



National Aeronautics and Space Administration

Distributed Spacecraft Autonomy (DSA):

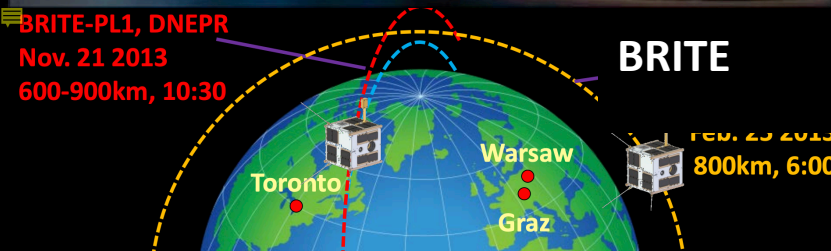
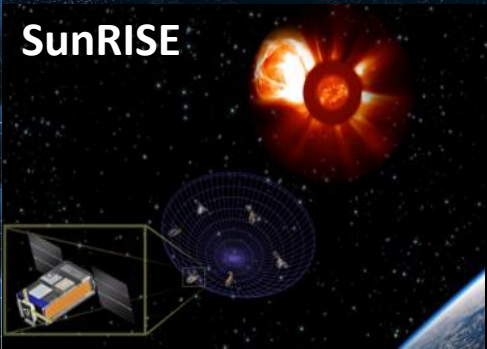
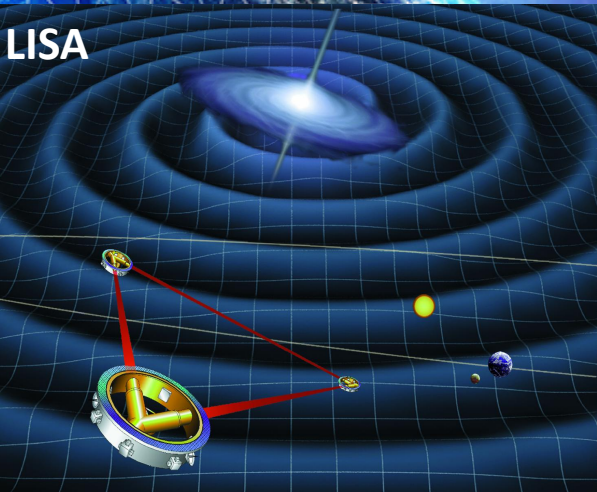
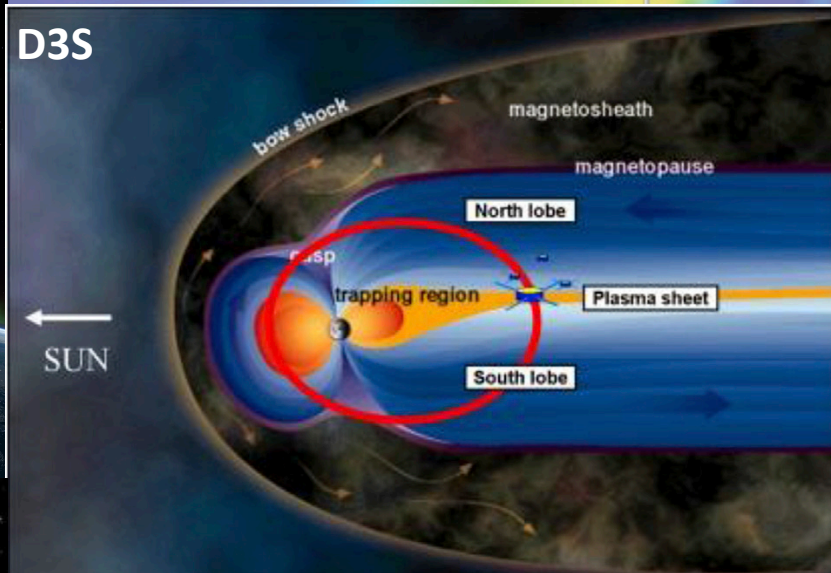
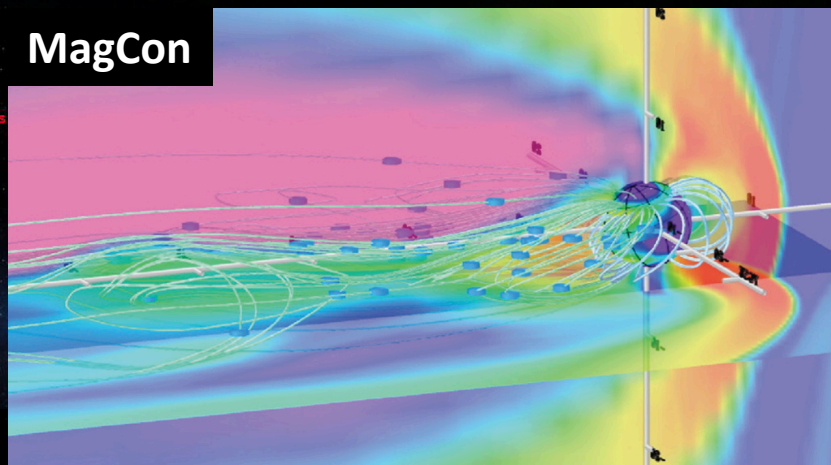
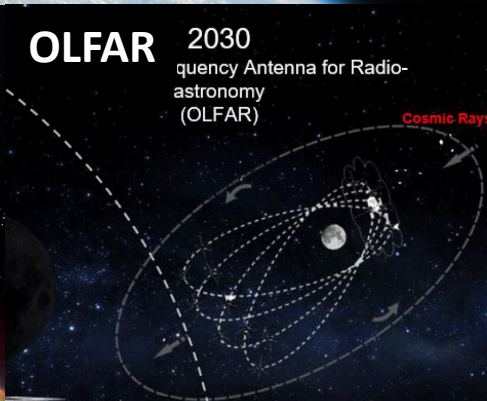
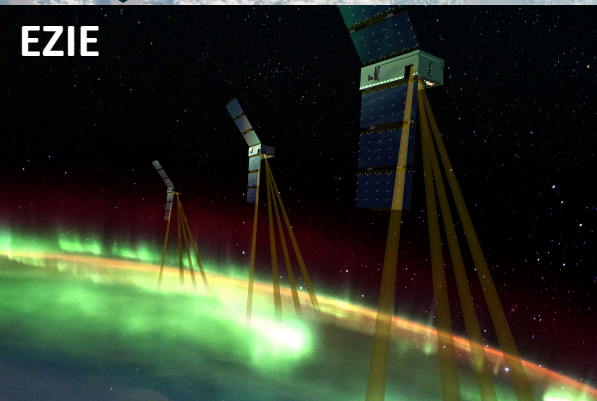
Daniel Cellucci
NASA Ames Research Center
Intelligent Systems Division



