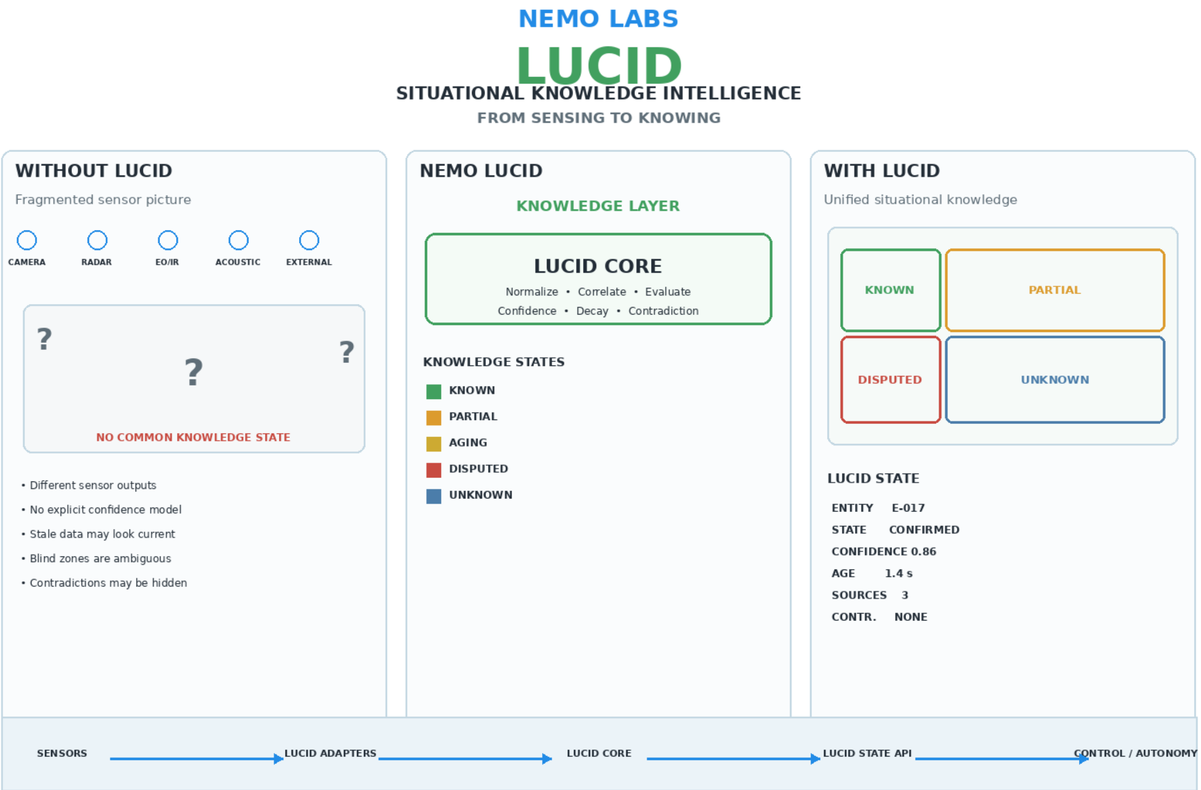
NEMO LUCID

SITUATIONAL KNOWLEDGE INTELLIGENCE

Intelligent Situational Knowledge Module

KNOW WHAT YOU KNOW. KNOW WHAT YOU DON'T.



CONCEPT

NEMO LUCID is a hardware-software situational knowledge platform designed for autonomous, robotic, sensor-based, and operator-assisted systems.

LUCID transforms fragmented data from cameras, radar, LiDAR, EO/IR systems, acoustic sensors, and other sources into a unified dynamic model:

what the system knows about its environment, how reliable that knowledge is, and what remains unknown at any given moment.

Most sensor systems answer the question:

WHAT DO I SEE?

LUCID introduces the next level:

WHAT DO I KNOW?

And, more importantly:

WHAT DON'T I KNOW?

