Sustainability or Survivability?
Eliminating the Need to Choose in LEO Satellite Constellations

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*On the (academic) job market.

Background & Motivation

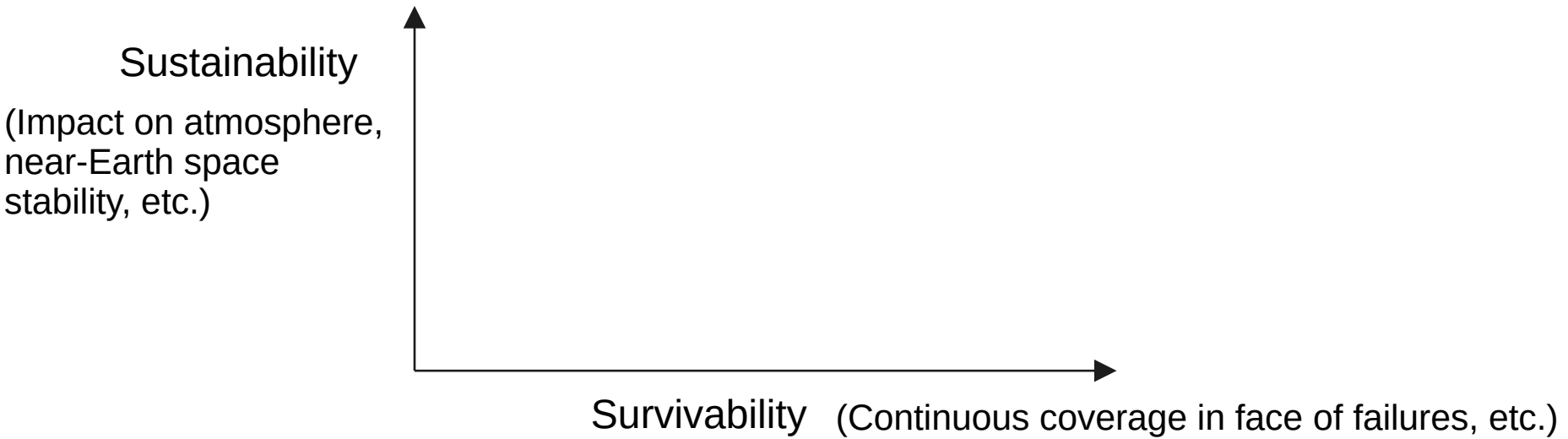
LEO satellite networks (LSNs) are an attractive solution to several challenging networking scenarios.

- E.g., direct-to-consumer and transit service in regions where terrestrial links are infeasible.
  - TMobile + SpaceX provide coverage in dead zones.
  - Starlink community gateways (Nauru, Nunavik).

Background & Motivation

LEO satellite networks (LSNs) are an attractive solution to several challenging networking scenarios.

However, LSNs embody a fundamental tension:



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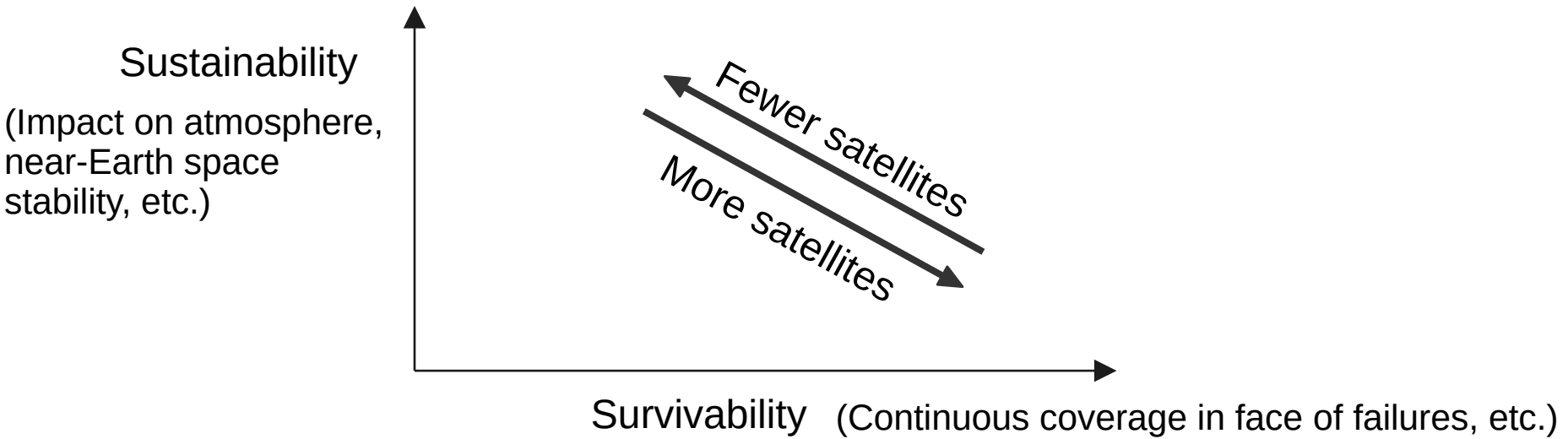
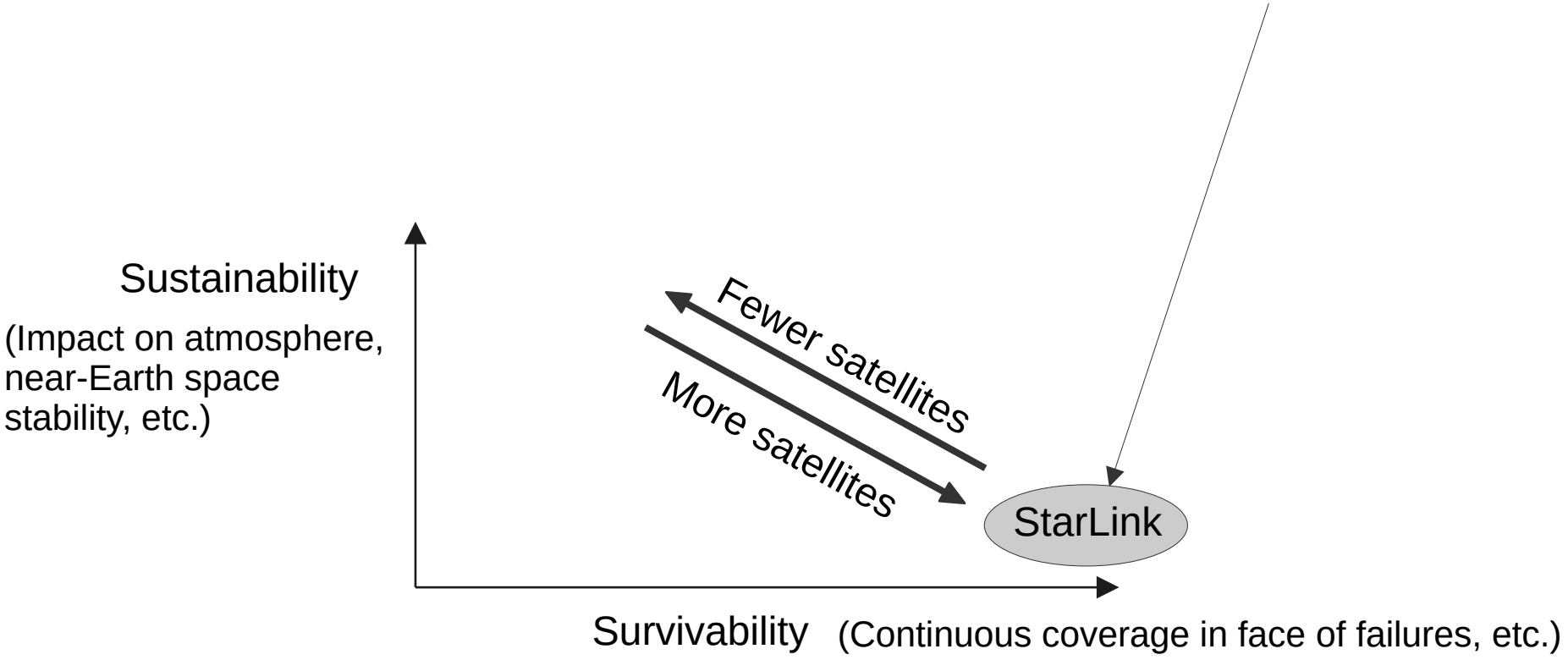
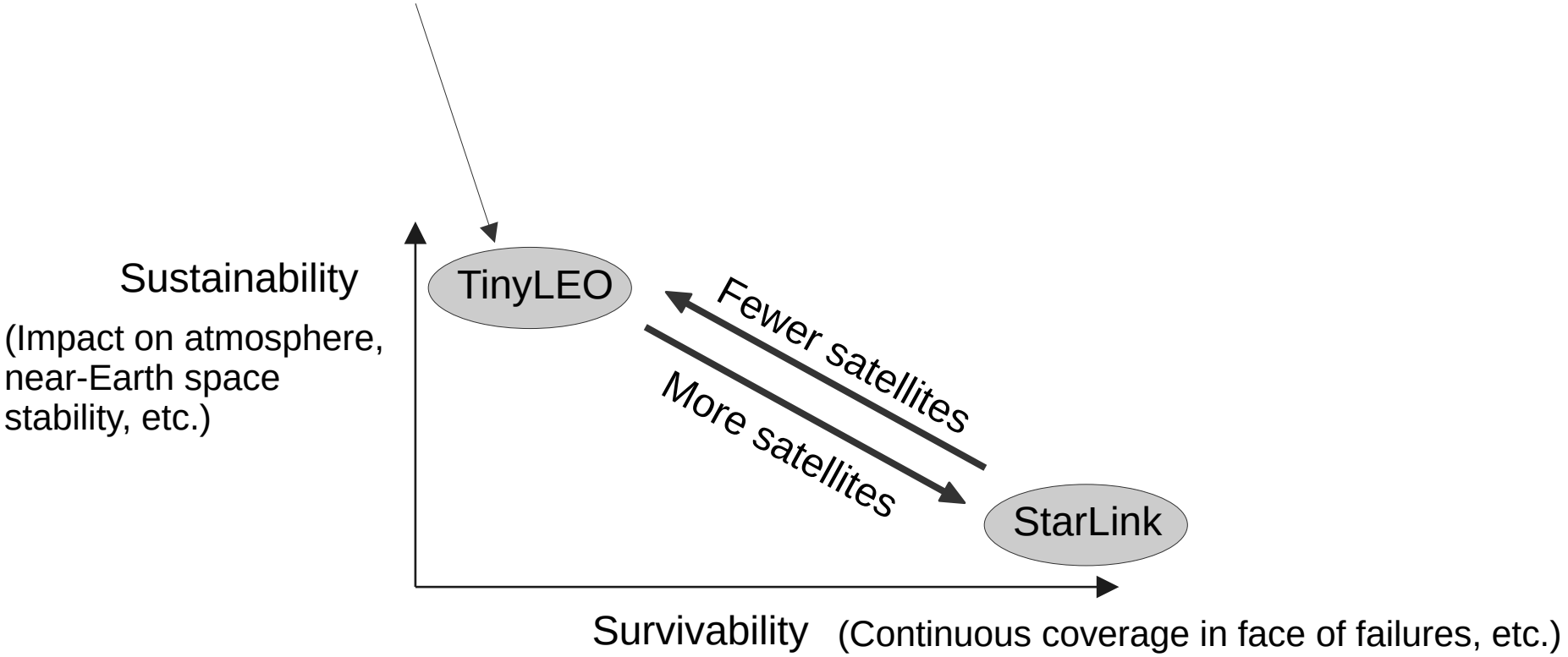


