Archeon C4

C2-Agnostic C4 Capability Layer for Autonomous Maritime Platforms

PATENT PENDING · U.S. Provisional Patent Application Filed December 2025

The Challenge

The U.S. Navy operates a heterogeneous fleet of autonomous maritime platforms, each with its own C2 system. Every vendor builds C4 capability vertically within their own platform. The result: vendor-specific silos where no vessel's C4 intelligence can coordinate with another vendor's. Fleet-level autonomous coordination across a mixed force is impossible without a horizontal integration layer.

Our Solution

Archeon C4 sits on top of any existing C2 system and extends it to genuine C4 through the Universal Adapter Interface ? a five-dimension integration contract that is invariant across C2 vendors. Platforms without C2 get a complete stack. Platforms with C2 get the C4 layer on top. Fleets with mixed vendors get the horizontal coordination layer.

The architecture runs on a 100ms processing cycle with five phases: Sense, Predict, Decide, Verify, and Arbitrate. The Verify phase is the governance gate ? no autonomous decision executes without AI governance approval. Every decision is logged with full provenance for after-action reconstruction.

Three Operating Modes

Cap-Up (Primary)
Layers C4 on any existing C2 via Universal Adapter Interface

Fleet Coordination
Coordinates across platforms regardless of underlying C2

Standalone
Complete C1/C2/C3/C4 stack where no C2 is present

Key Capabilities

- Universal Adapter Interface: Five-dimension C2-agnostic integration contract with 5 reference adapters
- AI Governance Gate: Runtime decision verification ? no decision executes unverified
- Predictive Link Management: Forecasts degradation before it occurs using geometry and sea-state models
- Fleet Coordination: Cross-vendor multi-asset coordination with CRDT-based COP sync
- Zero-Trust Security: AI-driven IDS, time-based trust decay, AES-256-GCM encryption
- JPDA Sensor Fusion: Mahalanobis gating, M-of-N track confirmation, covariance intersection
- Supervisory Control: ESCALATE response path with timeout tables and safe default actions
- Explainable Autonomy: Tamper-resistant black-box logging with decision provenance

Why It Matters

C2-Agnostic
Every deployed C2 platform is an integration target, not a competitor. One adapter ? full C4.

AI Governance
First-mover in runtime decision verification. 12-24 month competitive window. Regulatory tailwind.

Fleet Unity
Heterogeneous forces operate as unified C4 fleet regardless of vendor mix.

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Archeon C4 Architecture

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1. Universal Adapter Interface (UAI)

The architectural feature enabling C2-agnostic operation. Every adapter implements a five-dimension contract: Sensor Ingestion, Decision Injection, Authority Negotiation, Capability Discovery, and State Synchronization. Reference adapters implemented for UMAA DDS, Anduril Lattice gRPC, STANAG 4586, JREAP-C, and simulation. 14 unit tests validate full lifecycle.

2. COP Fusion with JPDA Data Association

Joint Probabilistic Data Association engine provides multi-sensor track fusion. Mahalanobis distance gating with configurable threshold, M-of-N track confirmation (3-of-5 default), covariance intersection fusion, and coast aging. Operates in standalone mode (newer-wins) or augmentation mode (external C2 authoritative). 43 unit tests.

3. Predictive Intelligence (CSCI-PRED)

Four components forecast link conditions: PLSAE computes path availability predictions, MLGSSM models maritime geometry and sea-state effects, EPAPE manages emission and power policy, and AMPRE selects optimal paths based on predictions. 25 unit tests.

4. Supervisory Control Interface (CSC-SCI)

Operator-in-the-loop architecture with four sub-components: Display Aggregation (rate-limited situational display), Command Validation (authority and capability checks), ESCALATE Response Path (category-specific timeout matrix with safe defaults), and Link Monitoring (heartbeat-based state tracking). 23 unit tests.

5. C4 Capability Level Evaluator

Five-level graduated autonomy model orthogonal to the C3 mode FSM: FULL, CONSTRAINED, SUPERVISED, C3_FALLBACK, SAFE_STATE. 10:1 hysteresis prevents oscillation (10 bad cycles to degrade, 100 good cycles to recover). Operator approval gates all upward transitions. SAFE_STATE has no automatic recovery. 17 unit tests.

6. Security & Intrusion Detection (CSCI-SEC)

AI-driven intrusion detection distinguishes EW attacks from motion-induced anomalies. Zero-trust enforcement with time-based trust decay and re-authentication. AES-256-GCM encryption, HKDF key derivation, key lifecycle management with zeroization. 29 unit tests.

