



# Digital Engineering Discussions

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# *Some Discussion Topics:*



- Motivation and importance of digital engineering
- How the Digital Engineering Strategy is more than just using digital tools
- How digital engineering fits into the larger systems engineering efforts
- Some context on what DoD is doing to help its organizations with digital engineering implementation approaches



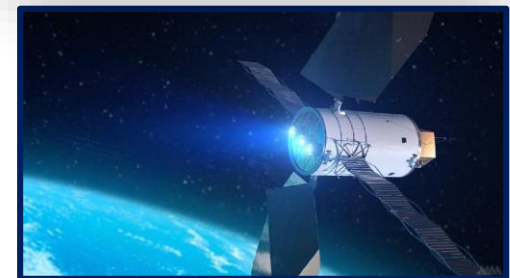
# USD(R&E) Mission

## ■ Ensure Technological Superiority for the U.S. Military

- Set the technical direction for the Department of Defense
- Champion and pursue new capabilities, concepts, and prototyping activities throughout the DoD research and development enterprise

## ■ Bolster Modernization

- Pilot new acquisition pathways and concepts of operation
- Accelerate capabilities to the warfighter



***“Our mission is to ensure that we, if necessary, reestablish and then maintain our technical advantage.”***

**– Under Secretary Griffin, April 2018**



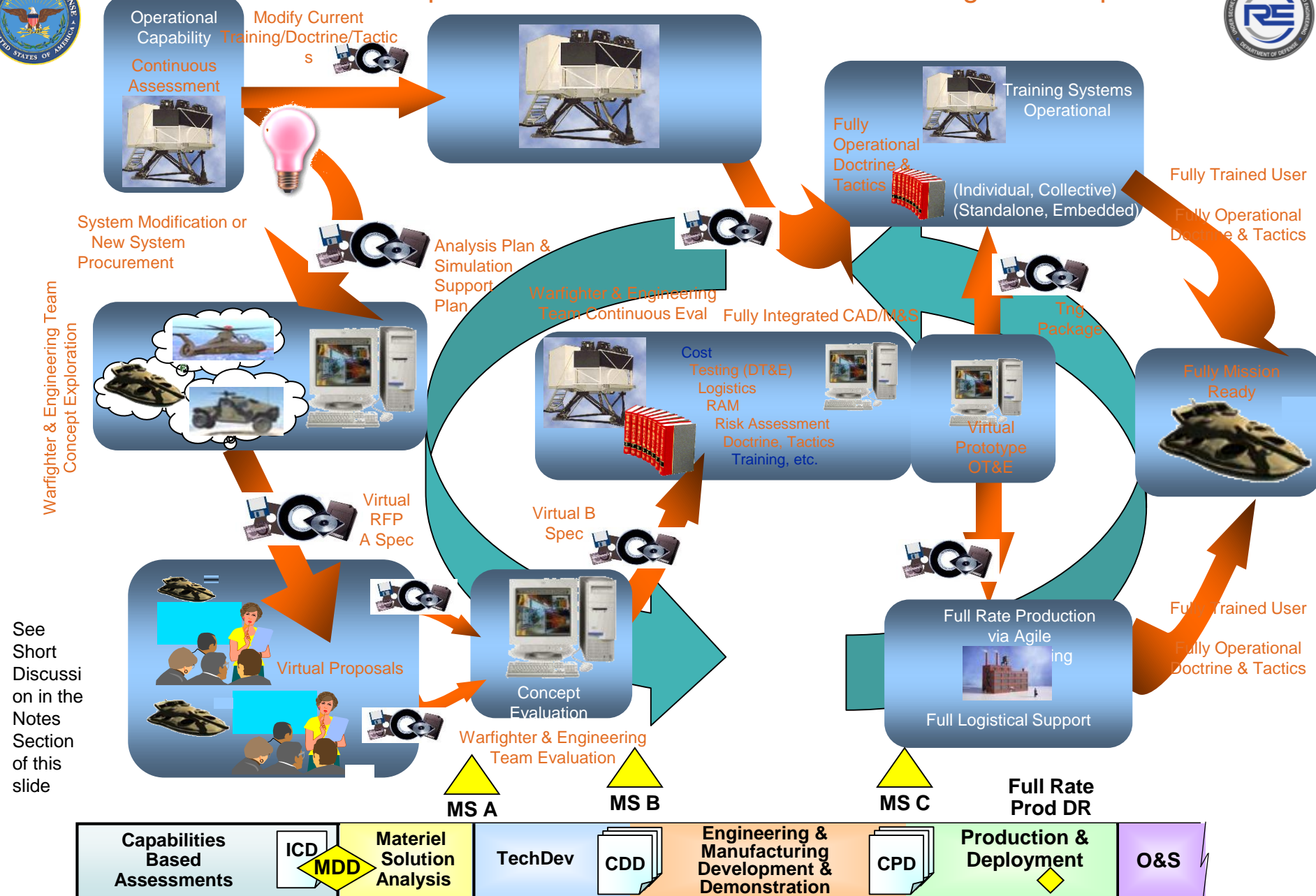
# From DoD Summer Study, 2010



**Probably the best thing we inside the beltway can do is not think we are smarter than those doing the real work; the objective should be to enable, not do, their work**

- Rethink the “M” in “M&S”
- Where virtual simulations can aid user (and developer) understanding of need/requirements, they fall short when it comes to physical system (HW and SW) design
- The techniques/tools tend to be created/used within the needing organization with little (notice I did not say none!) sharing
- A very important point: effective design modeling isn’t just about the tools, it isn’t even (as some would say) about the tools at all, it’s about the modeler and the wide range of techniques available to them – this section is really about enabling the modeler
- Related, the linkage between virtual simulations and high/higher fidelity physics models should also be explored
- Model Based Engineering (MBE): The use of “models” as a way of representing a system that is more expressive than paper but less obtuse than software and less expensive than a hardware prototype


# From Concept to Full Rate Production without Leaving the Computer

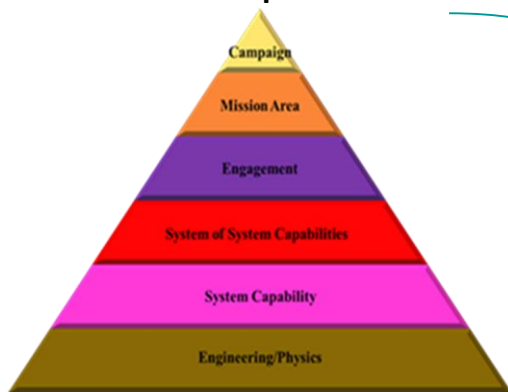


