

Overcoming Orbital Complexity

Why Space Needs Software-Defined Networks

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March 20, 2026



Aperio Space Technologies



BUSINESS
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Aperio Space Technologies is participating in the ESA Business Incubation Centre Hessen.



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Bent Pipe



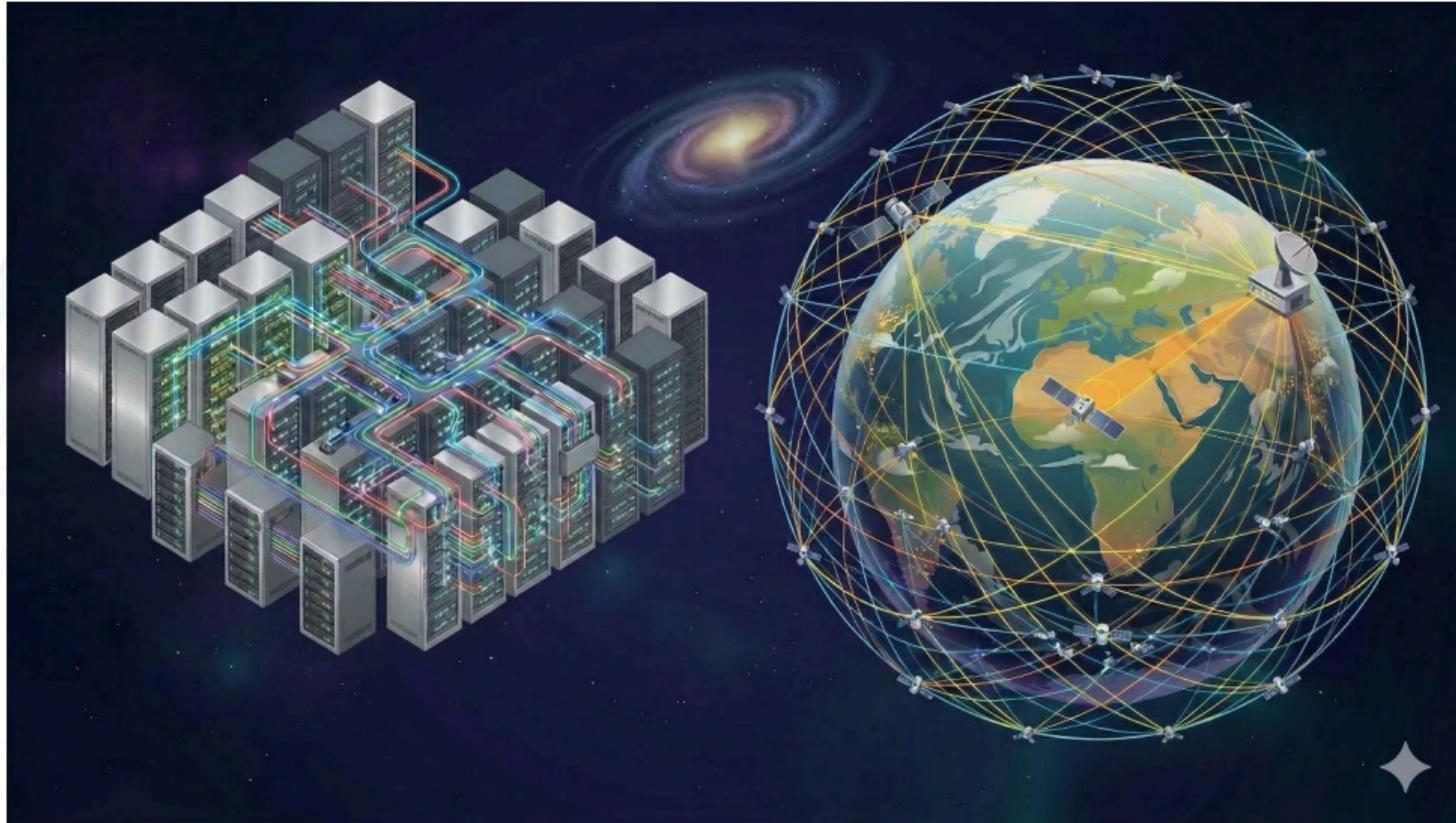
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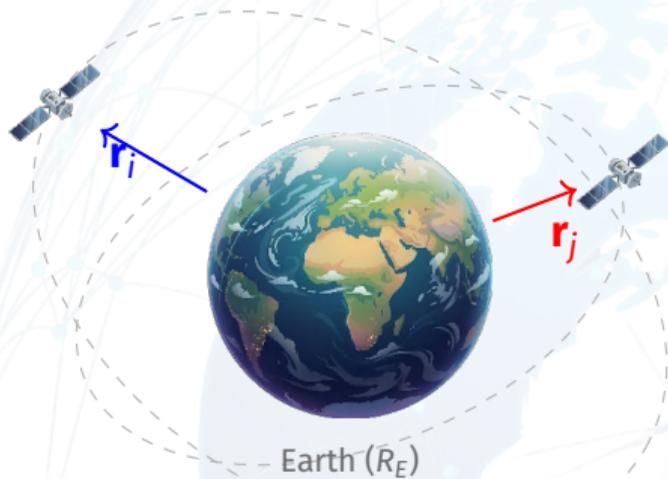
Mesh Network

