21st Annual National Defense Industrial Association Systems and Mission Engineering Conference

Mission Engineering: Evolving Acquisition to Support the Warfighter

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Office of the Under Secretary of Defense for Research and Engineering

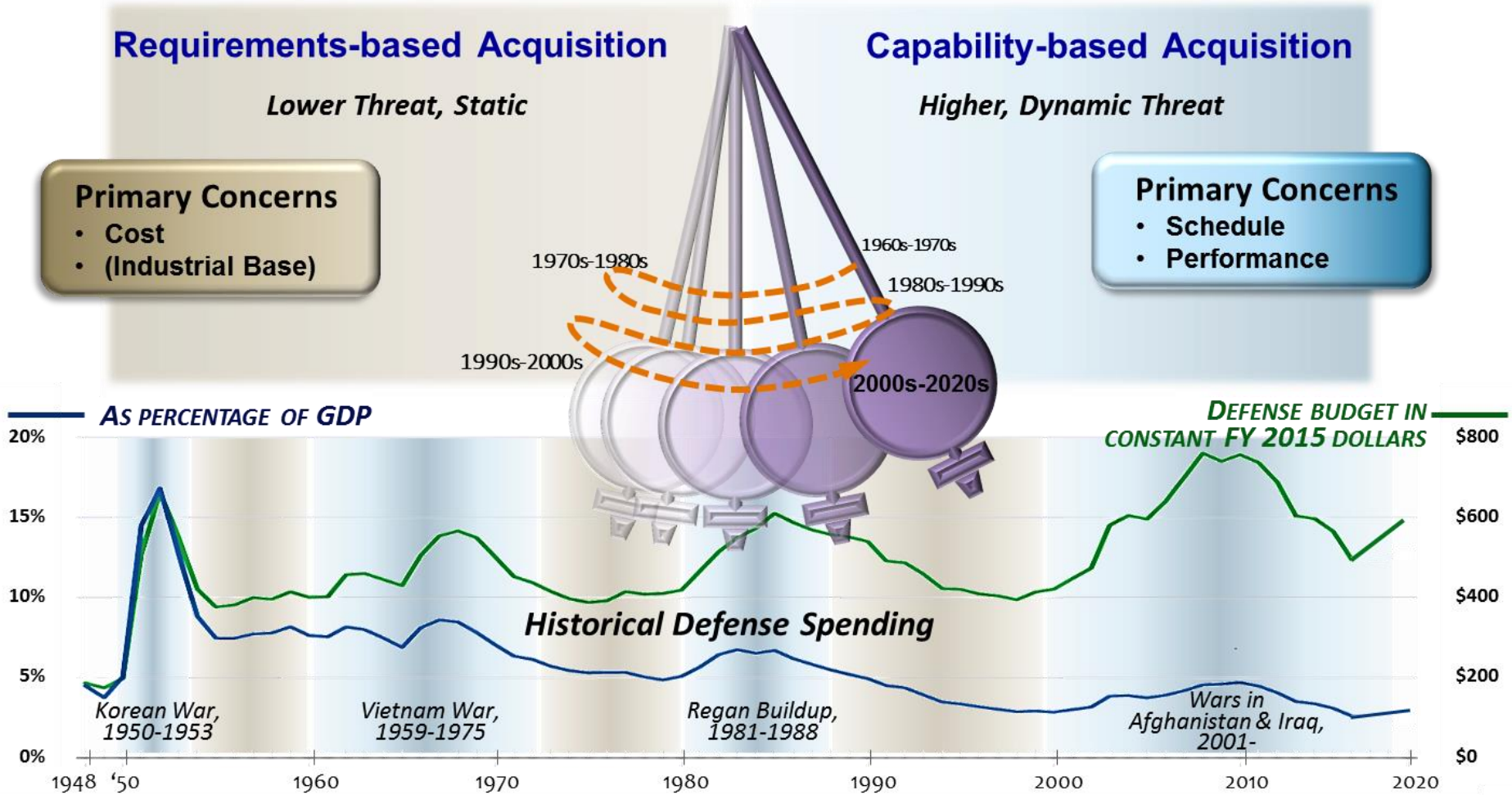
October 24, 2018

Pacing Mission Challenges

"Building upon our strengths and pursuing lethality, surprise, and speed will help us become a mission-focused, innovative Department that puts kill chains over systems, heterogeneity over uniformity, and adaptability over doctrine. We will assess capability gaps and needs by missions vs. system or Service, and we will focus on outcome rather than process."

—USD(R&E) Michael Griffin, June 2018

Shifting Acquisition Concerns – Capability vs. Platform



Sources: U.S. Department of Defense, *National Defense Budget Estimates for FY 2015*, April 2014, and Heritage Foundation calculations http://comtroller.defense.gov/Portals/45/Documents/defbudget/fy2015/FY15_Green_Book.pdf (accessed Jan 16, 2015).

Schedule (agility) and performance (innovation) dominate current Defense perspective

Increasingly Complex, Compressing Battlespace

- The complexity of battlespace is increasingly complex:
  - The number of combatants (red, blue and white) and their systems are increasing both in number and sophistication
- "Everything" is networked together to some extent
- The timeline of the battlespace is shrinking:
  - Nano-second decision making is required

Complex
Dynamic
Instantaneous
Kinetic/Non-kinetic
EW-Cyber
Battlespace

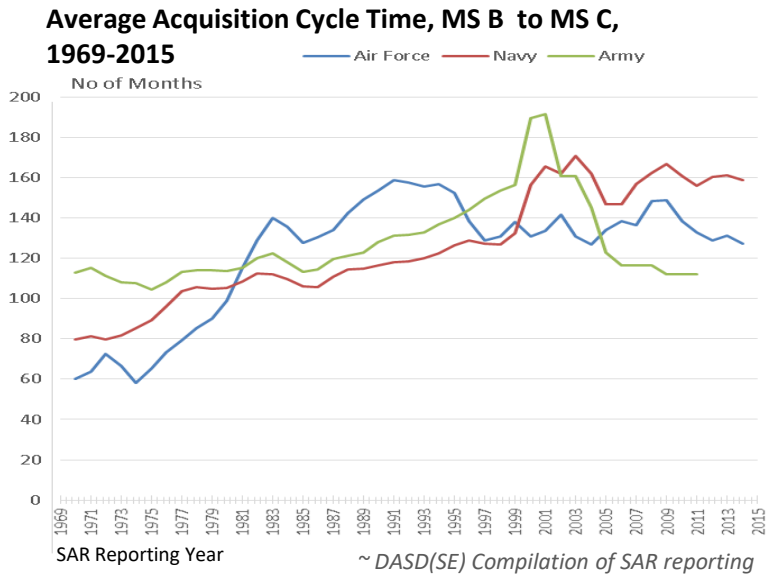
Source: https://culturalq.com/

Source: map.norsecorp.com/

The threat is evolving and invalidating our architectures
Key is to recognize these changing factors to better posture material solutions to rapidly/seamlessly enter and exit the battlespace

Current Acquisition is Falling Short

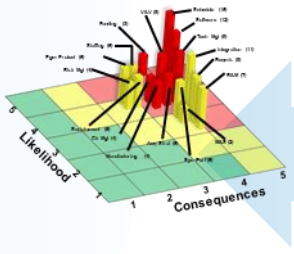
- Acquisition is taking longer
- Acquisition "failures" are increasing (Nunn-McCurdy breaches)
- Acquisition delivery is increasingly irrelevant to *current* warfighter needs

