Deep Space Communications

Colloquium
Panel
Overview

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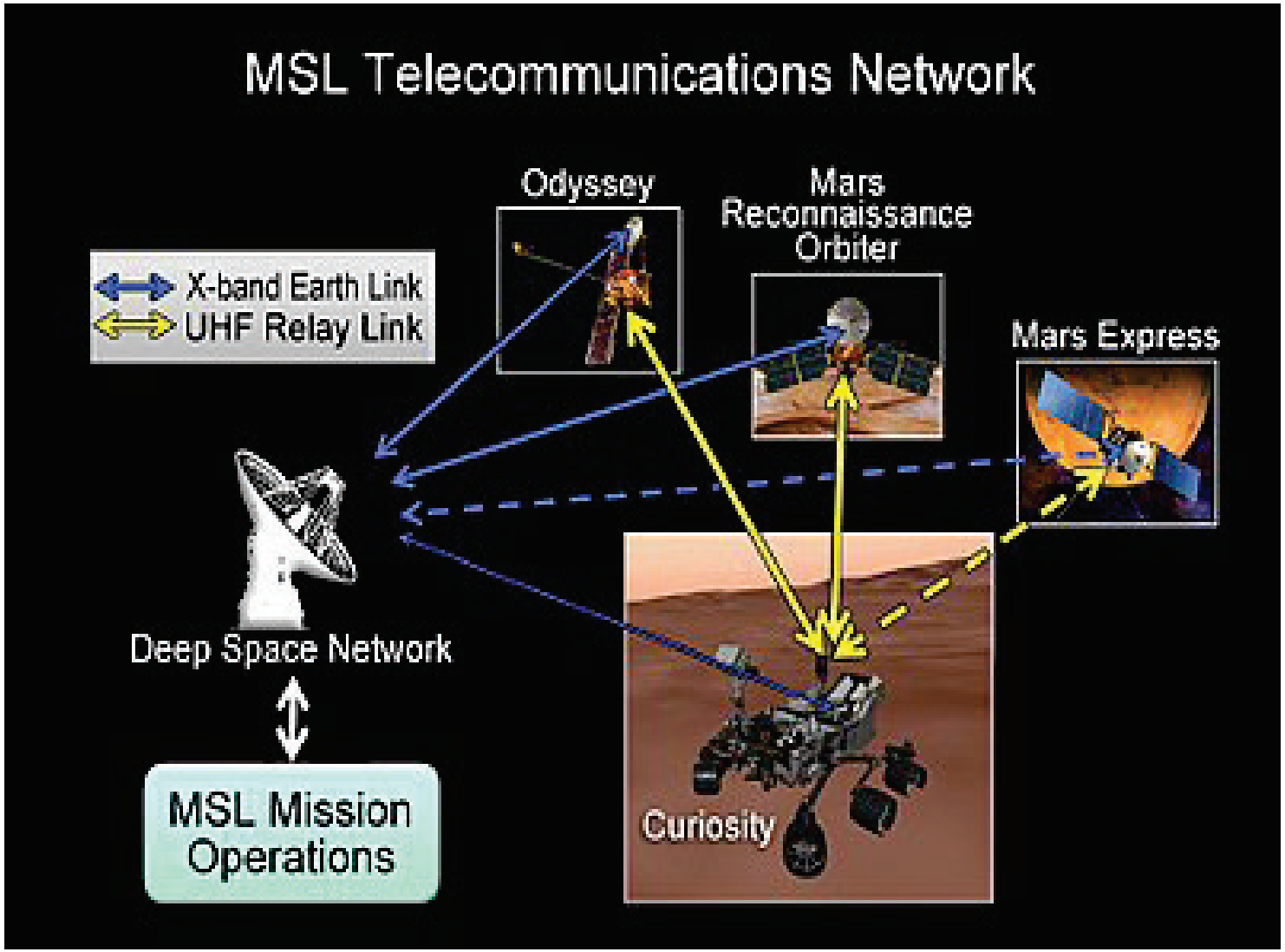
