

National Defense Industrial Association Systems and Mission Engineering Conference

November 2022

Systems Engineering Modernization Across the Lifecycle

SERC SEMOD Lifecycle Mental Model

Ms. Nadine Geier

Director, Systems Engineering

Office of the Executive Director, Systems Engineering and Architecture

Office of the Under Secretary of Defense for Research and Engineering



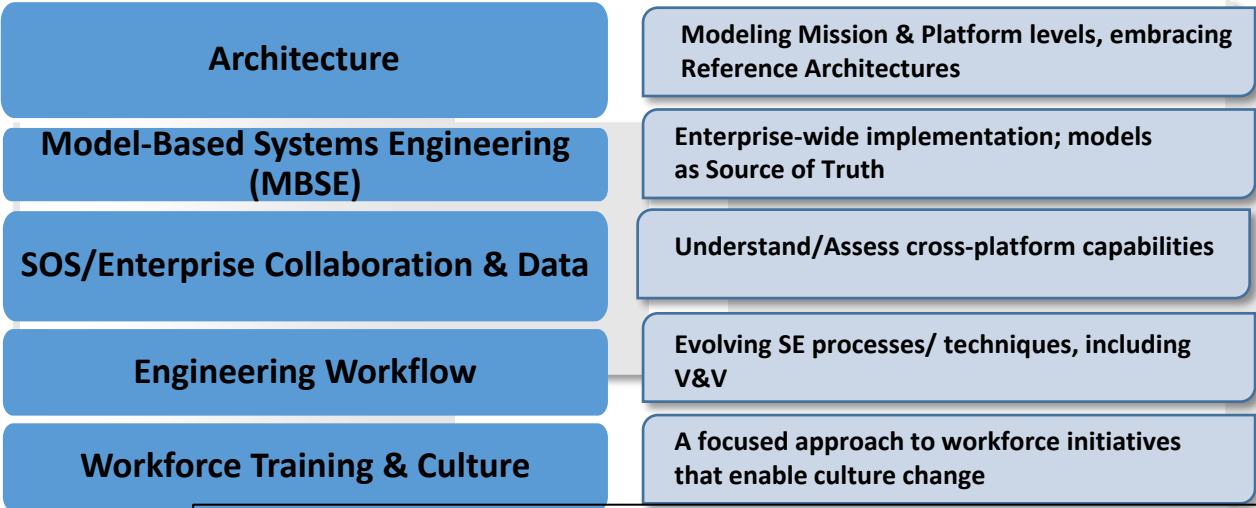


SE Modernization Problem Statement

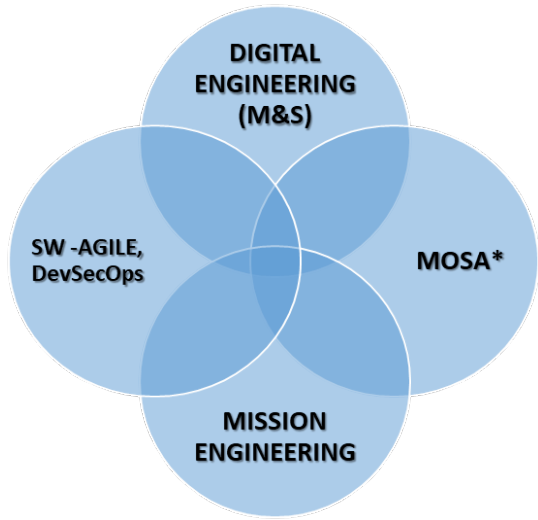
SE Modernization Problem Statement

“There is a lack of an integrated approach to implementation of SE Focus Areas that is creating a delay in full implementation of the Digital Transformation which is necessary to ensure the relevant guidance, skills, and training are available to deliver a robust, disciplined approach to weapon systems acquisition.”

Cross-Cutting Key Enablers



SE Modernization Focus Areas (Initial Scope)

