Embedded Capability Development: A Case Study in Rapid Missile Prototyping and Transition

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Motivation – Challenges of Traditional Capability Development

S&T Challenge

- Promising prototypes, weak transition path
- Limited acquisition readiness
- Late, episodic transition engagement

"Big A" Acquisition Challenge

- Sequential and rigid by design
- Slow to adapt during development
- Poor fit for rapid, low-cost systems

Takeaway

- Current approaches either produce promising prototypes without transition readiness or rely on structures too rigid for rapid adaptation
- A different execution model is needed to integrate technical learning, evolving requirements, and transition preparation from the outset

Embedded Capability Development Model

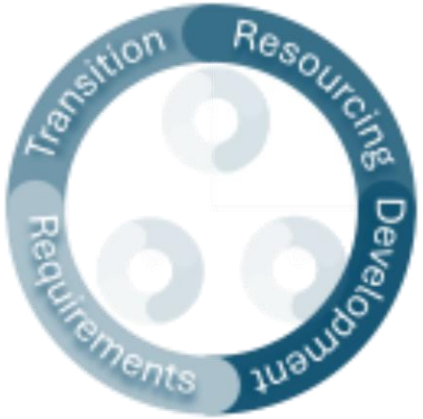
Practical execution model for maturing capability, refining requirements, and preparing for transition in parallel

Enabled Through Alignment

- Organizational alignment: a uniformed government developer, embedded in technical execution, serves as the accountable day-to-day link to the capability development chain
- Functional alignment: development, requirements, resourcing, and transition advance together within one effort

Core Execution Drivers

- Continuous technical participation and iterative prototyping
- Shared technical artifacts and evidence-based refinement
- Early industry collaboration and persistent stakeholder engagement



