TRAINING FOR THE DRONE-SATURATED BATTLEFIELD:

ADAPTIVE MODELLING AND SIMULATION

FOR SPACE-ENABLED MULTI-DOMAIN OPERATIONS

NATO CA2X2 FORUM 2026

Rome, 29 September 2026

Col. (ret.) Walter David

Climate & Security Consulting LLC

walterdavid.xyz@gmail.com

Outline

From recent conflict lessons to trainable command decisions

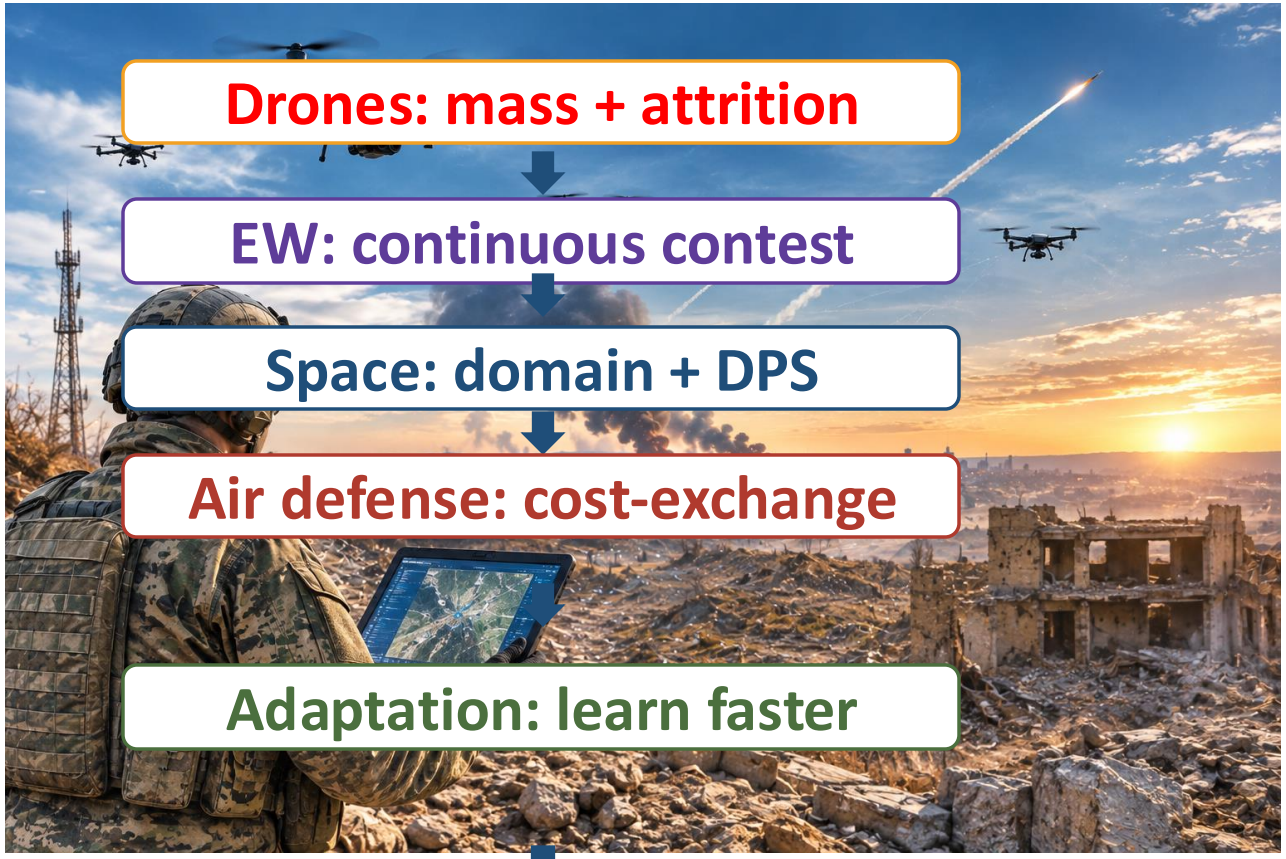
- **Changing Battlefield**
- **Training Gap**
- **HMT & CDC**
- **Adaptive M&S**
- **Training Vignettes**