This transforms conventional Sensor Fusion into Knowledge Intelligence.

1. PURPOSE

A modern autonomous system may receive information from dozens of different sources simultaneously.

However, a large volume of data does not necessarily provide a reliable understanding of the situation.

A camera may detect an object.

Radar may fail to confirm it.

Another sensor may temporarily lose contact.

Information from an external system may already be outdated.

Part of the environment may be outside current sensor coverage altogether.

For LUCID, these are different states of knowledge.

Core principle:

NO DETECTION ≠ NO THREAT

No detection does not constitute confirmed absence of an object.

LUCID enables a machine to account for the boundaries of its own knowledge.

2. LUCID'S PLACE IN THE SYSTEM

LUCID is designed as an independent intelligence layer between sensors and the control system.

SENSORS →NEMO LUCID→AUTONOMY / CONTROL / OPERATOR

LUCID does not require replacement of existing cameras, radar systems, or control software.

It adds a new layer between them:

KNOWLEDGE LAYER

3. FROM SENSOR DATA TO KNOWLEDGE

Conventional architecture:

SENSOR → DETECTION → CONTROL

LUCID architecture:

SENSORS→OBSERVATIONS→CORRELATION→CONFIDENCE→KNOWLEDGE→DECISION

The control system therefore receives more than a stream of detections.

It receives a structured knowledge state representing the surrounding environment.

4. LUCID STATE

For each object, event, or area of space, LUCID can form a set of knowledge attributes:

WHAT — what is being observed;

WHERE — where it is located;

WHEN — when the information was obtained;

SOURCE — which source provided it;

CONFIDENCE — how much the information can be trusted;

AGE — how fresh the information is;

CONTRADICTION — whether conflicting observations exist;

COVERAGE — how well the relevant area is being observed;

UNKNOWN — what information is missing.

The result is:

LUCID STATE

a unified machine-readable representation of current knowledge.

5. LUCID DECAY

Knowledge has a lifetime.

If an object was observed ten seconds ago, this does not mean its current state is known with the same level of confidence.

LUCID continuously recalculates the relevance of information.

CONFIRMED→AGING→STALE→UNKNOWN

An object therefore does not disappear from the world model immediately after contact is lost.

The system understands:

The object existed.
Its last known position is available.
No new observation has been received.
Confidence in the information is decreasing.

This differs fundamentally from a binary model:

DETECTED / NOT DETECTED.

6. LUCID CONTRADICTION

Different sources may report incompatible information.

For example:

CAMERA → OBJECT PRESENT

RADAR → NO CONFIRMATION

EXTERNAL SOURCE → OBJECT PRESENT

LUCID does not have to hide a conflict by automatically selecting a single source.

It can form the state:

DISPUTED

and provide the control system with explicit information about the contradiction.

The contradiction becomes part of the world model rather than a hidden data-processing error.

7. LUCID MAP

LUCID forms a dynamic Knowledge Map.

It shows more than the location of objects.

It shows the quality of knowledge across the observed space.

Areas may have the following states:

KNOWN — reliably known;

PARTIALLY KNOWN — only partially known;

AGING — information is becoming outdated;

STALE — information is outdated;

CONTRADICTORY — sources provide conflicting information;

UNOBSERVED — the area is not currently observed;

UNKNOWN — the state cannot be determined reliably.

The machine therefore gains a representation not only of the environment, but also of the boundaries of its own perception of that environment.

8. LUCID CORE

The central component of the platform is:

LUCID CORE

The software core may include:

Sensor Adapters → connection of heterogeneous information sources;

Normalization Engine → conversion of incoming data into a common model;

Entity / Track Store → maintenance of entities, tracks, and their history;

Confidence Engine → confidence assessment;

Contradiction Engine → detection of conflicting information;

Knowledge Decay Engine → management of knowledge aging;

Coverage Engine → analysis of actual sensor coverage;

Unknown Engine → identification of information gaps;

Knowledge API → delivery of results to external systems.