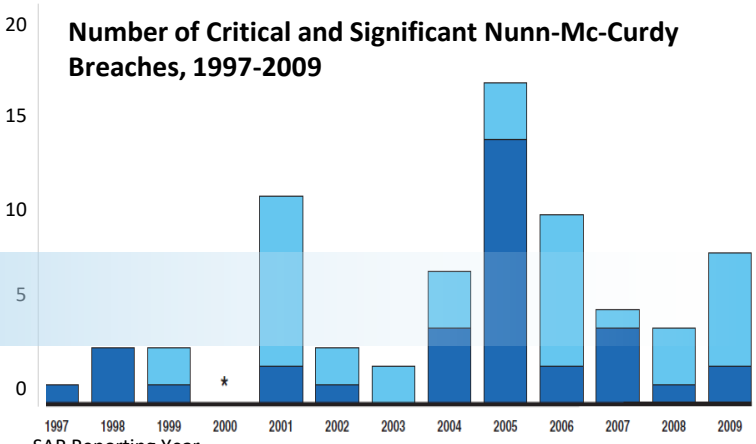


~ DASD(SE) Compilation of SAR reporting

The causes:

- Increasing complexity – integration and interdependencies
- Immature technology
- Monolithic expectations with unrealistic schedules
- The mission has evolved





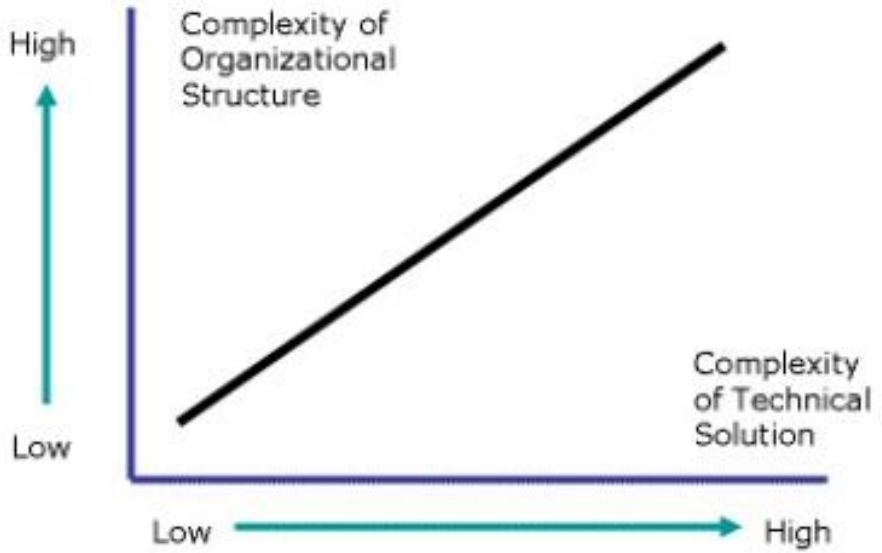
~ GAO Report, "DoD Cost Overruns", 2011

We are working harder but achieving less and less must develop capability at the Speed of Relevance

Conway's Law

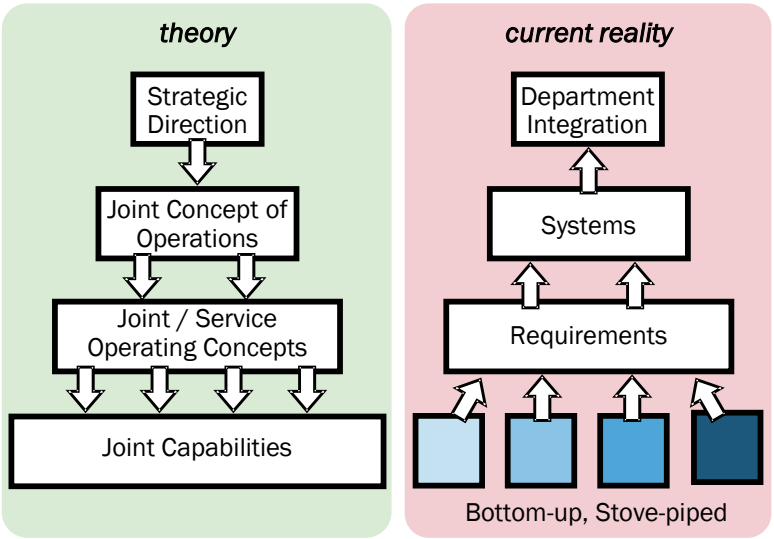
"Any organization that designs a system (defined broadly) will produce a design whose structure is a copy of the organization's communication structure…"

~ Melvin Conway, 1967



Department-Wide Realignment / Emphasis

- Acknowledgement that the battlespace is increasingly interconnected, and so should Defense engineering
- Great end-effects can be achieved from less-than-great systems… or even no systems
- Acceptance of judicious risk to make large gains
- Valuation of the speed & relevance of delivery, balancing cost & performance
- Understanding that great engineering cannot correct the shortfalls of an ill-conceived framework architecture