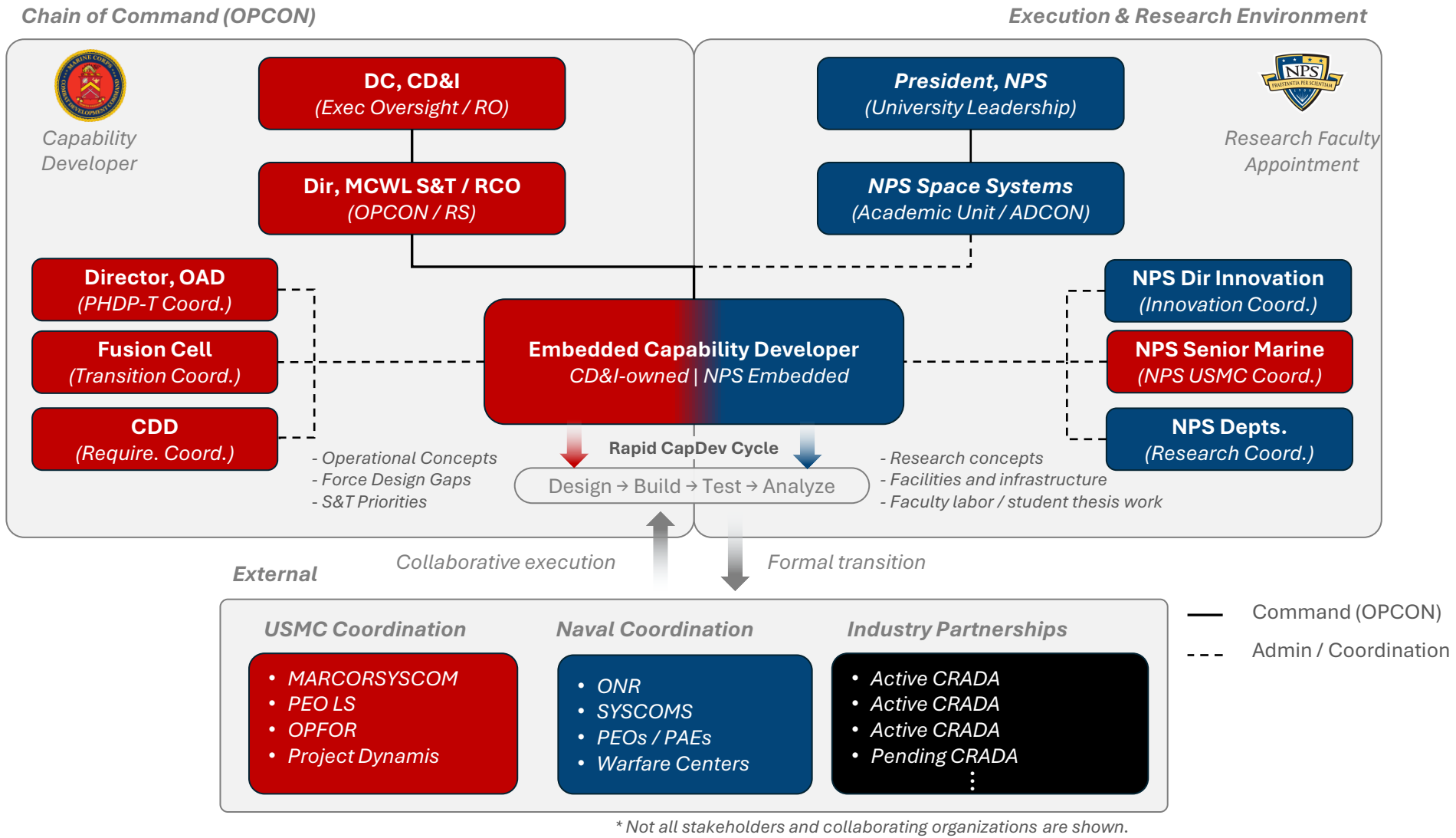
Integrated Iterative Development

Case Study: Low-Cost Tactical Missile System

Overview

- Government-industry missile development effort focused on low-cost tactical capability
- Serves as the case study for applying the embedded capability development model
- Illustrates how technical development, evolving requirements, and transition preparation can be advanced in parallel
- Well suited to the model because it involves rapid technical iteration, evolving design tradeoffs, and early transition considerations

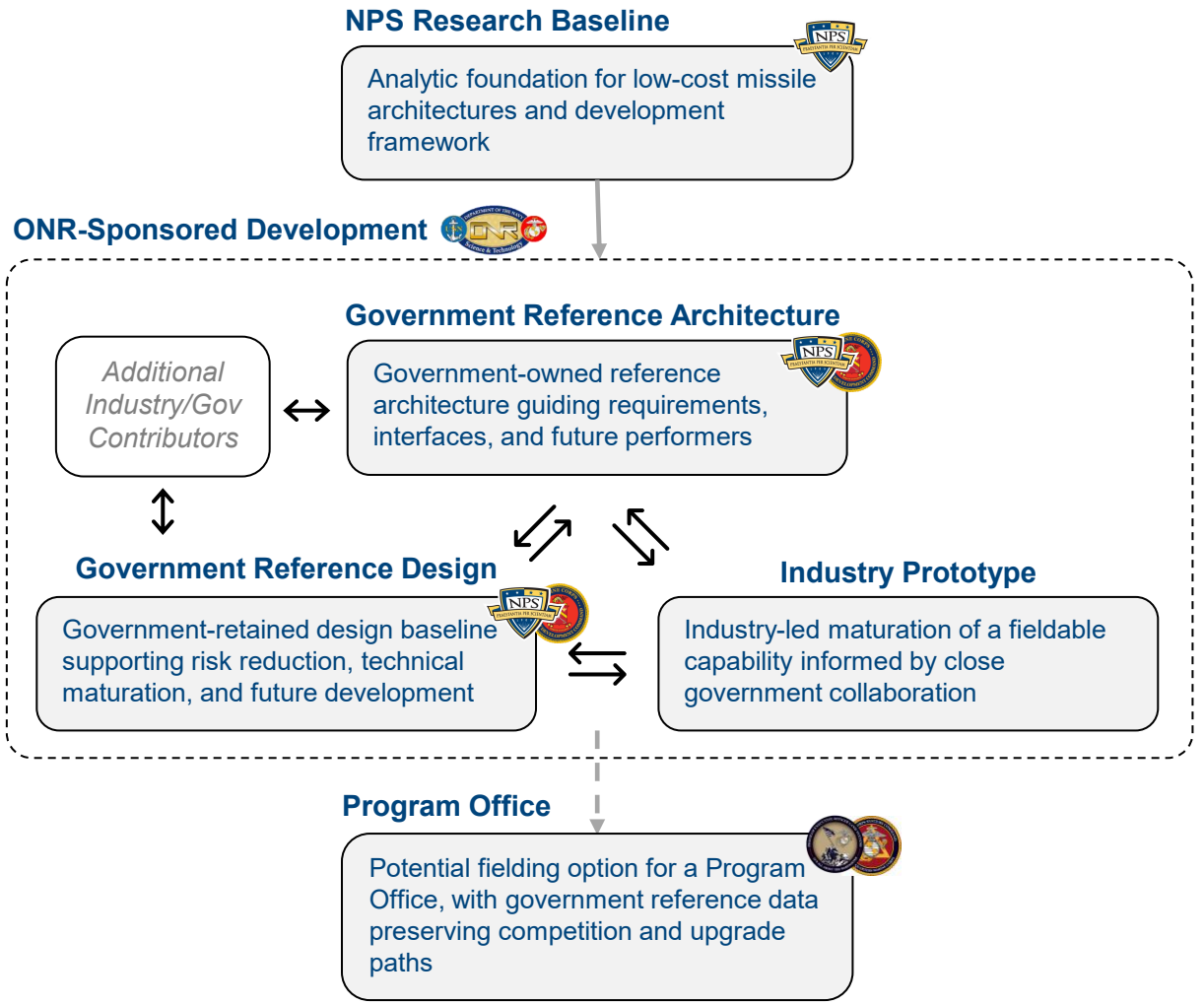
Model Execution: Organizational Alignment