9. LUCID UNKNOWN

One of the key principles of the architecture is:

UNKNOWN IS A VALID SYSTEM STATE

“Unknown” is not a system error.

It is a valid knowledge state.

LUCID can distinguish between:

OBJECT ABSENT

from

OBJECT NOT OBSERVED

and from

OBJECT STATE UNKNOWN

This prevents an autonomous system from drawing false conclusions from the absence of data.

10. LUCID QUESTION

The next level of development is the system's ability to determine:

WHAT DO I NEED TO KNOW?

If LUCID identifies a critical knowledge gap, it can generate an information request:

UNKNOWN→QUESTION→INFORMATION REQUIREMENT→OBSERVATION REQUEST→NEW DATA→KNOWLEDGE UPDATE

Perception thus evolves from a passive process into active acquisition of the information required to reduce uncertainty.

11. INTEGRATION

LUCID is designed primarily as an OEM technology. It can be integrated into existing systems without replacing the entire platform.

Potential data sources

- cameras;
- EO/IR;
- radar systems;
- LiDAR;
- acoustic systems;
- GNSS/IMU;

- telemetry;
- industrial sensors;
- external information systems;
- other LUCID nodes.

Potential hardware interfaces

Depending on the implementation:

Ethernet / CAN / CAN-FD / RS-485 / RS-232 / USB / GPIO / GNSS / PPS

Software integration

EXISTING SENSORS→LUCID ADAPTERS→LUCID CORE→LUCID STATE API→EXISTING CONTROL SYSTEM

The manufacturer does not need to rebuild its system around LUCID.

LUCID is integrated into the existing architecture as an additional Knowledge Layer.

12. LUCID NODE

Physical implementation of the technology:

NEMO LUCID NODE

A compact, protected computing module designed for direct installation on a platform or protected asset.

Potential configurations:

LUCID EDGE for compact autonomous devices;

LUCID NODE universal OEM implementation;

LUCID PRO higher-performance computing configuration;

LUCID RACK server-class implementation for large sensor systems.

All configurations use the common LUCID CORE software architecture.

13. LUCID LINK

Multiple modules can operate together.

LUCID NODE A ↔ LUCID NODE B ↔ LUCID NODE C

The nodes do not necessarily need to exchange all raw video streams and sensor data. They can exchange already-formed knowledge states.

Each node can understand:

- what a neighboring node knows;
- which source supports that knowledge;
- how fresh the information is;
- how reliable it is;

- whether contradictions exist.

This creates:

DISTRIBUTED SITUATIONAL KNOWLEDGE

14. LUCID PROTOCOL

A dedicated protocol can be developed for interoperability between different systems:

LUCID KNOWLEDGE PROTOCOL — LKP

A conventional sensor reports:

OBJECT DETECTED

LUCID reports:

OBJECT CONFIRMED
SOURCES: 3
CONFIDENCE: 0.87
AGE: 1.4 SEC
COVERAGE: PARTIAL
CONTRADICTION: NONE

The systems therefore exchange more than data. They exchange structured machine knowledge.

15. APPLICATION AREAS

The LUCID architecture is not tied to a specific type of platform.

Potential application areas include:

Autonomous Systems unmanned aerial, ground, and maritime platforms;

Robotics autonomous and semi-autonomous robotic systems;

Critical Infrastructure monitoring and protection of critical assets;

Industrial Automation distributed industrial sensor systems;

Maritime Systems monitoring and autonomous maritime robotics;

Security multi-sensor security and surveillance systems;

Smart Infrastructure distributed environmental perception systems.

16. KEY DIFFERENTIATOR

LUCID is not intended to become another camera.

It is not intended to become another radar.

It does not replace existing sensors.

It creates an intelligence layer above them.

Conventional system:

SEE

LUCID:

SEE → CORRELATE → EVALUATE → KNOW

The core NEMO product is therefore not a particular sensor.