1. Introduce the Distributed Spacecraft Autonomy (DSA) Mission
2. Highlight key capabilities being developed for DSA that are broadly applicable to mission development
3. Start a discussion about how distributed autonomy can help with previously infeasible Space Physics missions



Distributed Spacecraft Systems



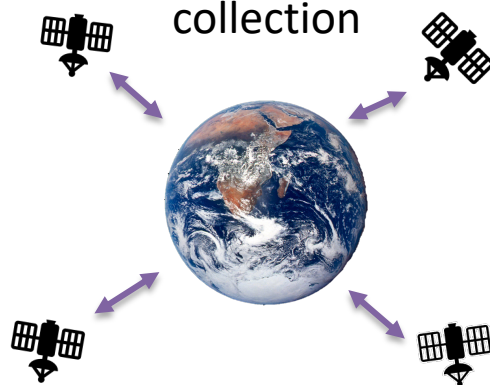


Motivation

What Does DSA Enable?

Enhanced system capabilities

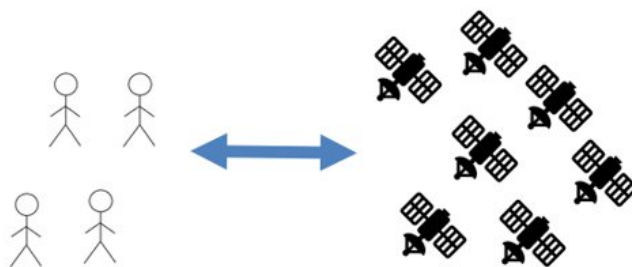
Simultaneous multipoint data collection



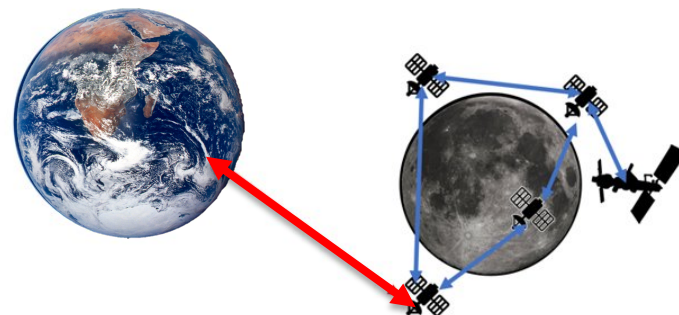
n to m vehicle operations

$$n < m$$

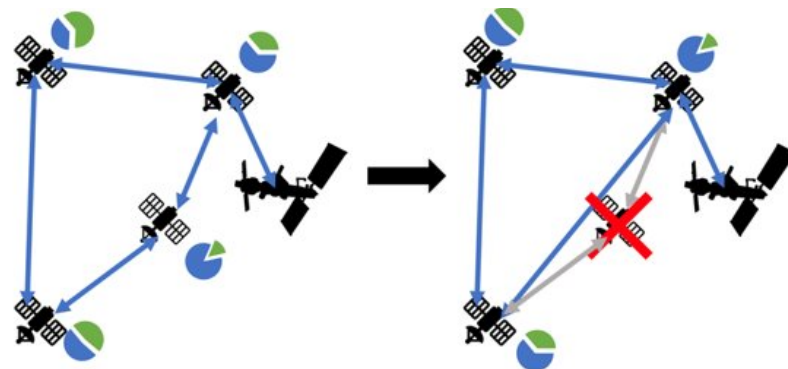