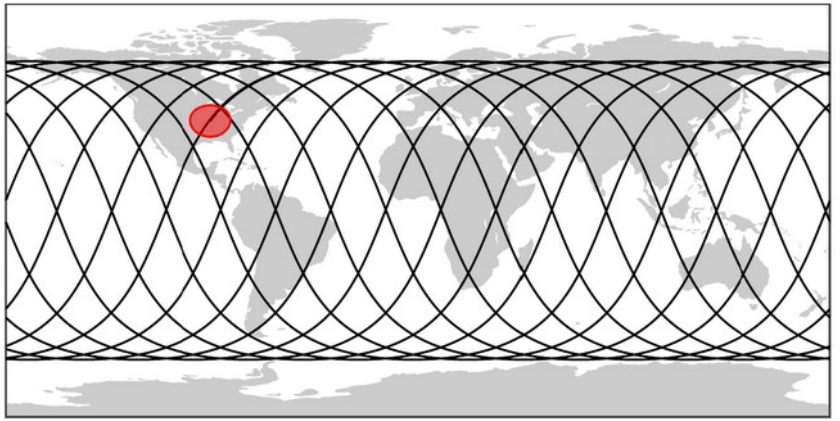
Present-day megaconstellations pose dire environmental consequences.

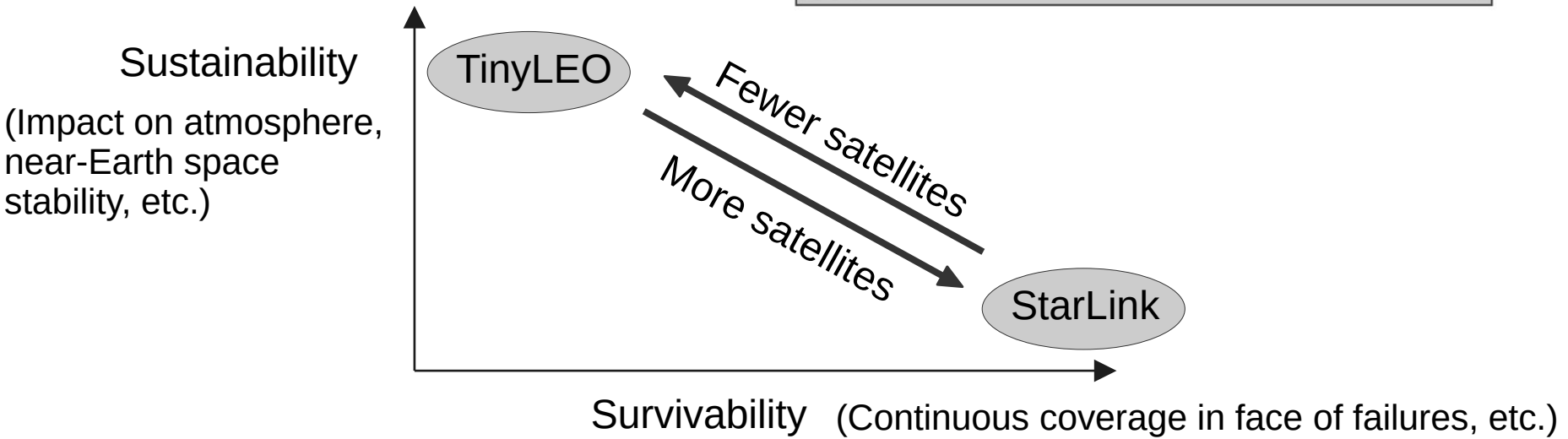


Initial attempts to reduce number of satellites compromise survivability.



Repeat ground-tracks are no silver bullet:





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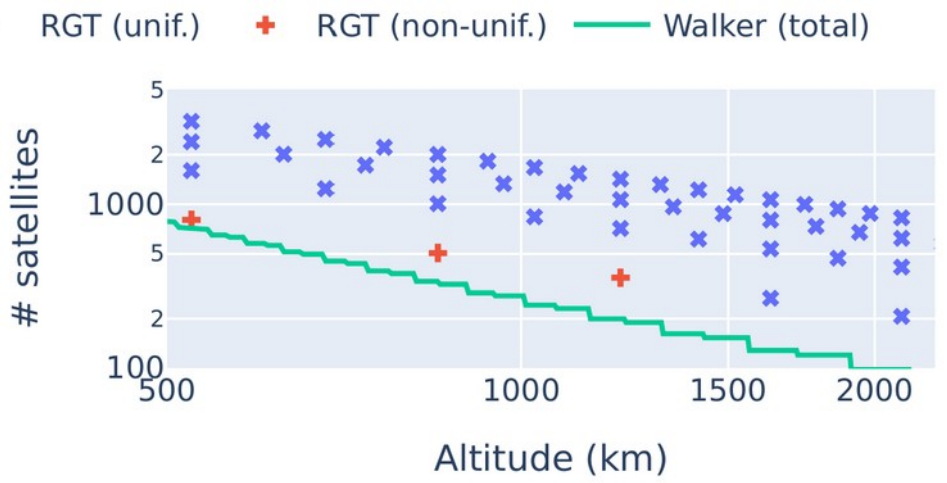
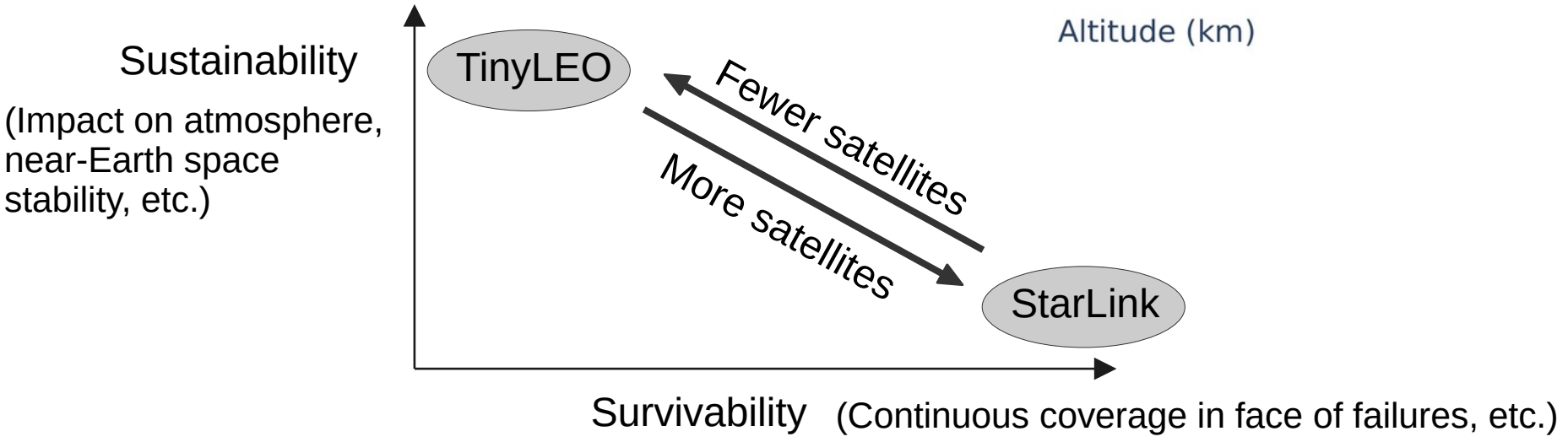
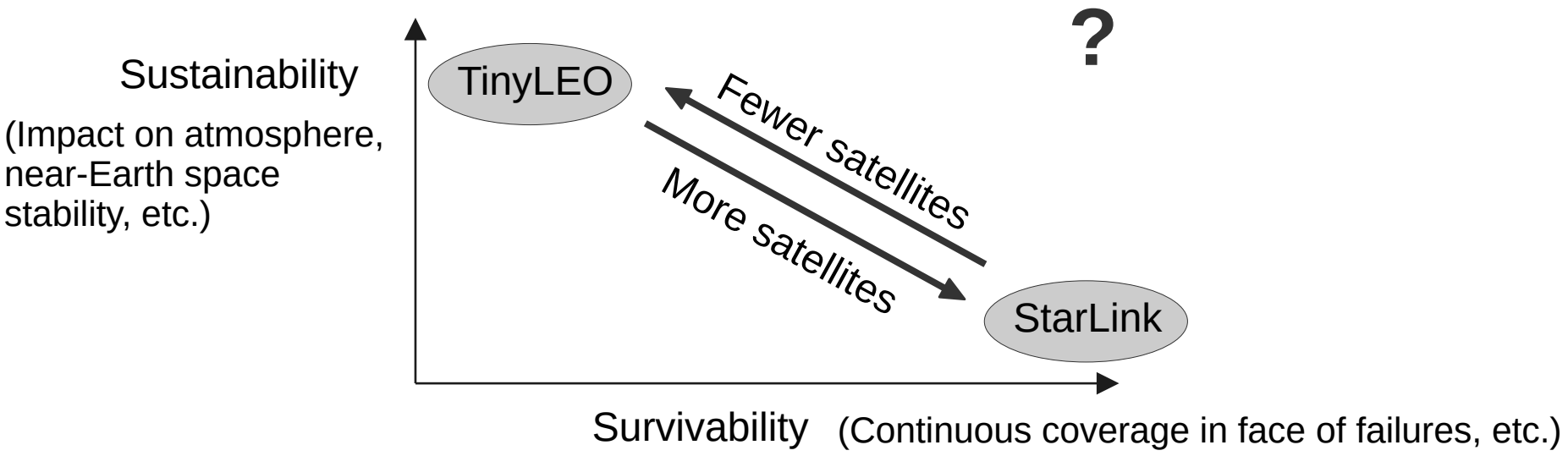