See Short Discussion in the Notes Section of this slide



# M&S

- Modeling and simulation (M&S) is an enabler of warfighting capabilities. It helps to save lives, to save taxpayer dollars, and to improve operational readiness.
- Defense Modeling and Simulation Coordination Office 
- Modeling and Simulation Enterprise – Technical Leadership



Model: A physical, mathematical, or otherwise logical representation of a system, entity, phenomenon, or process; i.e. “a representation of reality”

All usable in digital engineering; what do you need to do?....



# Digital Eng

“The goals (of the Digital Engineering Strategy) promote the **use** of digital representations and components and the **use** of digital artifacts as a technical means of communication across a diverse set of stakeholders.”

“Advancements in computing, modeling, data management, and analytical capabilities offer great opportunities for the engineering practice.

**Applying** these tools and methods, we are shifting toward a dynamic digital engineering ecosystem.”



# Digital Engineering

An integrated digital approach that uses authoritative sources of systems' data and models as a continuum across disciplines to support life cycle activities from concept through disposal





## Digital Engineering (DE)

- **Definition: Automation applied to rigorous definition of system elements**
  - Characterizes properties/relationships precisely
  - Models behavior using mathematics and physics
  - Curates with fierce discipline to maintain a *single, digital* definition of a system
- **DE yields measurable benefits. Examples:**
  - Sikorsky reports results on four helicopter projects:
    - 30% reduction in hardware engineering (CAD) design times
    - 50% reduction in error norms
    - Clean-sheet design: concept to 1<sup>st</sup> flight in 57 months vs. ~100 month baseline
    - Landing gear installation performed in 4 hours vice planned 2 days
  - Ford plans to reduce the schedule for new vehicle design by one year, convert vehicle testing from 80% physical/20% virtual to 20%/80%, and to make recalls based not on fleets, but on individual vehicles
  - GE models each individual commercial jet engine with its unique health history