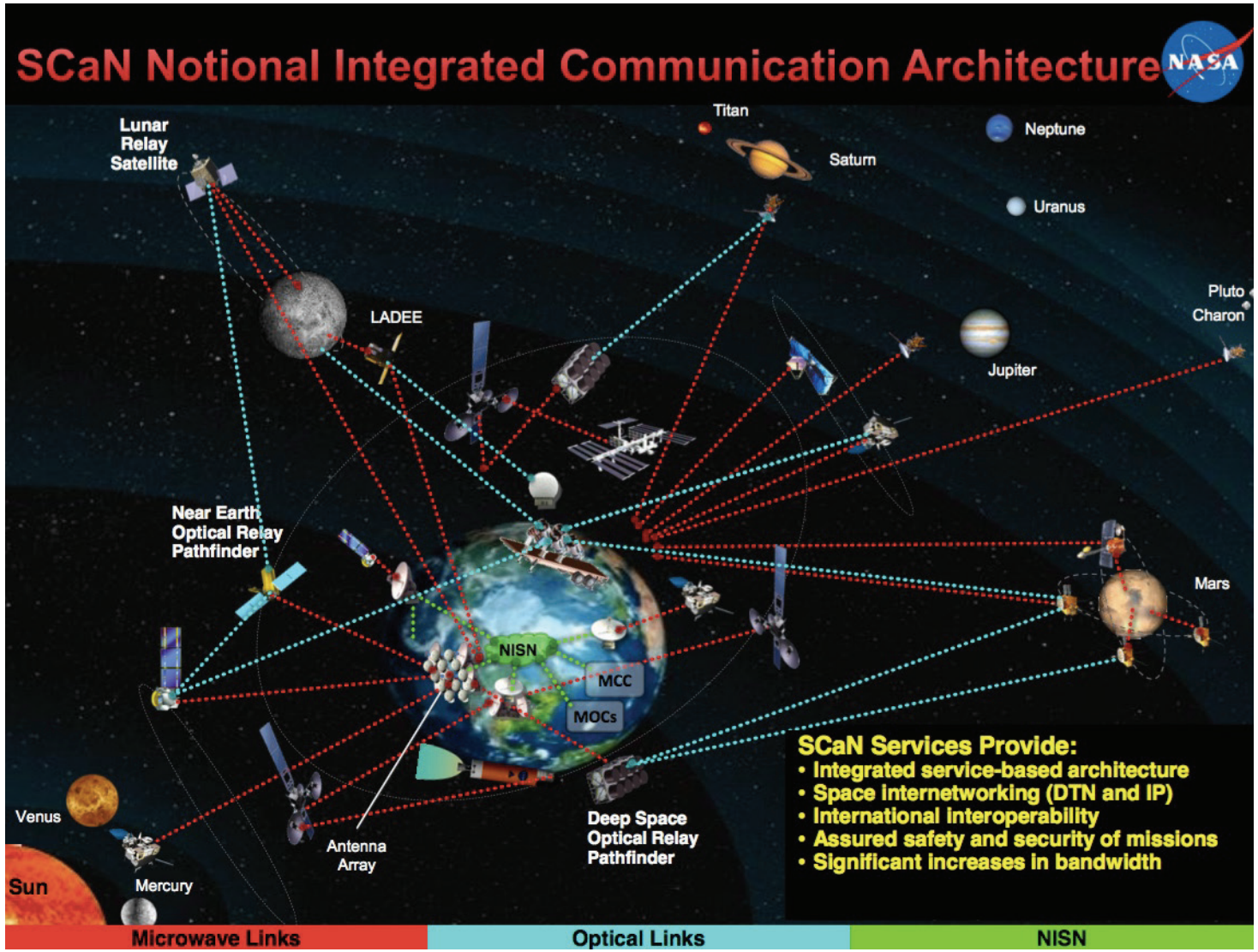
Deep Space Communications Evolution: Connectivity (DSC) To Networks (DSN)