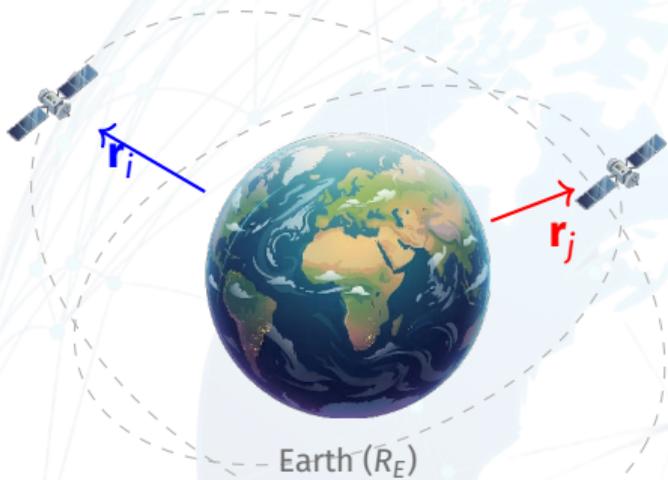


Terrestrial vs Non-Terrestrial Networks



1. Keplerian Orbit $r = \frac{h^2}{\mu(1+e \cos \theta)}$

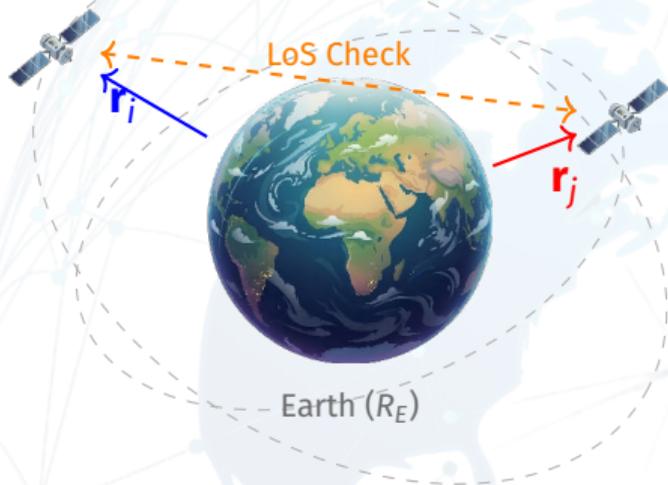




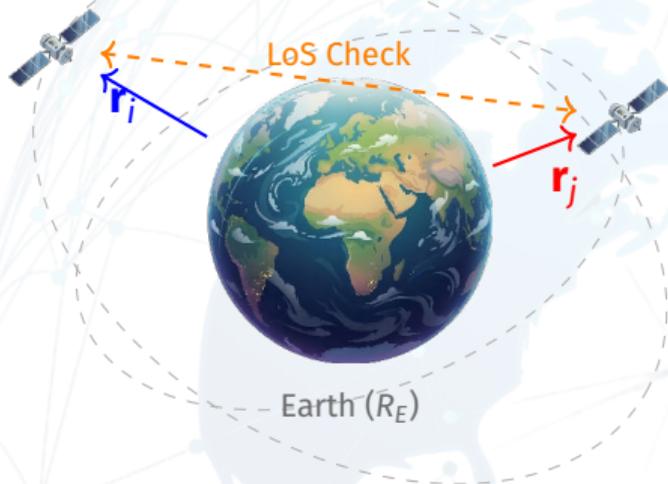
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2. **Kepler's Equation (Iterative)**

$$M = E - e \sin E \Rightarrow E_{n+1} = E_n - \frac{E_n - e \sin E_n - M}{1 - e \cos E_n}$$