Increased throughput and reduced cost



Increased Availability

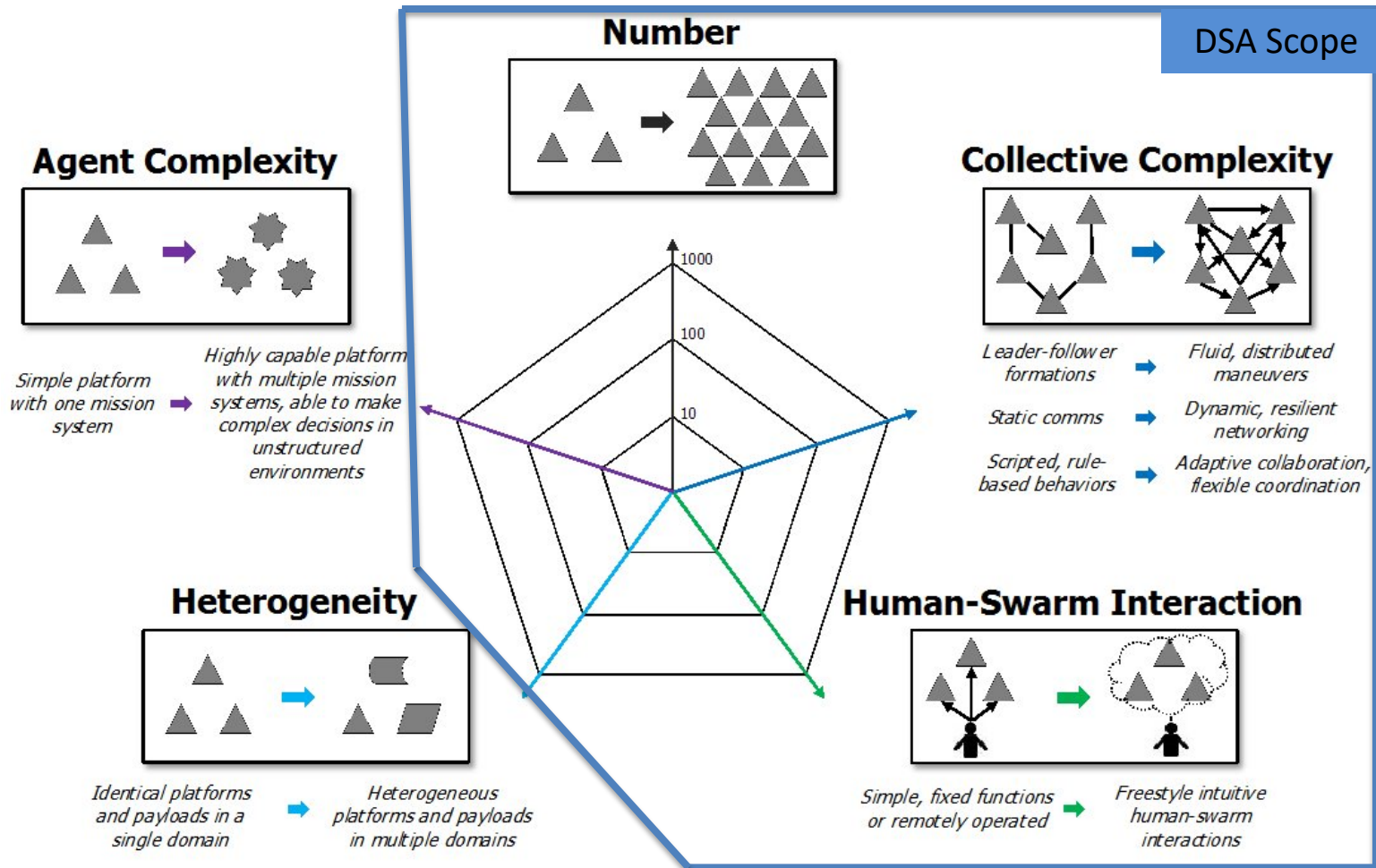


Reduced downtime and graceful performance degradation



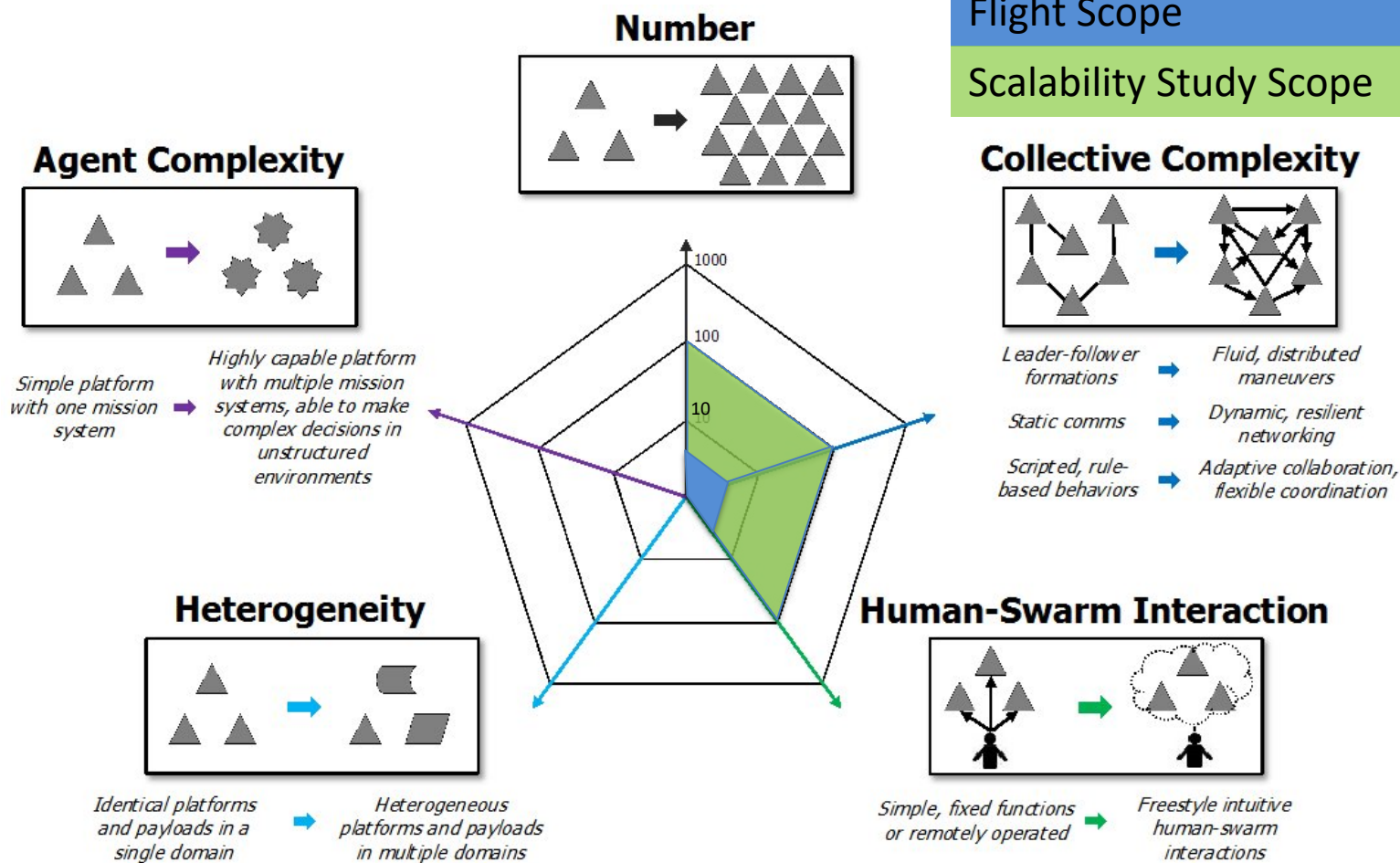


Motivation





Motivation





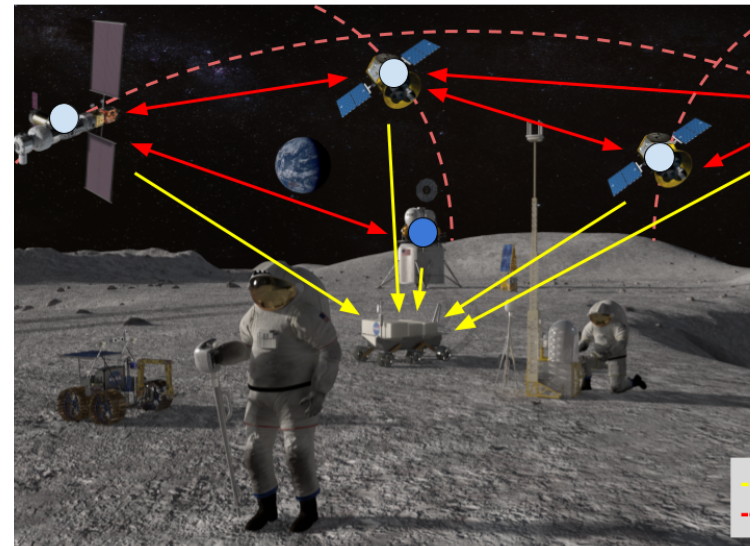
Motivation

Flight Payload



- Software payload on Starling-1 small spacecraft mission
- 4 nanosatellites
- LEO orbit
- Limited hardware access

Scalability Study



- Lunar Position, Navigation, and Timing mission
- Simulation using flight software
- Up to 100 satellites
- Variety of orbits around the moon