**Multiple case studies cite measurable benefits from implementing DE**





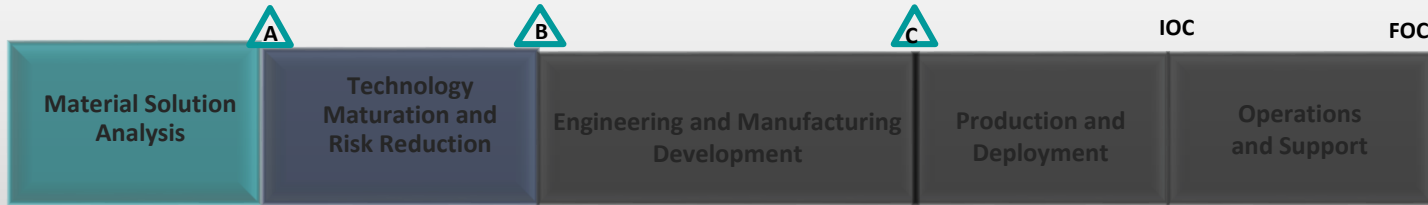
## *In this Competitive World, Imagine if...*

- Acquisition decisions were based on competing proposed models inside a synthetic multi-domain battlespace environment
  - *improving performance and saving money*
- Every fielded system had a “digital twin” that reflected the actual experiences of the system throughout its lifecycle
  - *enabling planned maintenance and situational upgrades*
- Joint training was conducted via distributed simulations and immersive environments representative of anticipated battlespaces
  - *and available wherever and whenever needed*
- An ongoing campaign of experimentation was established for every mission scenario to develop new concepts/CONOPs
  - *engaging warfighters and motivating innovation*
- Senior leadership routinely participated in ‘Strategic Gaming’ to identify shortfalls in existing capabilities and explore new options
  - *informing their decisions in the competitive national security environment*

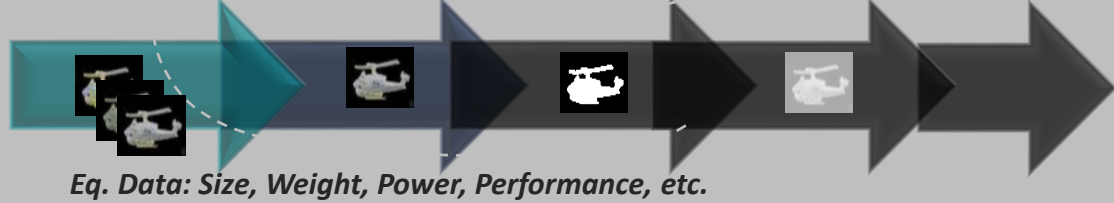
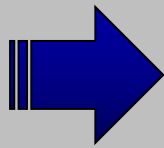
Proper adoption and use of GEMS can enable these important capabilities in support of the National Defense Strategy



# Digital Engineering - Framework for Communication

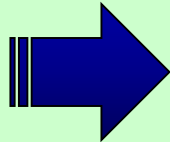


Digital System Model  
Weapon System  
Engineering Data



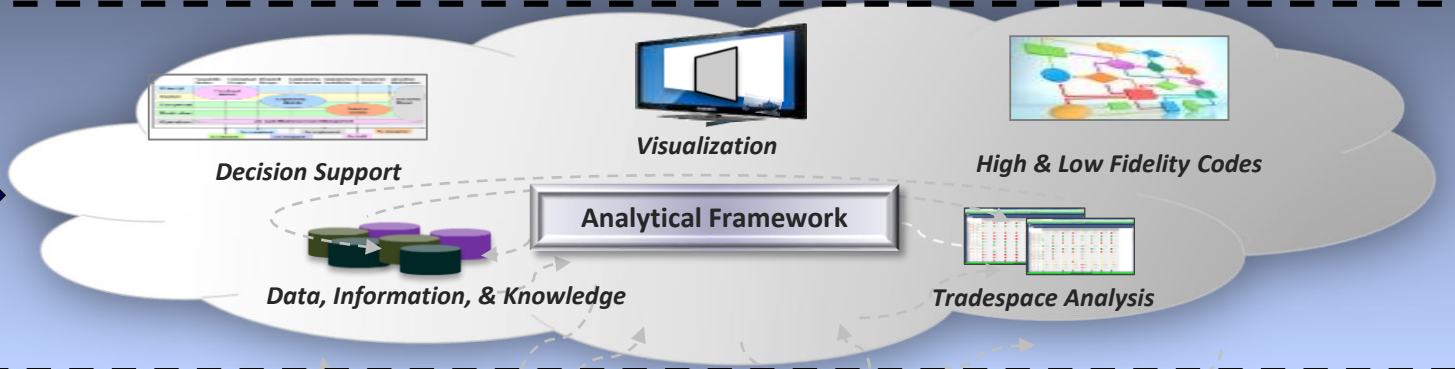
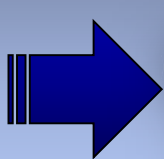
*Eq. Data: Size, Weight, Power, Performance, etc.*