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 $\mathbf{a}_{J_2} = \frac{3}{2} J_2 \frac{\mu R_E^2}{r^6} \left[\frac{x}{r} \left(5 \frac{z^2}{r^2} - 1 \right) \hat{i} + \frac{y}{r} \left(5 \frac{z^2}{r^2} - 1 \right) \hat{j} + \frac{z}{r} \left(5 \frac{z^2}{r^2} - 3 \right) \hat{k} \right]$



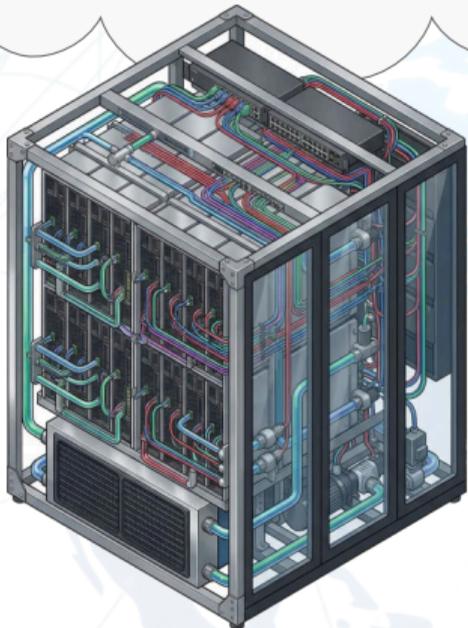
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6. **Solve the time-aware Routing Problem**

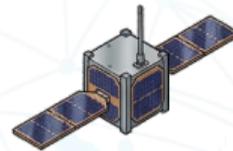
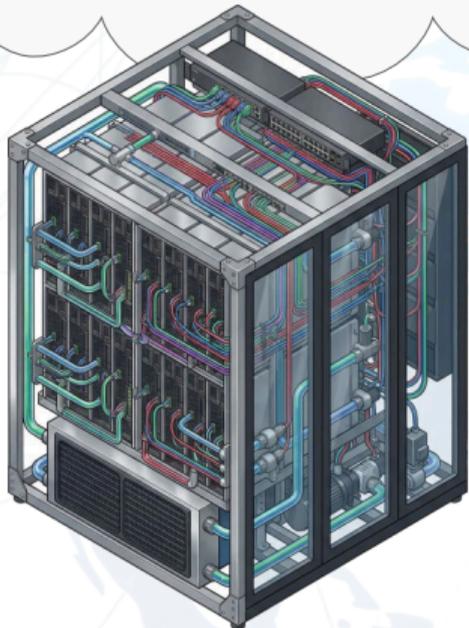
The Hardware Reality: SWaP constraints