We need to think enterprise-wide not just system-level

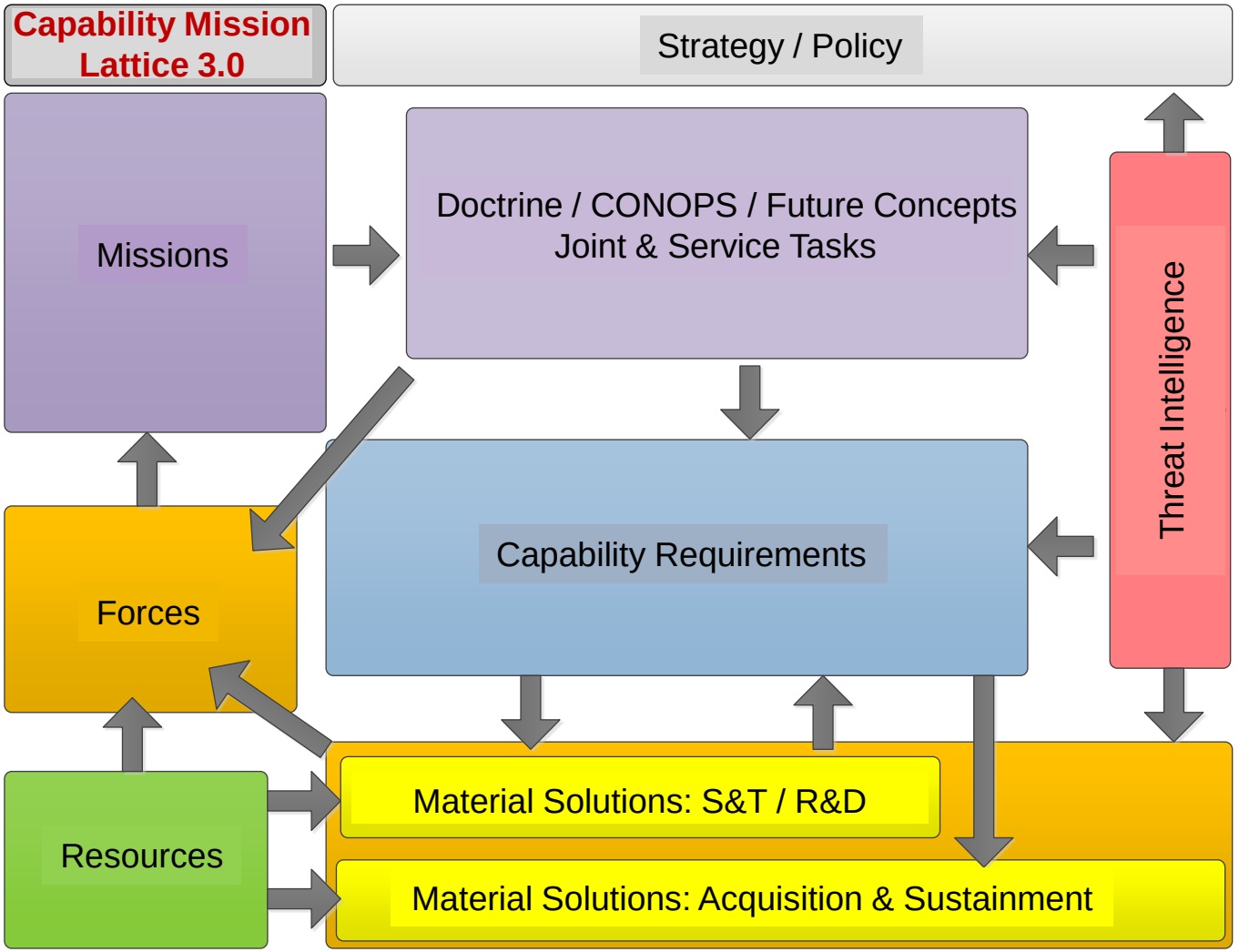
Department Re-Alignment / Emphasis

JCIDS Process change

- 2008-Present
- Goal: Synchronize JCIDS – DAS - PPBE

Added:

- Capability analysis
- More coordination steps
- Threat Intel input to Acq.



Redefined Acquisition process goal to better synchronize JCIDS – DAS – PPBE

Department Re-Alignment / Emphasis

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Added:

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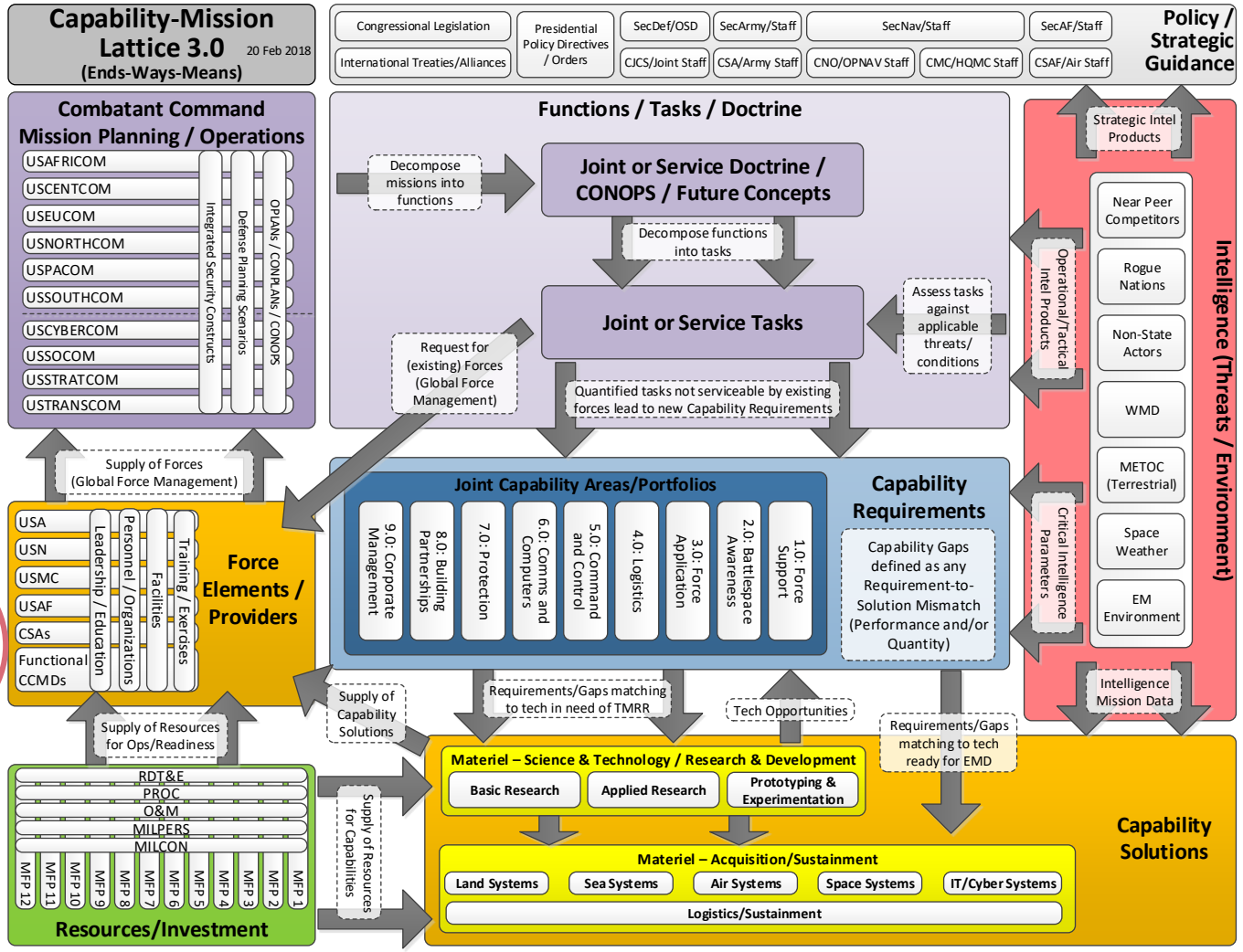
Improved but didn't solve means to manage technical tradeoffs and risks

- Short, Med. Long term
- ID areas of divestment



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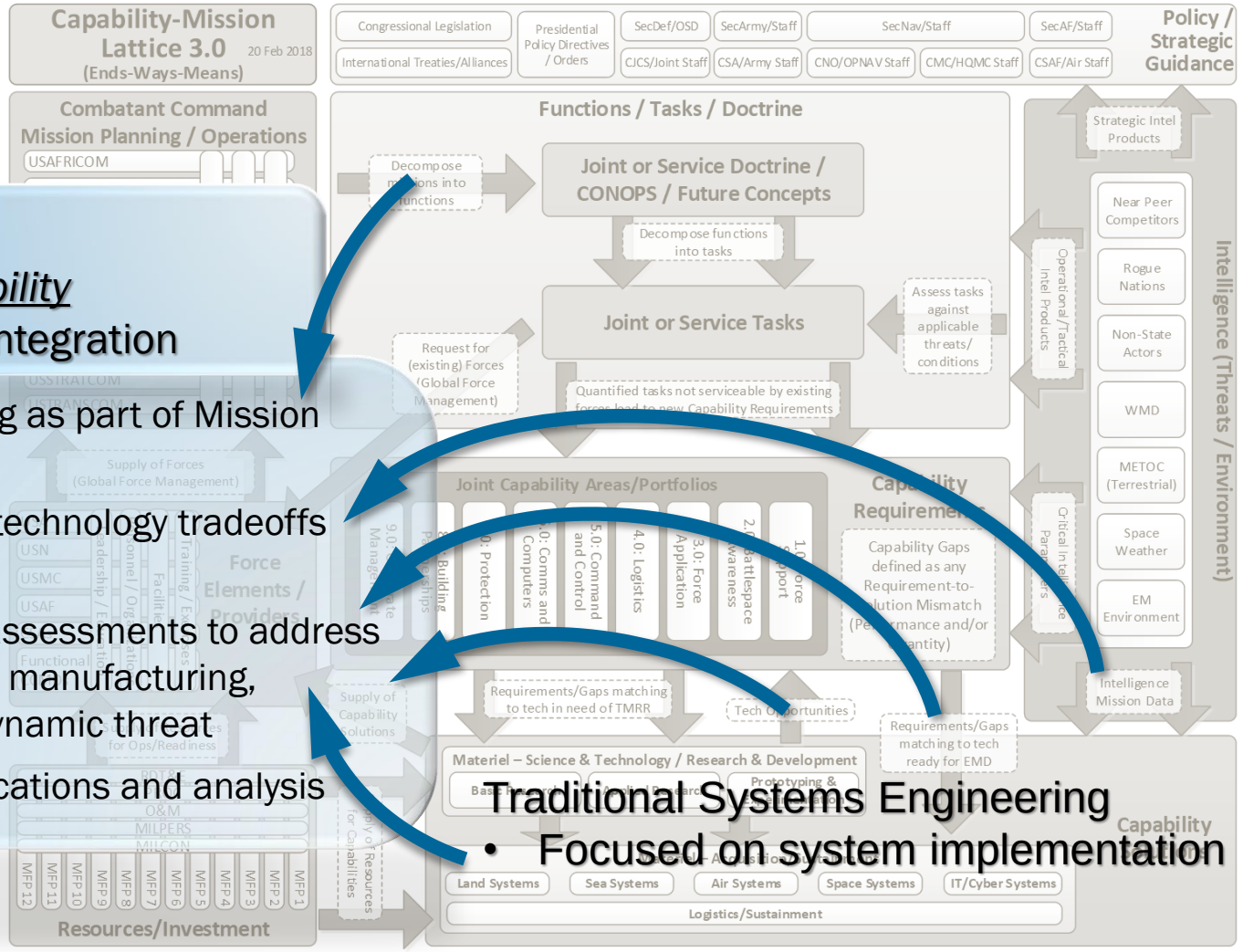


