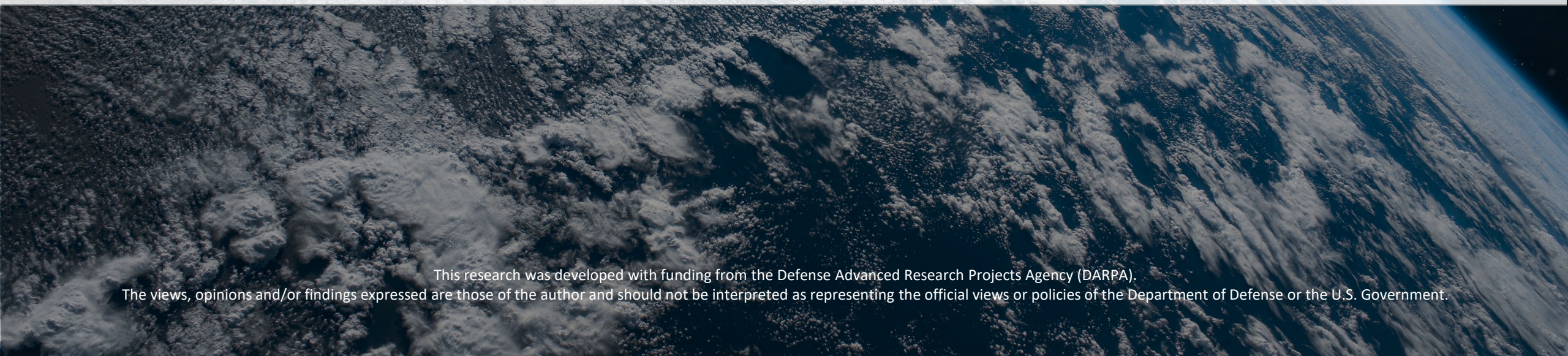
DARPA 10-year Lunar Architecture Capabilities Study (LunA-10)
Lunar Infrastructure Optical Node (LION)

FIBERTEK, INC.

25 April 2024

Mark Storm, Principal Investigator



This research was developed with funding from the Defense Advanced Research Projects Agency (DARPA).
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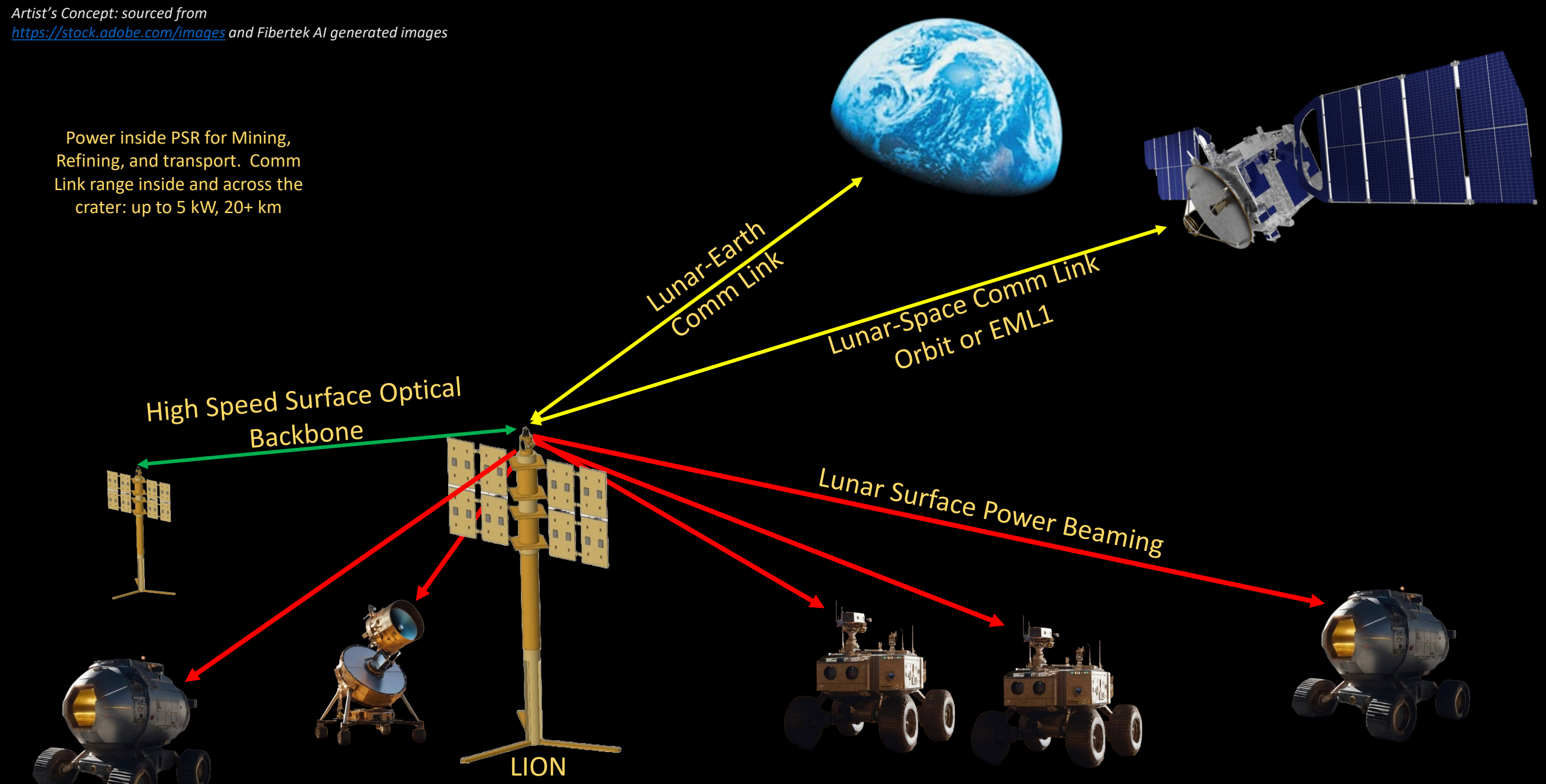
Artist's Concept: sourced from https://stock.adobe.com/images and Fibertek AI generated images