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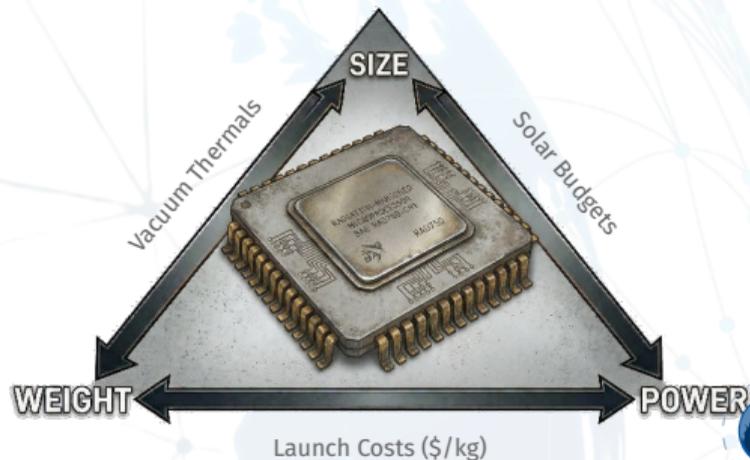
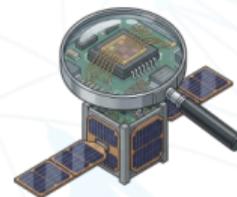
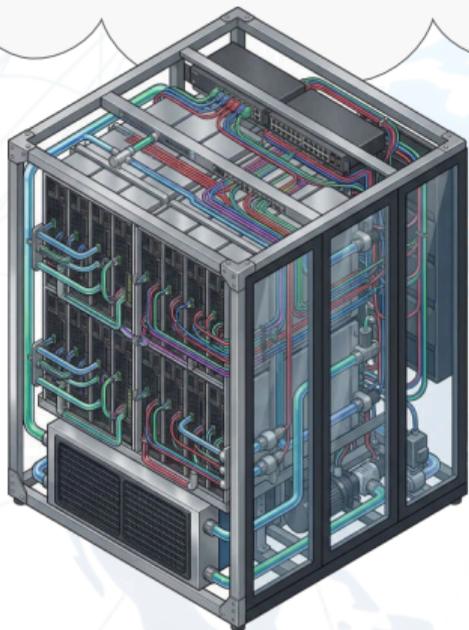
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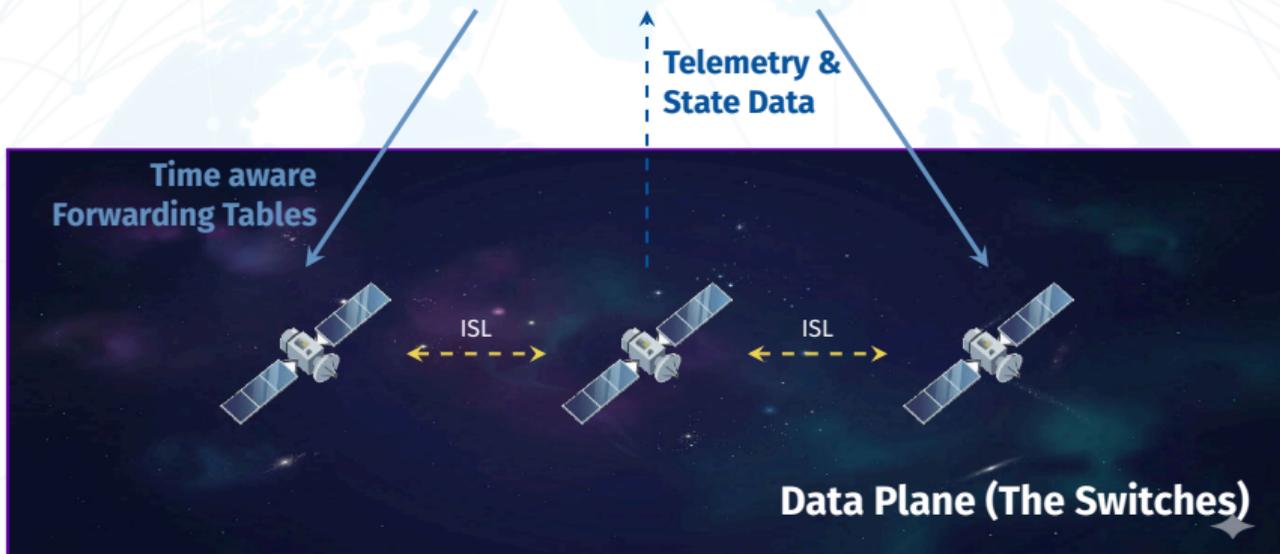