Mission Engineering
Shift focus to *capability* implementation & integration

- Integrate engineering as part of Mission Capability Analysis
- Inform of technical/technology tradeoffs more frequently
- Integrate technical assessments to address mission, technology, manufacturing, schedule realism, dynamic threat
- Tightened communications and analysis

Traditional Systems Engineering
- Focused on system implementation

Mission Engineering: Formalizes that engineering rigor and technical insight is key to informing the tradeoffs and risks taken earlier in the Mission-Capability decision

Mission Engineering

Mission Engineering is –

- Disciplined translation of mission needs into a ***Enterprise Mission Architecture*** providing the foundation to subsequently develop solution architectures and field systems
- ***Synchronization*** of solution architectures and system dependencies to achieve the enterprise mission architecture and meet the mission need
- Champion ***Capability-Enabling Technical Practices*** across the department to enable more relevant, timely, and agile solution architectures and systems
- Authoritative identification of ***Technical Risk, Opportunities,*** *and* ***Data-driven Insight*** to address decisions at all levels: chief engineer, PM, decision authority

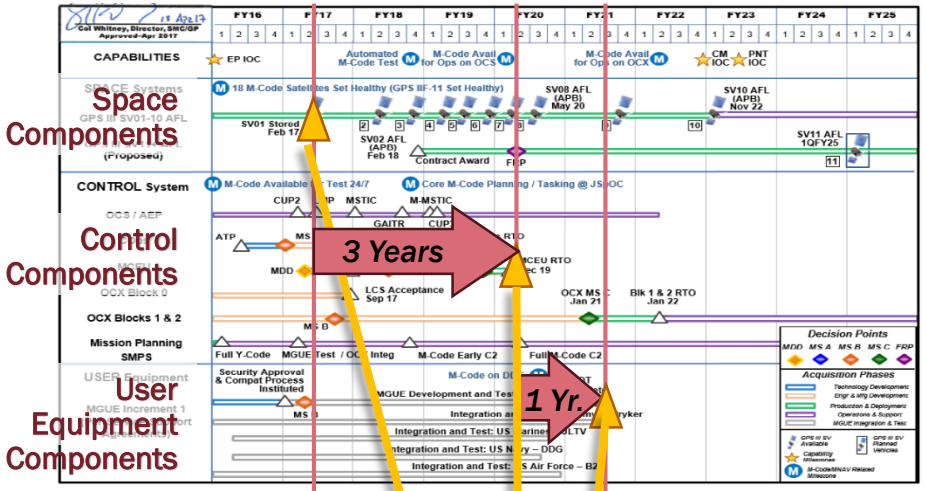
ME focus is: Enterprise-level architectures, interdependencies, enabling practices and authoritative technical insight

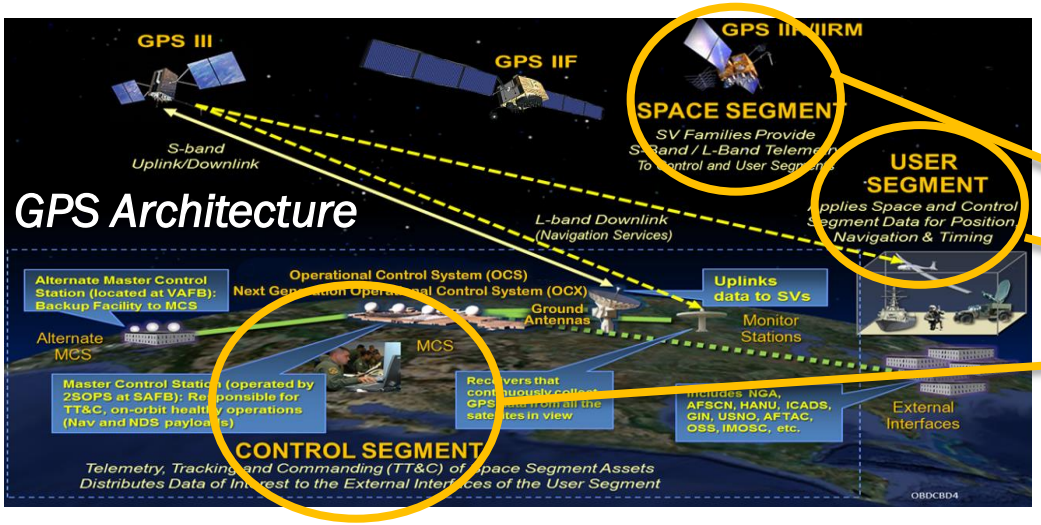
Improve Management of Interdependencies

- Synchronize acquisition program sequencing and timelines
- Synchronize / align shared dependencies and interfaces

Dependencies between programs are not universally tracked and carry hidden risks; improved insight across all ACAT-levels is needed

