

LUSTER-net

A scalable lunar-surface UVOIR
time-domain observatory

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LUSTER-net concept team | Caltech/IPAC | 2026



Artist's concept - one



Why the Moon - and why now?

WHY THE MOON

A stable surface for persistent observing

- **Long observing windows**
No repeated low-Earth-orbit occultations interrupt long time series.
- **Uninterrupted sky access**
Lunar surface provides atmosphere-free sky access.

WHY NOW

Lunar access is changing

ARTEMIS + MOON BASE

Moon Base planning is building sustained lunar-surface capability.

CLPS

Commercial payload delivery and integration are established pathways.

EMERGING SERVICES

Power, communications, relay, mobility, and logistics are becoming concrete interface trades.

The scientific need and the lunar access environment are converging.

Science drivers need persistent UVOIR follow-up

THE COMMON NEED

MINUTES



MONTHS

rapid response + stable
baselines + calibrated
products

EXOPLANET ATMOSPHERES

Repeated multi-band transits and stable photometry

MICROLENSING

Earth-Moon parallax and well-sampled light curves

SOLAR SYSTEM

Time-resolved photometry, astrometry, and non-sidereal tracking

TRANSIENTS + MULTI-MESSENGER

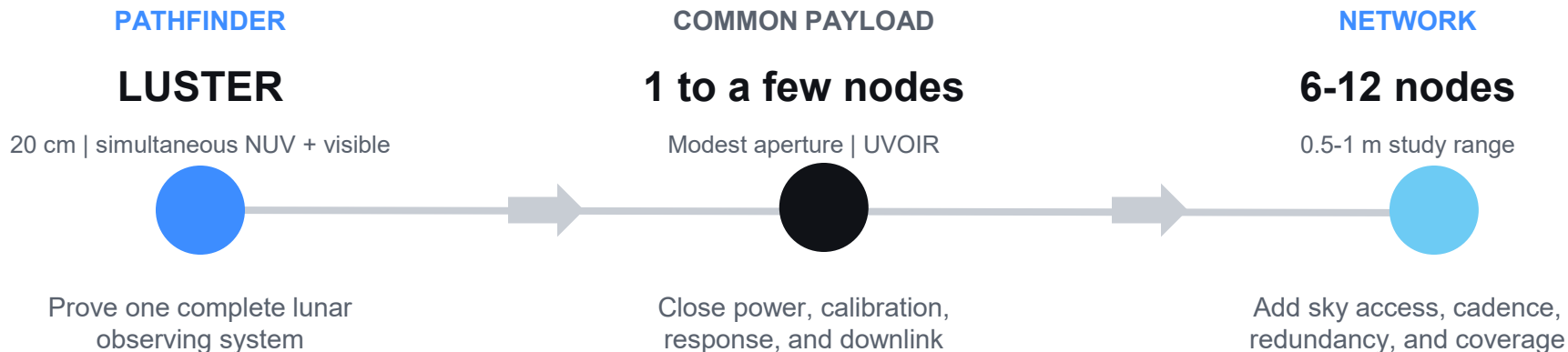
Rapid colors, light curves, and low-resolution spectra

STELLAR VARIABILITY

Long, consistently calibrated monitoring sequences

Discovery alerts identify the event; LUSTER-net is designed to characterize its physics.

LUSTER-net scales through repeatable payloads



What scaling provides

sky access • cadence • redundancy • wavelength coverage • rapid response

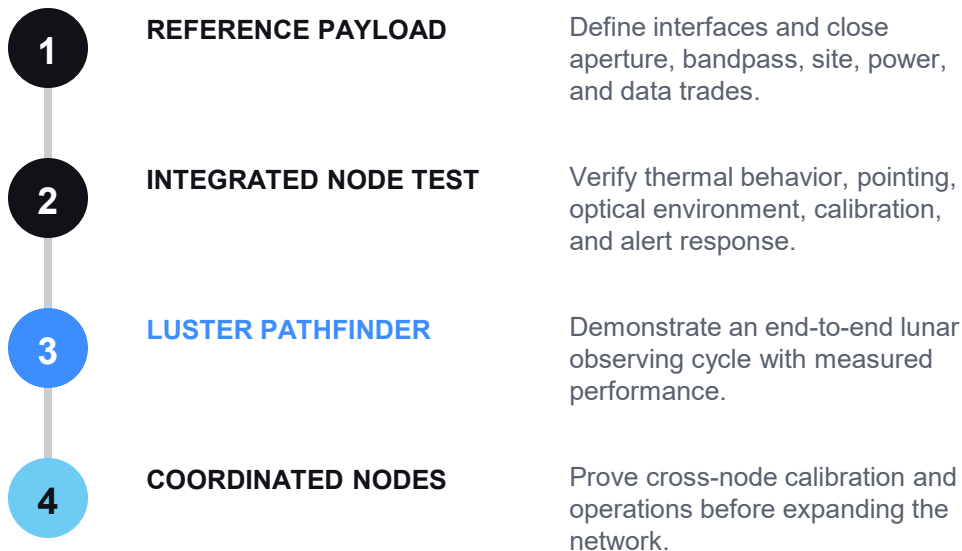
Node count, aperture, sites, and instrument mix remain study trades - not frozen requirements.

