



DoD ATS Executive Plenary Session

# **NDIA Automatic Test Committee Emerging and Future Test Technology Requirements**

Patricia Griffin, Ph.D.

Systems Engineering Division

Automatic Test Committee Chair

# DoD ATS Executive Plenary Session: Emerging and Future Test Technology Requirements



- **What steps do we take next?**
  - How does Industry decide which emerging technology meets investment criteria for the DoD market?
  - **Industry needs DoD input** to drive the right research investments
  - **DoD needs Industry trends** from other markets or DoD Prime designs that eventually drive sustainment requirements
  - We need a forum to exchange trends and DoD requirements, so the right investments are selected, designed, and fielded



USAF VDATS



US Navy eCASS



USMC VIPER/T



US Army NGATS

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- **Emerging and Future Test Technologies Noted by the ATC**
  - FPGA-based Synthetic Instrumentation
  - Model-based Test Engineering
  - Artificial Intelligence and Machine Learning (AI/ML) models
  - Increased amounts of Data
  - Higher Bus Speeds
  - mm-Wave advances pushing frequency spectrum higher
  - Cyber Security and CMMC impacts on test
  - Hardware-In-the-Loop (HIL) shifting from lab to field faster

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- **FPGA-based Synthetic Instrumentation:**

Embedded testing is a methodology that allows you to go beyond typical simulation and emulation and into the real world of physical testing. Built-in testing strategies that include predetermined embedded testing scenarios can reduce time to market as well as simplify repair and maintenance with obsolescence management. By replacing traditional test and measurement equipment with embedded synthetic FPGA-based instruments it is possible not only to achieve the significant reduction of test costs but facilitates high-speed and at-speed testing. This represents a paradigm shift in our use of instrumentation, enabling us to move beyond traditional test bench approaches.

- **Model Based Test Engineering:**

Model Based test engineering is an emerging trend to incorporate model-based representations of physical and digital products. Model based test engineering allows us to leverage digital engineering in the test domain and with the right forward-looking strategies, the test community could use some of the models that exist in the development and operational domains. Models allow us to take advantage of digital engineering capabilities for accurate physical simulation and provide a mechanism to make minor tweaks to the model as continuous iterative changes flow from the prime equipment.

- **Artificial Intelligence and Machine Learning (AI/ML) Models:**

AI/ML models optimize and improve the overall architecture from its core to the physical layer. Cognitive Electronic Warfare (EW) systems use computers for data collection and computation, probability calculations, and other data intensive functions. Advances in AI/ML provide new ways to adapt to the highly contested EM spectrum.

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- **Increased Amounts of Data:**

- A Systems of Systems (SoS) approach is needed to **manage data over time**, SoS strategies need to extend from the development and operational environments into the sustainment environment
- We need a common way to collect, store, tie data back to the UUTs, and plan for the iterative mods that will increase with the new acquisition strategy of **continuous iterative development modifications**
- The shift from copper to optical is accelerating, driving higher data rates, and creating a test environment with much **higher bus speeds and the need to capture and process large amounts of data, often in real-time**
- We need Data Strategies for Model-based Test Engineering

- **Other considerations:**

- The shift from copper to optical drives the need to **define and detect new fault sets related to optical degradation**
- mm-Wave advances are pushing the frequency spectrum higher, and we need **new coax connectors to handle the higher frequencies**

# Software for DoD Systems



- Massive increase of Data
- Test not keeping up with the needs of modern systems

## Why Revolutionize T&E?



- Revolutionize T&E
  - Address rapidly changing and technologies and systems that continually evolve over their lifespan
  - Support the DoD in rapidly providing warfighting capabilities to counter advanced threats and new technologies
- Director Guertin, DOT&E – Statement of Intent: “We will transform test and evaluation to enable delivery of the world’s most advanced warfighting capabilities at the speed of need.”

- Current test and evaluation methods are failing to meet the need of modern systems:
  - Software enabled functionality that is built to change overtime (both deterministic code and machine learning and artificial intelligence code)
  - Fail to incorporate relevant credible sources of information
  - Do not adapt at the speed of the threat (cyber and otherwise).