- Drones • Space • EW • Cyber
- Platform models miss adaptation
- Orchestrate across domain • synchronize effects
- Degradation • adaptive OPFOR • AAR
- Train decisions, not demonstrations

Train command adaptation, not technology operation

Open-Source Lessons from Recent Conflicts

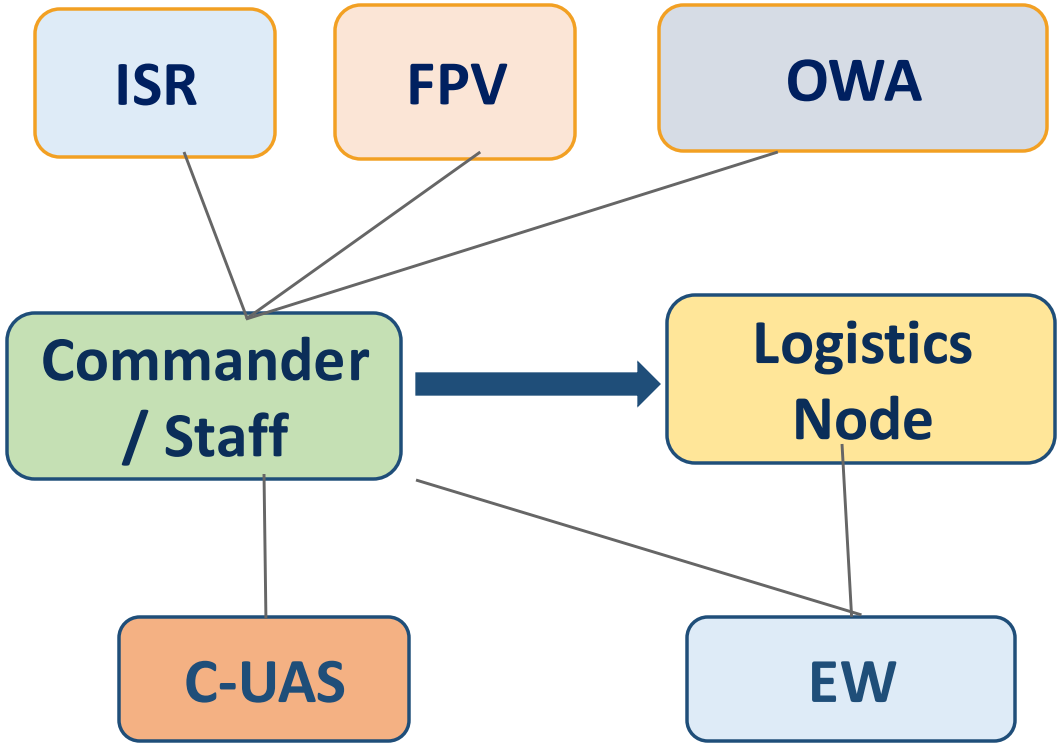
- Drones reshaping air and ground operations
- EW and spectrum adaptation are continuous contests
- Space DPS enablers and dependencies
- Cost-exchange pressure forces layered defense and smarter training
- Rapid learning cycles compress doctrine, procurement and tactics