** Not all stakeholders and collaborating organizations are shown.*

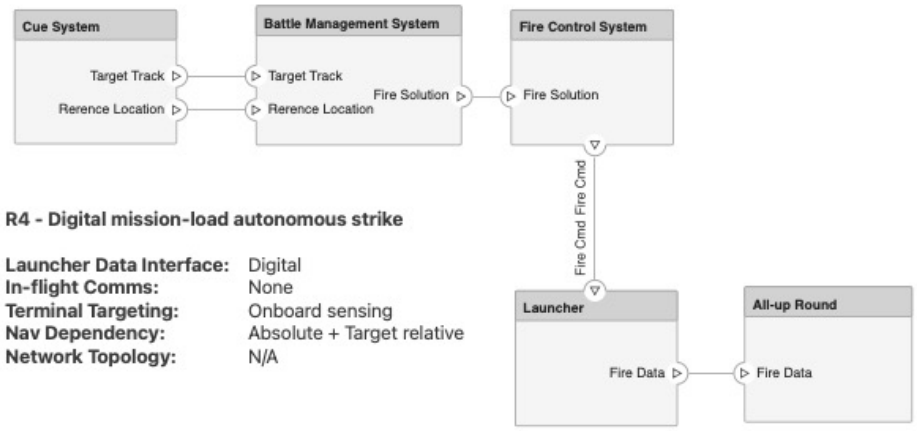
Capability Maturation and Transition Pathway

- NPS dissertation established the analytic basis and initial feasibility for a low-cost missile architecture and development framework.
- ONR Code 352, through a Future Naval Capability (FNC) program, provides the S&T program structure supporting continued missile development.
- Within the FNC, NPS is developing the Government Reference Design and Architecture, building on the validated dissertation framework and insights from CRADA maturation with industry.
- Transition of an industry-delivered, production-ready capability, co-developed alongside a government-owned reference design, allowing a Program Office to field immediately while retaining data rights, competition, and future upgrade paths.



