OASIS: Orbital AI Supercomputer Infrastructure

Daniil Galakhov
Chiang Mai, 2025

Contents

Executive Summary

OASIS (Orbital AI Supercomputer Infrastructure) is a concept for a distributed, space-based computing system designed to process Earth observation (EO) and other sensor data directly in orbit. The goal is to overcome the inherent delays and bandwidth limitations of current satellite operations, where raw data is downlinked to Earth before analysis.

By integrating AI processing capabilities, high-speed laser inter-satellite links, and RF ground communications into a constellation of low-Earth orbit “ReCor” (Relay + Core) satellites, OASIS can transform raw data into actionable insights before it ever leaves space. This architecture reduces the time from data acquisition to delivery from several hours — or even a day — to under 20 minutes.

The system is built entirely on existing, commercially available technologies: optical terminals from vendors such as Mynaric, Tesat, Skyloom, and ReOrbit; RF systems from Comtech and Kongsberg; and compact AI accelerators from manufacturers like Sophon, Hailo, and NVIDIA. No new science is required — only careful engineering, integration, and funding.

Applications span rapid EO analytics, real-time weather forecasting, marine traffic optimization, renewable energy grid support, disaster monitoring, and defense/security operations. A detailed simulation of the constellation, developed in Unity with precise astrodynamic algorithms, confirmed the feasibility of achieving these capabilities with current technology.

OASIS represents a viable, high-impact space infrastructure project with clear commercial, environmental, and strategic value. The concept is technically mature, proven in simulation, and ready for development by qualified partners with the necessary resources.

Background & Motivation

Modern Earth observation (EO) satellites produce enormous volumes of raw data — high-resolution optical imagery, radar returns, multispectral measurements, and atmospheric readings. This data is indispensable for applications ranging from weather forecasting to disaster response and global security. However, in current operational models, **the processing bottleneck is on a transmission hop from space to Earth**.

Most satellites transmit their unprocessed data to ground stations utilising radio frequency during short visibility windows. As mentioned above, the volume of this data is large, but data transmission speed and duration are limited by physics itself - transmitter power, radio interference in Earth atmosphere, and orbital mechanics (determining transmission window time). Received data can be queued, processed and distributed to end-users only on the ground. The result: **latencies of several hours to a full day**, even for time-critical events such as natural disasters or maritime incidents.

The OASIS concept was born from a key insight:

If the data can be processed in space, near the source, the result can reach decision-makers within minutes instead of hours.

In spring 2025, public announcements from Chinese companies claimed the launch of “orbital AI supercomputer” satellites. While technically intriguing, these early implementations showed significant architectural limitations, including narrow application scope and lack of integrated high-speed interconnectivity. This highlighted an opportunity: to design a more **scalable, vendor-agnostic, and application-flexible** orbital computing system — one that could be deployed using **off-the-shelf technologies** and integrated into the global space economy.

From the outset, OASIS was envisioned not as a single monolithic spacecraft, but as a **network of small, interoperable satellites**, each capable of both data relay and onboard AI processing — the **ReCor node**. By equipping these nodes with laser inter-satellite links, RF ground communications, and modular AI accelerators, the system could:

- Receive raw data from client satellites in orbit
- Process it locally using advanced AI algorithms
- Relay actionable results directly to the relevant ground stations or other satellites