Train command through change

The Drone-Saturated Battlefield

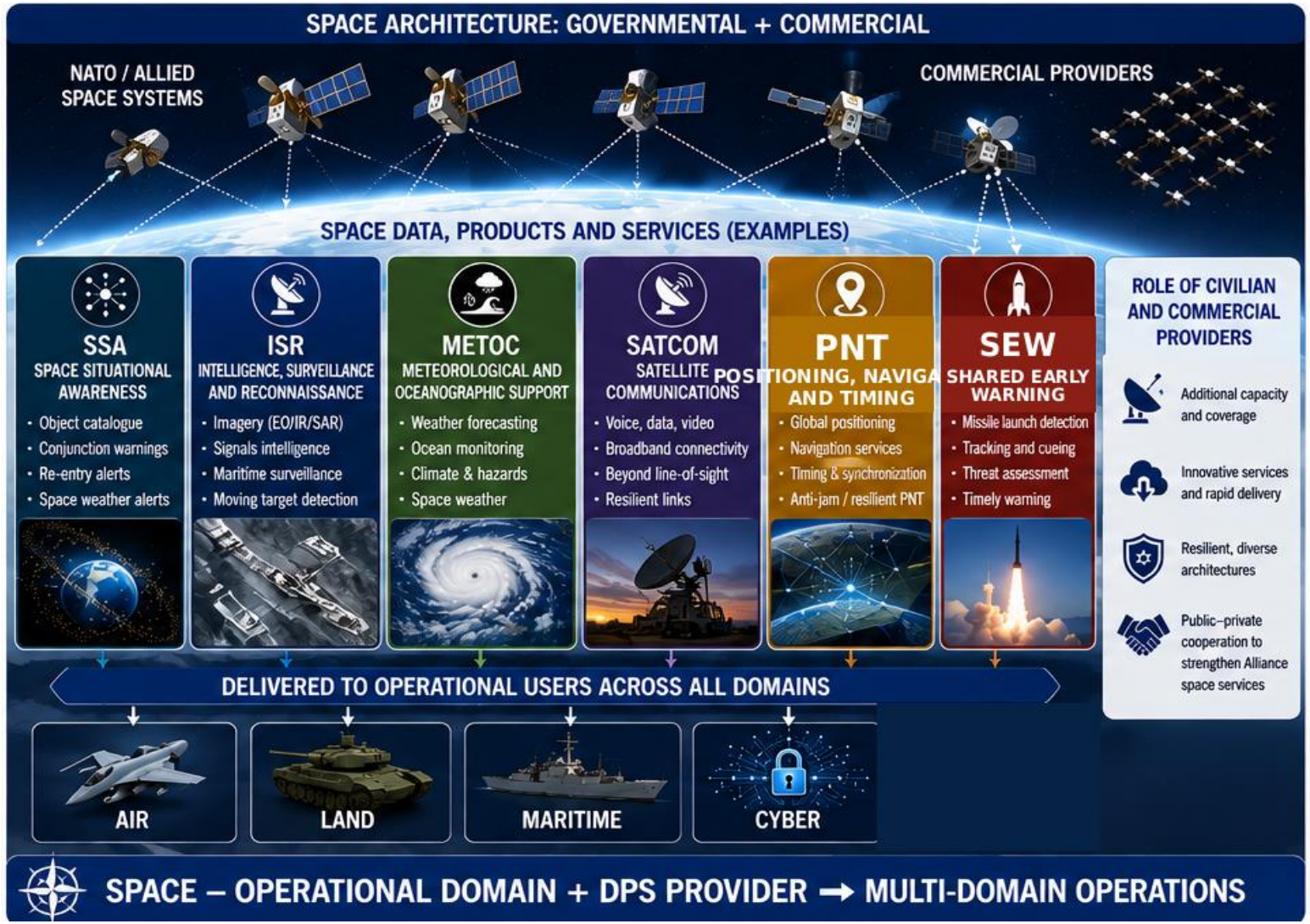
- Small UAS provide persistent observation and tactical reach
- Massed one-way drones stress air defense and civil resilience
- FPV drones accelerate target acquisition and strike cycles
- Counter-UAS must combine kinetic, EW and passive measures
- Training must reproduce density, uncertainty and adaptation



Train density • uncertainty • adaptation

Space Domain Data, Products and Services

- **Space operational domain**
- **Delivering Data, Products and Services (DPS)** through functional area
- Trusted service providers, **commercial**
- M&S to **reproduce** partial or complete **loss of space services**



Contested Electromagnetic Environment

- GNSS and COMMS jammed, spoofed or degraded
- EW changes quickly as both sides shift frequencies and techniques
- Spectrum awareness becomes a command and training requirement
- Cyber and EW effects interact with space and drone operations
- Synthetic environments must **model degradation** of connectivity