Digital System Model  
Supporting Data  
(Program and System)



*Data Rights*                      *RAM*                      *Cost*                      *Training*  
*Manufacturing*                      *Sustainment*                      *Schedule*                      *Facilities*  
*Test and Evaluation*

Digital Thread  
Tools  
Analytics  
Processes  
Governance

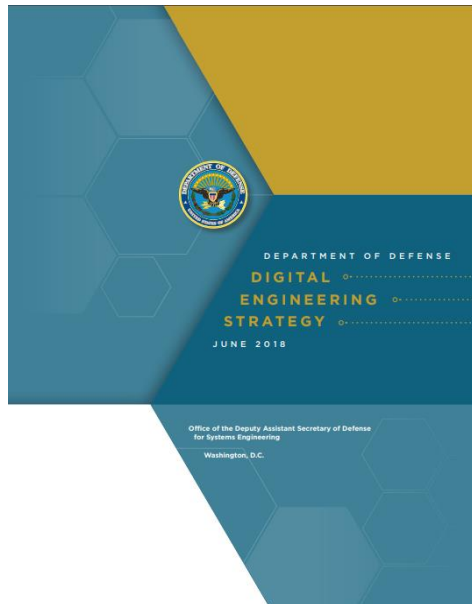




# Digital Engineering in Practice



DoD DES



- 1 Drive implementation
- 2 Gain leadership commitment
- 3 Engage workforce
- 4 Discern resource allocation
- 5 Measures Results

**Digital Engineering is a catalyst for change in the techniques we use to engineer our systems.....**



# Digital Engineering Implementation



## Dr. Griffin

“This strategy describes the “what” necessary to foster the use of digital engineering practices. Those implementing the practices must develop the “how” – the implementation steps necessary to apply digital engineering in each enterprise.”