Operational Capability of M-code PNT





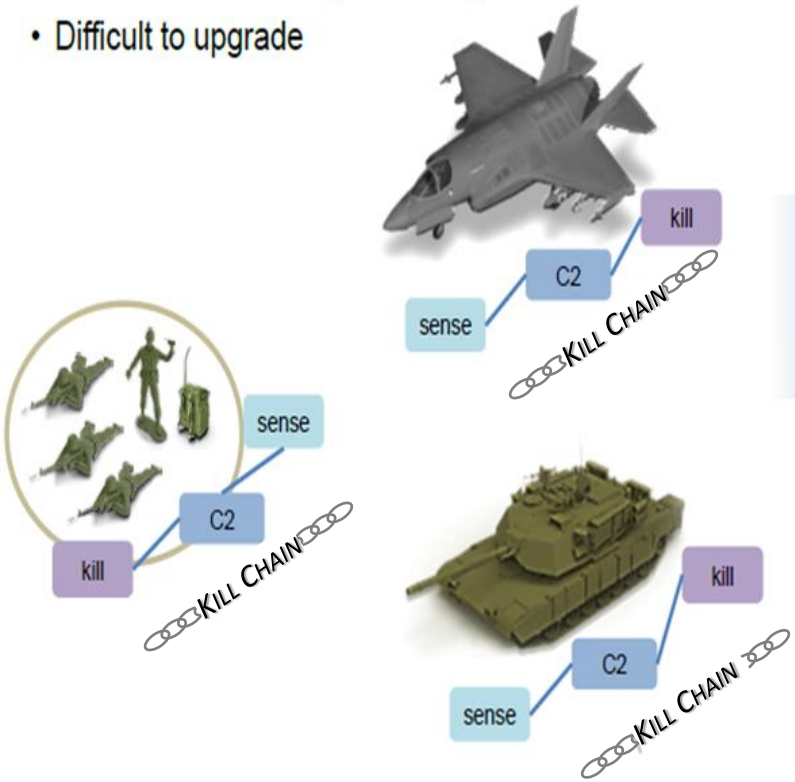
Shared Dependencies

Improved synchronization and dependency management is critical

Emphasize End-to-End Mission Effects

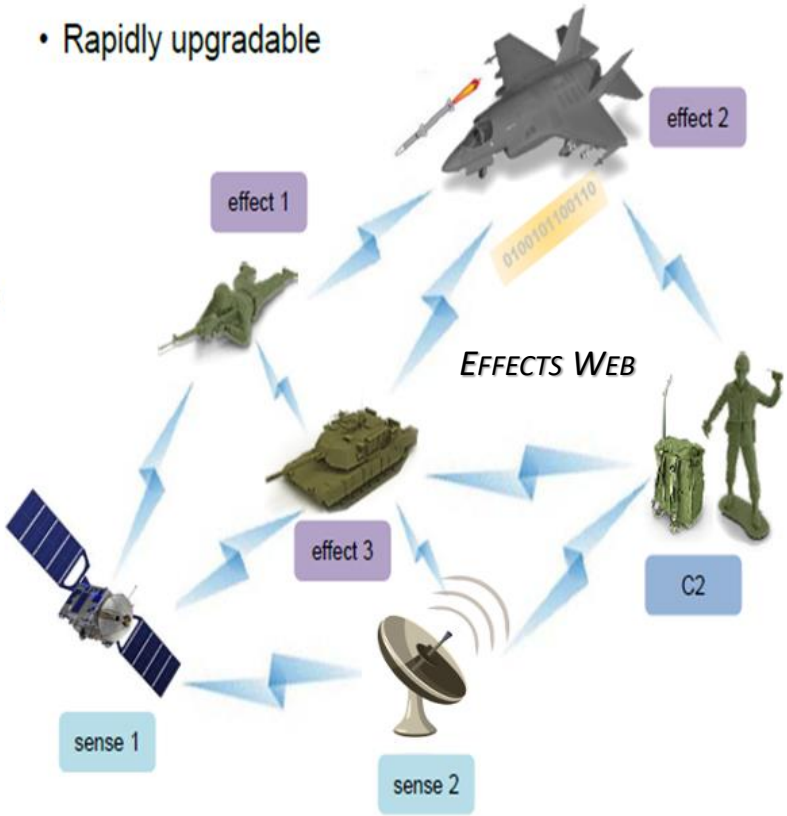
From Monolithic Kill Chains…

- Risk centralized in monolithic platforms
- Vulnerable to evolving adversary kill-chains
- Difficult to upgrade



To Adaptive Kill Webs…

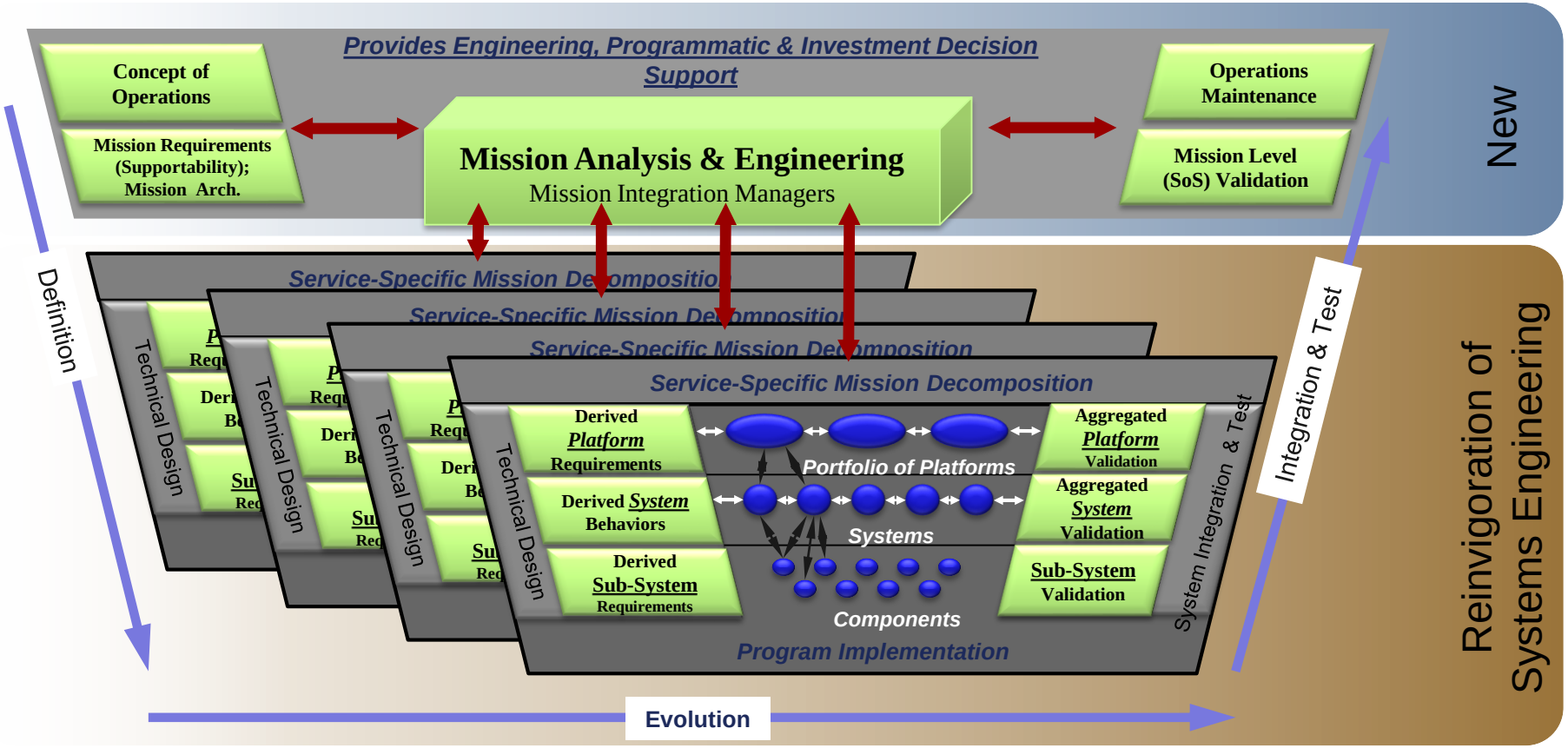
- Risk distributed across manned/unmanned platforms
- Adapts to evolving adversary kill-chains
- Rapidly upgradable



- In today's acquisition process, programs are matured independently
- System-of-systems integration occurs when delivered