Introduction to SDN: The Control Plane



SDN Controller

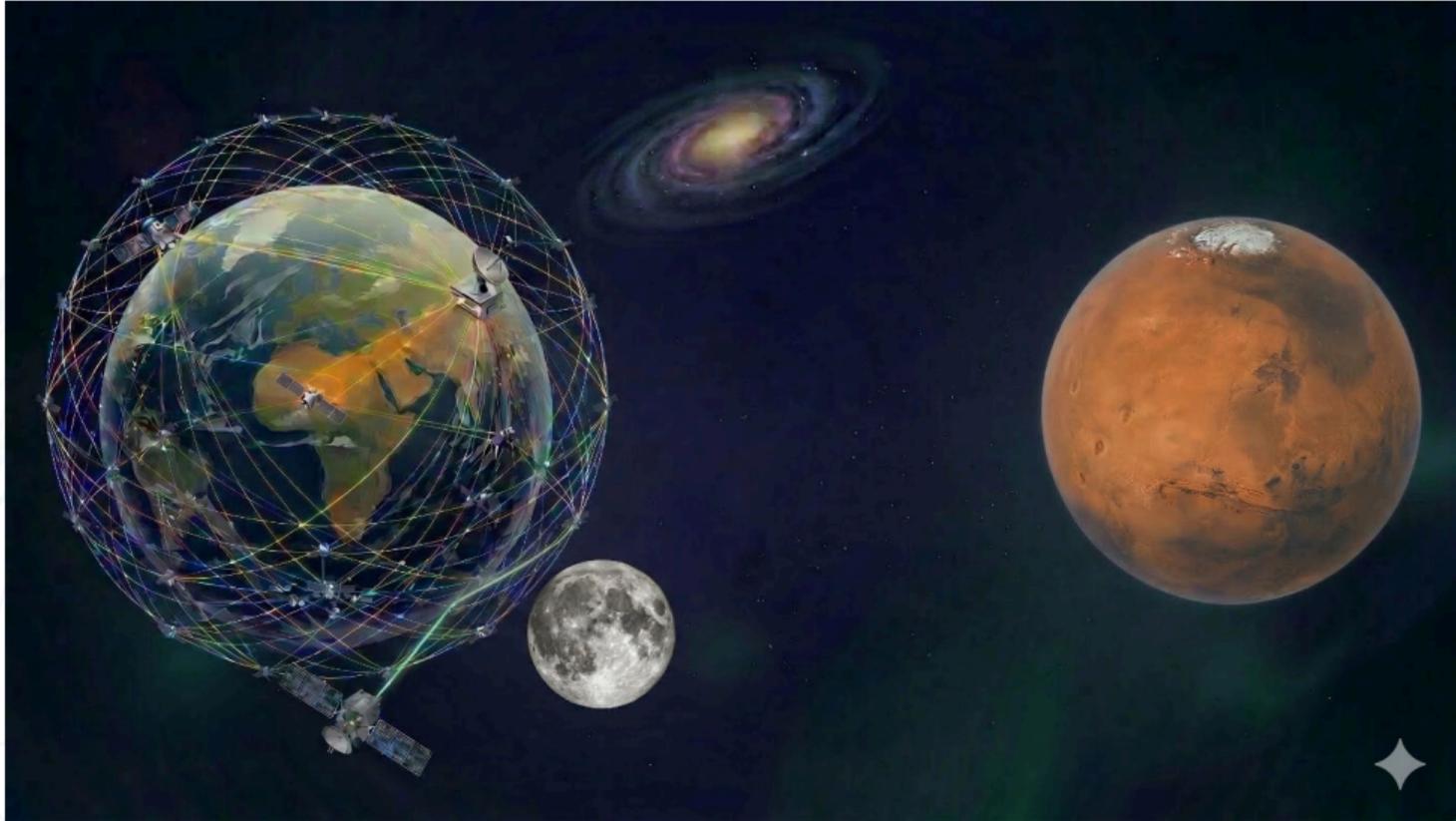
Global View & Route Calculation