The core product becomes:

MACHINE KNOWLEDGE

LUCID is developed as an experimentally verifiable knowledge architecture. Each core mechanism — confidence, contradiction, decay, coverage and unknown-state handling — can be independently measured, stressed and validated.

NEMO LUCID

FROM SENSING TO KNOWING.

Know what you know.
Know what you don't.

NEMO LABS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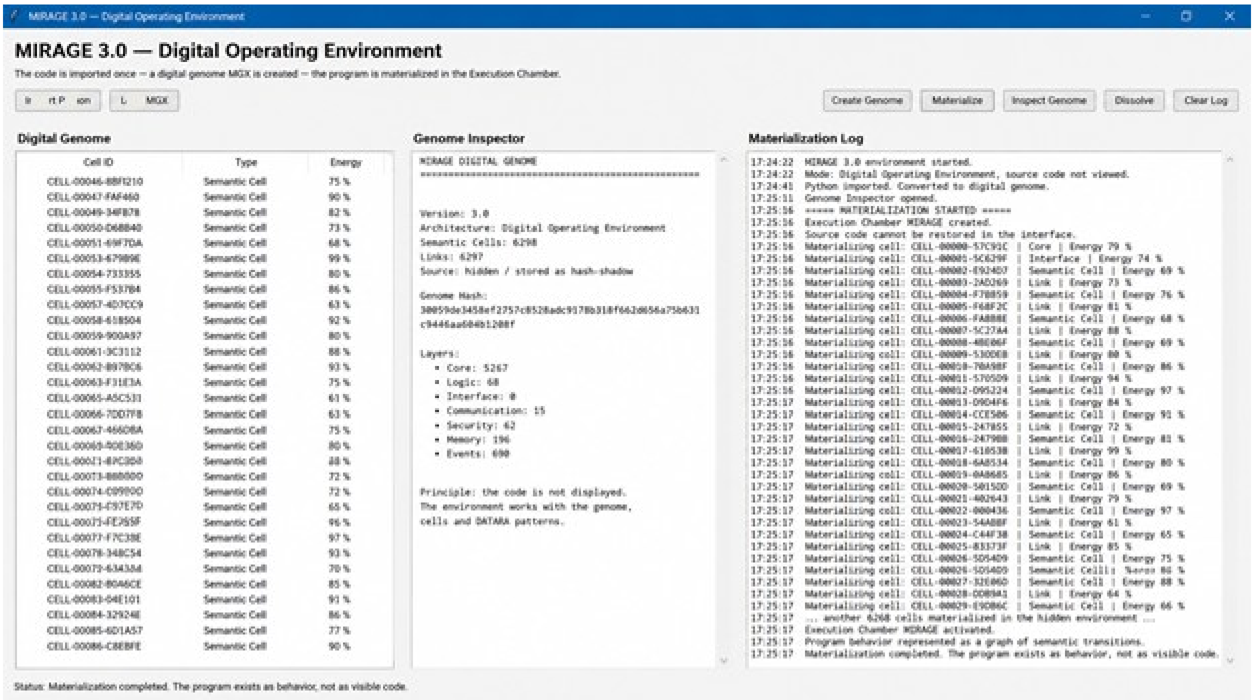
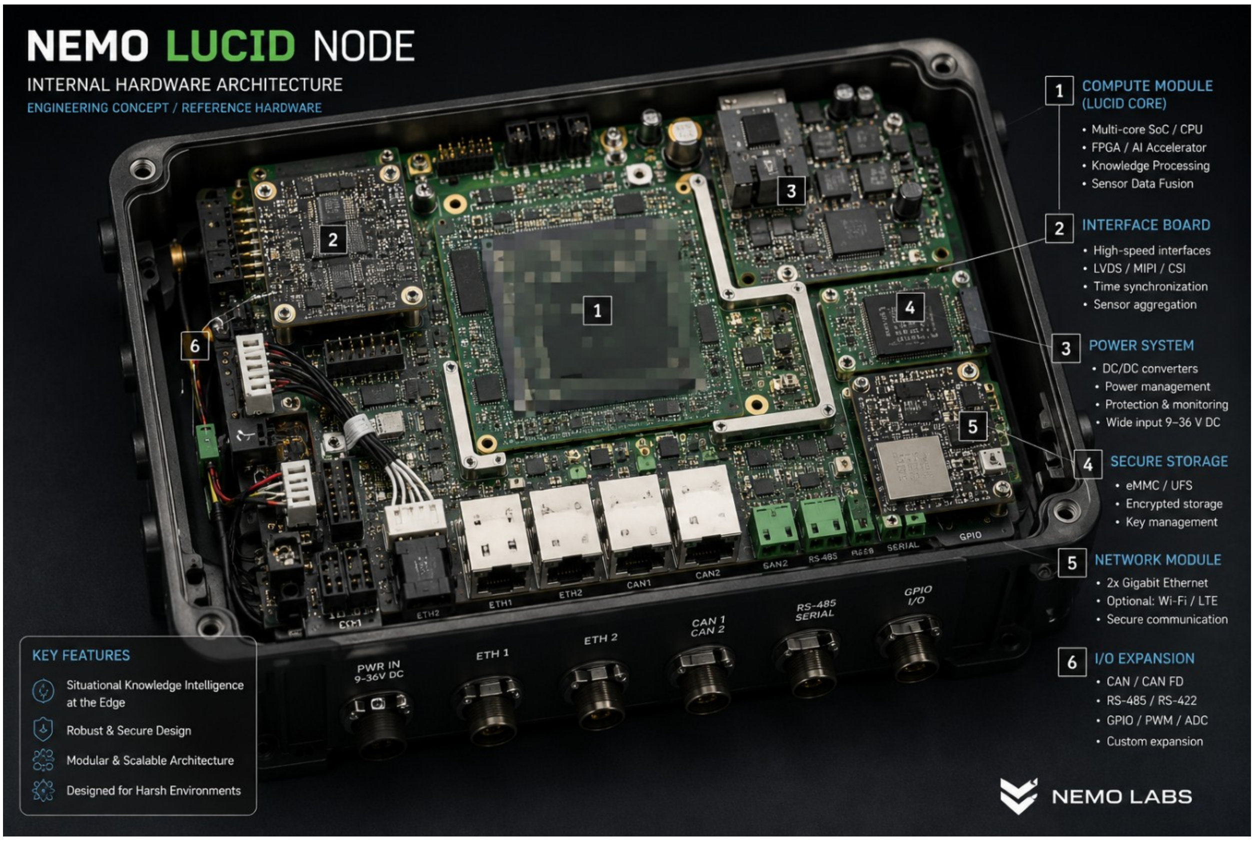