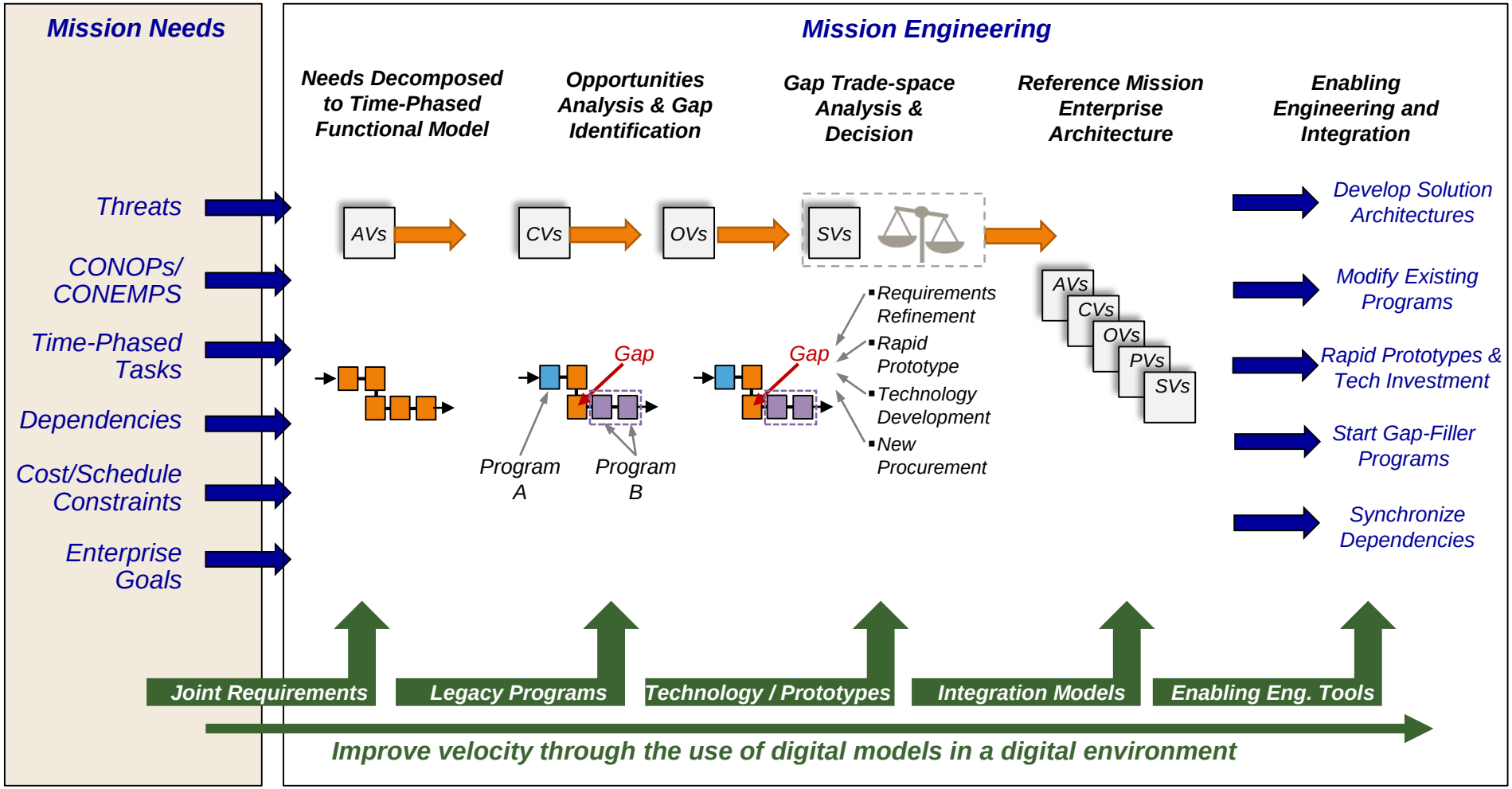
Optimize enterprise effects vs. platform effects

Practice Systems Engineering Excellence



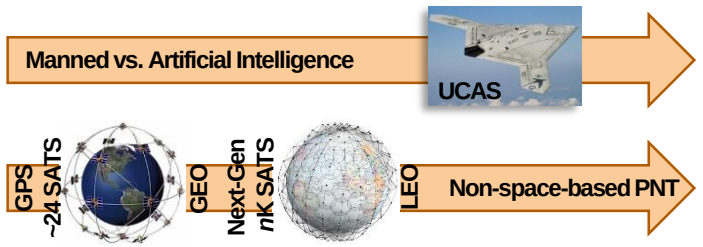
Extend engineering rigor & analysis to impacts across mission threads

Mission Engineering Enterprise Planning –
Multiple Services, Multiple Domains



Extend engineering rigor & analysis to impacts across mission threads

Value Speed of Delivery at All Levels/Spirals

ENGINEERING LEVEL	DESCRIPTOR	TIMELINE	EXAMPLE
COMPONENT Within constraints	**CONTINUOUS DELIVERY** of capability developed and acquired in the context of recognized constraints	<1-2 Years	
BLOCK Trading constraints	**ITERATIVE DEVELOPMENT** delivering **"Minimum Viable Product"**	~3-4 Years	
PLATFORM Evolving constraints	**RE-STRUCTURE and SEQUENCE** platforms to optimize the trades made in the previous two levels … • Avoid 30-year monolithic acquisitions • Buy 100 before committing to 1000s	~5-10 Years	
EPOCH Redefined constraints	**RE-DEFINE THE FRAMEWORK ARCHITECTURE;** achieve next level of performance	>10-15 Years	

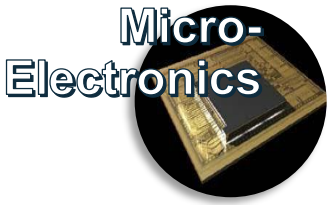
Emphasis: 1980s-2015

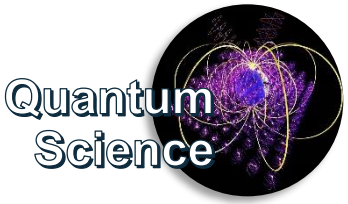
Emphasis: 2015 - Future

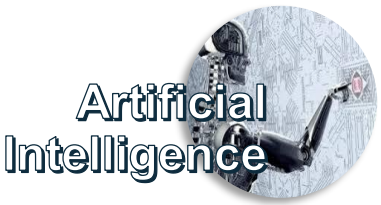
Next generation – shift from component-block to platform-epoch focus

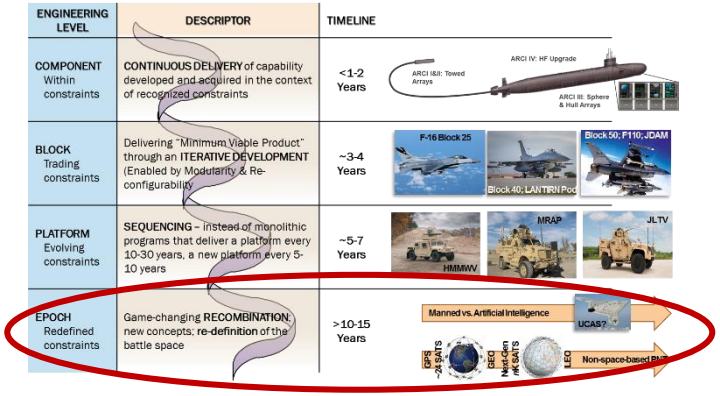
Research Epoch Changers – Redefine Framework Architecture

- The next *conflict* may be an evolution on our current capability …
- But the next *war* will be fought in a way just barely considered today