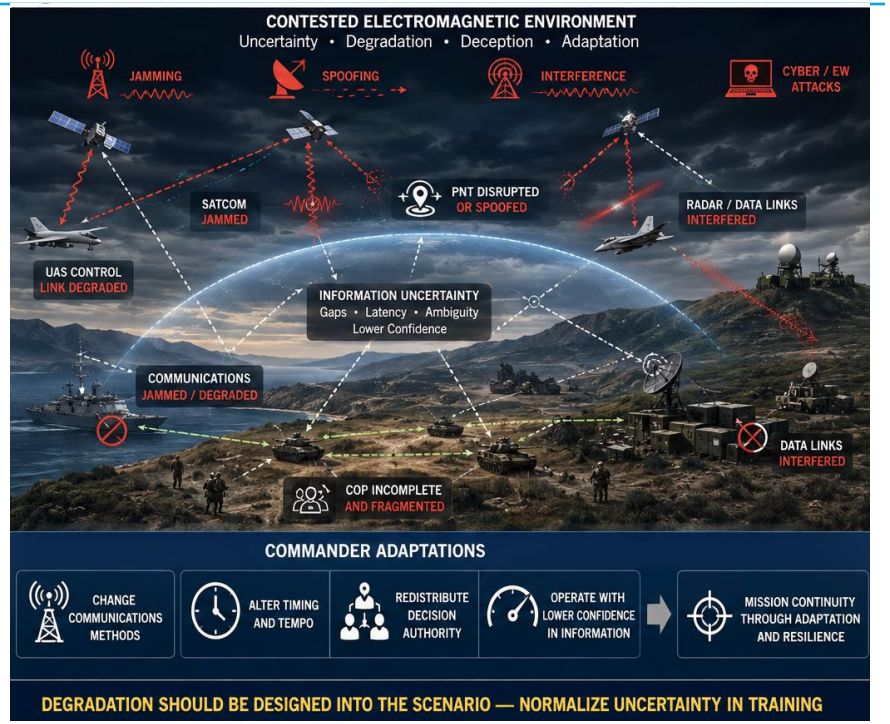
Comms

PNT

UAS C2

Radar

Data Links



Train degraded connectivity

Traditional Training is No Longer Enough

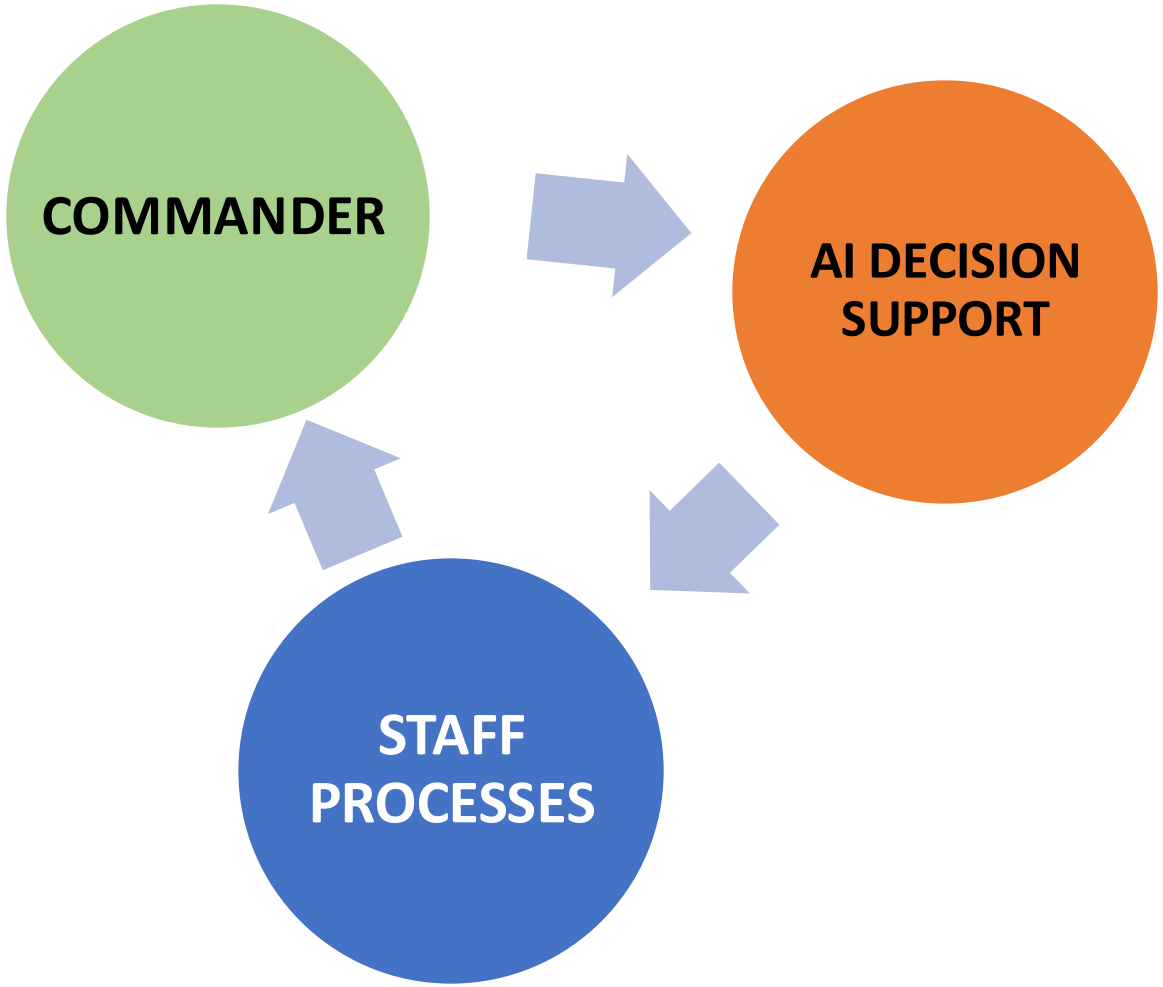
- Platform-centric simulations underrepresent cross-domain dependencies
- Stable scenarios miss the speed of battlefield innovation
- Perfect information creates unrealistic staff behaviours
- Single-domain play does not train space-enabled MDO decisions
- After-action review must assess command adaptation, not only attrition

Traditional training bias	Future training need