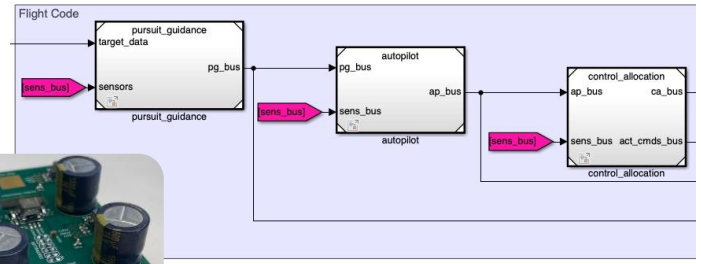
Model Execution: Enabling Tools

Government Reference Architecture



Government Reference Design

Flight Software / Simulation



PCBs

CAD Models

Test Data

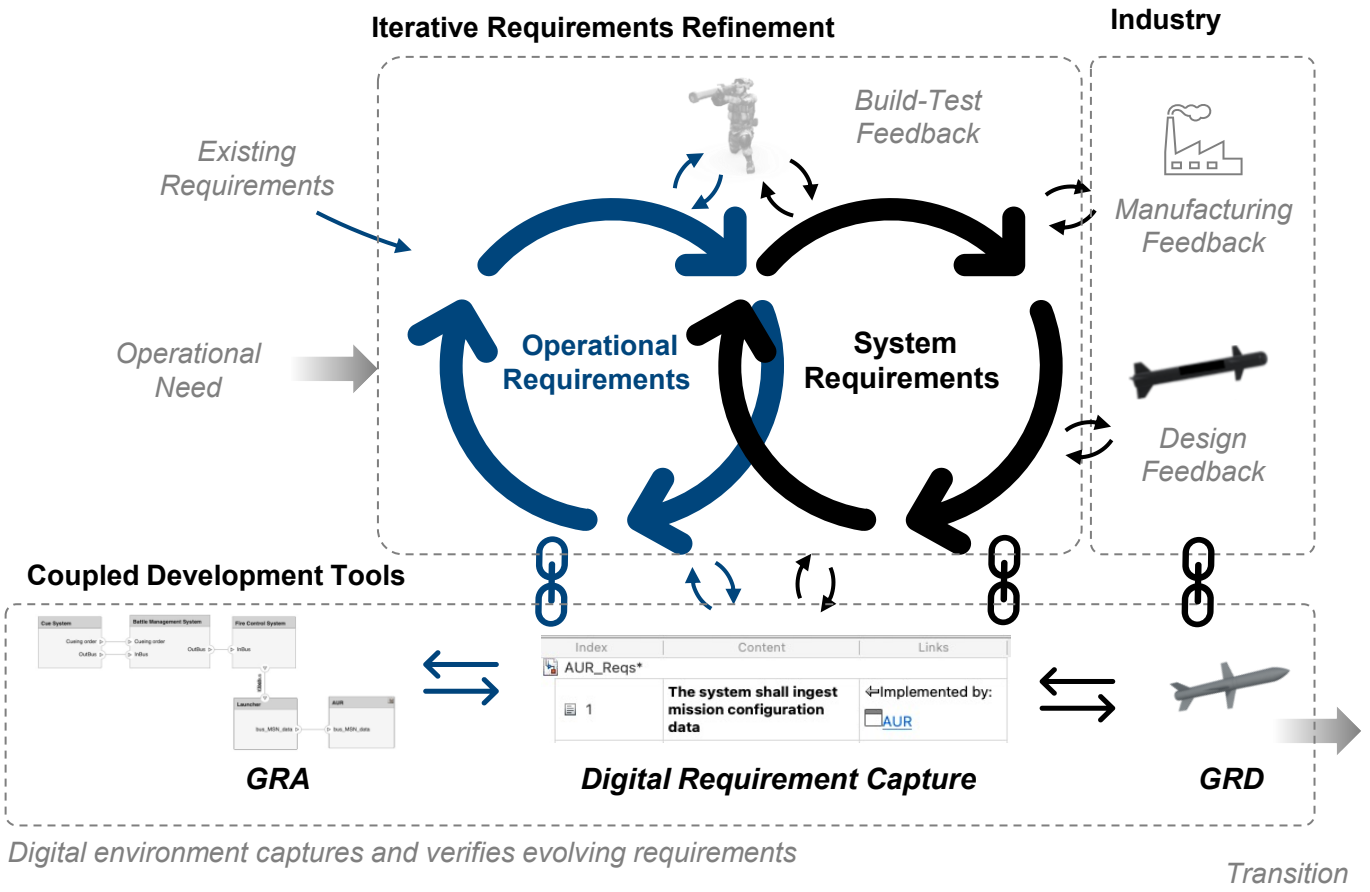
- Authoritative living baseline for requirements, interfaces, and verification
- Used to evaluate mission-thread and architecture tradeoffs early
- Refined iteratively with the reference design and prototype evidence

- Executable government baseline for software, hardware, simulation, and physical design
- Collaboratively matured with industry through iterative development
- Preserves continuity, supports transition, and enables future competition

Iterative Requirements Development

Evidence-Based Requirements Development

- Begins with operational need, not a fixed requirement set
- Detailed requirements emerge and mature alongside design, build, test, and analysis
- Requirements discipline is maintained, but embedded within the learning process
- Design evidence, prototype results, and implementation realities shape the evolving baseline
- Set-based analysis and GRD prototyping inform feasibility, tradeoffs, and transition relevance before requirement lock