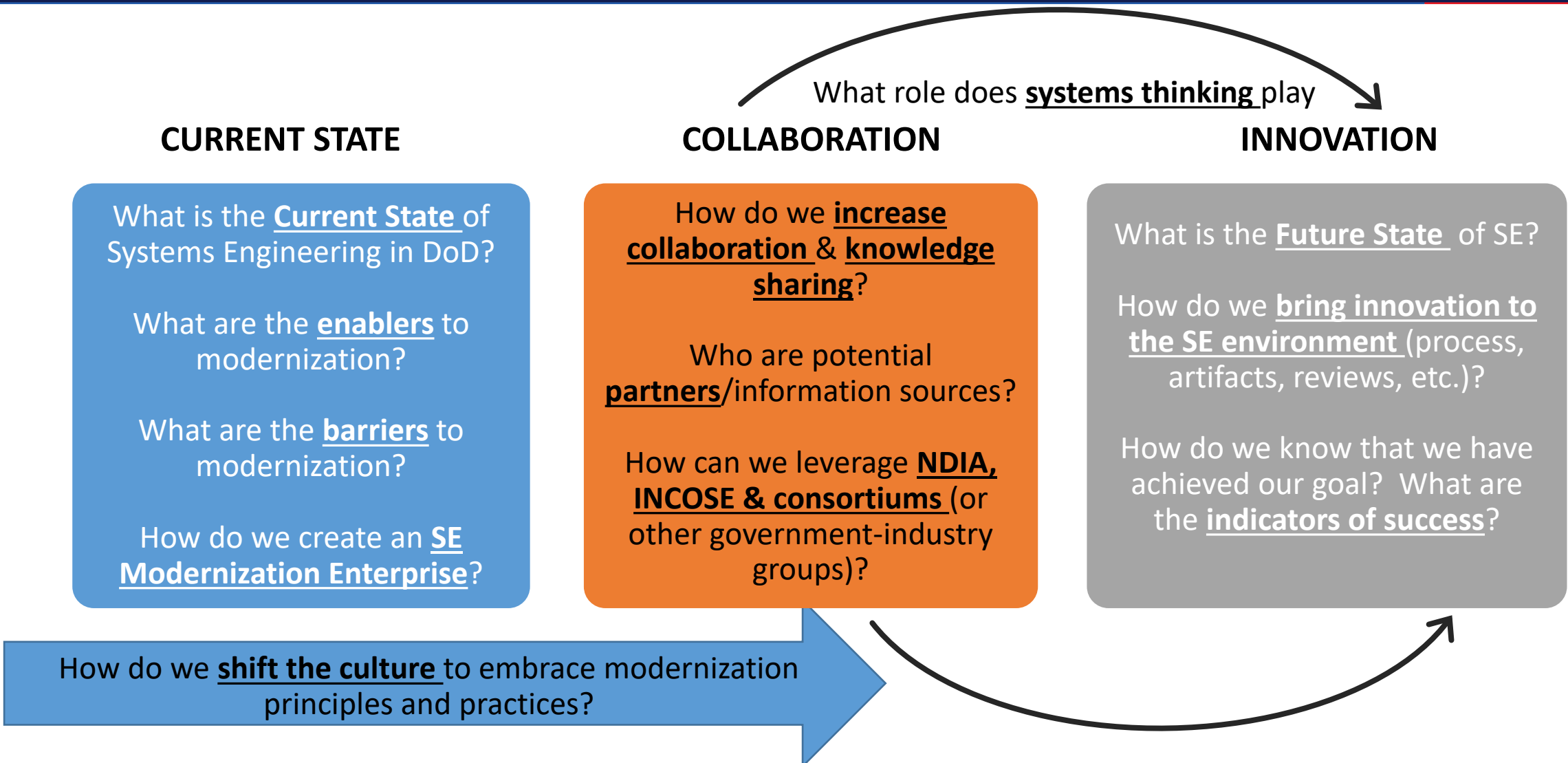


Collaborating with Government, Industry & Academia

ENABLERS RESULTED FROM INITIAL OUTREACH/INFORMATION SESSIONS

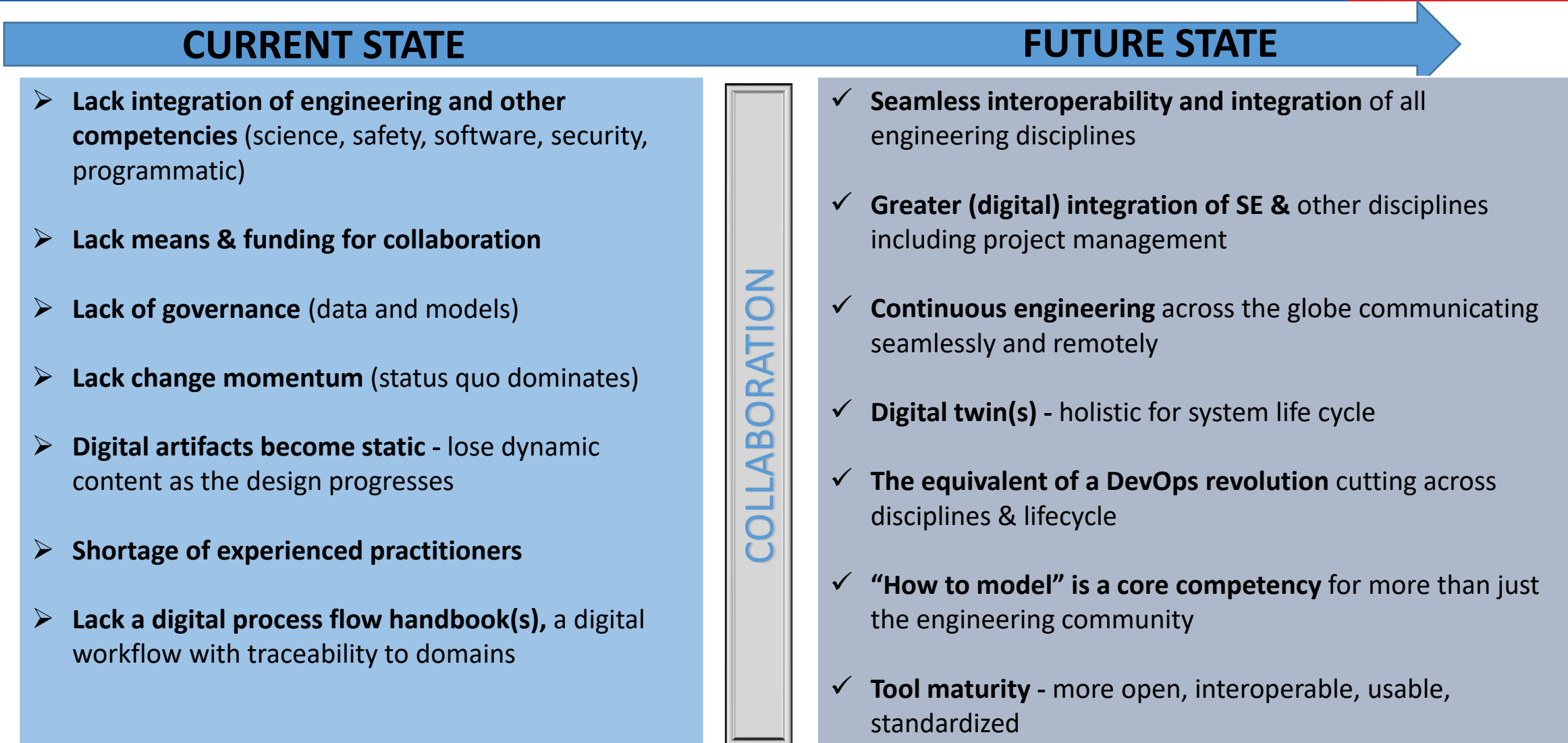


Questions Used for Phase 1 Information Sessions





Responses from INCOSE Workshops/Information Sessions





NDIA Activities Advance the SEMOD Initiative

SEMOD Focus Areas

- **MOSA**
 - SE Division (SED) produced MOSA White Paper
 - ✓ Developed MOSA Metrics guidance for programs
- **Agile Software/ System Development**
 - ✓ Agile Deliveries for Agencies, Programs, & Teams (ADAPT) Committee focused on promoting Agile System Development and DevSecOps for programs
 - ✓ Joint SED/ Integrated Program Management Division (IPMD) working group on Agile Program Execution
- **Digital Systems Engineering (DSE)**
 - ✓ SED-level working group addressing evolution of MBSE to DSE
- **Mission Engineering (ME)**
 - SED-level working group studying ME implementation
 - ✓ Conducted Survey of Industry's Mission Engineering capabilities
 - Provided review/ recommendations to DoD ME Guidebook update

SEMOD Cross-Cutting Key Enablers

- **Architecture**
 - ✓ SE Division (SED) Architecture Committee leads system architecture focus
- **MBSE**
 - SED Modeling & Simulation Committee leads MBSE focus
- **SoS/ Enterprise Collaboration & Data**
 - ✓ System of Systems (SoS) Committee leads this area
 - ✓ System Security Engineering Committee leads focus on Enterprise Collaboration & Data
- **Workforce Training & Structure**
 - ✓ SED Education & Training Committee leading SEMOD/Digital Acquisition Thread study