Platforms	Services
Stable COP	Dynamic COP
Perfect links	Degraded links
Scripted enemy	Adaptive enemy

Assess command adaptation

Human-Machine Teaming as Training Method

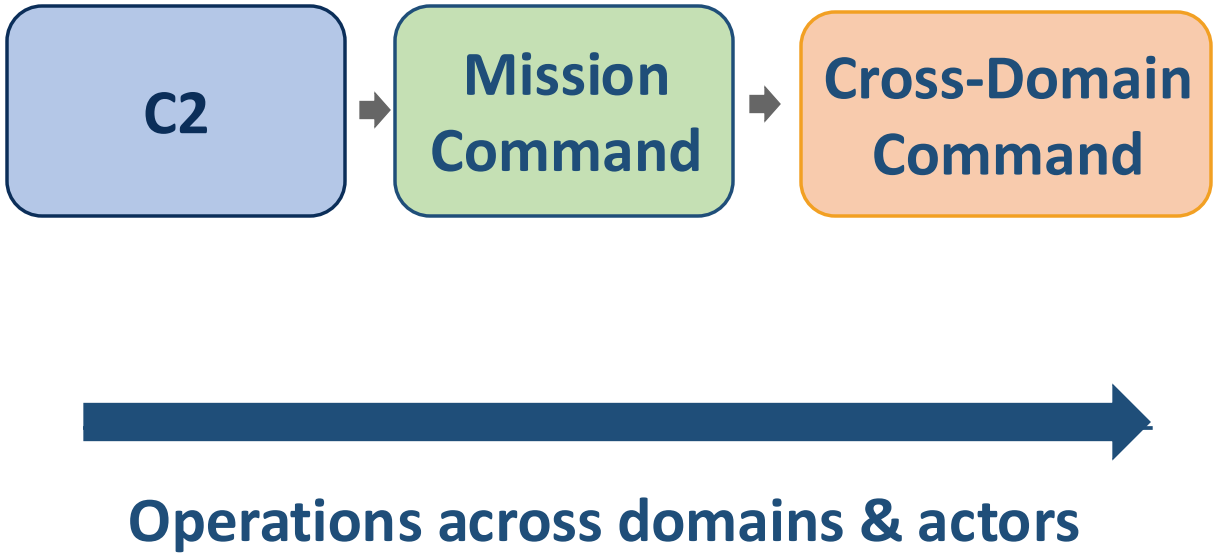
- AI accelerates sensing, correlation, prioritization and options
- Humans provide intent, judgment, context and accountability
- Trust must be calibrated through repeated realistic interaction
- HMT training must include AI error, ambiguity and explanation
- The commander closes the loop; AI supports the loop