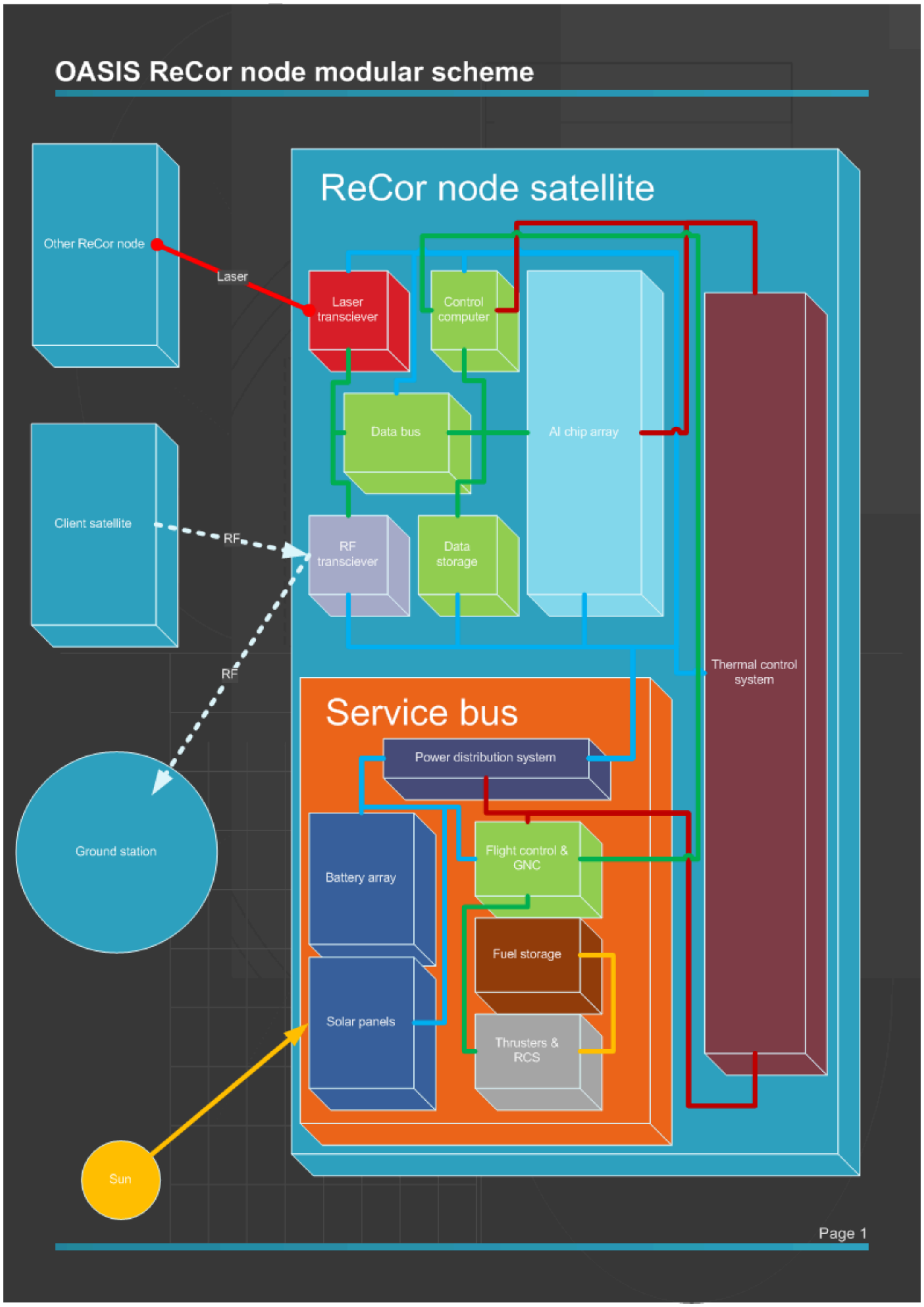
The potential impact of such an infrastructure extends far beyond faster EO data delivery:

- **Maritime industry**: Optimize shipping routes dynamically, including for new-generation wind-assisted cargo ships, by integrating real-time weather and ocean current data
- **Renewable energy**: Improve stability of national grids by predicting solar and wind output with minute-scale updates
- **Emergency response**: Detect and map floods, wildfires, or earthquakes within minutes, enabling immediate action
- **Defense & security**: Provide low-latency ISR (Intelligence, Surveillance, Reconnaissance) data even in regions with no ground infrastructure

In short, OASIS addresses an increasingly critical gap in space infrastructure: the ability to **shorten the sensor-to-decision cycle from hours to minutes**. This is not only a technological leap, but also a commercial and strategic advantage for the organizations that adopt it.