✓ Denotes subject of a 2022 NDIA S&ME Conference presentation



SEMODO Lines of Effort

ALIGNED TO

EACH PAIN POINT ADDRESSED BY MULTIPLE LINES OF EFFORT

Workforce: DE/SE Topic Workshops & Webinars

Topics for NDIA Discussion

- 1. Build an Integrating Framework** that incorporates key activities across these domains and focus areas.
- 2. Align and Integrate Systems Engineering Practices** to specific acquisition pathways.
- 3. Develop a set of Artifacts and associated Meta-Data** for a categorization and information framework that captures policy, guidance, and lessons learned into a body of knowledge.

As we developed the integration framework, we realized the “mental models” and related language of DoD systems Engineering were still too rooted in large scale major capability acquisitions and document-driven processes. We needed to re-envision the purpose and goals of modernized “digital” SE practices.

- Causally Related
- Derived from Workshops and Discussions with stakeholders
- Using the Integration Framework
- Address the slow uptake of modernized systems engineering processes
- Shown in the Fishbone diagram (next chart)
- Driven by the goal of seamless and efficient digital flows from data to decision artifacts and from decision artifacts back to data.

Highlighted items are
workforce related



Digital Engineering (DE): implement “an integrated digital approach that uses authoritative sources of system data and models as a continuum across disciplines to support lifecycle activities from concept through disposal.” Enabler to manage lifecycle efficiency.

