Digitally transforming the security posture of supply chains using Model-Based Enterprise

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“Resilient, diverse, and secure supply chains are going to help revitalize our domestic manufacturing capacity and create good-paying jobs...

It’s about resilience, identifying possible points of vulnerabilities in our supply chains, and making sure we have the backup alternatives or workarounds in place.

-- Remarks by President Biden at 24 FEB 2021 Signing of an Executive Order on Supply Chains

But we’ve been saying it for years...

- DoD Digital Engineering Strategy says digital transformation will address challenges associated with complexity, uncertainty, and rapid change in deploying and using systems.

- McKinsey recommends using a holistic and systematic analysis in making decisions on how and where to best deploy and maintain technologies and capabilities.

- MITRE says DoD needs better use of its existing resources to identify, protect, detect, respond to, and recover from network and supply chain threats – we must protect systems as much as we try to deploy them.
It's all about Integrated Logistics!

“You will not find it difficult to prove that battles, campaigns, and even wars have been won or lost primarily because of logistics.” -- General Dwight D. Eisenhower
Presentation Outline

1. It’s all about Integrated Logistics!

2. Opinions and Recommendations
Figurative Map of the successive losses in men of the French Army in the Russian campaign 1812 ~ 1813

Drawn by M. Minard, Inspector General of Bridges and Roads (retired).

Paris, November 20, 1869.

The numbers of men present are represented by the widths of the colored zones at a rate of one millimeter for every ten thousand men; they are further written across the zones. The red designates the men who entered Russia, the black those who left it. — The information which has served to draw up the map has been extracted from the works of M.M. Thiers, de Séguir, de Fersen, de Chambray and the unpublished diary of Jacob, the pharmacist of the Army since October 28th. In order to better judge with the eye the diminution of the army, I have assumed that the troops of Prince Fersen and of Marshal Davout, who had been detached at Minsk and Mogilev and have rejoined near Orsha and Vitebsk, had always marched with the army.

GRAPHIC TABLE of the temperature in degrees below zero of the Réaumur thermometer.

https://commons.wikimedia.org/wiki/File:Minard_Update.png
"Logistics is the bridge between the economy of the Nation and the tactical operations of its combat forces. Obviously then, the logistics system must be in harmony, both with the economic system of the Nation and with the tactical concepts and environment of the combat forces.

-- Rear Admiral Henry E. Eccles

Supply Chain readiness is both a national defense and economic security challenge!

Query the Network
INTEGRATED LOGISTICS
Dynamic Model Connections

Design Information

Material Information

Manufacturing Information

Shipping Information

Dynamic Information Model

"All I want is a secure system where it's easy to do anything I want. Is that so much to ask?"
Opinions and Recommendations

With great promise, comes more work...
Opinion #1

To win in tomorrow’s cyber and/or physical environments, we must be able to predict where to engage, what we need to engage, and rapidly understand and diagnose our readiness to engage.
Recommendation #1

• The DoD (and all of USG), using a public-private partnership, should develop a standards-based flexible and modular integration framework / architecture for acquiring and delivering systems

• Immediate Actions
  • Learn to leverage technologies systematically by inserting and removing technology as needed in existing environments. Don’t buy the hype.

  • Study and standardize the interfaces. This is where the hard-technical problems exist, but also holds the maximum ROI.

  • Increase convergent, multi-disciplinary PMO teams that include configuration managers and logisticians
    → deploy model-based operational control*

Generate Supply-Chain Digital Twins
Cyber-Physical Relationships

Digital Object → Physical Object → Digital Model

Digital Object → Physical Object → Digital "Generator"

Digital Object → Physical Object → Digital "Shadow"

Digital Object → Physical Object → Digital Twin

--- manual dataflow --- automatic dataflow

Model-Based Intelligence and Security

Conceptual Interoperability

Enterprise Connectivity

Linked Data

Trust and Traceability

Autonomous Knowledge Generation

Autonomy
16S Knowledge (e.g., risk strategy)
Understanding of 16S science (e.g., predictive models)
Supply-Chain 16S Information (e.g., logistics flows, disruption detection)
Basic Data (e.g., sensorsand software-generated)

Cyber Space

Physical Space

Objectives Scope

Realization

Digitalization

Methods Tools

Distributed A&IS Digital Twins
Opinion #2

Policy is a larger barrier to success than technology. The Digital Thread / Twin are unsustainable in the current environment.
Quantifiable Example...