A practical roadmap uses modest, repeatable payloads

THE HARDWARE PREMISE

**No novel
large-aperture
optical architecture
is required.**

The development challenge is reliable lunar-surface operation: power, thermal stability, calibration, and coordinated observing.



Scale only after the node closes its power, calibration, and operational requirements.

Common operations make the nodes one observatory

The network is valuable only if its measurements and decisions remain consistent across sites.

01

PLAN + POINT

Stable tracking, long dwell times, non-sidereal targets, and rapid target-of-opportunity response.

02

COORDINATE

Shared priorities, cadence, target handoff, and network-wide response to external alerts.

03

CALIBRATE + DELIVER

Common timing, photometric calibration, quality control, and consistent science products.

one timing model • one calibration framework • one policy

Power sets and demanding design drivers

THE DECISION VARIABLE

AVAILABLE POWER

MODE A OBSERVE THROUGH NIGHT

Power supports the payload, thermal stability, processing, and communications.

MODE B SURVIVE; SCIENCE OFF

Power protects critical systems; observing resumes after daylight and recalibration.



POINTING + TRACKING

**BASIS
ESTABLISHED**

Stable surface and long dwell times are favorable; payload-level performance still requires verification.



OPTICAL ENVIRONMENT

**OPERATING
PRECEDENT**

Chang'e-3 UV operations provide precedent for covers, contamination control, and lunar-surface observing.



PROCESSING + RADIATION

IN DEVELOPMENT

Edge processing, storage, fault management, and radiation qualification remain open work.



DATA + COMMUNICATIONS

**ECOSYSTEM
EVOLVING**

Interfaces are developing with Artemis, Moon Base, CLPS, and lunar-relay infrastructure.

Power is the system-level discriminator; the remaining drivers are manageable verification programs.

LUSTER can grow with the emerging lunar ecosystem

FLY THE PATHFINDER

Payload + delivery

Use CLPS-class delivery and integration; define a standard payload envelope; carry a self-contained power and communications baseline.

CONNECT WHEN READY

Shared lunar services

Maintain compatible interfaces for Moon Base power, communications, relay, mobility, and logistics; adopt services only after site and schedule compatibility are verified.

DISTRIBUTE THE PROGRAM

Strategic partnerships

Industry leads flight systems and integration; NASA and universities lead payloads, calibration, and science operations; international partners can contribute nodes, processing, or ground support.

Design the first payload to operate independently; add shared services when they are available and compatible.

Four decisions define the program sequence

4

program
decisions

01	SCIENCE PERFORMANCE	Response time, stability, wavelength coverage, cadence, and products
02	PAYLOAD + SITE	Aperture, bandpasses, field of view, pointing, sites, and power
03	OPERATING CONCEPT	Day/night mode, calibration, data flow, and network coordination
04	DEPLOYMENT PLAN	Pathfinder scope, delivery, partners, cost, risk, and scale-up gates

LUSTER pathfinder → prove one node → prove coordination → scale to LUSTER-net

Thank you

CONTACT

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WHITE PAPER + REPOSITORY

LUSTER-net white paper
arXiv:2607.06548
arxiv.org/abs/2607.06548

LOSP planning repository
Current access: contact the presenter

Questions, collaboration, and pathfinder partnerships are welcome.

Backup: what LUSTER and LOSP already establish

LUSTER

20 cm

simultaneous NUV +
visible

Reference concept for
sensitivity, detectability,
and lunar scheduling

PATHFINDER CONCEPT

LOSP development stack



YIELD

Photometric
detectability



SCHEDULER

Lunar-site
allocation

Also developed: scenario manifests • run scripts • module contracts • integration tests

Planning software and analysis heritage - not flight autonomy or qualified hardware.

Backup: requirement trades and verification

CAPABILITY	PRIMARY TRADES	VERIFICATION APPROACH
UVOIR coverage	Bandpasses, detector architecture, thermal control, optical environment	End-to-end throughput and calibration tests
Time-domain response	Alert latency, slew/settle, scheduler authority, non-sidereal tracking	Injected-alert hardware-in-loop campaign
Stability	Pointing, thermal drift, cross-node calibration transfer	Long-duration stability and intercalibration test
Data system	Full frames vs stamps, compression, storage, relay/downlink	Closed-loop data-volume and latency simulation
Surface operations	Night observing vs survival mode, sites, power, dust, service interfaces	Thermal-power demonstration followed by the lunar pathfinder

Backup: core references

MISSION CONCEPT + PROGRAM

LUSTER-net ASTRA Mission Concept Description
arXiv:2607.06548
NASA ASTRA Initiative materials (2026)
NASA Ignition: Plan for the Moon (2026)
NASA Moon Base development phases (2026)
NASA Commercial Lunar Payload Services

TECHNICAL + OPERATIONAL HERITAGE

Brown et al. (2013)
Las Cumbres Observatory Global Telescope Network
doi:10.1086/673168
Wang et al. (2015)
18-month Chang'e-3 lunar UV telescope operations
doi:10.1007/s10509-015-2521-2
LUSTER / LOSP development records

Primary program and technical sources used throughout the presentation.