- Deep Space Communications proven, enhanced, RF-based since the 1960's
- Performance Baseline: Simplex Systems; Space Platform to Earth; Limited bandwidth and quality
- Dependencies: Costly ground infrastructure; limited SWaP onboard space platform for scale; budget cycle
- Future: Deep Space (planetary optical) Networks

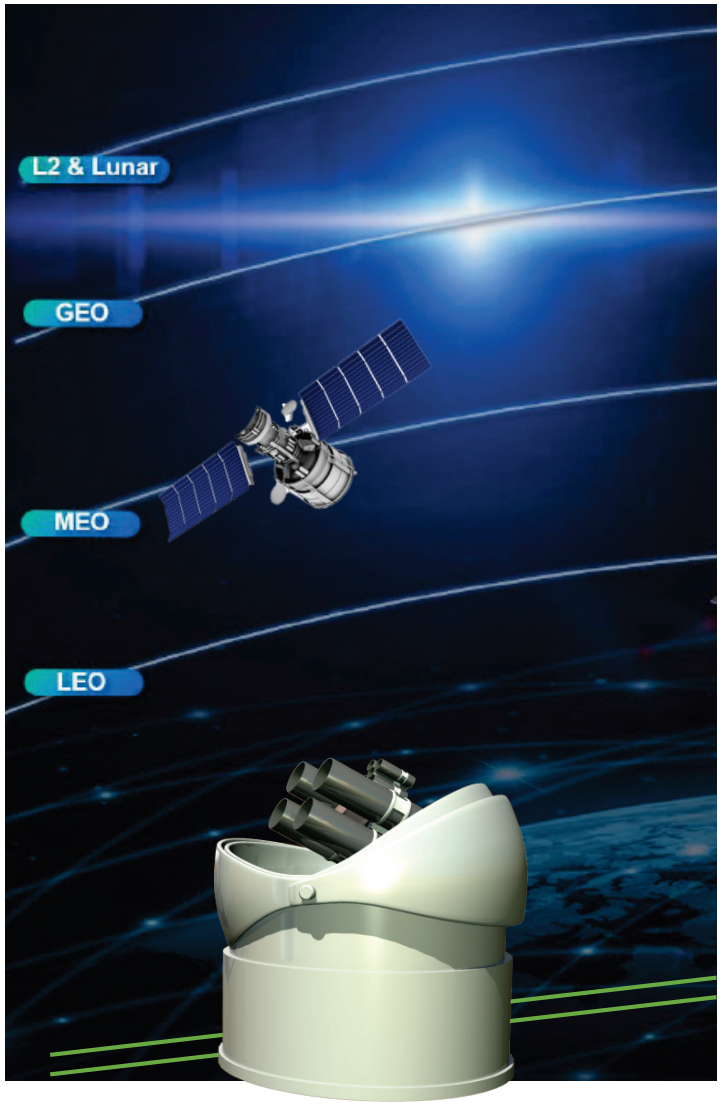
Deep Space Networks: Integrated Communication Infrastructure



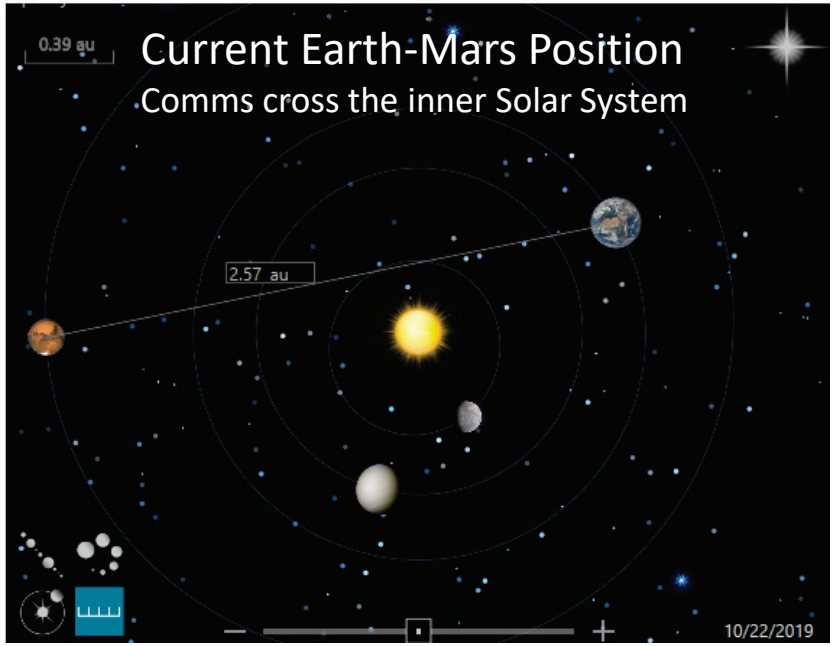
- Migration From Legacy DSC platforms to Next-Gen integrated, hybrid platforms – RF & Optical
- Performance Baseline: Increase bandwidth (Kbps - Gbps); enhanced data quality (High Resolution)
- Dependencies: Significant integrated, dual-use, space & ground infrastructure (RF & Optical); Sustainment & Expansion; Private capital
- Future: NASA “Commercial” SCaN; Private sector infrastructure integrated with space agency platforms; service-based relationship