- Cost Constructive Model (COCOMO) II analysis of the Next Generation Air Dominance (NGAD) aircraft

- Software development and sustainment for Digital Thread est. ~$80 to $180 billion

- Digital Twin development and sustainment est. ~$1 to $2 trillion

“That’s the way we’ve always done it.” isn’t working!

Why the significant USAF cost estimate?

• Policy!

• The current acquisition and sustainment policies extend the time cycle of deployments and fielding of systems

• GAO (2011): “DoD cannot [continue to] outsource its technical and program management experience and intellect and still expect to acquire new systems that are both effective and affordable.” – and quickly delivered.
Counter point...

- Several studies support significant cost savings and efficiency gains with technologies such as:
  - Linked-data
  - Rapid data curation, query, discovery, and retrieval
  - Industrial Semantic Web – forming a sort of supply-chain Internet
  - Industrial Internet of Things - mass sensing and monitoring networks
  - Artificial Intelligence and Advanced Analytics

- Further, evidence to enabling an integrated smart-manufacturing approach could provide industry with a $100 billion annual savings opportunity\(^1\)

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Recommendation #2

Joint Design
- Be proactive, instead of reactive. Must consider subsystems jointly during design, while considering objectives and requirements of subsystems.

Joint Optimization
- Maximization of overall system effectiveness requires joint design and analysis of subsystems.

Joint Causation
- Subsystems are affected by causal events in the external environment, and changes in one subsystem cause changes in the others.

Must Respect the Theories of:
- Control
- Observations
- Supply Chain Systems
- Organization and Policy (Psychosocial and Physical)
- Technology Subsystem
- External Environment (What are the first-level interactions with the system?)

Supply Chains are Sociotechnical Systems

TIERN
PRIMES
TIERN
USG
R&D
T&E
Attack
Defense
Personnel Subsystem
Business
End User
Designer
Engineer
Tradesman

5G
Opinion #3

The United States, and specifically the DoD, are the best in class for fielding technologies. However, the United States’ adversaries are investing heavily and catching up quickly. The United States faces a blended attack (e.g., economic, intelligence, cyber, physical) on our key industrial sectors that support our national defense and economic security.


Adversarial Capital Investment

• China is investing in $1B in Digital Ledger Technologies (e.g., Blockchain)

• The Belt and Road Initiative: includes strategic investment in key industry sectors and technologies
  • https://www.cfr.org/backgrounder/chinas-massive-belt-and-road-initiative
Recommendation #3, Moon Shot!

• The United States should holistically and systematically develop a strategy for rapid identification, protection, detection, response, deployment, and recovery of assets and capabilities in times of emergency or conflict.

• Immediate Actions:
  • Technology Investments: Better integrate projects and PMOs with overlapping technology needs and investments (e.g., autonomy, digital twin)
  • Appropriations: Advocate for solutions to the “different pot of money” problems → DoD’s 6.1 vs. 6.3 sort of challenges
  • Force Multiply: Develop “Action” Forces that pull expertise from the research labs, FFRDCs, UARCs, etc. to be rapid-response teams to solve hard problems of need quickly
Summary
In closing...

• For 15 years, the United States has been on a Digital Transformation path towards an extended enterprise using the concepts of model-based enterprise, digital thread, and digital twin.

• However, most advances have occurred in domain-specific silos that do not advance the needed level of integration for quick design, build, and fielding of critical systems across resilient supply chains.

• Now, the US must develop a Whole of Nation strategy that, does not destroy the siloes, but instead connects supply chains with a digital thread and monitored with a digital twin!
Last words... To maintain dominance, the US needs **open architectures and policies** to support the “brownfield” realities of manufacturing and allow **interconnectivity** across decentralized supply chains.

This is about making sure the United States can meet every challenge we face in this new era – pandemics, but also in defense, cybersecurity, climate change, and so much more. And the best way to do that is by protecting and sharpening America’s competitive edge by investing here at home.

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Thank you! Questions?

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