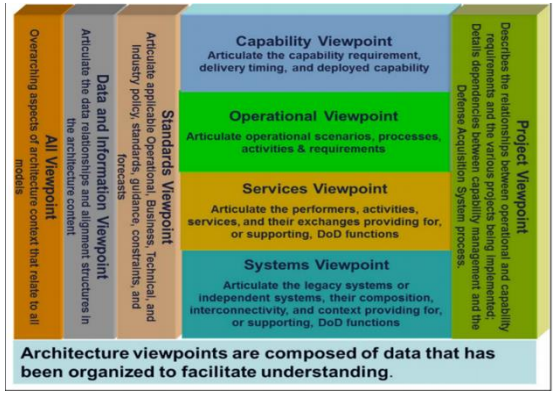




ENGINEERING LEVEL	DESCRIPTOR	TIMELINE
EPOCH Redefined constraints	**RE-DEFINE THE FRAMEWORK ARCHITECTURE;** achieve next level of performance	>10-15 Years

Maintaining relevance by changing the rules of the game, or playing a different game altogether

Deriving a Reference Enterprise Mission Architecture for the Space Domain



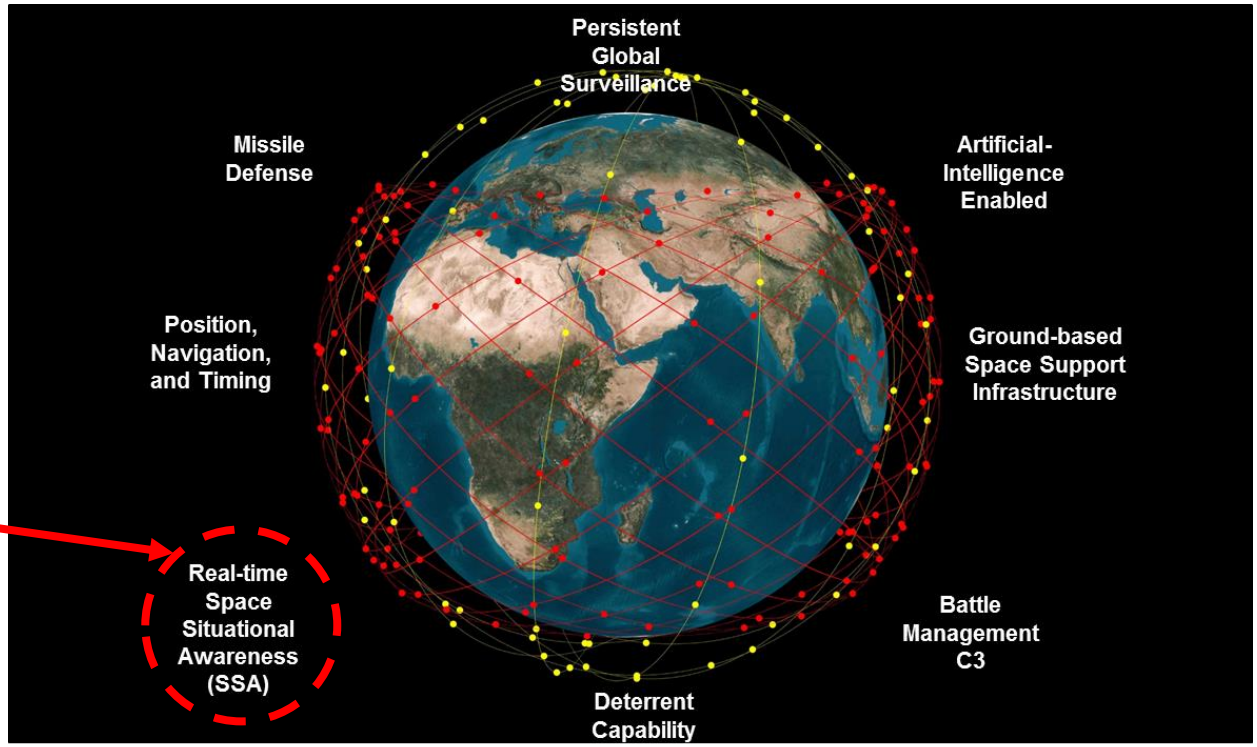
From JCIDS Manual

Space Missions' Reference Architecture(s)

"Space Architecture Study Initiative"

-- ASD(R&E), 2018

- Phase I
  - Real-Time Space Situational Awareness
- Phase II–*X*
  - The Other Mission Areas



Extend engineering rigor & analysis to impacts across mission threads

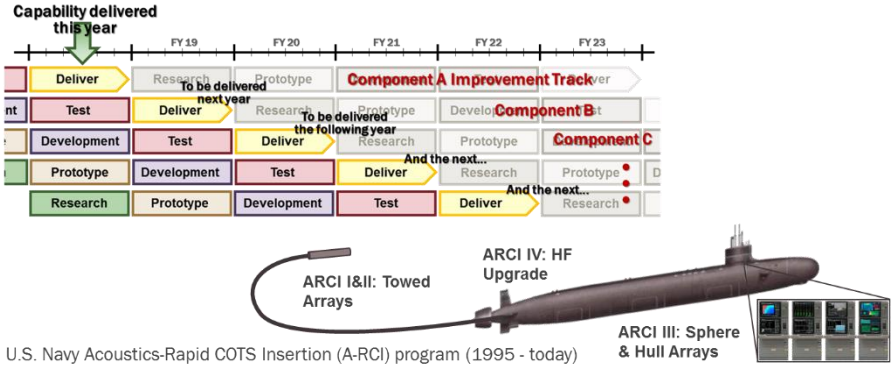
Addressing the Challenge – Acquisition at the Speed of Relevance

Factors impacting …

VELOCITY	RELEVANCE
• **CONTINUOUS CAPABILITY DELIVERY**	• **ARCHITECTURES**
– Sequence – ARCI-Model – Appropriate vs. Innovate – Automation – Common Production Environments – Enterprise Optimization	– End-to-End Effects – Grand Scales / Unified Architectures = Challenges – Reduce Complexity – Loosely Coupled / Tightly Integrated, and Vice Versa
• **MINIMUM VIABLE PRODUCT (MVP)**	• **PRESERVING OPTIONS**
– Iterative Development – Pre-Planned Product Improvement – Pre-Planned Obsolescence – Right-Sizing – Improve Program Scoping and Metrics	– Prototyping – Manage Acceptable Risk – Failure Tolerance – JCTDs – Technology Insertion – De-couple – Hardware / Software – Technical Readiness
• **REDUCING LATENCY**	• **MULTI-FUNCTIONALITY / RESILIENCE**
– Evolve Acquisition Processes – Data-Driven Decision Making – Communities of Practice – Credibility in Engineering Planning	– Interdependencies – Mission Threads – Evolve Requirements Processes – Modularity – Programs, Frameworks, Architectures – Cyber / Security Resiliency

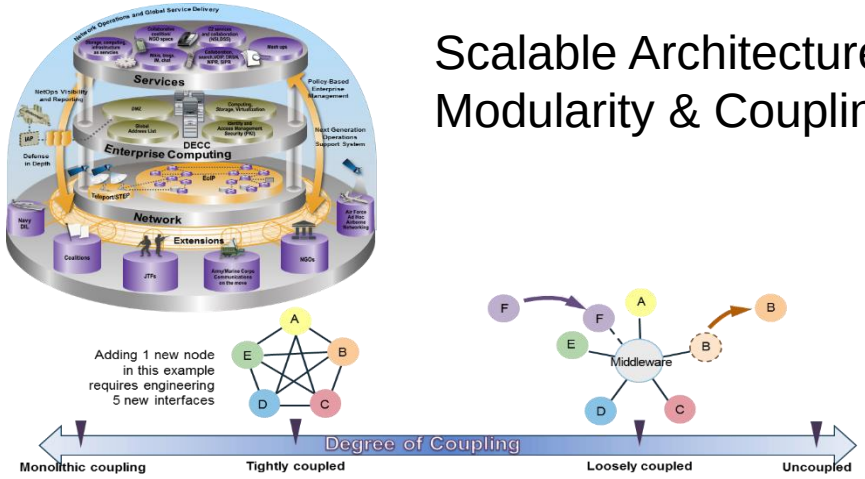
Key Enabling ME Approaches

Foster Continuous Delivery



U.S. Navy Acoustics-Rapid COTS Insertion (A-RCI) program (1995 - today)