Deep Space Infrastructure: Earth To Beyond

- Infrastructure:
  - Deploy from Earth outward; Dual-Use or Bespoke
  - Earth Apertures – Disbursed, Open, Accessible
  - Earth Relays (LEO, MEO, GEO, Cislunar)
  - Lunar and Lagrangian – Base Stations; Orbiting Platforms; Relay Transfer Platforms (L1, L2)
  - Other Planetary Orbit – Dual Use Platforms
- Temporary Relays - Bespoke
  - "Duckling" networks that follow a mission – but will not stay in alignment for typically more than a few months
- Evolved Relays
  - Long range mesh and persistent relays,
  - Advanced comms; amps; telescopes, antennas
  - Advanced propulsion technology needed
  - Low mass, high acceleration, long endurance, low cost necessary to station keep while overcoming solar gravity



Deep Space Networks: Basic Challenges



DISTANCE! (Comms loss as Range^2)

- Near Earth GEO Orbit – 36,000 km
- Lunar Orbit – 385,000 km (10x)
- Earth to Mars – 70,000,000 to 400,000,000 km **(10,000x)**

GRAVITY! (Unstable Orbits and Changing Paths)

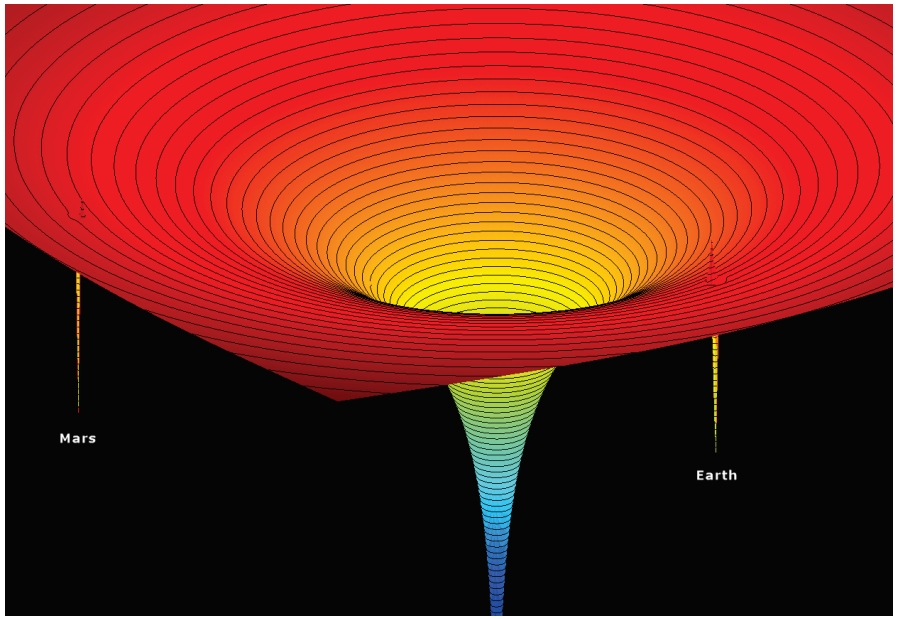
- Can only persist easily in planetary orbits and at Lagrangian points

TECHNOLOGY

- Low SWaP-C: LCT's; ISL's; Amplifiers; Power; Platforms
- Pointing and tracking – acquisition control plane

DEMAND !