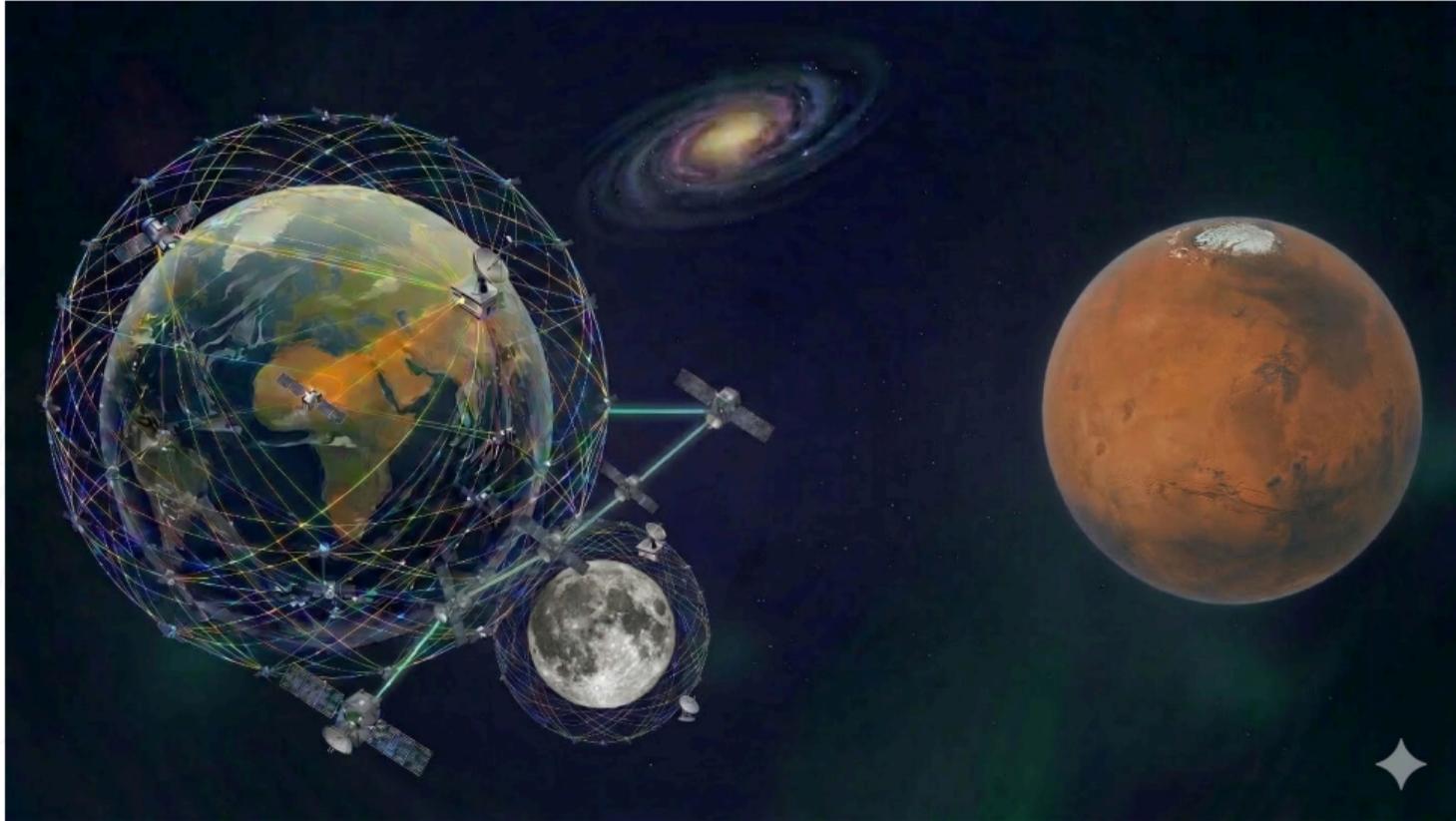
Time-Aware Routing



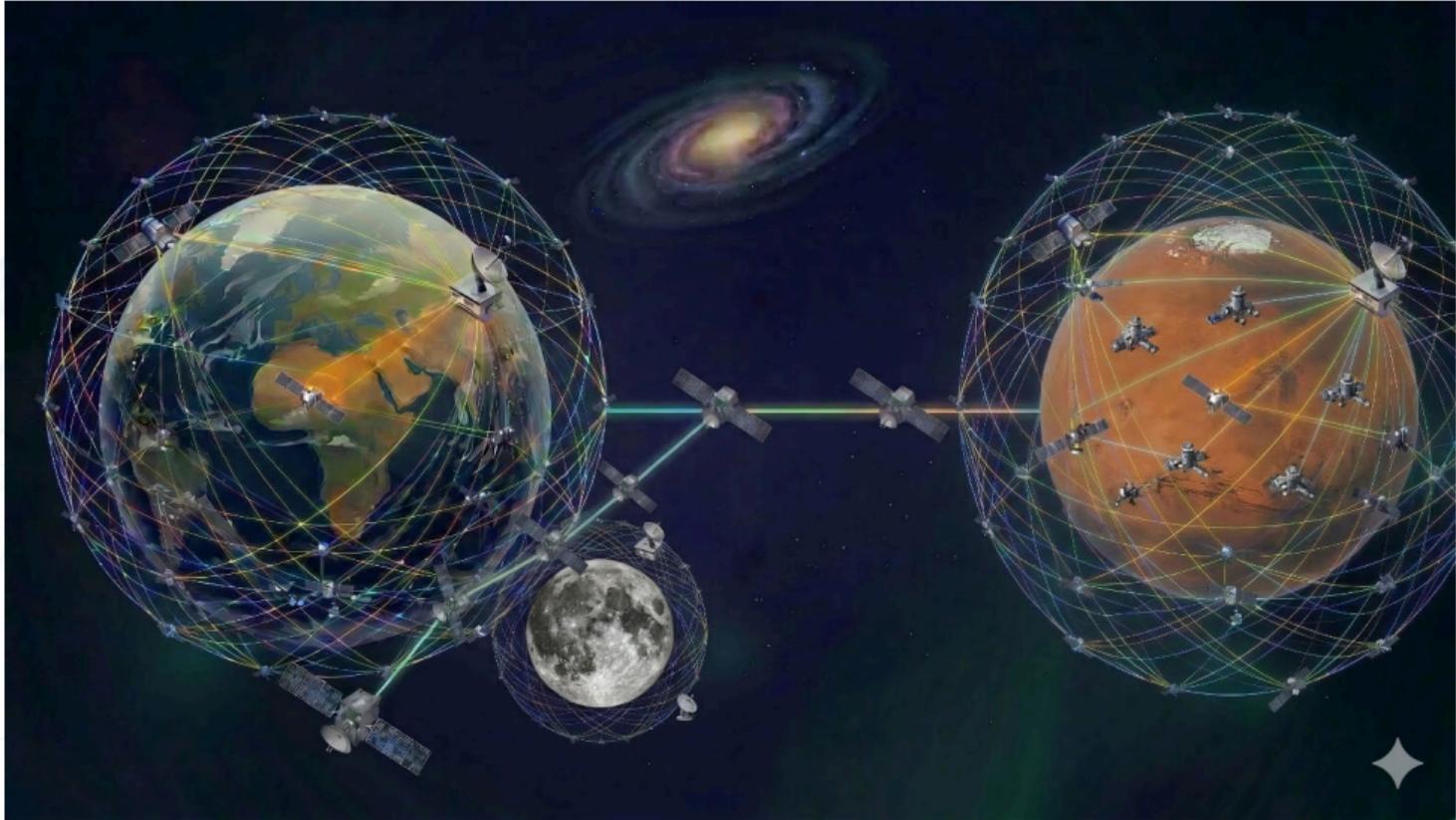
Adaptability to Diverse Environments