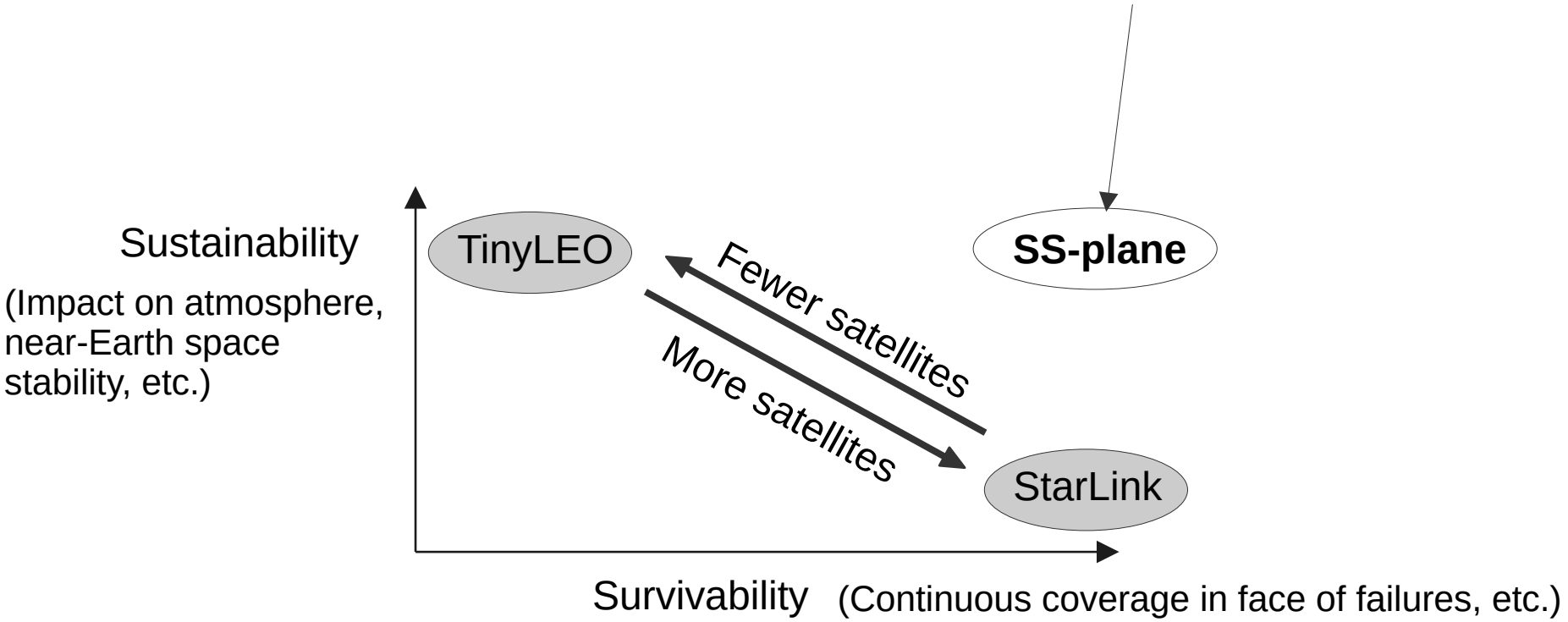
TinyLEO: Li et al., SIGCOMM'25

Can we *eliminate the need to choose?*



Demand is heliocentric → Sun-synchronous (SS) constellations

Can we *eliminate the need to choose? Yes!*



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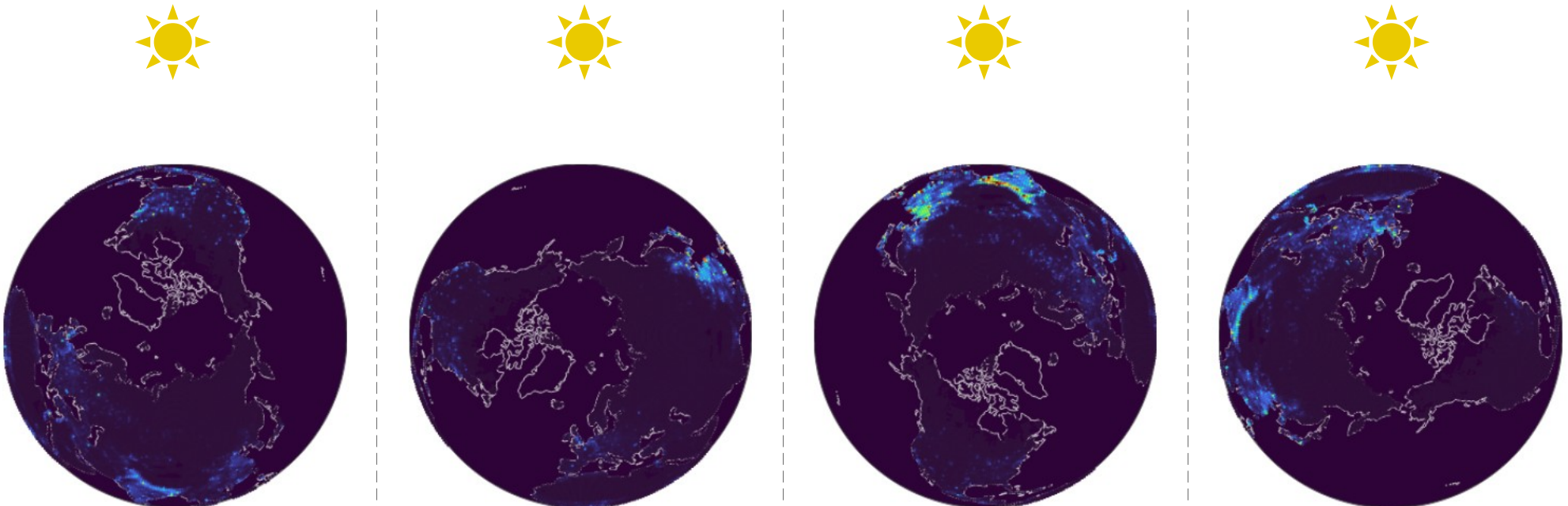