Intent → machine support → staff action → human judgment

Cross-Domain Command for MDO

- CDC is the evolution of C2 required for MDO
- Command orchestrates across domains and actors
- The commander synchronizes effects across domains and actors
- CDC preserves human authority while exploiting machine-speed support
- Training develops judgment, tempo, orchestration and synchronization



Orchestrate across domains • Synchronize effects

Adaptive M&S Framework: Train the Adaptation Cycle

- Model services, dependencies and sensor-to-shooter webs, not only platforms.
- Represent SATCOM, PNT, spectrum, ISR and data quality as service states.
- Inject adaptive adversary behaviour into scenarios and opposing forces.
- Instrument HMT, decision tempo and AI use.
- Generate AAR evidence on orchestration and effects synchronization.

Operational Services | **Synthetic Scenario** | **Command Training** | **AAR Evidence**

Service states

Available | **Degraded** | **Denied** | **Restored**

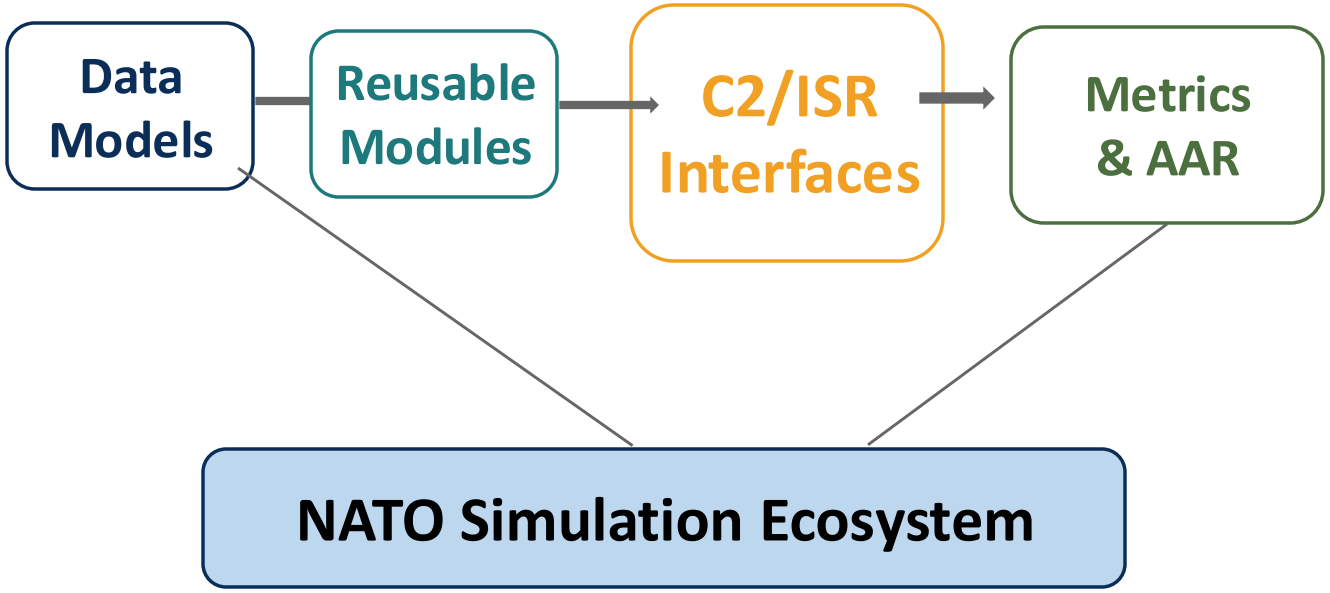
Train recovery under degradation

Assess tempo • orchestration • effects • HMT

AAR → institutional learning