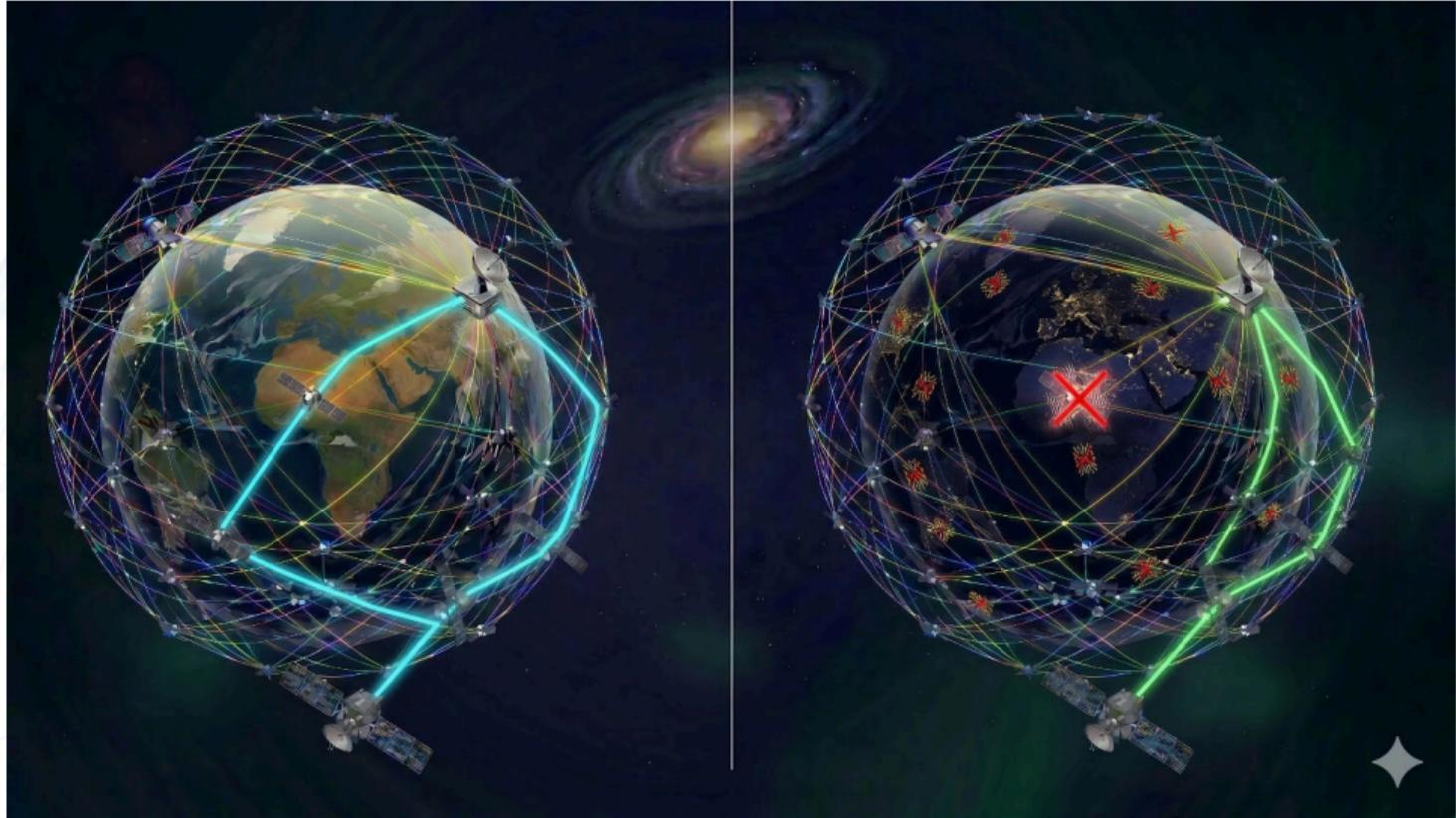
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Adaptability to Diverse Environments