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Lunar Infrastructure Optical Node (LION)

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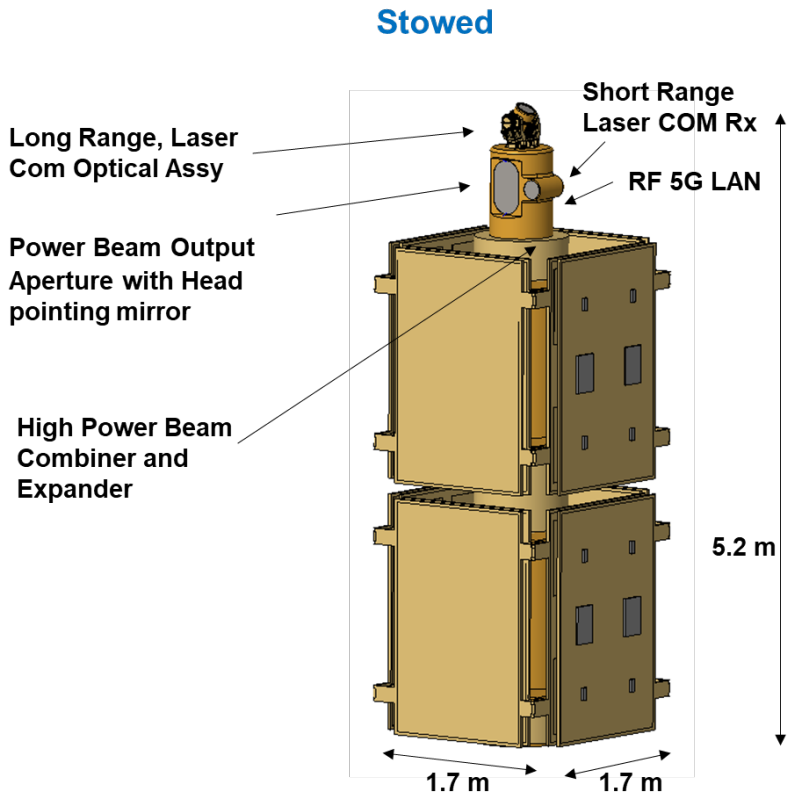
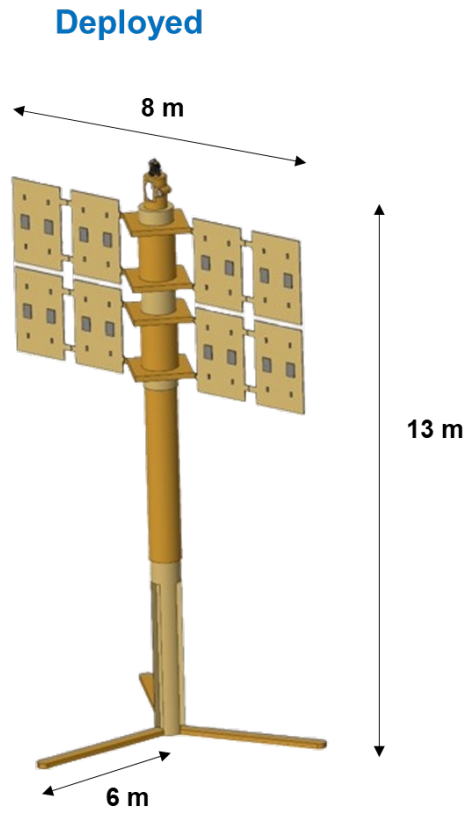
Key Hardware Features