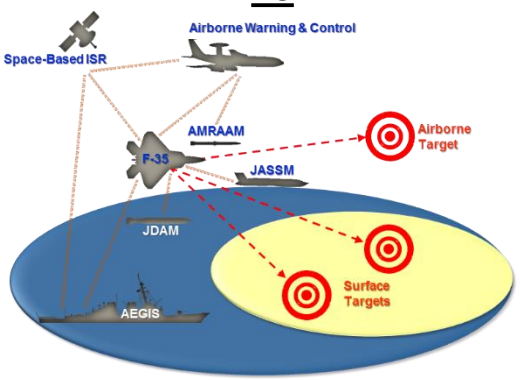
Scalable Architecture, Modularity & Coupling



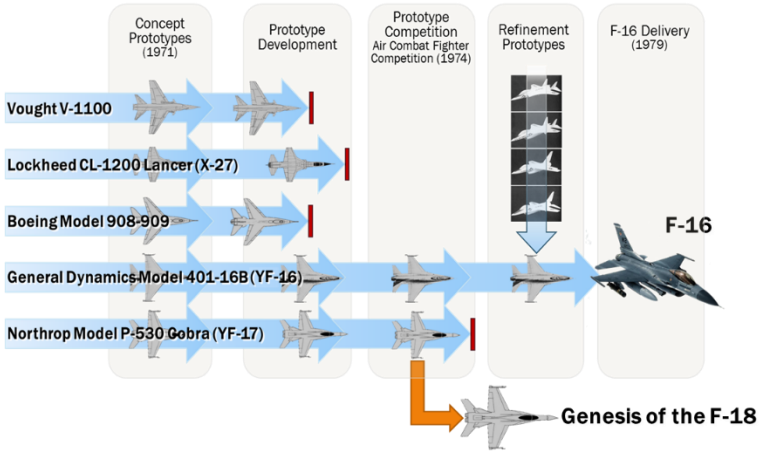
Avoid Monolithic Approaches

From

To



Promote Experimentation / Prototyping



Delivery architecture and prototyping are key to timely, relevant capability delivery

Enabling Processes & Tools

What We Do Now

- Evolve SE practice
- Independent Technical Risk Assessments (ITRA)
- Risk / Opportunity Management
- Modeling & Simulation
- Modularity – MOSA
- Should-Schedule Analysis
- Data Transparency
- Digital Engineering – Model Based Systems Engineering
- Architecture Analysis
- Interdependency / Interface Mgt.
- Measures of Resiliency
- Other tools to abstract the appropriate data to leadership decisions

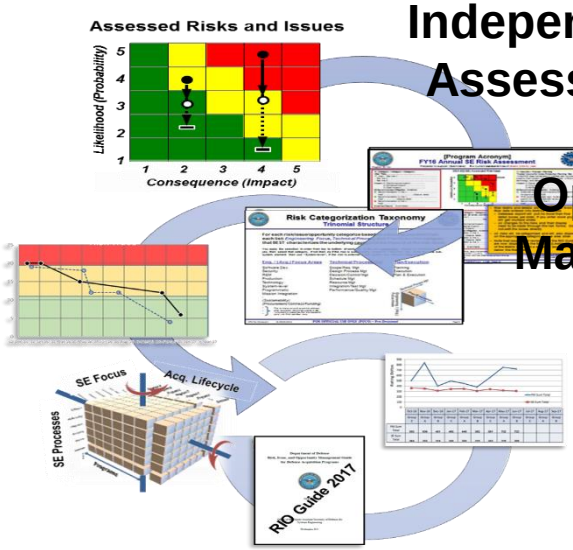
What We Need to Be Able to Do Better

- Next Generation Threat System (e.g., ONR Strike Group Defender)
- Virtual World Visualization Software
- Architecture Management Integration Environment - open interfaces and integration for simulation models/analysis tools (e.g., Magic Draw Suite, Rational Rhapsody, DOORS)
- Standalone / Networked Tools - DREN / SDREN, Joint Sim Environment / NSWC Dahlgren Division Ship Labs, Army Labs, etc.
- MBSE and SE integration in SYSML, RSA, etc.
- Improved Data Analytics / Tools
- Robust Cyber Effects (Offensive / Defensive) Modeling

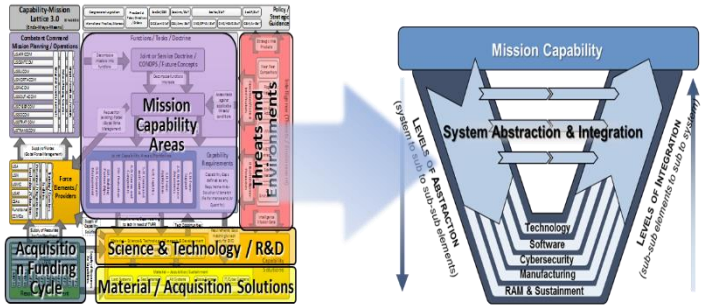
Need academia/industry's help – improved insights on data-driven capability decisions

Key Enabling ME Processes & Tools

Independent Risk Assessment and Risk & Opportunity Management

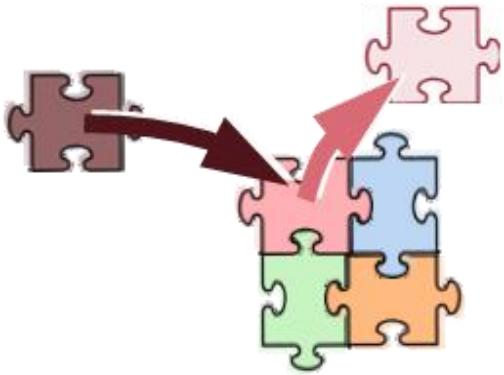


ME Capability Framework



Modeling & Simulation

Modular, Open Systems Approach (MOSA)



Refinement of existing tools is needed

Way Ahead: Challenges for DoD and Industry

- How do we accelerate mission need to mission delivery?
- What are the technical measures, metrics, & data to track technical progress toward mission capability vs. traditional specs?
- How do we synchronize interdependent acquisitions regardless of ACAT level? How do we manage dependencies?
- How do we preserve more solution options later in the acquisition cycle?
- How do we set mission performance requirements to promote SoS–centric vs. platform-centric solutions?
- How do you incentivize mission "ilities" – survivability, modularity, adaptability, availability, resiliency, security?
- How do we evaluate candidate solution architectures under a mission reference architecture? What are the models?
- What are industry standards for data/products to improve communication/integration? How do others access that information?
- How do we address IP issues to facilitate collaboration?
- How do we acquire common operating systems and architectures separate from platforms?
- What tools better enable cross-mission dependency and gap analysis?

As a community we need to better address operational mission performance in acquisition

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Solving Problems Today – Designing Solutions for Tomorrow










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