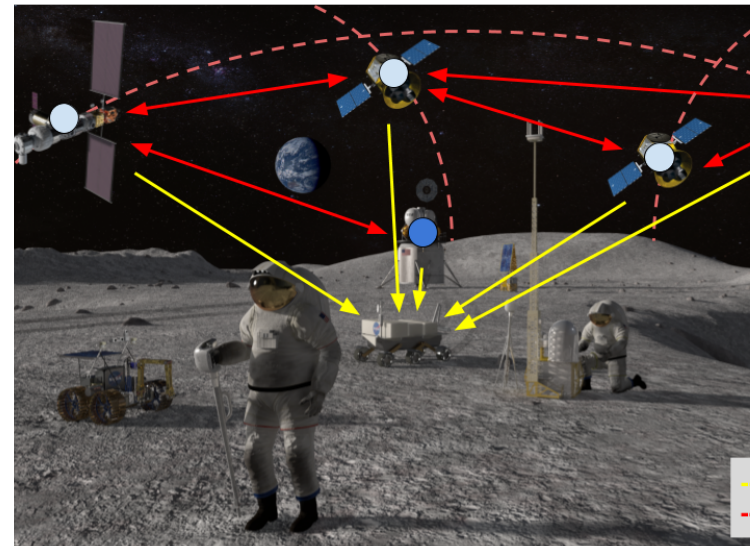
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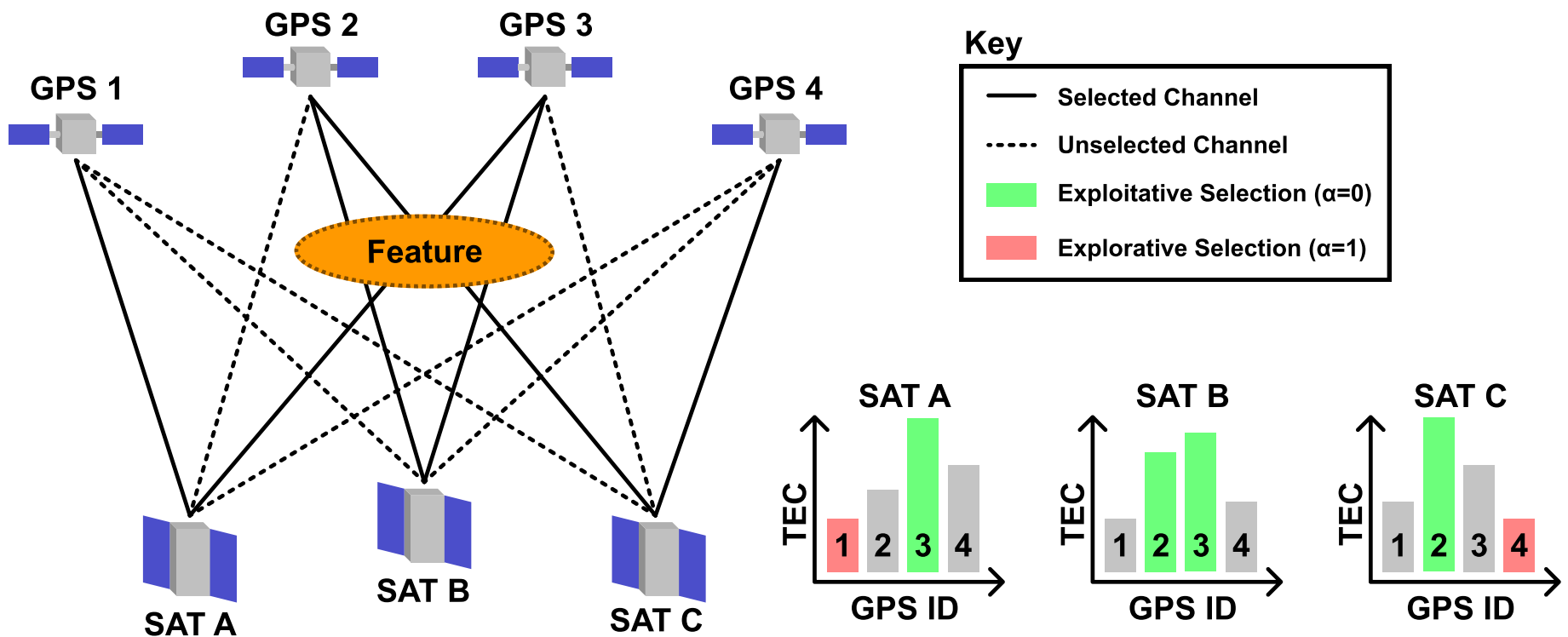
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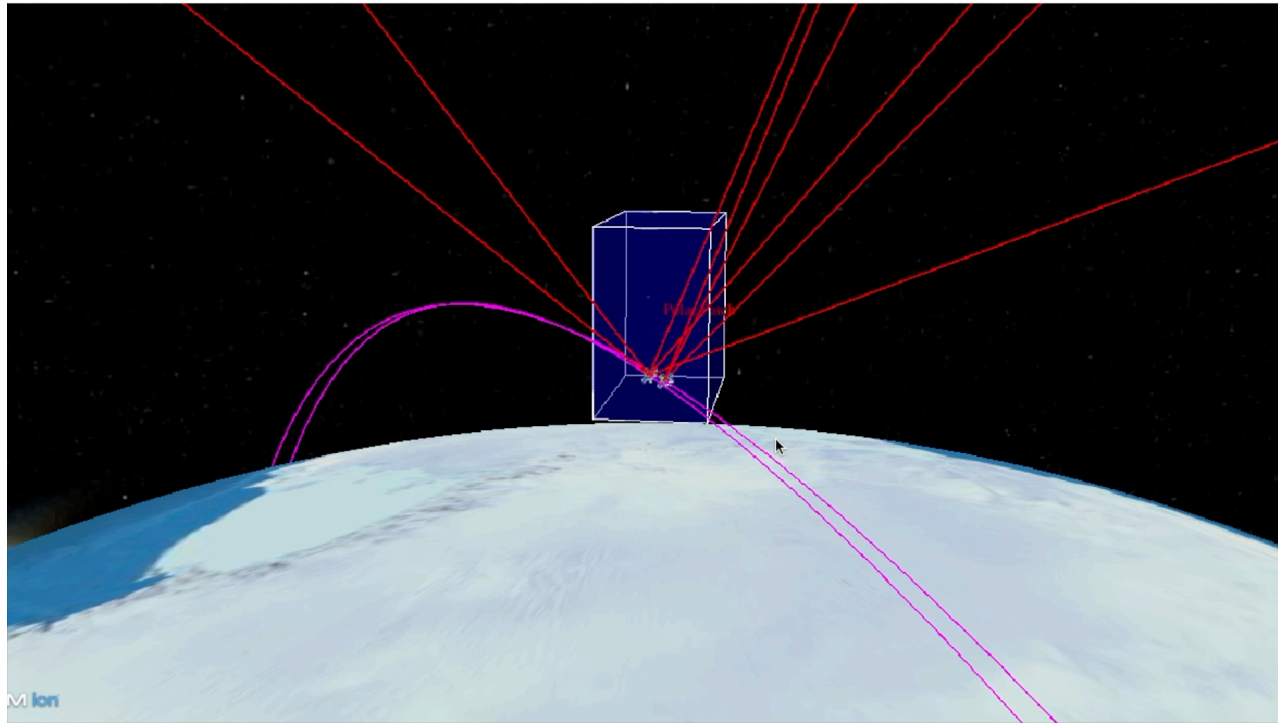