- Customer service requirements
- Scale, Cost, Partnerships



Source: http://rainbowboys.blogspot.com/2007/08/homemade-gravity-field-plot.html

Deep Space Networks: Transition From Govt To Commercial DSN

DEEP SPACE COMMUNICATONS

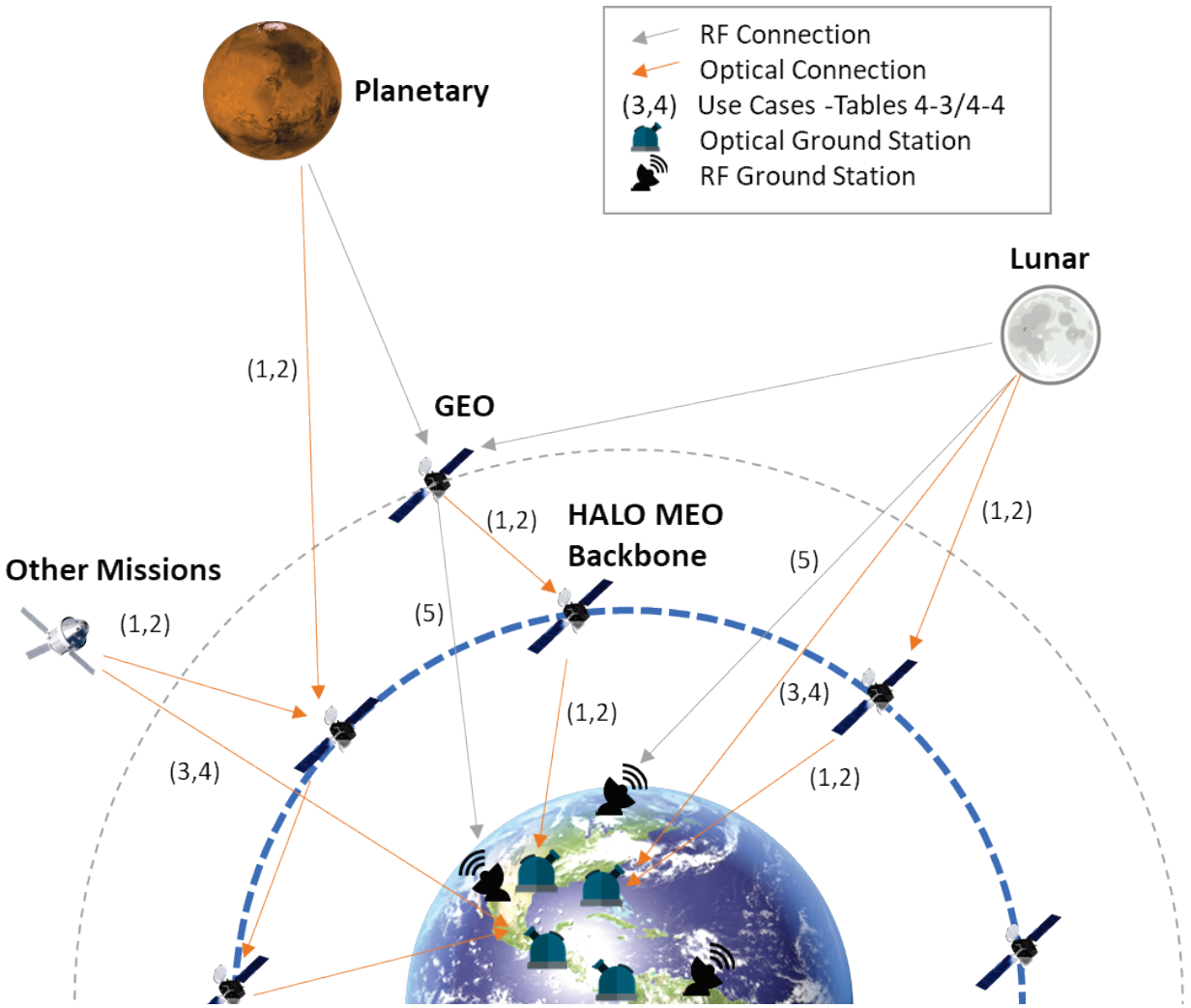
- Unique Government-funded and operated systems
- Government mandated standards and detailed specifications
- Unique point solutions
- Fielding paced by Government budgets & development of black boxes
- Emphasis on science and technology, not extended operations
- Commercialization of tech not services