## Service Strategies and Plans



Outlines DoD’s five strategic goals for Digital Engineering initiatives



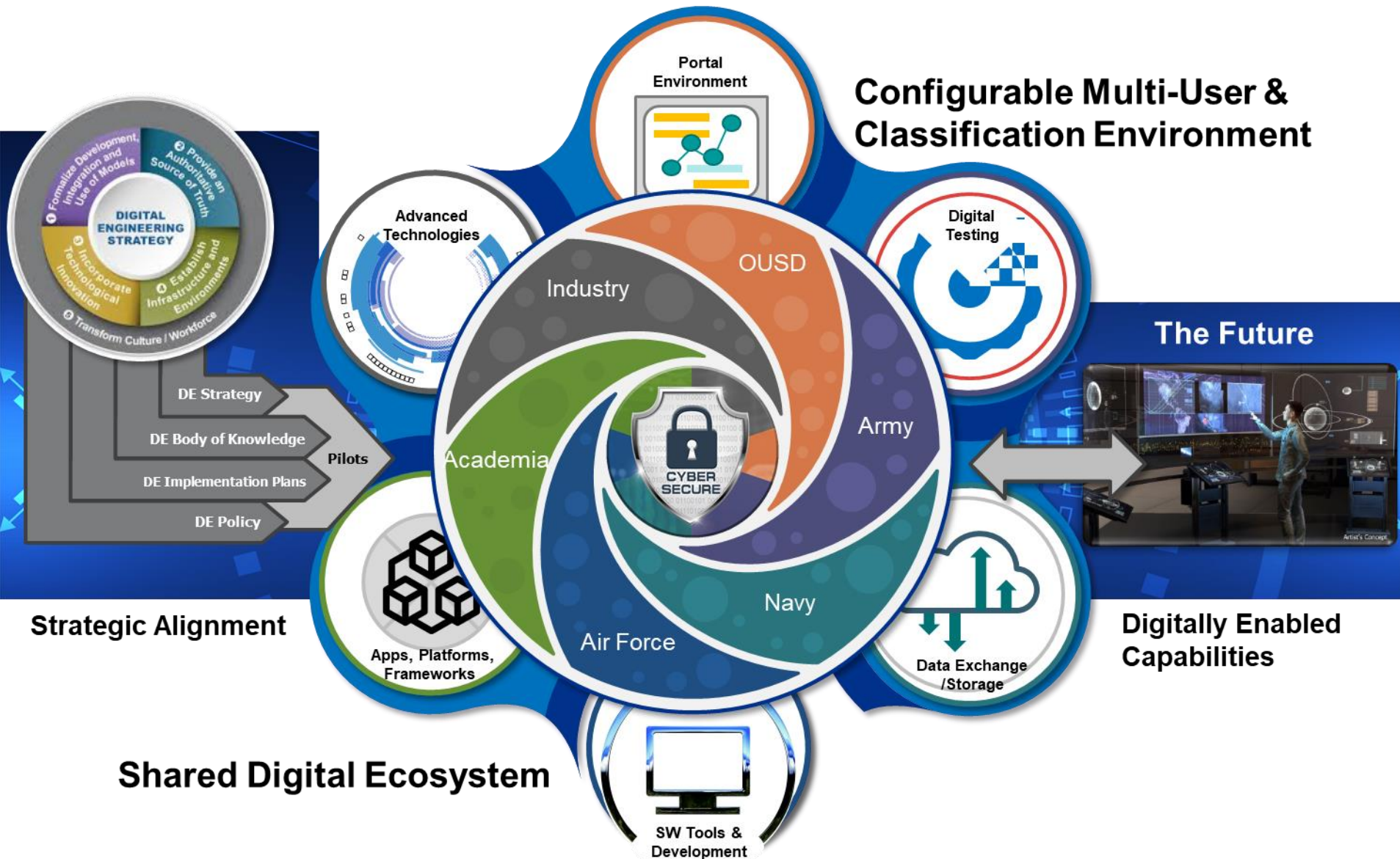
## Collaborative Activities

- Collaboration
  - Digital Engineering Working Group / Community of Practice
    - Tiger Teams
- Systems Engineering Research Center
- INCOSE/NDIA Digital Engineering Information Exchange Working Group; Conferences, etc
- Engineering WF Task Force
- DoD Digital Engineering Body of Knowledge (DEBoK)
- Align understanding of Modeling and Simulation with Digital Engineering

**Implementing Digital Engineering Across the DoD**



# Digital Engineering USE Basics





# Summary/Next Steps

- **Driving Digital Engineering transformation through a focus on implementation.**
- **Build/mold/refine Digital Engineering Community of Practice/Practitioners**
- **Must have / work to shape:**
  - Digital Practices
  - Digital Ecosystem – Infrastructure, tools, data
  - Decision maker willingness to accept digital artifacts and engineer in new ways



# ***For Additional Information***

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# Digital Engineering Collaborations



- **Digital Engineering Working Group**
  - Interagency, DoD Services/Agencies, industry, and academic collaboration
  - Addresses challenges, shares best practices, and facilitates tiger teams to develop strategy, implementation, policies, and guidance
- **Systems Engineering Research Center**
  - Sponsors research on metrics, curation, and tool innovation
- **NDIA / INCOSE**
  - Shapes initiatives to drive digital engineering transformation
  - **NDIA/INCOSE Digital Engineering Information Exchange Working Group**
- **Engineering Workforce Competency refresh**





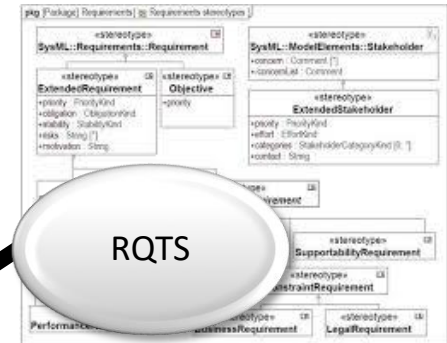
# Using the Digital Ecosystem

- Storage
- Tools
- Compute

WORKFLOW

ACCESS

- DoD
- Classification
- Accessible to stakeholders

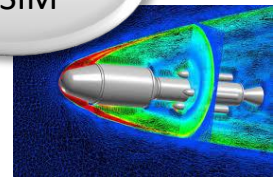


RQTS

DESIGN & ANALYSIS

- Tools
- Software Development

MODEL & SIM



FUN3D  
Fully Constructed Numerical Shocks

TEST & EVAL

- Data Collect
- ASoT Available



INNOVATE

- Data Mining
- Machine Learning
- GPGPUs Available