GPS Channel Selection – Autonomous coordination of “scientific” observations between satellites

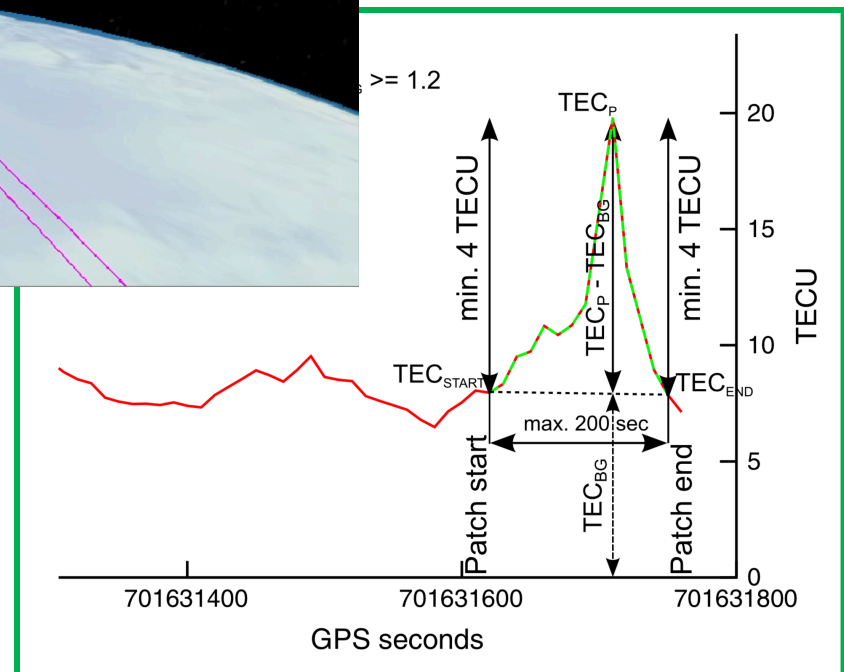




Channel Selection Experiment



- ESA Swarm dataset used for validation
- Polar patch detection using TEC data introduced in Noja et. al. 2013