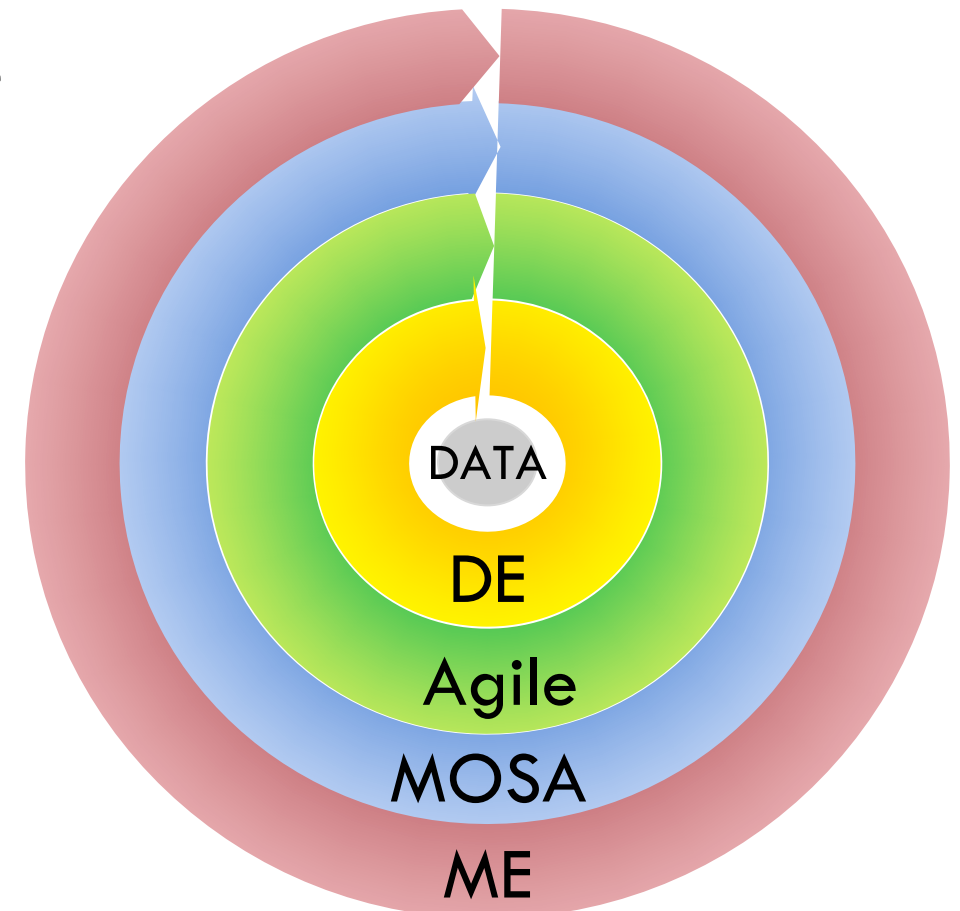
Agile/DevOps: begin with a high-level capture of business/technical needs, continually implement and deploy to define & build value. Enabler to manage risk.

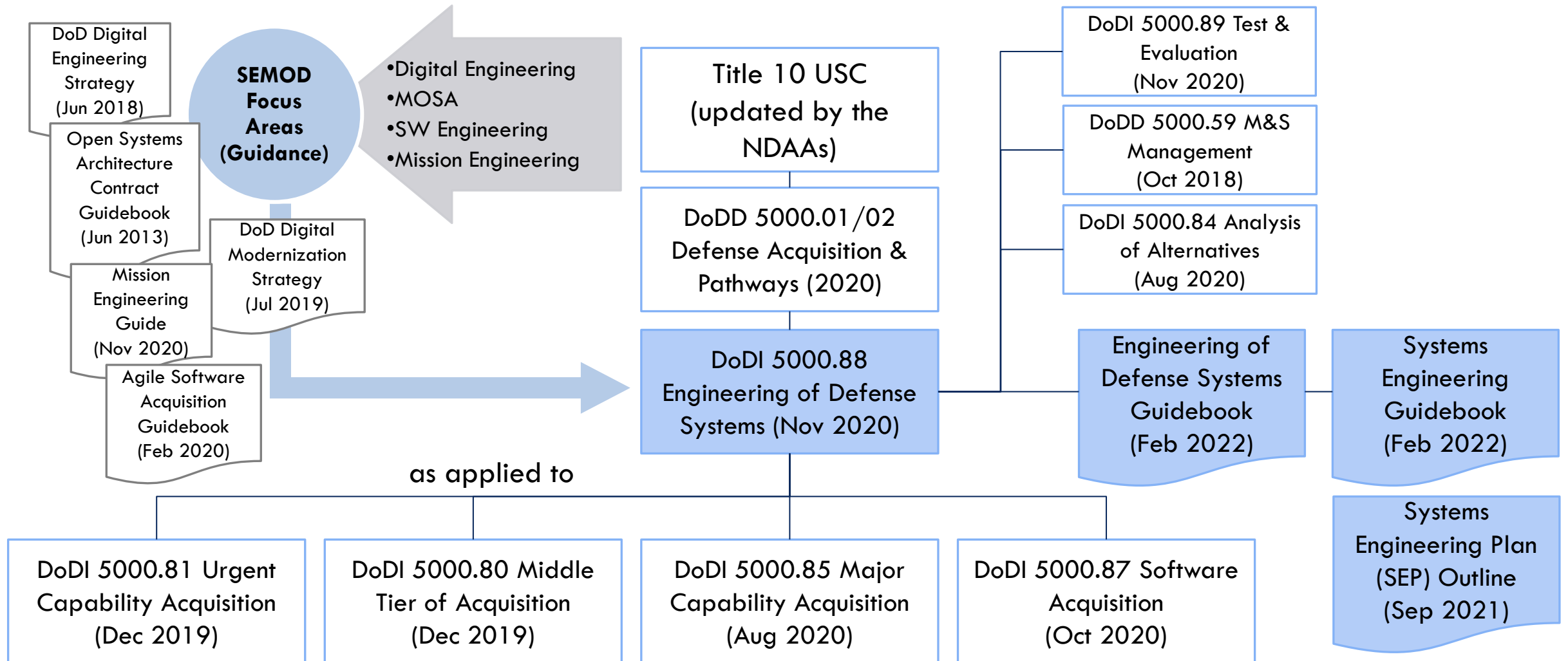
Modular Open Systems Approach (MOSA): use modular design, control interfaces, adopt open standards, measure conformance. Enabler to manage adaptability and change.