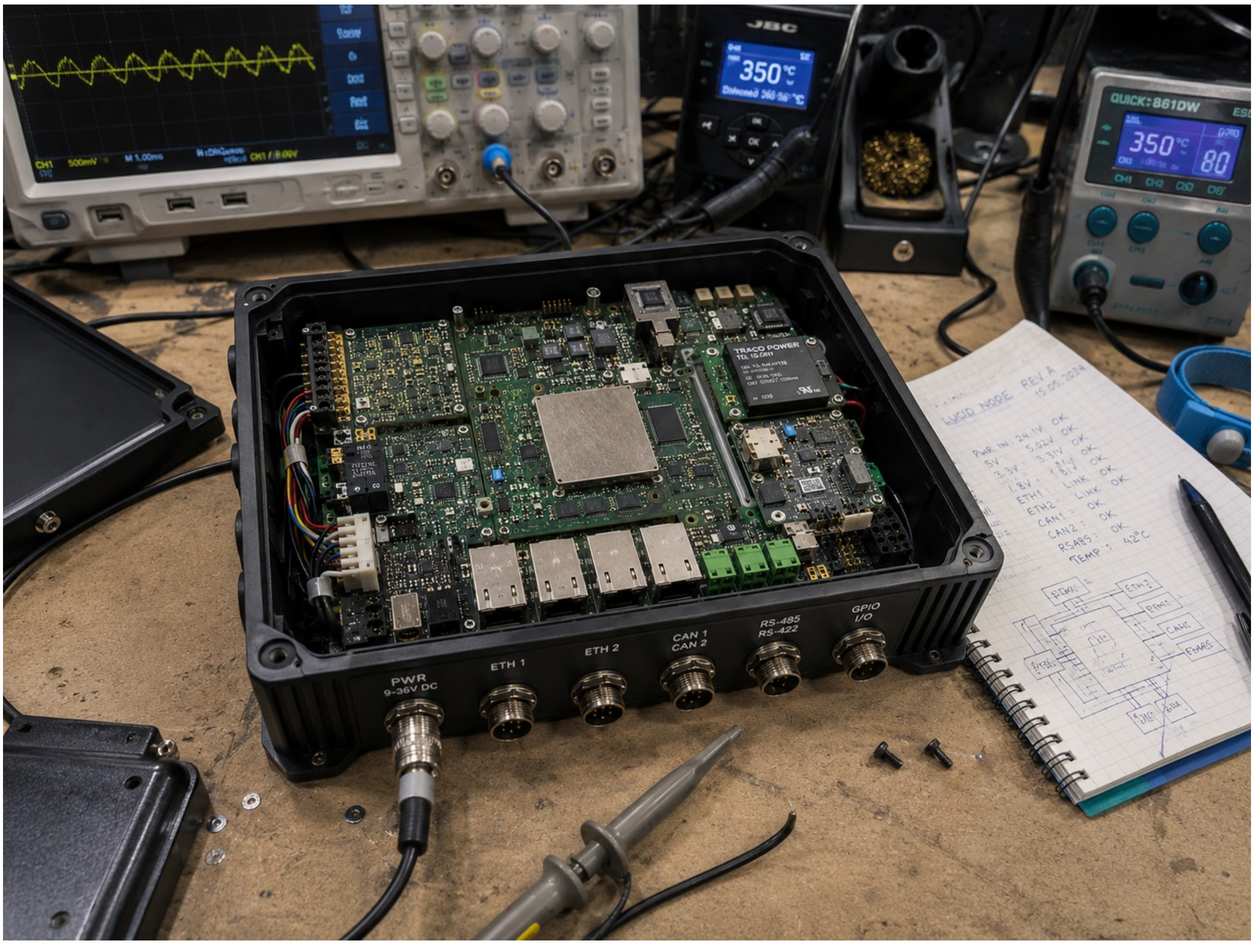



NEMO LUCID NODE
INTERNAL HARDWARE ARCHITECTURE
ENGINEERING CONCEPT / REFERENCE HARDWARE
1 COMPUTE MODULE (LUCID CORE)
• Multi-core SoC / CPU
• FPGA / AI Accelerator
• Knowledge Processing
• Sensor Data Fusion
2 INTERFACE BOARD
• High-speed interfaces
• LVDS / MIPI / CSI
• Time synchronization
• Sensor aggregation
3 POWER SYSTEM
• DC/DC converters
• Power management
• Protection & monitoring
• Wide input 9–36 V DC
4 SECURE STORAGE
• eMMC / UFS
• Encrypted storage
• Key management
5 NETWORK MODULE
• 2x Gigabit Ethernet
• Optional: Wi-Fi / LTE
• Secure communication
6 I/O EXPANSION
• CAN / CAN FD
• RS-485 / RS-422
• GPIO / PWM / ADC
• Custom expansion
KEY FEATURES
Situational Knowledge Intelligence at the Edge
Robust & Secure Design
Modular & Scalable Architecture
Designed for Harsh Environments
PWR IN 9-36V DC
ETH 1
ETH 2
CAN 1 CAN 2
RS-485 SERIAL
GPIO I/O
NEMO LABS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