Aegis Orbital Compute Node (AOCN)

Orbital Compute Spine for Power-Intensive, Heat-Limited Workloads

AOCN

Program Positioning

The **Aegis Orbital Compute Node (AOCN)** is a modular, shielded, power-dense compute platform deployed in **Low Earth Orbit (LEO)**, designed to host high-energy, thermally constrained computational workloads that strain terrestrial infrastructure.

AOCN is **not** a general-purpose cloud replacement. It is an **orbital accelerator layer** — a compute spine intended for workloads where continuous power availability, thermal isolation, physical security, or space adjacency provide strategic advantages.

The system is fully compatible with **current launch vehicles, current space-rated power systems, existing thermal control technologies, and commercial compute hardware**, with no reliance on speculative propulsion, materials, or physics.

Design Philosophy

AOCN follows three core ASI principles:

1. **Thermal realism over compute hype**
   Heat rejection, not compute density, sets system scale.
2. **Infrastructure-first modularity**
   Compute is a payload; power, cooling, shielding, and comms are the product.
3. **Evolutionary deployment**
   Solar-powered LEO nodes today; higher-power nuclear or cislunar variants later — without redesigning the core architecture.

Baseline Orbit & Operating Regime

- **Orbit:** 500–600 km circular LEO
- **Inclination:** 51.6° (ISS-class) or sun-synchronous variants
- **Radiation Environment:** Magnetosphere-protected, manageable SEU rates
- **Lifetime:** 10–15 years per node with modular refresh

LEO is intentionally chosen to:

- minimize radiation shielding mass,
- reduce latency to ground,
- enable frequent servicing and hardware replacement,
- allow stepwise scaling rather than one-shot megastructures.

System Architecture Overview

1. Structural Core

- Cylindrical or hex-prismatic pressure-tolerant module
- Aluminum-lithium primary structure
- Internal racks mounted on vibration-isolated frames
- External attachment points for radiators, solar wings, and comms booms

No rotating elements required.
Artificial gravity is not needed for electronics and would complicate thermal management.

2. Compute Payload

- **Hardware class:** Commercial GPUs, accelerators, and CPUs (COTS)
- **Form factor:** Ruggedized rack units with conformal coating
- **Fault tolerance:**
  - ECC memory throughout
  - Continuous memory scrubbing
  - Checkpointed workloads
  - Graceful degradation by node

Expected operating assumption:

Bit flips occur; system-level software handles them.

This mirrors ISS avionics philosophy, scaled to modern compute.

3. Thermal Management & Heat Rejection (Critical Path)

All electrical power ultimately becomes waste heat.

Cooling stack:

- Cold plates → pumped liquid loops
- Heat exchangers → radiator feed loops
- Deployable radiator panels with high-emissivity coatings

Radiator regime:

- Operating temperature: 350–450 K
- Heat rejection: ~500–1,000 W/m^2 (order of magnitude)
- **Radiator area:**
    - ~2,000–5,000 m^2 per MW of sustained compute load

Radiators are:

- segmented,
- replaceable,
- stowable for launch,
- derived from ASI tanker and station thermal designs.

4. Power Generation & Storage

Phase 1 (near-term):

- Deployable solar arrays
- 1–5 MW class per node
- Lithium-ion or solid-state battery buffering for eclipse periods

Phase 2 (future-compatible, not required for v1):

- Nuclear heat source with Brayton conversion
- Shared radiator farms
- Power export to adjacent Aegis infrastructure

Power architecture is **decoupled** from compute payload to allow upgrades without redesign.

5. Radiation Mitigation & Shielding

- Passive aluminum hull shielding
- Targeted **water shielding** around compute racks
- Optional use of lunar-sourced water in later phases

Shielding strategy focuses on:

- reducing SEU frequency,
- stabilizing internal temperatures,
- extending hardware lifetime.

This is a **mass-efficient mitigation**, not full deep-space hardening.

6. Communications Architecture

Space-to-space:

- Optical (laser) inter-satellite links
- High-bandwidth, low-interference backbone

Space-to-ground:

- Hybrid optical + Ka-band RF
- Optical downlinks to dedicated clear-sky ground stations
- RF fallback for availability and legacy integration

AOCN is optimized for:

- batch workloads,
- streaming outputs,
- asynchronous job execution — *not* ultra-low-latency consumer traffic.

Representative v1.0 Node Specifications

Parameter	Value (Order-of-Magnitude)
Total Mass	40–80 metric tons
Continuous Compute Power	200–500 kW
Electrical Input	1–2 MW
Radiator Area	2,000–5,000 m^2

Shielding Mass	15–50 tons (water + structure)
Operational Life	10–15 years
Servicing	Robotic + crew-compatible

Operational Concept

- Nodes are launched in modular segments
- Assembled robotically or via crewed servicing missions
- Compute payloads are **swappable**
- Radiators and solar wings are replaceable independently
- Nodes operate autonomously with periodic ground tasking

This enables:

- rolling hardware refresh,
- incremental scaling,
- graceful failure modes rather than catastrophic loss.

Use Cases (Near-Term, Realistic)

- AI and ML training runs
- Climate and physics simulations
- High-energy rendering and modeling
- Secure government compute workloads
- Space-based autonomy and navigation processing
- Pre-processing for Earth-based data centers

AOCN does **not** compete with terrestrial hyperscalers — it complements them where Earth-side power, cooling, or security becomes the bottleneck.

Integration with the Aegis Ecosystem

AOCN slots naturally into ASI's broader architecture:

- **Tankers:** deliver water shielding and radiator working fluid
- **Long-Hauler:** logistics, relocation, servicing
- **Aegis Station:** crewed maintenance and future power sharing
- **Gradient One:** artificial gravity research adjacent to compute
- **LMM:** space-adjacent AI workloads and autonomy research

In later phases, AOCN becomes the **compute backbone** for a permanent orbital industrial economy.

Strategic Rationale

The AOCN approach recognizes a simple truth:

In space, compute is easy. Heat rejection is infrastructure.

ASI already builds infrastructure.

That makes orbital compute a **natural extension**, not a speculative detour.