## THE PROBLEM

Autonomous systems are making decisions faster than humans can supervise. The DoD's Replicator Initiative is scaling autonomous mass across every domain. The Collaborative Combat Aircraft program is fielding AI wingmen alongside human pilots. Both demand governance infrastructure that does not yet exist — no standardized architecture enforces authority boundaries in real-time.

## THE SOLUTION: AUTHREX GOVERNANCE ARCHITECTURE

AUTHREX is a research program developing governance architectures that manage the full lifecycle of authority within autonomous systems: trust evaluation, authority computation, command gating, multi-agent consensus, deliberation enforcement, adversarial deception detection, and deterministic recovery.

| FRAMEWORK | FULL NAME | FUNCTION |
|---|---|---|
| SATA | Sensor & Actor Trust Assessment | Dempster-Shafer trust fusion |
| HMAA | Human-Machine Authority Allocation | 4-level authority, asymmetric hysteresis |
| ADARA | Adversarial Deception-Aware Reasoning | Deception probability discounting |
| MAIVA | Multi-Agent Integrity Voting & Aggregation | Byzantine-resilient consensus ($f < n/3$) |
| FLAME | Forced Latency for Authority-Managed Escalation | Mandatory deliberation windows |
| CARA | Controlled Authority Recovery Architecture | Deterministic GREP-phase recovery |
| ERAM | Escalation Risk Assessment Model | Escalation trajectory analysis for C2 |

## CROSS-DOMAIN PORTABILITY

| DOMAIN | PLATFORM | SPEC | STANDARD | APPLICATION |
|---|---|---|---|---|
| DEFENSE | BLADE-EDGE | 72 comp · $139K | DoDD 3000.09 | Directed energy governance |
| MARITIME | BLADE-MARITIME | 84 comp · $43K | MIL-STD-810G | Patrol vessel surveillance |
| INFRASTRUCTURE | BLADE-INFRA | 92 comp · $12K | SIL 3 / NERC CIP | ICS/SCADA protection |
| AUTOMOTIVE | BLADE-AV | 62 comp · $16K | ISO 26262 ASIL-D | Drive-by-wire authority |

## DUAL-USE APPLICATION MATRIX

| DEFENSE APPLICATION | FRAMEWORK | COMMERCIAL APPLICATION |
|---|---|---|
| Fratricide prevention under EW spoofing | SATA + ADARA | AV: forced override during sensor degradation |
| UAV swarm Byzantine node compromise | MAIVA | Warehouse robotics: isolating malfunctioning units |
| Maritime GPS spoofing into foreign waters | ADARA + ERAM | Commercial shipping: rerouting loss prevention |
| Power grid SCADA command injection | FLAME + CARA | Industrial: deliberation before load-shedding |

## EVIDENCE & READINESS

**4 U.S. Provisional Patents**
63/999,105 · 64/000,170 · 64/002,453 · 64/005,607

**23 DOI-Verified Publications**
12 Zenodo records · 11 SSRN papers · CC BY 4.0

**12 Browser Simulations**
Seeded PRNG · bit-exact reproducibility

**6 Physical Research Platforms**
Rover · UAV · BLADE-EDGE · MARITIME · INFRA · AV

### TECHNOLOGY READINESS LEVEL

| | | |
|---|---|---|
| Governance Frameworks | TRL 2–3 | PUBLISHED |
| Browser Simulations | TRL 3–4 | IMPLEMENTED |
| Hardware Platforms (BLADE) | TRL 2–3 | DESIGNED |
| Physical Testbeds | TRL 3 | PROTOTYPE |

## STRATEGIC ROADMAP

| Q2 2026 | CURRENT | 7 frameworks · 4 patents · 4 BLADE designs · 12 simulations · 23 publications |
|---|---|---|
| Q3 2026 | NEXT | Hardware assembly · Patent conversion · FPGA RTL · UAV flight validation |
| Q4 2026 | PLANNED | SATA-FLAME on FPGA (TRL 4→5) · SBIR Phase II · BLADE-MARITIME integration |
| Q1–Q2 2027 | TARGET | TRL 5→6 · Utility patents (projected) · Research partnership / CRADA |

## VERIFICATION & VALIDATION

Simulation (current) → Formal Logic / TLA+ (in progress) → HITL / Zynq FPGA (Q3 2026) → Physical Testbed (Q4 2026)

Aligned with: DoDD 3000.09 · NIST AI RMF 1.0 · MIL-STD-882E · ISO 26262 · NERC CIP · IEC 61850

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