Time →

Data sources:
- SEDAC GWP,
- CESNET-TimeSeries24

cmisa@cs.uoregon.edu

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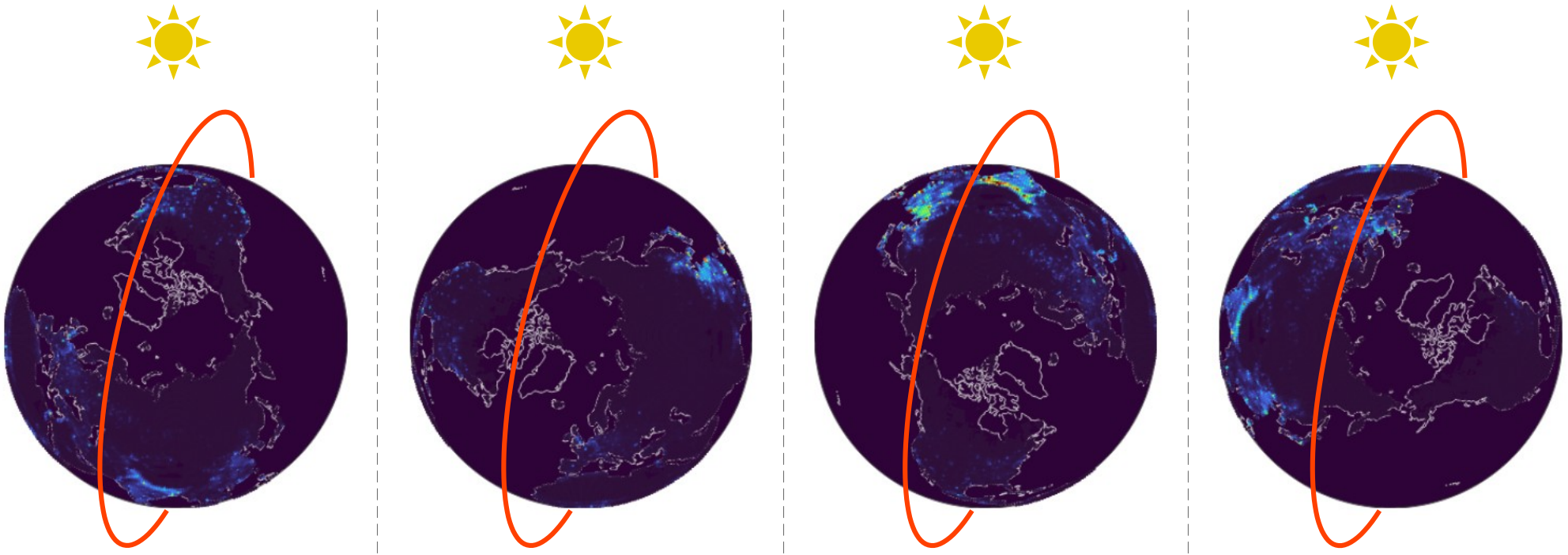

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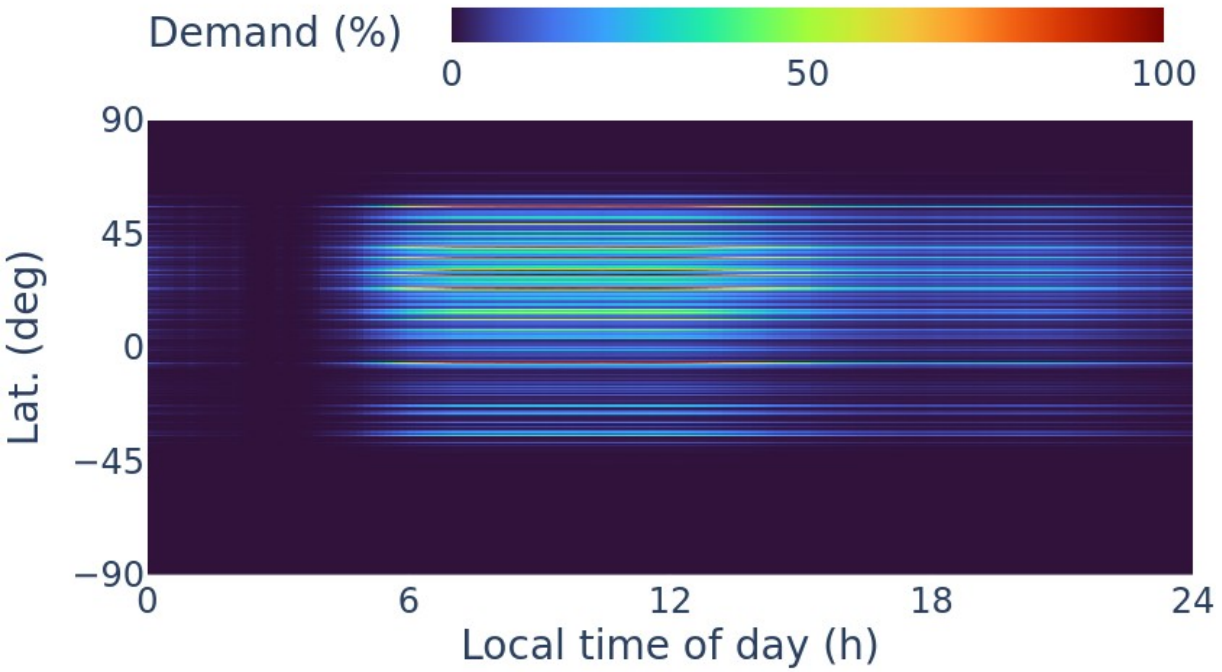