- Low-mass, efficient thermal management
- Modular, configurable design for multi-service integration, scalability, inherent redundancy
  - Laser Power Beaming
  - Optical/RF Communications
  - Position, Navigation, & Timing (PNT)
- High-TRL component technologies





High-efficiency, sustained laser power beaming on the Lunar surface through low-mass and efficient thermal management

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LION Scalability - SWaP Optimized Solutions

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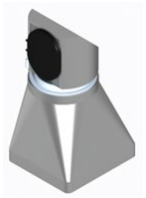
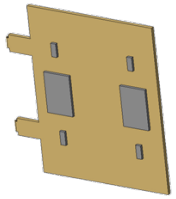
Regulated Power to User (kW)

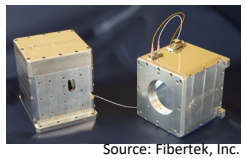
LION Nano

- **0.35 kW regulated power**
- Mass: <80 kg, *no tower*



Source: Fibertek, Inc.

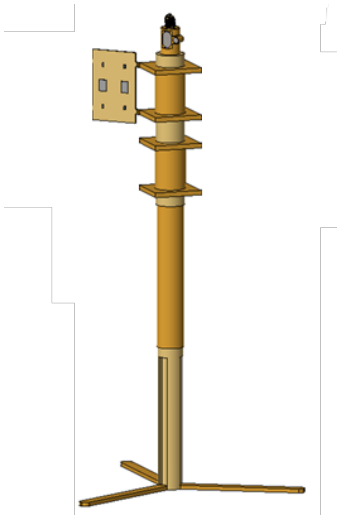




Source: Fibertek, Inc.

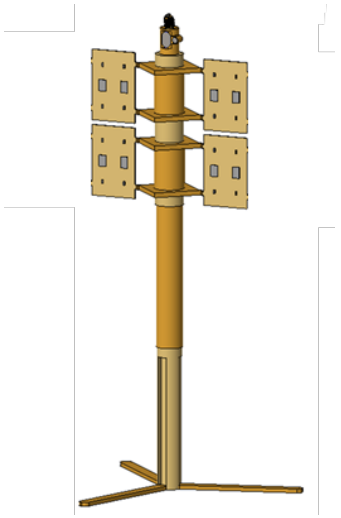
LION Micro

- **0.74 kW regulated power**
- Mass: 223 kg, including tower
- Tower height per application



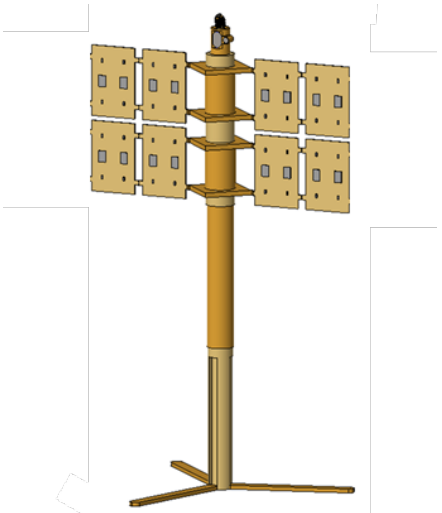
LION Mini

- **3.0 kW regulated power**
- Mass: 285 kg, including tower
- Tower height per application



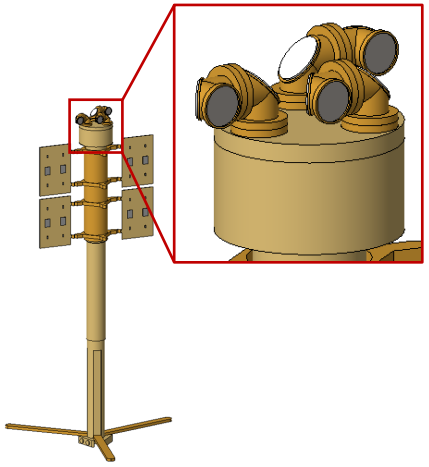
LION

- **5.9 kW regulated power**
- Mass: 360 kg, including tower
- Tower height per application



