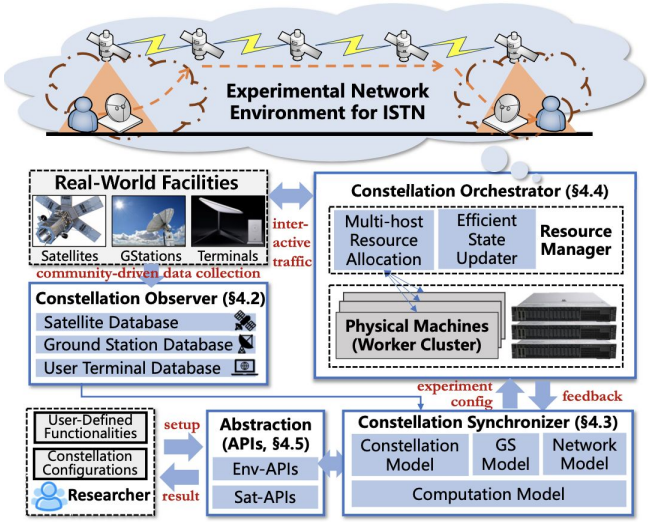
Technical Approach

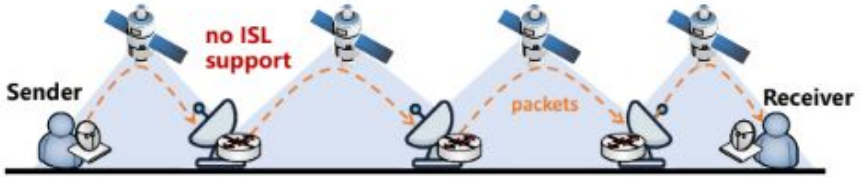
- Constellation-consistency
- System-level & networking stack realism
- Flexible and Scalable environment
- Open, Low-cost and easy-to-use interface

Category / Tools		(i) Constellation Consistency	(ii) System and Networking Stack Realism	(iii) Flexible and Scalable Environment	(iv) Low-cost and Easy-to-use
Live LSNs or platforms	Live Starlink ([34])	✓	✓	✗	✗
	PlanetLab ([20])	✗	✓	✗	limited
	Emulab ([7])	✗	✓	✗	limited
Simulators and orbit analysis tools	STK ([35])	✓	✗	✓	limited
	GMAT ([11])	✓	✗	✓	✓
	SNS3 ([76])	for GEO only	✗	✓	✓
	Hypatia ([60])	✓	✗	✓	✓
	StarPerf ([61])	✓	✗	✓	✓
Emulators and variations	MiniNet ([55, 68])	✗	✓	✓	✓
	DieCast ([54])	✗	✓	limited at scale	✓
	Etalon ([69])	✗	✓	limited at scale	✓
StarryNet **(this paper)**		✓	✓	✓	✓

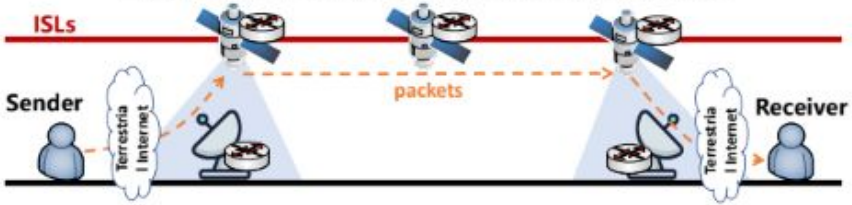


Technical approach

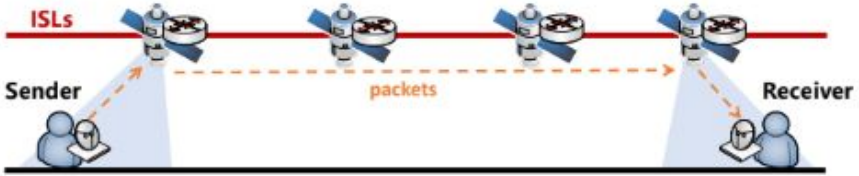
(a) **SRLA**: satellite relays for last-mile accessibility.



(b) **SRGS**: satellite relays for ground station networks.



(c) **GSSN**: ground station access for satellite networks.



(d) **DASN**: satellite networks directly accessed by terrestrial users.

APIs:

sn.create_nodes(), sn.create_links(), sn.get_distance(node_index1, node_index2, time_index)…

Parameters:

Altitude (km), Cycle (s), Inclination, Phase shift, # of orbit, # of satellites, Duration(s), update_time (s), …

Milestones

In Progress:

- Conducted thorough research on current simulators (completed).
- Running simulators to replicate and validate previous results (in progress).

Up next:

- Compare the obtained results and formulate further discussions.
- Test the performance of the simulators on standard PC hardware as an alternative to using a high-performance server.

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Thank you!