7. Mode Management & Safety (CSCI-ORCH)

Five-mode FSM (PRIMARY, ALTERNATE, DEGRADED, EMERGENCY, OVERRIDE) with 12 threat-driven transitions. Safety arbiter enforces conservative decisions. Fail-safe controller handles catastrophic conditions. Dual-compute arbitration specified for Phase 5 hardware integration. 21 unit tests.

8. AI Governance (CSCI-GOV) · Specified

Runtime decision verification gate in the 100ms processing cycle. Trust scoring with multi-factor aggregation. Decision provenance with hash-chain integrity. Adversarial input detection. Continuous compliance monitoring against DoDD 3000.09 and NATO AI PRUs. Implementation: Phase 2.

Standards & Integration

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MOSA / Open Architecture Compliance

OMG DDS v1.4	DDS-native middleware via CycloneDDS
UMAA	Reference adapter implemented · Navy procurement gate
STANAG 4586 Ed. 4	Reference adapter for NATO UxS interoperability
JREAP-C	Reference adapter for coalition data exchange
MIL-STD-498	SDD structure and documentation compliance
DoDD 3000.09 (2023)	AI governance architecture designed for compliance
NATO AI PRUs	Six principles addressed in CSCI-GOV design
IMO MASS Code	COLREGS compliance in CSCI-TAC design
FIPS 140-3	AES-256-GCM, CNSA 2.0 algorithm selection
MIL-STD-810H / 461G	Hardware qualification (Phase 5 gate)

Integration Targets

Implemented (Reference Adapters)

- UMAA DDS ? CANES, GCCS-M, AEGIS, Minotaur
- Anduril Lattice ? gRPC SDK integration
- STANAG 4586 ? NATO UxS interoperability
- JREAP-C ? Coalition tactical data links
- Simulation ? Development and test adapter

Identified (API Integration Planned)

- Sea Machines SM300 ? SMLink REST API
- L3Harris ASView ? ASView SDK
- Saronic Echelon ? Echelon command API
- Forterra AutoDrive ? control interface
- AeroVironment ? AV_Halo integration

Competitive Differentiation

- C2-Agnostic: No competitor provides C4 across heterogeneous C2 platforms
- AI Governance: Runtime decision verification with trust scoring. 12-24 month first-mover window
- Fleet Coordination: Cross-vendor coordination ? competitors only within their own ecosystem
- Predictive Comms: Forecasts degradation 30-120s ahead via geometry and sea-state models
- Zero-Trust: AI-driven IDS distinguishes EW attacks from platform motion anomalies

Implementation Maturity

Codebase	Rust, 10 crates, #[deny(unsafe_code)]
Tests	250 passing, 0 warnings
SDD	v2.0.2, 2,490 lines, GO verdict
CSCIs	10 total (7 built, 3 specified)
Interfaces	44 DDS topics, 5 QoS profiles
Current TRL	TRL 4 (component validation)
Research	19 reports, ~17,000 lines

Development Roadmap

Phase 1	COMPLETE	UAI, COP, SCI, C4 levels, QoS
Phase 2	Next	AI governance (CSCI-GOV)
Phase 3	Planned	Tactical autonomy (CSCI-TAC)
Phase 4	Planned	Mission planning (CSCI-MPR)
Phase 5	Planned	Fleet coordination protocol
Phase 6	Planned	Integration & qualification

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Engagement & Contact

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Engagement Options

Technology Demonstration

Evaluate Archeon C4 capabilities against your specific mission requirements and platform configurations. See the Universal Adapter Interface, AI governance gate, and predictive communications resilience in action.

Platform Integration Partnership

Collaborate with Spartan X on adapter development for your C2 platform. Ideal for C2 vendors, AUSV manufacturers, and program offices seeking C4 capability without building it internally. Joint development agreements available.

R&D Collaboration

Engage through SBIR/STTR, OTA, CSO, or direct R&D contracts to accelerate specific capability areas ? AI governance, tactical autonomy, fleet coordination, or platform-specific adaptation for your operational environment.

Licensing

License Archeon C4 for integration into your autonomous platform or fleet management system. The C2-agnostic architecture means a single integration effort delivers full C4 capability.

Active Teaming

Tideman Marine (SIGNED) — 9m hull, Navy-certified, sea trials complete. Reference deployment platform.

About Spartan X Corp

Spartan X Corp is a veteran-founded, Service-Disabled Veteran-Owned Small Business (SDVOSB) headquartered in Austin, Texas. We specialize in autonomous systems, AI-driven solutions, edge computing, and cybersecurity for defense and intelligence customers. Our team brings deep expertise in maritime operations, autonomous systems, and contested-environment architecture. We hold Seaport NxG contract vehicle access and maintain active relationships with Navy program offices, combatant commands, and defense primes.

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