Richard P. Feynman Center for Innovation

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Technology Snapshot

Los Alamos NATIONAL LABORATORY

Extremely Low Resource Optical Identifier (ELROI)

A License Plate for Satellites

Market Applications

Space Traffic Management, Regulatory Compliance, Mission Assurance, End-of-Life Satellite Management, Commercial Launch Services

Technology Readiness Level 8

IP Information

U.S. Patent No. 10,250,336 and 16/539,380

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Overview

Engineers at Los Alamos National Laboratory have developed a "license plate" for satellites to help solve the growing problem of space traffic management. The Extremely Low-Resource Optical Identifier (ELROI) is a simple, easy-to-fly, solar-powered beacon that can be attached to a satellite for tracking. Each ELROI unit transmits a custom identification number that can be read from the ground using signal processing techniques also developed at Los Alamos.

Problems Solved

Identifying space objects after launch remains a persistent challenge. When dozens of satellites are deployed simultaneously, determining which object is which using traditional radar or optical tracking methods is slow, error-prone, or sometimes impossible. This lack of real-time, reliable identification hinders satellite commissioning, increases operational risk, and undermines space traffic management efforts.

ELROI solves the space object identification problem by providing an autonomous, low-cost, optical beacon that broadcasts a unique ID from orbit. ELROI is:

- easy to implement (enables simple assignment of unique IDs);
- solar-powered (maintains autonomy even if satellite loses power);
- compact (designed to be easy to fly, taking up minimal satellite real estate);
- lightweight (lean design is appropriate to fly on large and small vehicles alike); and
- enables definitive post-launch identification of satellites faster than conventional means.

In 2024–25, ELROI was demonstrated successfully on LaCE-1 and R5-S4 satellites, providing the first definitive identification for each satellite in orbit ahead of operator or catalog resolution.

Key Advantages

Ultra-Low SWaP-C (Size, Weight, Power, and Cost). Final designs aim for just a few grams and a few cubic centimeters, requiring minimal power.

No RF Interference. Uses optical rather than radio frequency, sidestepping spectrum crowding and regulatory issues.

Autonomous and Passive. No spacecraft support required; beacon runs independently, even on dead satellites.

Fast and Robust Identification. High-confidence decoding of unique identifiers using ground-based photon counting techniques, even with low signal strength.

Scalable and Flexible. Can be added to any space object, including CubeSats and deployable debris, without complex integration.

Resilient Design. Uses robust encoding schemes (e.g., BCH error-correcting codes) to ensure ID recovery under high noise and low signal conditions.

Next Steps

For ELROI to become a standard part of space operations, three parallel tracks must advance:

- Beacon Manufacturing: Move from prototypes to production-scale manufacturing of standardized, miniaturized ELROI units.
- Ground Network Expansion: Establish a distributed network of ground stations using cost-effective photon-counting or hybrid imaging systems.
- Operator Adoption: Encourage satellite operators to integrate ELROI through demonstrated benefits, policy incentives, and regulatory encouragement.

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NNSA National Nuclear Security Administration