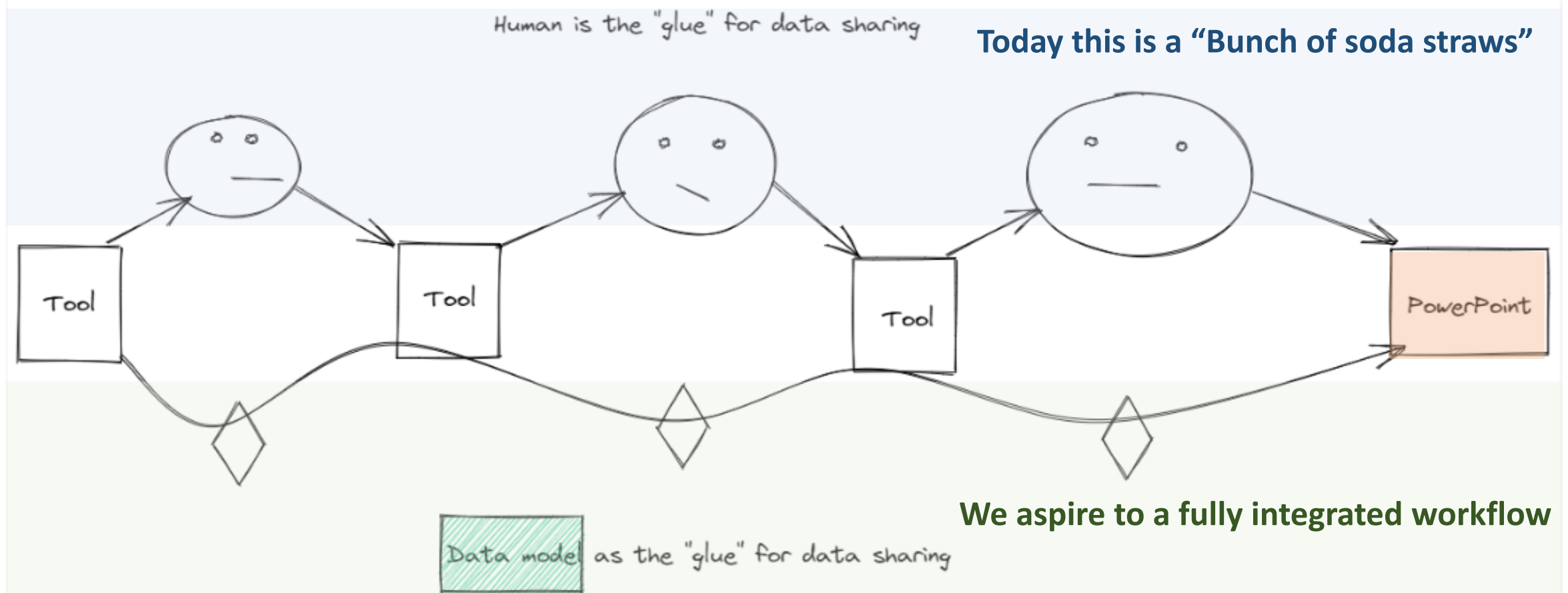
Mission Engineering (ME): continually provide engineered mission-based outputs to inform requirements, prototypes, design, and investment. Enabler to manage portfolios.

DoD Data Strategy: “data as a strategic asset”