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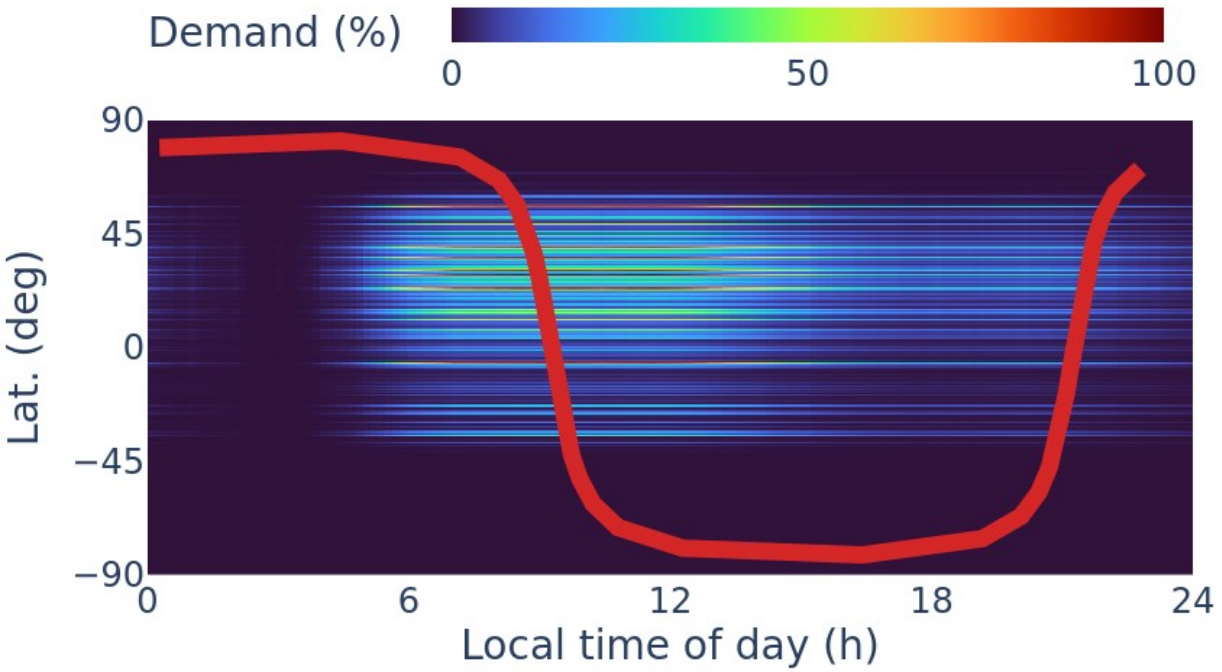
SS-planes correspond to *fixed traces* on this plot.



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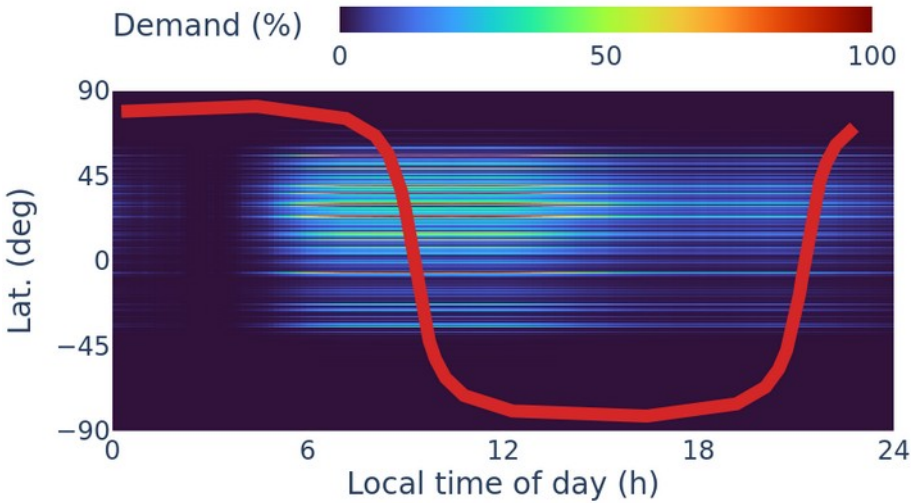
Greedy algorithm:

- *Select point with highest bandwidth demand.*
- *Add an SS-plane that intersects that point.*
- *Repeat until all demand is satisfied.*



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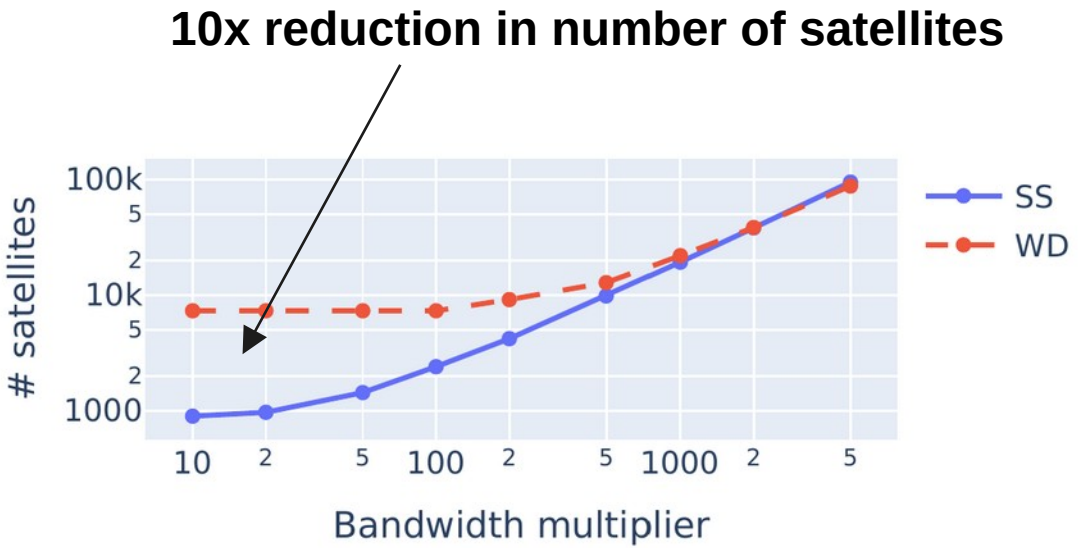