NATO Simulation Ecosystem Requirements

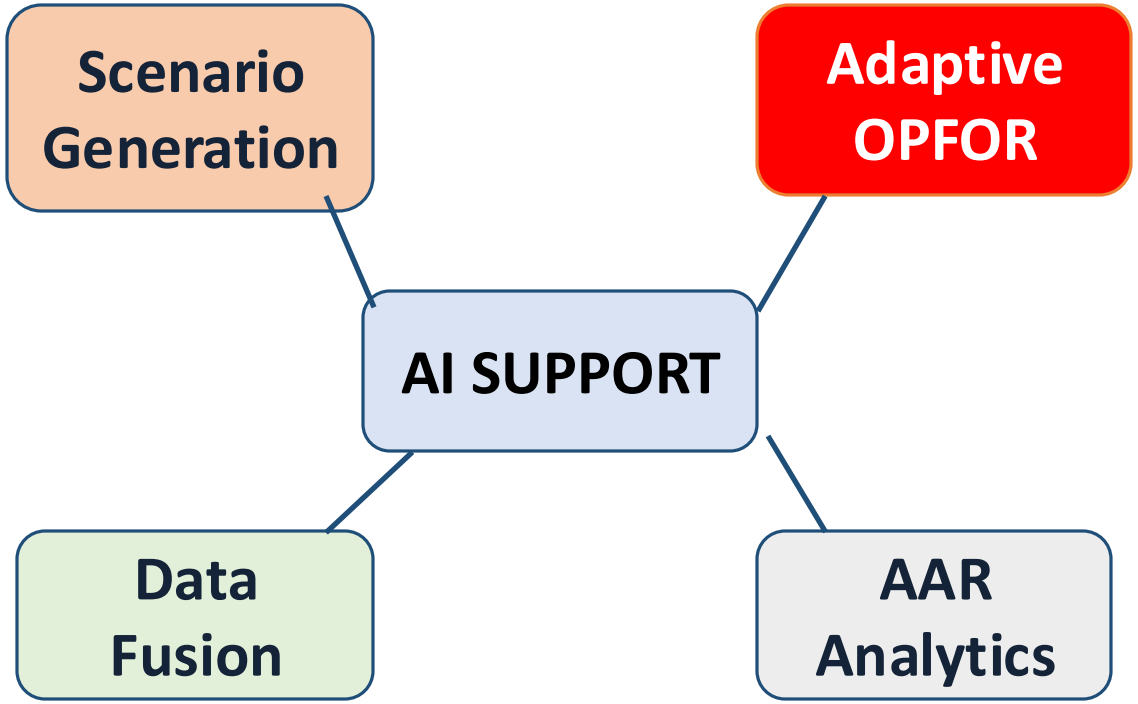
- Interoperable data models for domains, services and effects
- Reusable scenario components for UAS, EW, space and cyber
- Interfaces for C2, ISR, logistics and operational analysis tools
- Common metrics for readiness, tempo and HMT performance
- Open architectures to support multinational and industry integration



Open • interoperable • multinational

AI as Decision Support, Not Autonomous Command

- Generate adaptive scenarios and non-scripted opposing-force behavior
- Fuse multi-source information into explainable decision aids
- Highlight anomalies, uncertainty and confidence limits
- Support automated after-action review and learning analytics
- Preserve governability, accountability and human decision authority



Explainable • governed • human-authorized

Training Vignettes: Decisions under Degradation

Vignettes force decisions

- **Convoy** → Drone watch + degraded PNT
- **Air defence** → Missile + drone salvo
- **Joint fires** → SATCOM loss + EW
- **C-UAS node** → Protect logistics + C2
- **Coalition Staff** → Uneven information sharing