**The 4 focus areas generate a layered,
continual, and data-centered model**



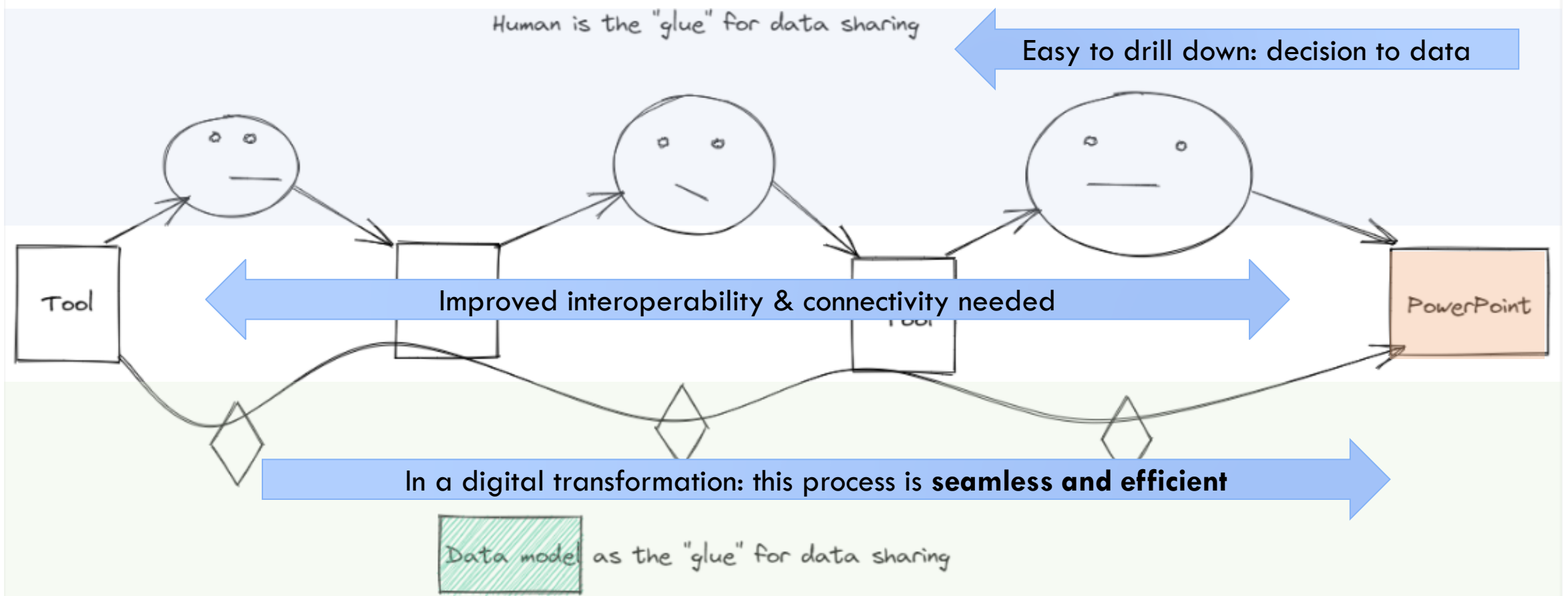




Digital Artifact - An artifact produced within, or generated from, the engineering ecosystem.

These artifacts are generated **through transformation of data and models into views** in order to visualize, communicate, and deliver data, information, and knowledge to stakeholders.

SEMOD evolves toward **seamless and efficient** digital flows from data to decision artifacts and from decision artifacts back to data.

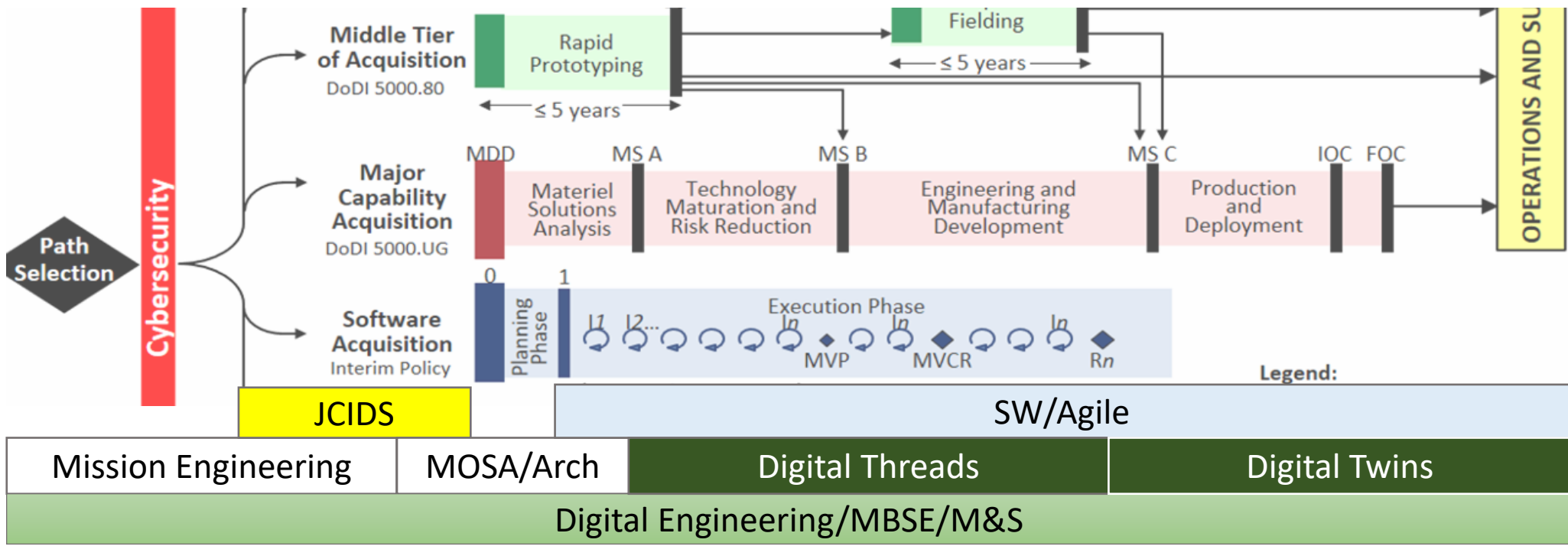


Lack of an integrated approach is creating a delay in full implementation of the Digital Transformation