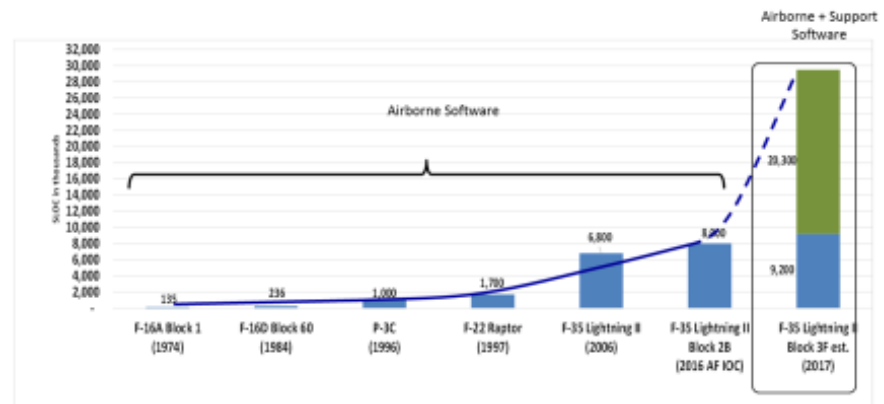


Figure. Software Lines of Code from 2018 DSB Report on Design and Acquisition of Software for Defense Systems.

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## Industry/Technology Trends

### DoD Digital Engineering Vision

"DoD's vision is to have an engineering enterprise that connects the digital and physical worlds across a system's lifecycle. The end-to-end digital enterprise will incorporate a model-based approach in a digitally connected environment enabled by advanced technologies to conduct full lifecycle activities from concept to disposal."

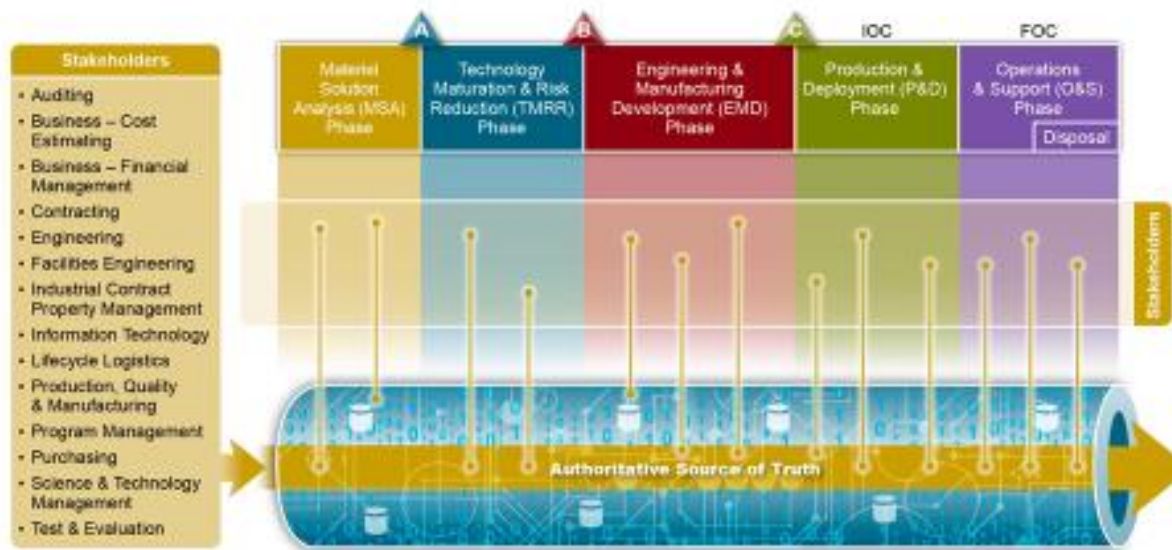


Figure 5: Authoritative Source of Truth

Source: U.S. Department of Defense, *Digital Engineering Strategy*, June 2018

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## Industry/Technology Trend