OPEN TO ALL SCALEABLE COST-EFFECTIVE

DEEP SPACE NETWORKS

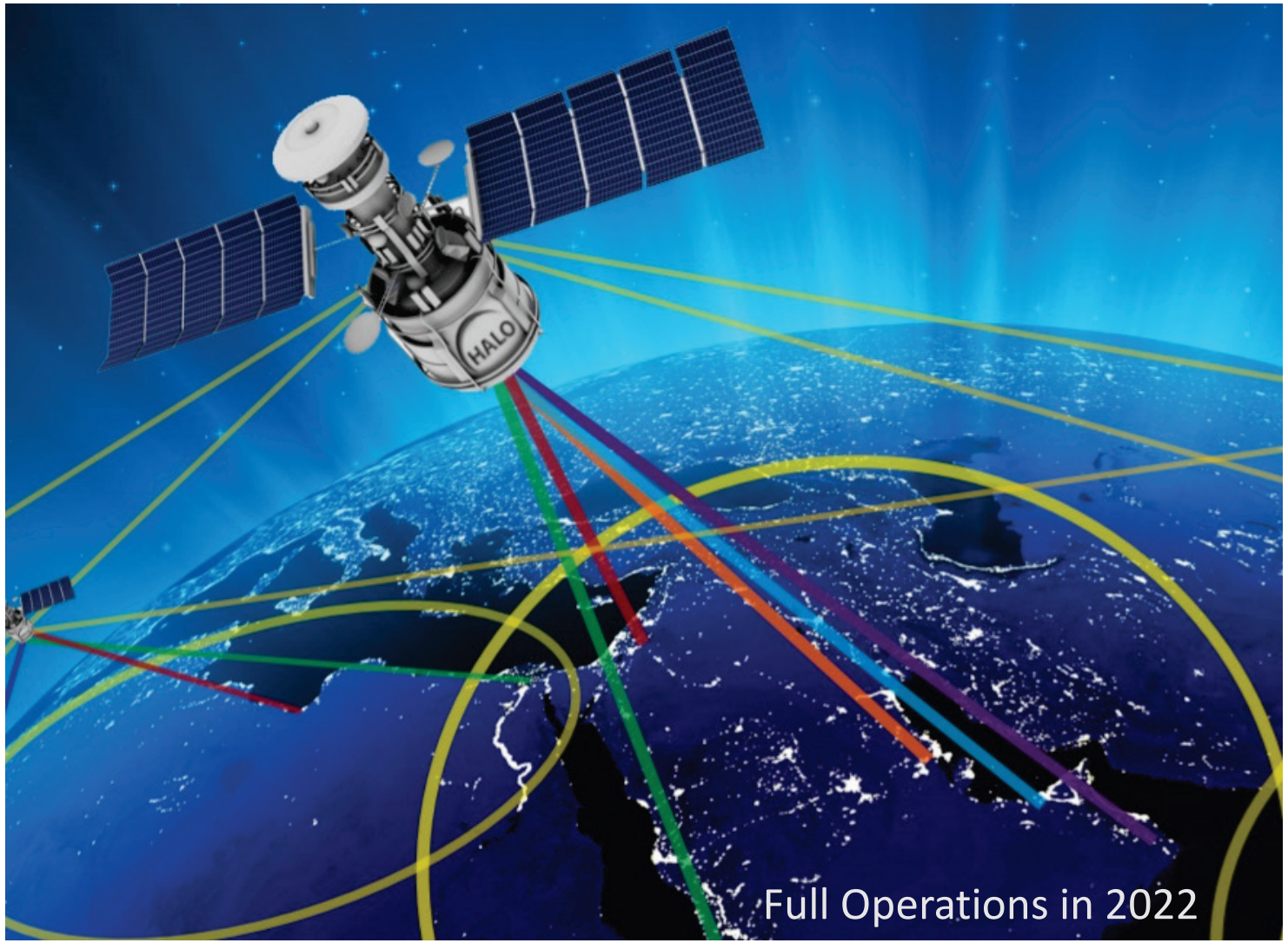
- Commercially financed infrastructure – risk/reward balance
- Race to Scale & Diverse Users
- Industry Scale drives vendor standards
- CAPEX/OPEX advantage goes to most cost-effective solutions
- Fielding paced by demand for innovation and advanced services
- User experience drives additional investment in infrastructure

Deep Space Networks
A Commercial Use Case – "HALO"



Satellite Connection
1. Compatible user terminal connected to dedicated HALO terminals oriented to space
2. Compatible user terminal connected to hosted space terminal (e.g. a NASA payload)
Ground Connection
3. Compatible space user terminal connected to HALO Ground Node
4. Compatible space user terminal connected to hosted optical terminal at HALO Ground Node
5. Compatible space RF user terminal connected to ATLAS RF Ground Node

Deep Space Networks: About Laser Light



- High Articulated Laser Optics (HALO™) global network
- Baseline: Carrier-grade, on-demand, end-to-end routes anywhere in the world with unprecedented privacy & security.
- In Design: Space-based optical relay services (near Earth and Lunar)
- Future: Advanced distribution network for Deep Space planetary networks

Deep Space Networks: "HALO System" Segments

- HALO Optical Satellite System™ (OSS)
  - Global laser satellite MEO constellation
- StarEdge™ Ground Nodes (SGN)
  - Laser enabled ground nodes, directly connected to SD-WANs for local distribution
- Extended Ground Network (XGNS)
  - Everything to route HALO terrestrially;
  - SDN equip, OTN equip, long haul and metro finer, colo, hosting, interchange, etc.
- StarBeam™: Network Operating System (NOS)
  - Distributed, fully autonomous AI operating system