LION Multi

- **Individual beam directors per laser**
- **Power scalable**
- SWaP: Scalable, up to full LION
- Tower height per application



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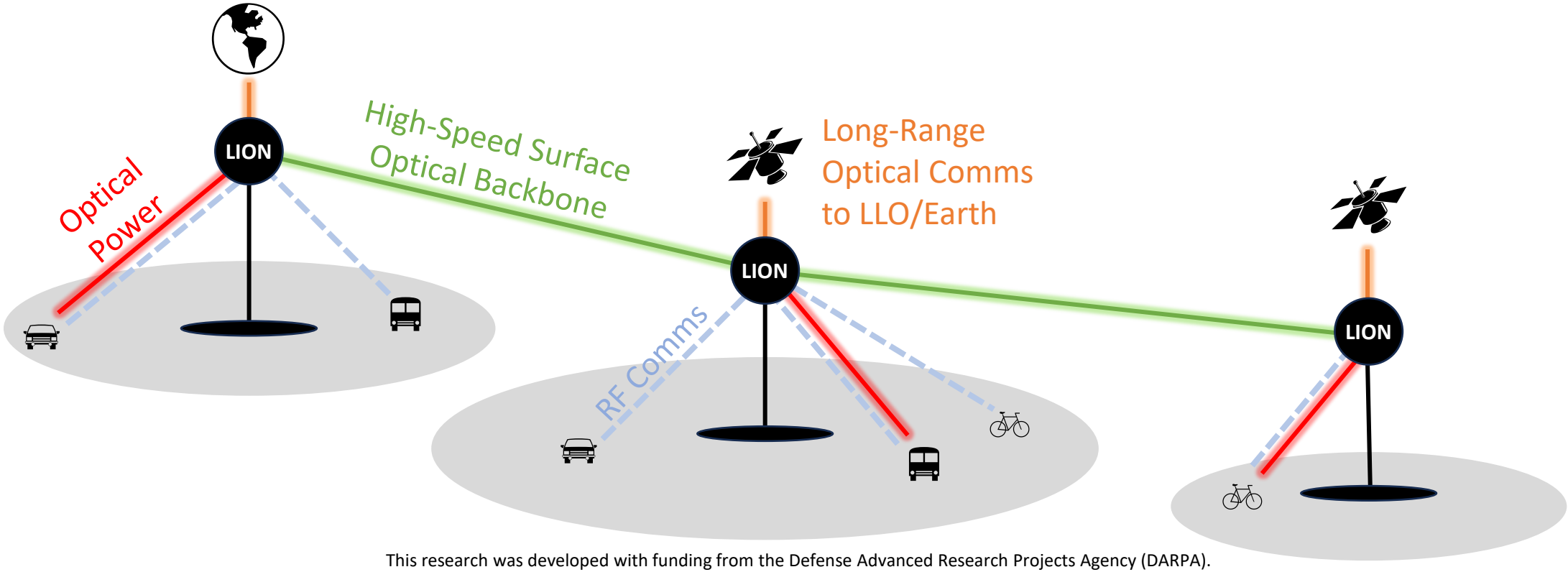
LION Network Scalability

- Each LION terminal serves as a *fully capable* network node providing:
  - Optical Power Beaming
  - Long-Range Optical Comms (to Orbit or Earth)
  - Surface RF Comms (between users)
  - Short-Range Optical Network Comms (high-bandwidth users, LION terminals)