System Architecture

ReCor node design



RF Communications

Each ReCor node is equipped with dual-purposed RF communication system, including functions of:

1. **Client Uplink/Downlink Interface** – Handles data exchange with Earth observation or other client satellites. This uses standardized S-, X-, or Ka-band links, compatible with existing EO platforms. Vendors such as **Comtech** and **Kongsberg** offer compact, high-performance RF terminals suited for LEO-to-LEO links.
2. **Ground Station Interface** – Transmits processed results to Earth via Ka-band or high-capacity X-band. Multiple modulations (QPSK, 8PSK, 16APSK) can be supported to match different ground station capabilities.

RF remains the universal interface for compatibility and redundancy, ensuring OASIS can serve both legacy and modern space assets without requiring new ground infrastructure.

Laser Inter-Satellite Links

High-speed laser terminals connect ReCor nodes into a low-latency, high-bandwidth mesh. These links handle bulk data transfer between nodes, enabling processing to be dynamically routed to available capacity. Vendors such as **Mynaric**, **Tesat** and **Skyloom** provide flight-ready optical terminals capable of multi-Gbps throughput over thousands of kilometers.

The laser mesh allows:

- Timely reduce duration of internodal data transmission
- Bypassing ground stations for internodal data delivery
- Rapid redundancy in case of node failure

AI Processing Units

OASIS relies on compact, space-rated or ruggedized AI accelerators, chosen based on power efficiency, processing capability, and integration flexibility. Examples include:

- **Sophon BM1684X** – High-performance AI processor optimized for inference tasks, with low power draw.
- **Hailo-8** – Ultra-efficient edge AI chip, ideal for real-time computer vision and pattern recognition workloads.
- **NVIDIA Jetson Orin** – Flexible AI computing platform with robust CUDA ecosystem support, suitable for mixed workloads.

AI module choice can be tailored to the client’s processing needs, from simple EO image classification to complex multi-sensor fusion.

Data Flow Logic

1. **Acquisition** – Client satellite collects raw EO or sensor data and transmits it via RF to the nearest ReCor node.
2. **Processing** – The ReCor node runs onboard AI inference to convert raw data into high-value outputs (e.g., object detection maps, weather models, change detection layers). If the current node is busy at the moment, it will relay data to the next node.
3. **Distribution** – Processed results are transmitted directly to the nearest ground station via RF, or routed via the laser mesh to another node for delivery to a different geographic region.
4. **Relay** – Data storage allows intermediate nodes to forward results during optimal visibility windows.

This architecture ensures minimal delay between data capture and actionable output, while also allowing flexible routing based on client location and operational priorities.

Applications & Market Potential

OASIS is designed as a flexible orbital computing infrastructure, capable of supporting a wide range of applications where speed, reliability, and global reach are critical. Its architecture allows integration with both existing and future space assets, serving multiple industries and government sectors.

Earth Observation Acceleration

By processing raw EO data directly in orbit, OASIS can deliver actionable intelligence to ground users in under 20 minutes. This enables near-real-time monitoring of environmental changes, urban growth, agricultural health, and industrial activity. EO providers benefit from reduced ground infrastructure requirements and faster data delivery to clients.

Maritime Traffic Optimization

The maritime sector is undergoing a technological shift toward efficiency and reduced emissions, including the use of wind-assisted propulsion. OASIS can integrate real-time weather and oceanographic data to provide dynamic routing updates to vessels, improving fuel efficiency and safety. This capability is especially valuable for large cargo and container fleets operating on tight schedules.

Renewable Energy Grid Support

Power generation from solar and wind sources is inherently variable. OASIS can supply power grid operators with precise, minute-scale forecasts of energy production potential, based on integrated satellite-derived weather data. This allows for more accurate load balancing, reduced reliance on fossil-fuel backup systems, and improved grid stability.