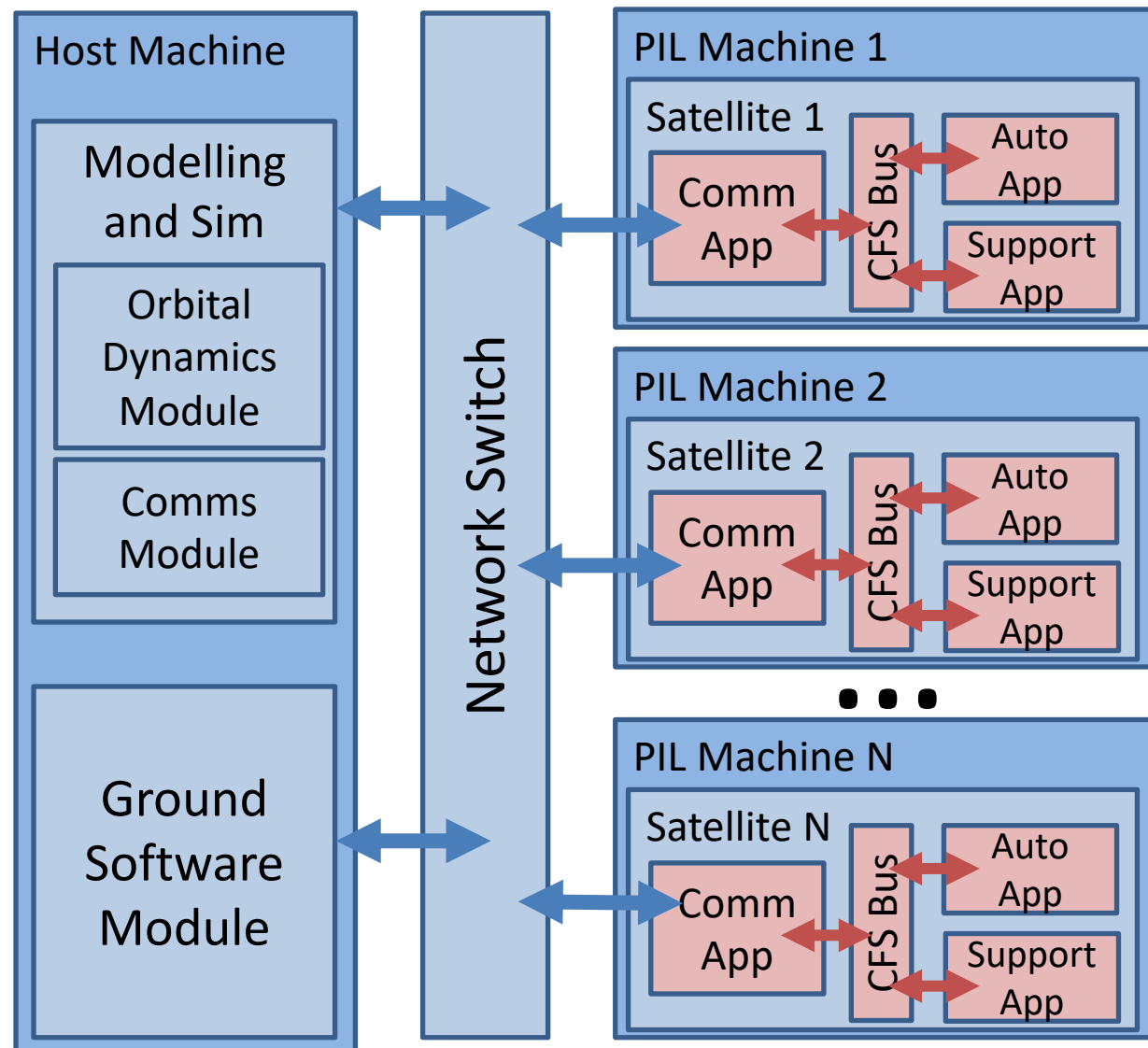






Key Products

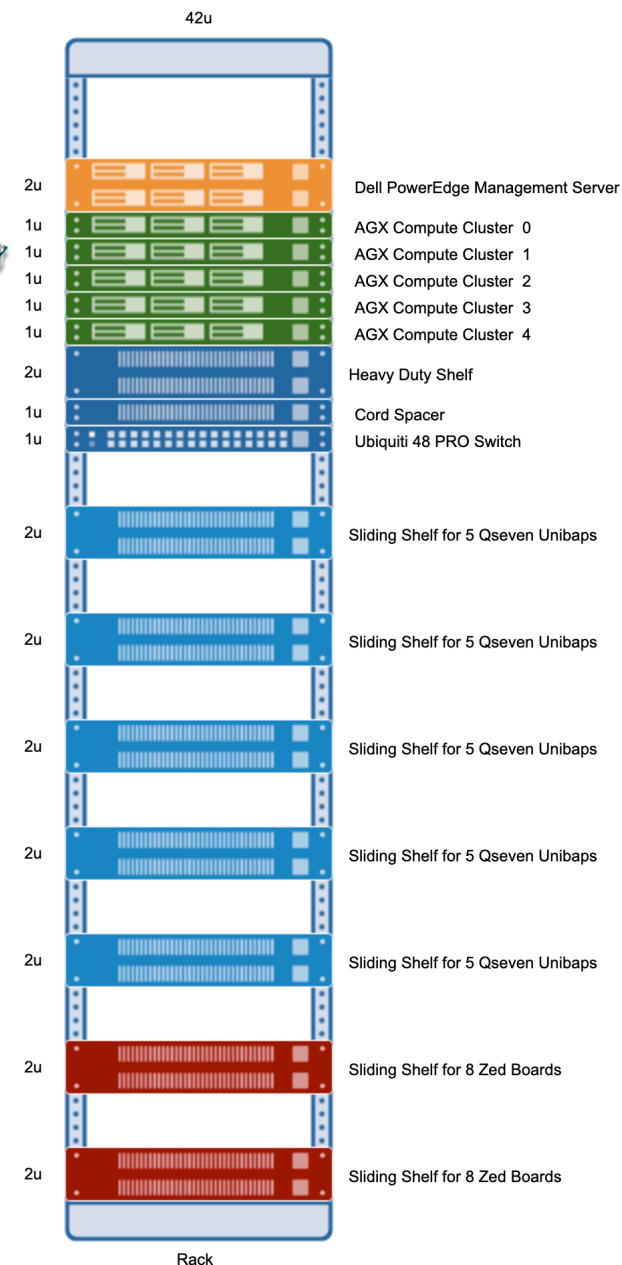
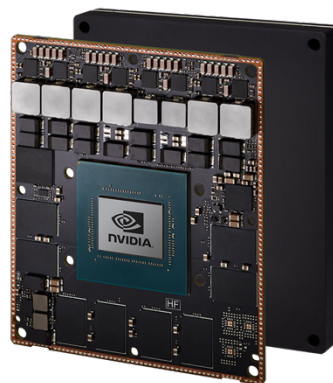
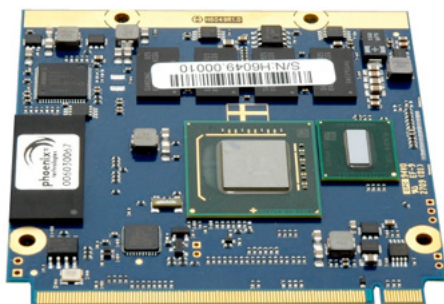
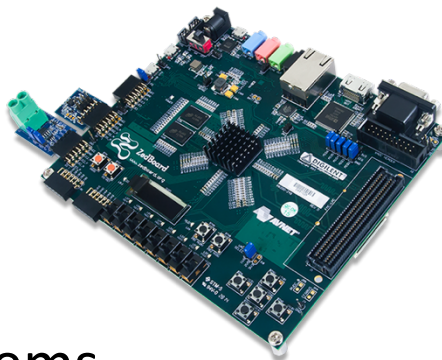
- Virtualization of the flight software bus
- Simulation of satellite crosslink network
- Modelling system for generating environment data