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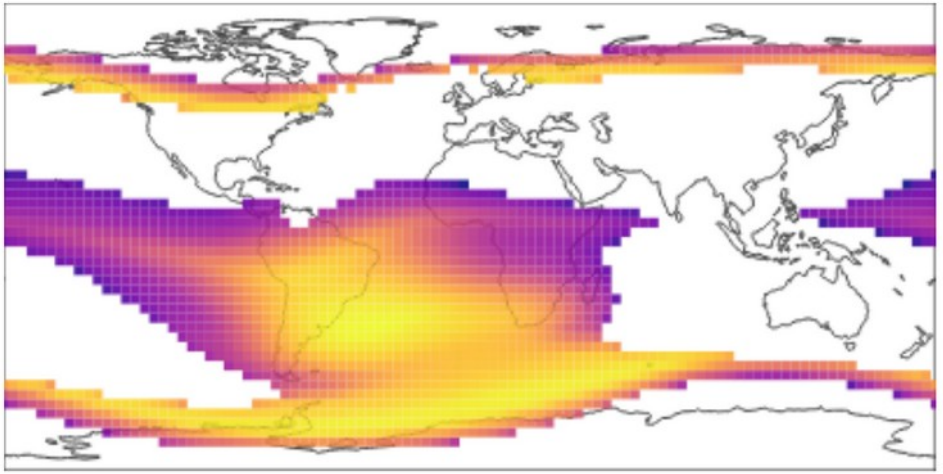
Radiation exposure is also key to survivability vs. cost tradeoff.



Data source: IRENE, electron flux at ~560 km

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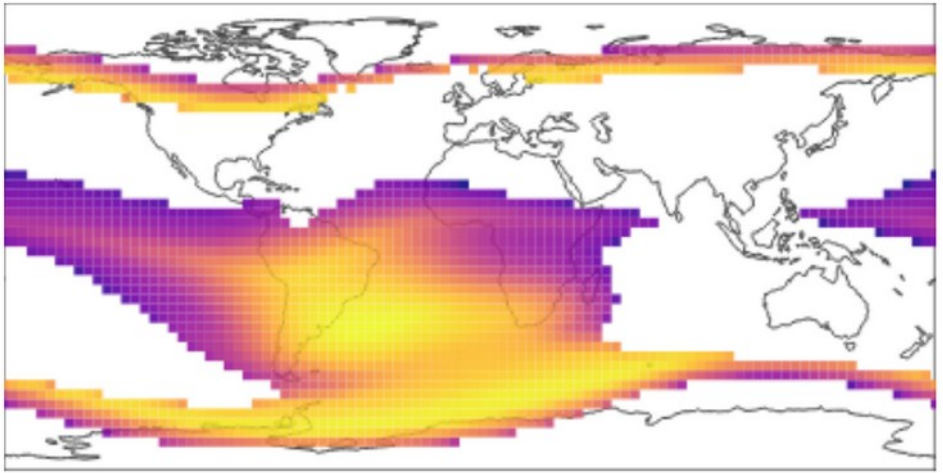
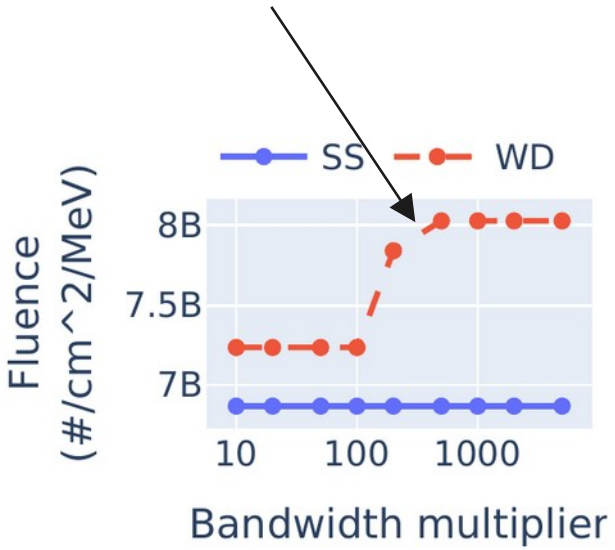
~23% reduction in radiation exposure





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Future challenges:

- *How to make time-aware **topologies and routing**?*
- *How can reduced radiation exposure improve **fault tolerance** protocols?*
- *What **simulation** methodologies are required?*
- *How should **control plane** evolve to handle heliocentric traffic patterns?*

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- ***How can we determine the best "sizes and shapes" for SS-plane constellations based on spatiotemporal demand structure of relevant applications?***

Thanks!

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