Rapid Disaster Response

Natural disasters often cause damage in areas where ground communications are disrupted or nonexistent. OASIS can detect and map floods, wildfires, landslides, earthquakes, and storm impacts within minutes of occurrence. This allows emergency services to prioritize resources, coordinate relief, and improve response times.

Defense & Security

For national security applications, OASIS provides low-latency ISR (Intelligence, Surveillance, Reconnaissance) data to military and intelligence operators, even in denied or remote regions. Its high-speed laser interconnects allow rapid delivery of processed intelligence across continents without dependence on ground station availability.

Other Potential Markets

The modular design of OASIS also allows for specialized applications, such as:

- Environmental treaty compliance monitoring
- Space situational awareness data fusion
- Supporting AI-driven autonomous platforms (drones, unmanned surface vessels)
- Real-time analytics for climate research missions

Market Potential

The space data services market is projected to exceed USD 20 billion annually by the early 2030s, with accelerating demand for near-real-time intelligence. By bridging the gap between data acquisition and decision-making, OASIS positions itself as an enabling infrastructure for multiple high-value verticals. Its vendor-agnostic design and reliance on off-the-shelf technologies make it attractive for governments, commercial EO providers, and multinational corporations seeking competitive advantage in information speed and quality.

Development & Simulation

The OASIS concept was validated through a detailed orbital simulation, designed to model constellation behavior, inter-satellite communications, and data processing workflows. The goal of the simulation was twofold: to confirm the technical feasibility of the architecture and to present the concept in a clear, interactive format for potential investors and partners.

Choice of Simulation Platform

While several specialized space simulation tools exist, many are either unsuitable for public demonstration or excessively complex for early-stage presentations. **Unity** was chosen as the development platform for the OASIS simulation for the following reasons:

- **Rich Interaction & Presentation** – Unity's graphics and user interface capabilities allowed for clear, visually engaging demonstrations of constellation operations, making it accessible to non-technical audiences.
- **Rapid Development Cycle** – Unity's component-based architecture and asset pipeline enabled fast prototyping and iteration.
- **Lightweight Deployment** – The ability to export directly to WebGL allowed easy sharing of an interactive demo without requiring specialized software on the user's side.

Although Unity is not optimized for high-precision orbital mechanics — due to limitations such as float-based math, a general-purpose physics engine, and lack of built-in astrodynamic algorithms — these issues were addressed through custom development.

Custom Astrodynamics Implementation

To ensure accuracy, the **simulation incorporated algorithms and propagation models from David Vallado's "Fundamentals of Astrodynamics and Applications"**, adapted and implemented in C#.

Key features of the astrodynamics subsystem included:

- Two-body and perturbation-based orbital propagation
- Time-accurate visibility and link-budget calculations
- Inter-satellite distance and latency estimation
- Handover logic for RF and laser communications

All algorithms were **tested and practically verified** against known orbital data to ensure precision within the context of the demonstration.

Development Process

The simulation was developed over three weeks, leveraging:

- **Senior-level Unity development skills** for efficient UI/UX and interaction design
- **Strong astrodynamics expertise** to integrate precise orbital behavior
- **ChatGPT as a co-programmer, project manager, and 2D asset generator**, reducing workload by an estimated 20–25% through rapid prototyping, code review, and creation of visual elements such as sprites and icons

Simulation Capabilities

The final simulation allowed:

- Visualization of the full OASIS constellation in LEO
- Dynamic modeling of RF and laser link connections between nodes
- Demonstration of data acquisition, processing, and distribution flows
- Measurement of latency improvements compared to conventional EO downlink models

Results

In simulation, OASIS consistently reduced EO data delivery time from an average of **8 hours** in conventional architectures to **approximately 15 minutes** in the modeled configuration. This confirmed that, with available technology, a functioning orbital AI supercomputer is achievable without fundamental scientific breakthroughs.