- Ground Software Module for processing telemetry/data





Key Products

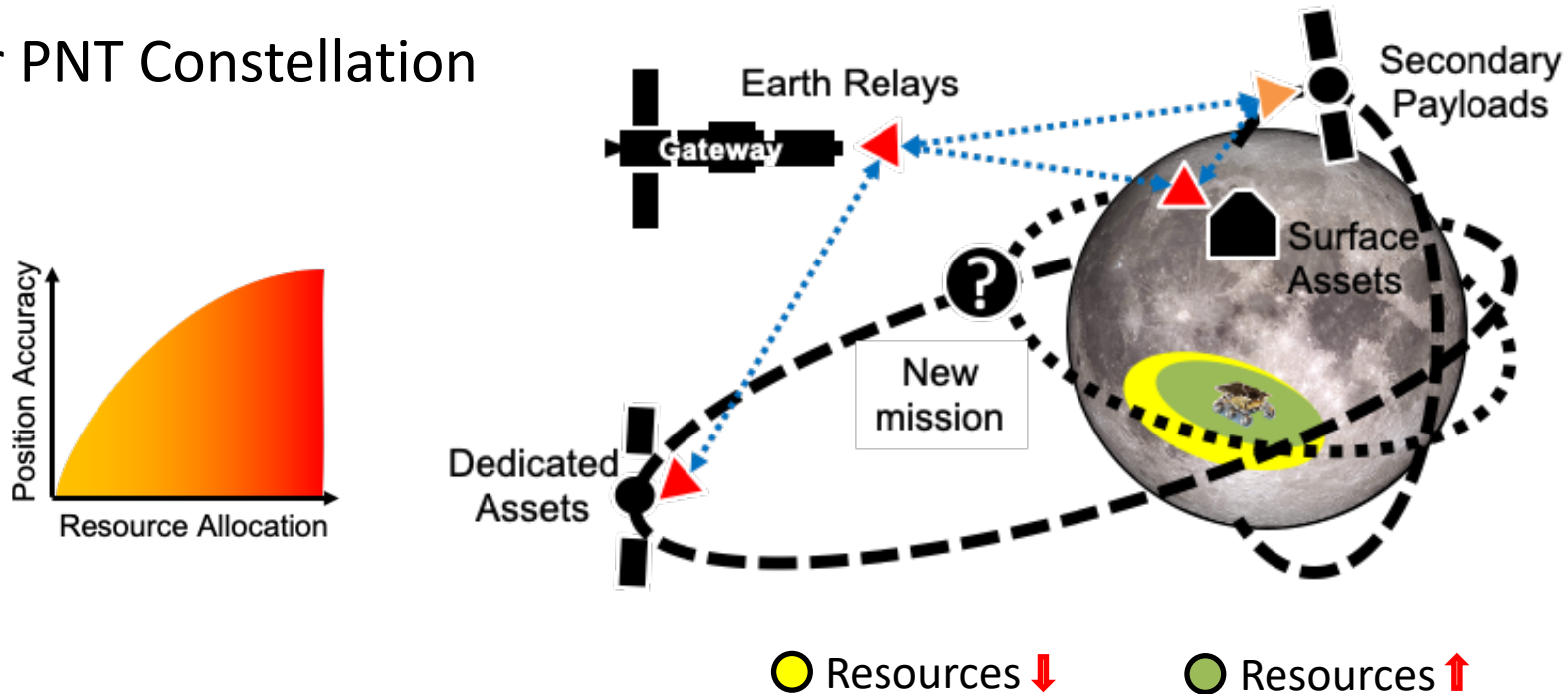
- 100 Processors
 - 15 Zed Boards
 - 25 Unibap GPU SoCs
 - 60 Nvidia AGX GPU SoCs
- Integrated into Server Systems
 - Potential for expansion with other PiLs
- Not included but considered
 - Leon Sparc Arch
 - Q7 boards