Common Workflow Practices used today

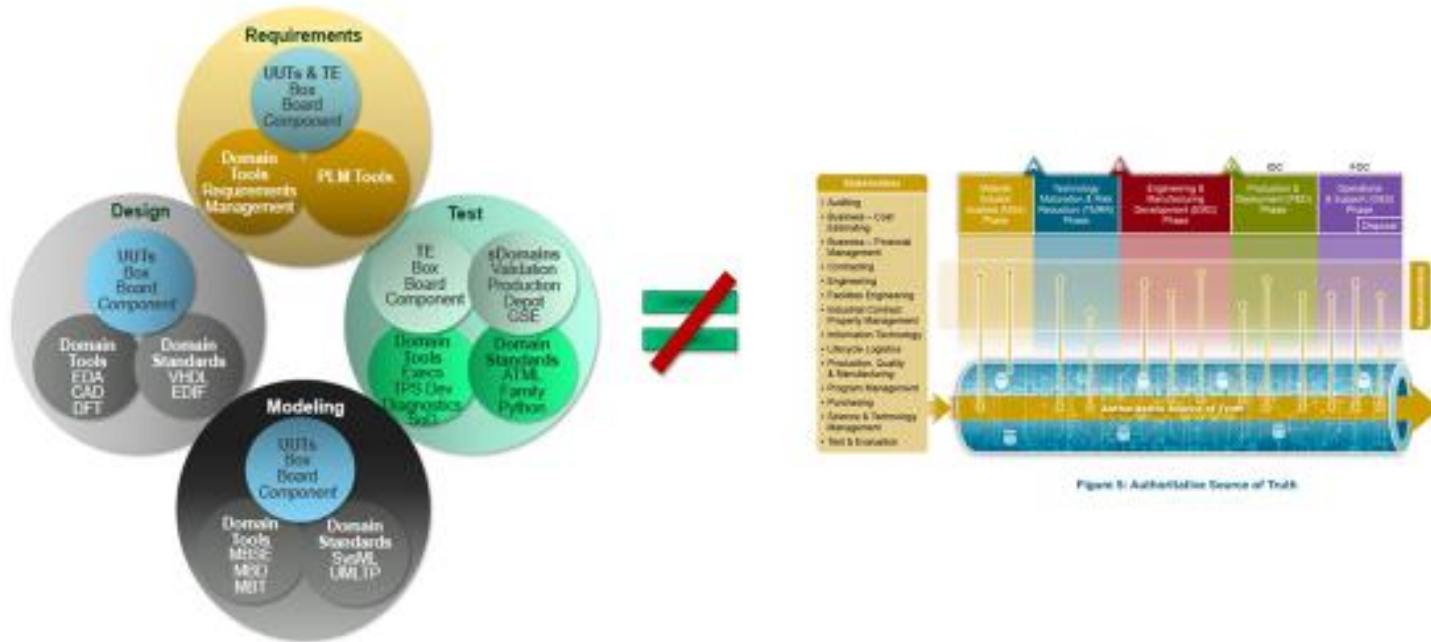


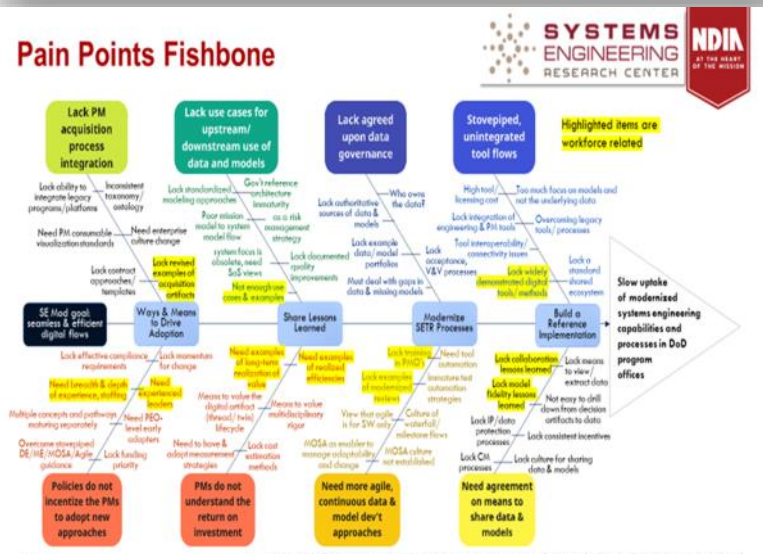
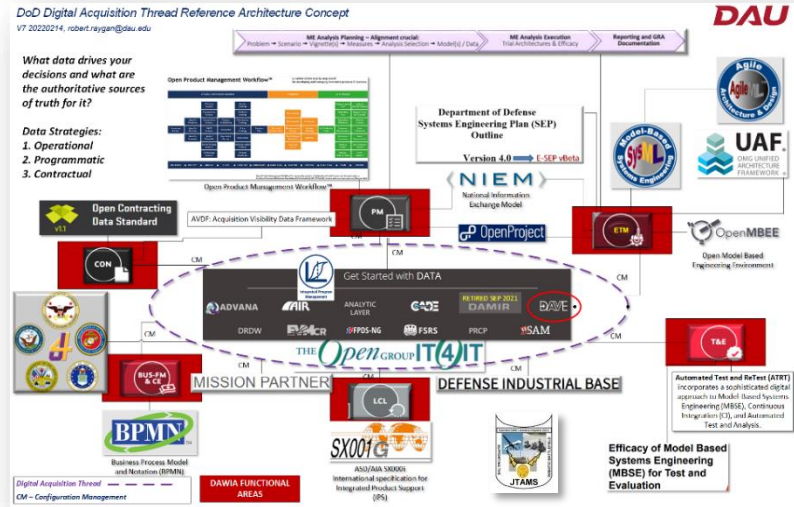
Figure 5: Authoritative Source of Truth



# Concept for DoD Digital Acquisition Architecture



- The research, design, and operational communities have invested in modeling and have learned a lot about the challenges of integrating SE processes and DE/DT tools.
- We need to learn from them where we can and start with smaller objectives targeted to our greatest test needs.
- Using their pain points and lessons learned we can jump start our strategies.
- It's time to educate the operational domains about what we need from their models, so that Sustainment Engineering and Testing is integrated into the DoD DT architecture.



10 • Chart from Systems Engineering Modernization (SEMod) and Digital Acquisition Thread Report August 22, 2022, Robert E. Raygan, Ph.D., DAU Professor of Engineering Management

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## • Digital Transformation (DT) Initiatives:

- The lack of an integrated approach to implementation of systems engineering focus areas is creating a delay in full implementation of the Digital Transformation
  - We all have this problem - research, prototyping, operational test, and sustainment test modeling efforts are impacted
- We have the potential to positively impact Test modeling by extending current operational models to include sustainment
- Early representation of UUT models from the operational models would positively impact Test DT
- DT can be supported by IEEE ATML standards