Cost & Deployment Roadmap

Cost Estimation

The full-scale OASIS system, designed for global coverage, can be realized using existing commercial satellite buses, communications hardware, and AI accelerators. Based on current market prices for manufacturing, launch, and integration, the total cost is estimated to be **approximately USD 470 million**.

This figure includes:

- Satellite manufacturing and payload integration
- Optical and RF communication terminals
- AI processing hardware and supporting avionics
- Launch services for multiple orbital planes
- Ground segment expansion for RF reception and control
- Systems engineering, testing, and commissioning

Because OASIS is based entirely on **off-the-shelf, flight-proven technologies**, non-recurring engineering (NRE) costs are minimized, and development risk is reduced.

Return on Investment (RoI) modeling suggests that the system can achieve profitability within 3–4 years of full deployment, depending on the mix of commercial contracts, government partnerships, and defense-sector agreements.

Deployment Phases

Phase 1: Simulation & Feasibility (6–9 months)

- Detailed modeling of constellation configurations and dataflow performance
- Vendor selection for RF, optical, and AI modules
- Regulatory and frequency coordination planning

Phase 2: Investment & Integration (12–18 months)

- Securing funding from commercial, governmental, or mixed sources
- Finalizing spacecraft bus design and payload integration plan
- Establishing partnerships with launch providers and ground network operators

Phase 3: Regional Ring Deployment (18–24 months)

- Launch of initial 4-8 ReCor nodes into a single orbital plane for partial regional coverage
- Operational testing with live EO data streams
- Early service contracts with maritime, energy, and EO sectors

Phase 4: Global Mesh Deployment (~3 years from Phase 1)

- Expansion to full constellation with multiple orbital planes
- Achieving continuous low-latency global coverage
- Integration with allied and commercial satellite networks for interoperability

Conclusions & Next Steps

The OASIS project demonstrates that a distributed orbital AI supercomputer is both **technically feasible** and **commercially viable** using existing, off-the-shelf technologies. By processing data in space rather than on the ground, OASIS shortens the sensor-to-decision cycle from hours to minutes, creating significant advantages across Earth observation, maritime navigation, renewable energy, disaster response, and defense applications.

The concept has been validated through:

- Detailed system architecture design
- Vendor analysis for all major subsystems
- Custom-built orbital simulation using precise astrodynamics models
- Demonstrated proof-of-concept showing EO data latency reduction from 8 hours to ~15 minutes

The project's modular, scalable design enables gradual deployment — from small prototype clusters to a full global mesh — reducing investment risk while building operational experience and client relationships.

However, OASIS is a **heavyweight space infrastructure initiative**. Unlike software startups, such a project cannot progress in an environment of financial instability. It requires steady funding, structured partnerships, and a multi-year execution plan.

Next Steps

To advance from concept to operational reality, the following steps are recommended:

- **Secure Strategic Partnerships** – Identify and engage satellite manufacturers, communication system providers, and launch service operators aligned with OASIS's technical requirements.
- **Investment Acquisition** – Target both governmental programs and private sector investors capable of supporting multi-year infrastructure projects.
- **Prototype Deployment** – Launch a limited number of ReCor nodes to validate the system in orbit and demonstrate capabilities to early clients.
- **Regulatory Preparation** – Complete spectrum allocation, licensing, and cross-border coordination for both RF and optical communication links.
- **Market Engagement** – Formalize agreements with potential anchor clients in EO, maritime, energy, and defense sectors to secure early revenue streams.

Status & Availability

The OASIS concept is technically mature, with core algorithms, simulation models, and operational architecture already defined. The project is now at a stage where **funding, partnerships, and execution planning** will determine its future.

I am currently available for collaboration, consultation, or direct engagement to bring OASIS — or its derived concepts — to operational reality. Interested parties with the capability to contribute financially, technically, or strategically are encouraged to make contact.