Potential Extended Missions

Lunar PNT Constellation

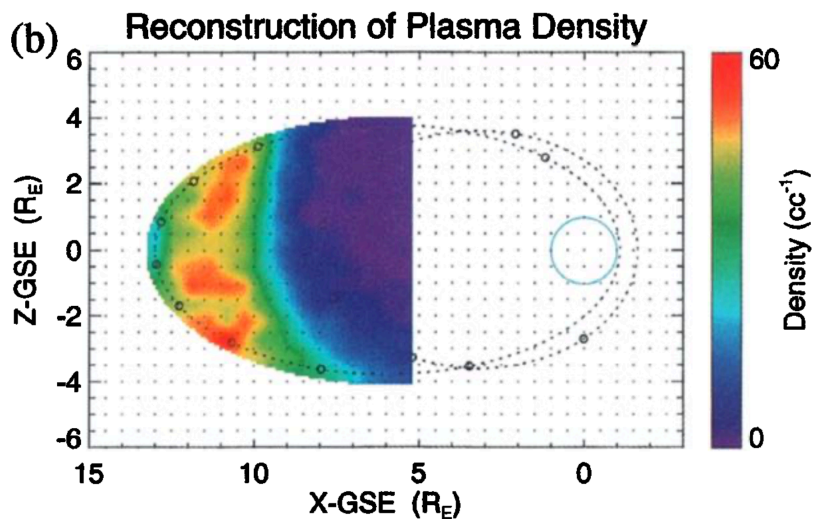
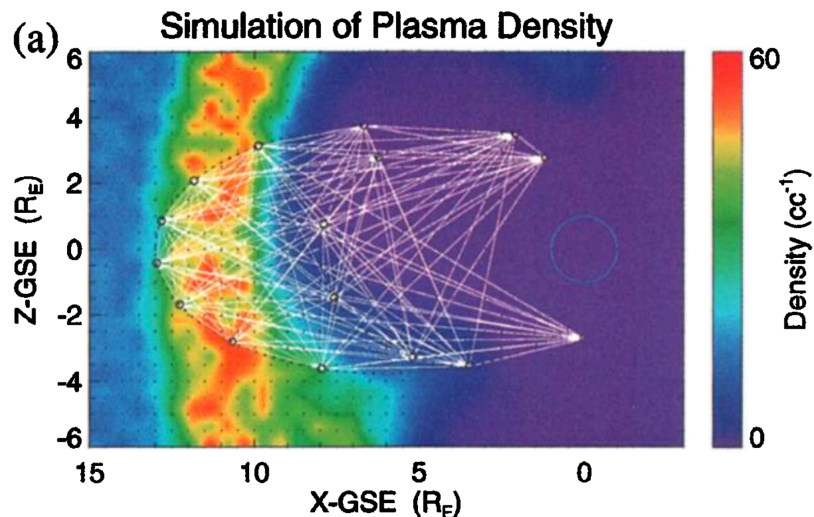


- PNT Service for places where a dedicated constellation is infeasible (Moon, Mars, etc.)
- Radio module transceivers providing position determination with distributed estimation
- Variable resource allocation based on current mission needs



Potential Extended Missions

MagCAT



More complex coordination strategies

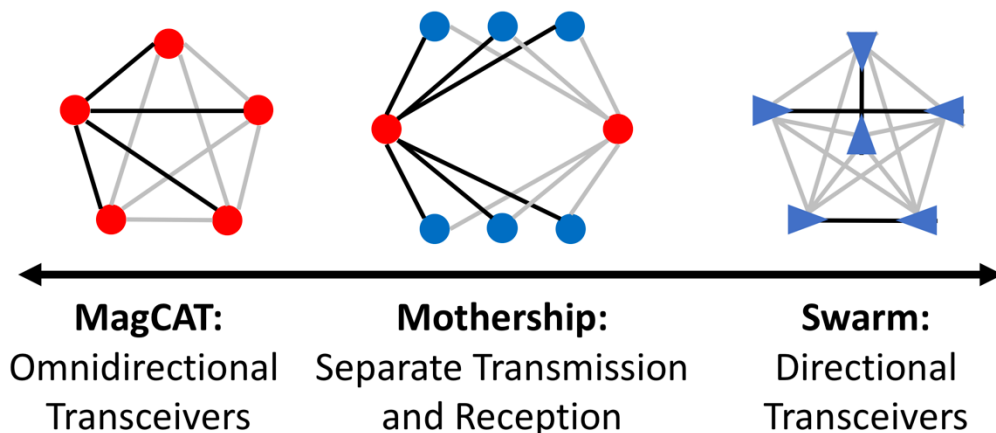


Lower SWaP of hardware



More collection points

● Smallsat ● Largesat — Active Link — Inactive Link





Potential Extended Missions

Thank you!