- The test requirement document (TRD) of the UUT can be used to provide capability models, with paths and switching needed to output a range of measurements available by the ATE/ATS, **IF** the test data is detailed enough

## • Barriers to Digital Transformation:

- DT is costly. Will DoD fund costly model development?
- High-fidelity **ACCURATE** simulation models of ATE instruments, Run Time SW, other ATE software, and UUTs need to be developed

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## Industry/Technology Trend



We have a start:

1. We have an established data format
2. We have established data labels
3. We have an owning committee

# ATC Closing Comments

- We need a **forum to exchange trends and DoD requirements**, so the right products are selected for investment, designed, and fielded
- Examine emerging technologies for application to DE/DT and to **define new fault sets** for diagnostic test
- Embedded synthetic FPGA-based instruments make it possible not only to achieve a significant reduction of test costs but facilitates high-speed and at-speed testing which **represents a paradigm shift**
- Leverage digital engineering models from the development and operational domains by **extending those models into the test domain**
- A Systems of Systems (SoS) approach is needed to **manage data over time**
- Create a plan for the acquisition strategy of continuous iterative development modifications so Automatic Test **keeps up with the speed of the threat**
- **Embrace DE/DT by using the IEEE ATML standards** that our industry has developed and use a SME to ensure mods are added carefully and thoroughly
- Ensure the data you receive is quality data. Use a third-party SME if needed
- Is DE/DT important enough to DoD to **fund it properly?**

Questions?

**Thank you! Have a great AUTOTESTCON show!**