Air-defense triage

- **Round 1** → Normal PNT/SATCOM
- **Round 2** → Degraded PNT + delayed ISR
- **Round 3** → Adaptive threat + bad AI cue

Measure: tempo • allocation • AI use • coordination • effects sync

Lessons → command decisions

Conclusion

Operational context

Drone saturation reveals the training problem

→

Training method

HMT develops calibrated human-machine judgment

→

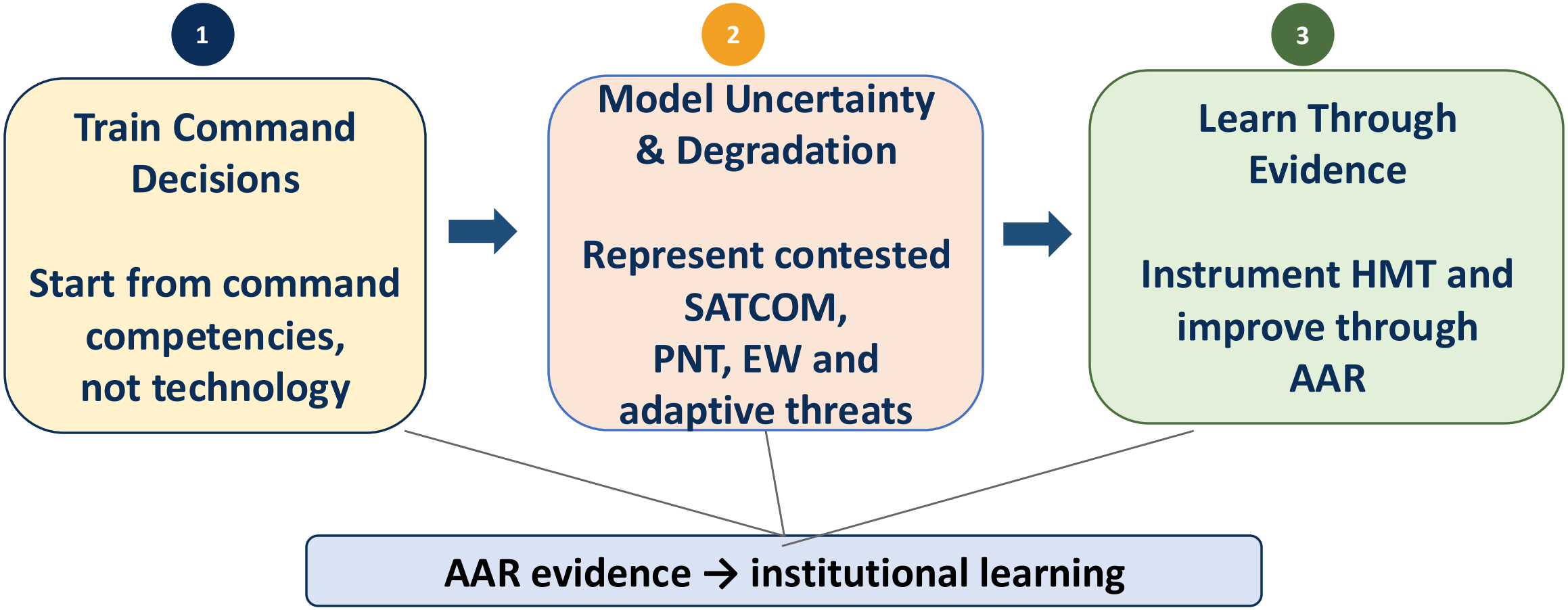
Command objective

CDC evolves C2 to orchestrate operations and synchronize effects across domains and

Mission-centric • Human-centered • Space-enabled

Train command, not gadgets.

Recommendations



Questions & Answers

Walter David
Climate & Security Consulting LLC

walterdavid.xyz@gmail.com
walter.david@ronininstitute.org

CLIMATE & SECURITY
CONSULTING LLC