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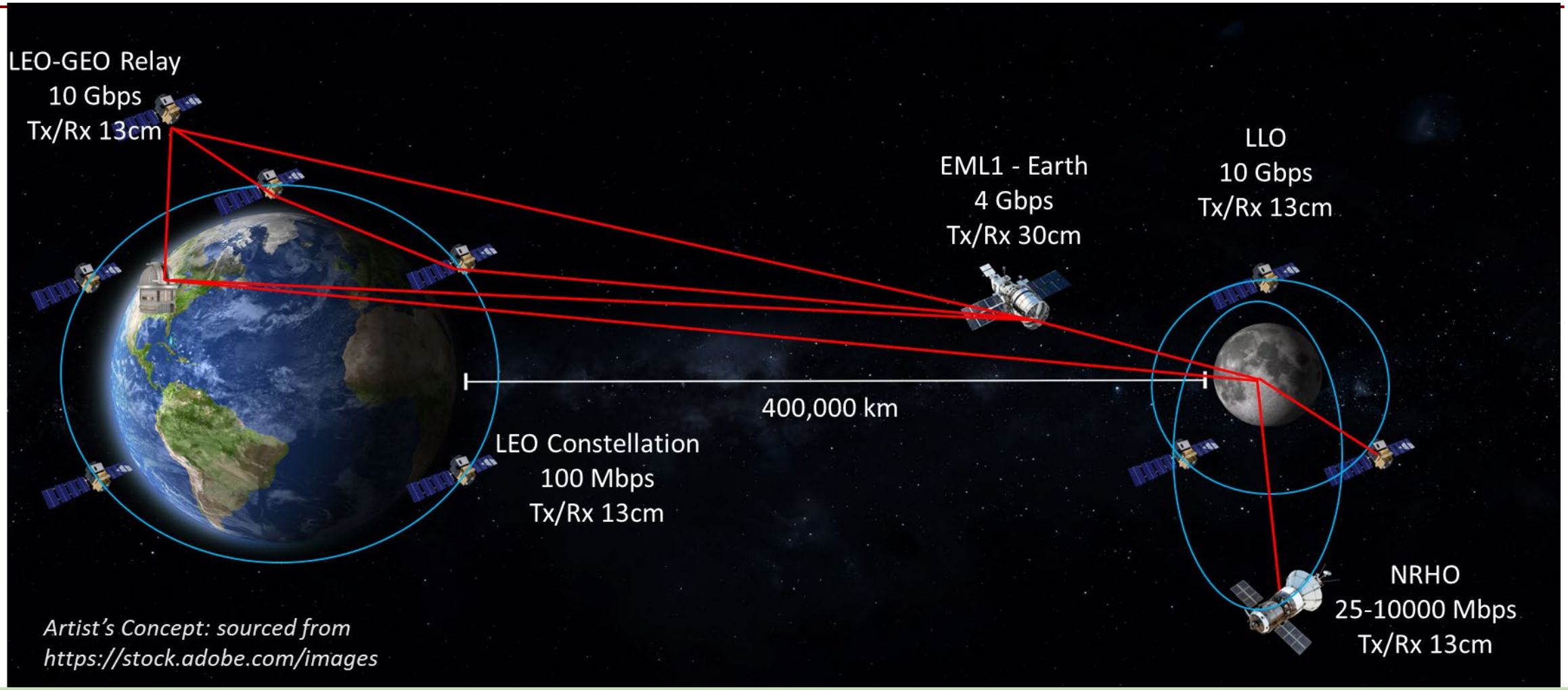
Off Surface Optical Links to support persistence



Long-range optical comms link budgets modeled from first principles and verified using commercial software enables key capabilities from lunar surface direct to Earth, satellite relays, and constellations.

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LION: Power & Data Costs

	Input Power Cost (Daytime) ($/kWh)	Power Beaming ($/kWh): Fully Loaded Production Price ($/kWh)	Power Beaming ($/kWh): Distributed Launch Costs ($/kWh)	Optical Communication to Earth/Orbiter ($/Gb): Fully Loaded Production Price ($/Gb)	Optical Communication to Earth/Orbiter ($/Gb): Distributed Launch Costs ($/kWh)
	Earth: 0.1	**1.4k – 1.8k**	432	0.6 – 0.9	0.15
	10	**1.4k – 1.8k**		0.6 – 0.9	
CBE	**100**	1.8k – 2.2k		0.6 – 0.9	
	1,000	6.4k – 6.8k		0.7 – 1.0	

- Operating costs are *low*, biggest unknown is input power costs
  - On Earth, power is ~ $0.10/kWh
  - Current Best Estimate (CBE) Lunar Daytime Input Power: $40 – $600/kWh
- Launch costs assumes $500,000/kg, tower is included in Power Beaming payload only
  - Users will have to purchase or provide their own laser power receiver & optical communications payloads
- Assumptions include:
  - 10-year mission
  - 90% operational duty cycle
  - 1 LION terminal
    - Power Beaming: 20% end-to-end efficiency
    - Laser Comms: 400 Mbps
- LION Nano: Cost is driven by launch (35 kg @ $500k/kg = $17.5m for expected 1 Lunar day, unknown operational time or input power costs)

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