Adaptability to Problems: Jammed Satellites

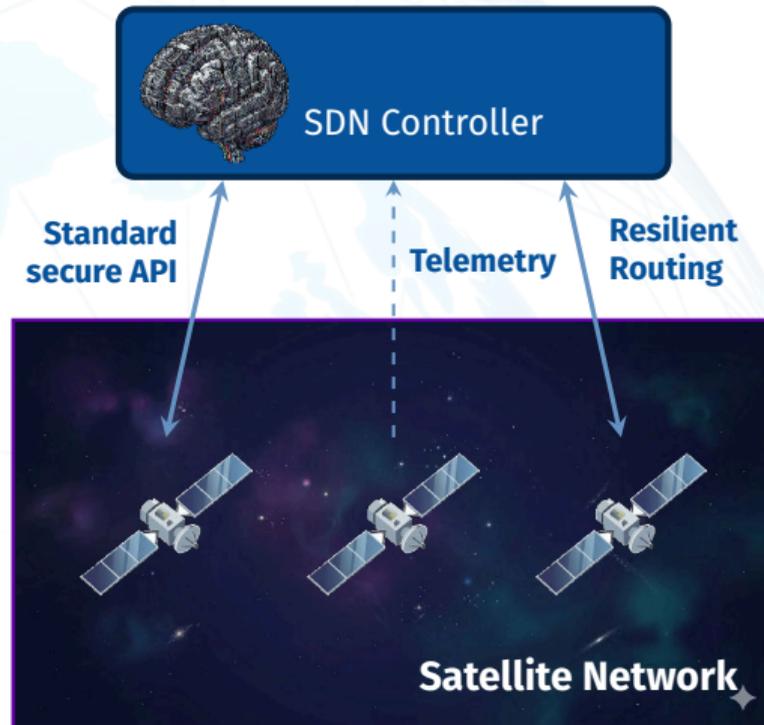


Adaptability to Problems: Dual Use



1. The Engineering Challenge

- Highly dynamic Topologies → Computational Challenge
- SWaP limits → Offload Computations



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- Highly dynamic Topologies → Computational Challenge
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2. The Shift to Space

- Introduction of Non-Terrestrial Networking for 5G, 6G and beyond
- Europe's push to a sovereign resilient infrastructure (IRIS²), Germany SatComBW2, etc.
- → European solutions are needed!



Thank You. Any Questions?



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**Let's talk about your constellation
to shape the future of space connectivity together.**

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