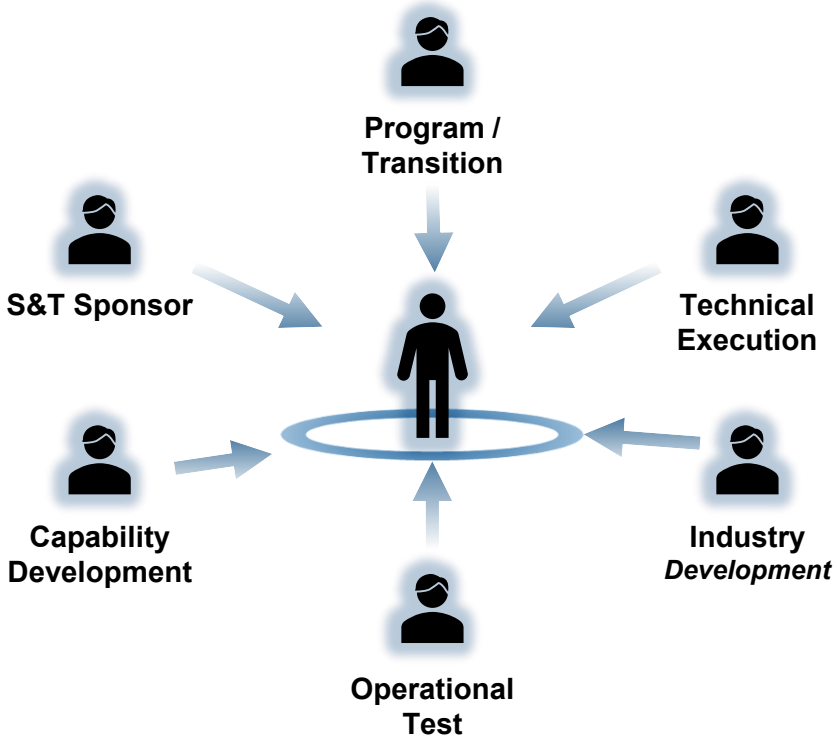


***Result**: a more realistic, evidence-based requirement set aligned to operational utility*

Early Stakeholder Integration and Transition Alignment

Stakeholder and Industry Integration

- Stakeholders are engaged early enough to shape the evolving baseline, not react to it later
- Embedded capability developer serves as the integrating point across sponsors, requirements, test, transition, and technical stakeholders
- Industry collaboration occurs through sustained day-to-day engagement against a shared technical baseline
- Sprint-style coordination helps surface blockers, retire risk, and align near-term development priorities
- Result: tighter technical, requirements, and transition feedback loops with less translation loss across organizational boundaries



Embedded Capability Developer as Integrating Node

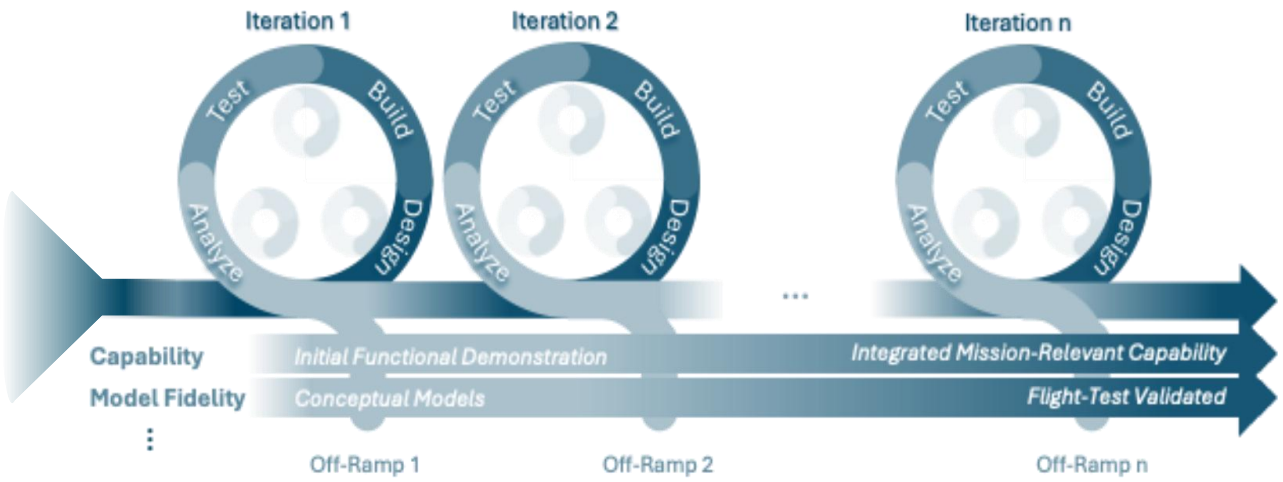
Applicability, Limits, and Implications

Development Spectrum

- Best suited to development-intensive capabilities that cannot simply be bought and cannot be responsibly specified in full detail at the outset
- Most useful when operational need is clear, but the technical solution remains meaningfully uncertain
- Depends on a technically credible, operationally grounded government lead with sufficient institutional access
- Requires both a viable development environment and a plausible transition pathway
- Does not replace formal acquisition, but helps improve the technical and programmatic baseline before later commitments harden

Conclusion: Early Observations from Implementation

- Early execution shows tighter coupling of architecture, design, verification, and prototype activity
- Collaborative maturation of the GRA and GRD has improved the credibility and utility of the government baseline
- Set-based analysis has shifted requirement development from early assumption to evidence-based convergence
- Result: a stronger, more coherent, and more transition-ready baseline while the system is still being defined



Operational Need

Transition-Ready Baseline

Collaborative Iterative Development