SEMOD Initial Framework (SERC)

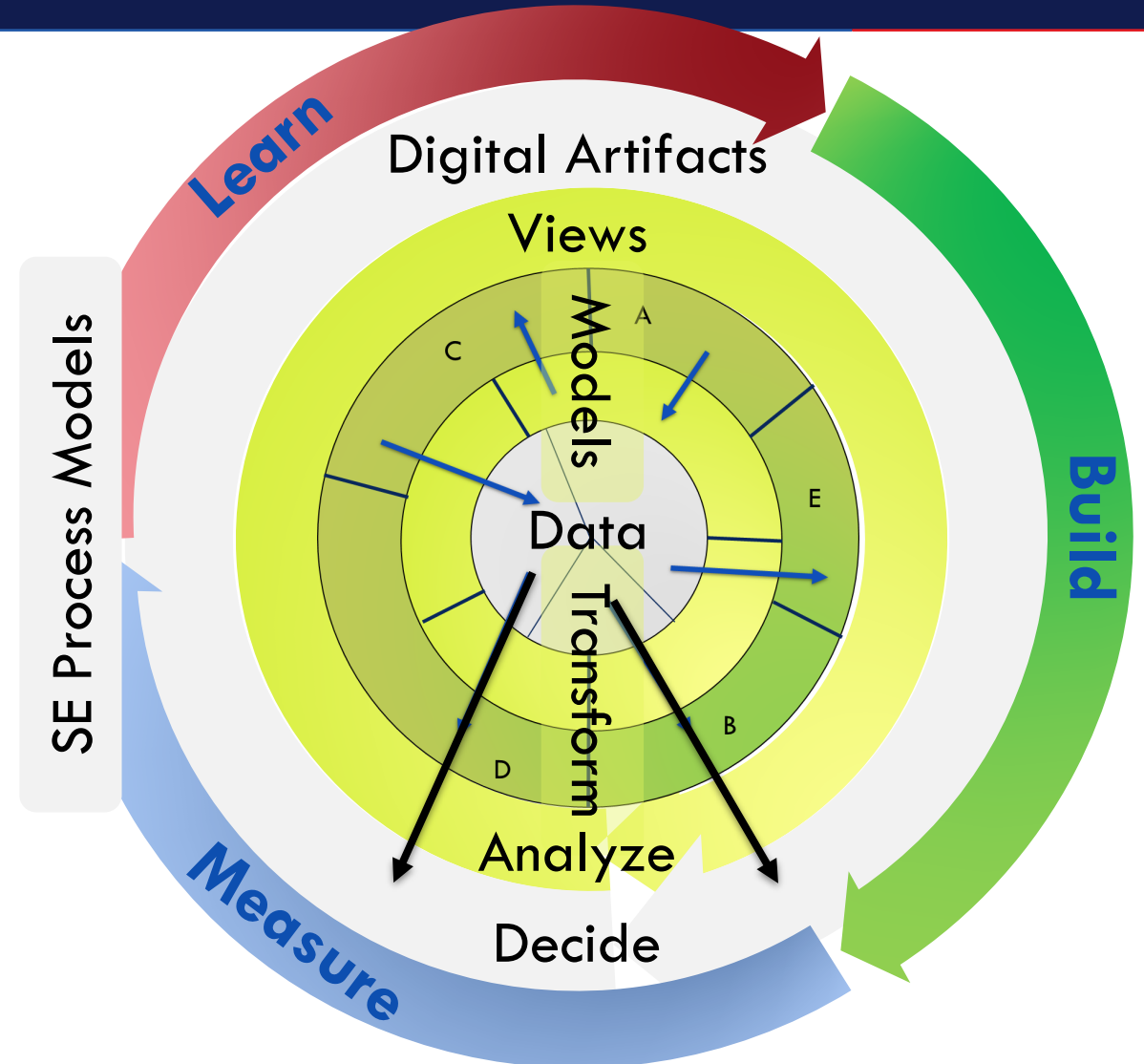
- Digital Transformation introduces digital & model-based information flow into the acquisition lifecycle
- SERC is mapping information items and digital artifacts related to handoffs in 3 acquisition pathways
- Examining (1) IEEE15288/INCOSE Handbook, (2) INCOSE/NDIA SEBoK, (3) DAU guides (new), (4) NAVAIR “Skyzer” DE Pilot effort. Framework will define “What digital info/artifact might be exchanged at each decision point?”





A Revised Mental Model of the Systems Engineering Lifecycle

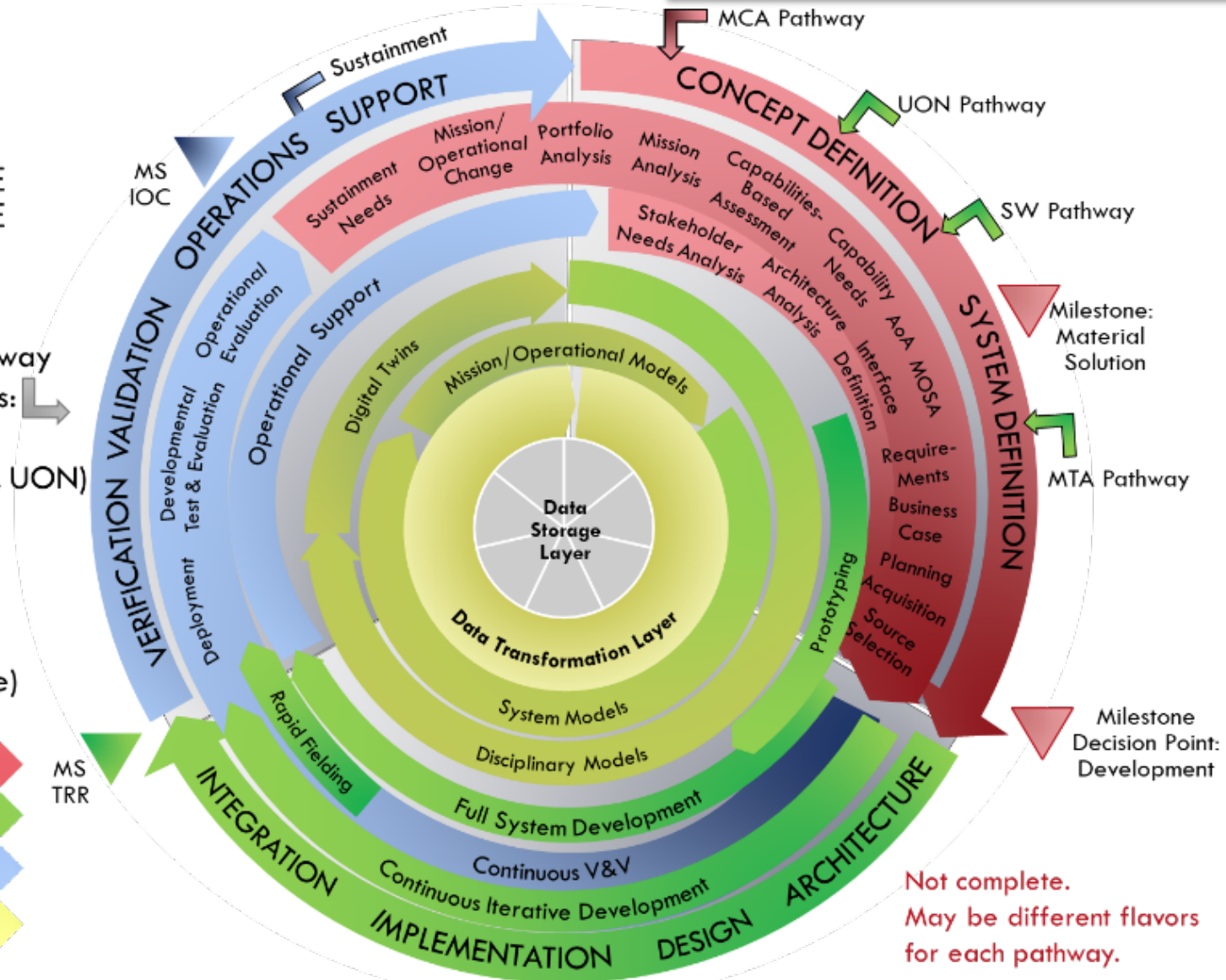
- SEMOD redraws the stages of the SE Lifecycle in a circular process to represent it as:
 - 1) data transformations at the core
 - 2) layered across disciplines & tasks
 - 3) continuous processes that could be entered from any point
- Data is transformed through Models into Decision Artifacts
- Data remains accessible via Decision Artifacts



SE Modernization Mental Model

NOTIONAL VIEW: FULL SE MODERNIZATION LIFE CYCLE

- Cyclic nature of modern SE
- Still milestone-based ▼
- SE core principles in every Acq pathway
- Flexible system life cycle entry points: ➡
- **Learn-Build-Measure** (MCA)
- **Build-Measure-Learn** (Mid-Tier, SW, UON)
- **Measure-Learn-Build** (Sustainment)
- Continuous Iterative Development processes (around the circle)
- Continuous Data Management and Transformation processes (at the core)





Systems Engineering Modernization and Digital Engineering

“seamless and efficient use of
data and models...data to
decision artifacts and back...
continuous and iterative...”

SEMOD Project

Improving
the “Digital”
in Systems
Engineering

“authoritative sources of data
and models...continuity across
lifecycle...concurrency across
disciplines and domains...”

DoD DE Strategy

Improving
the “Systems”
in Digital
Engineering

- SE Modernization and related focus areas represent a more significant shift in acquisition and engineering practices than envisioned by any single initiative
- The integration of these requires new mental models
 - Data at the core – many lessons learned will drive evolution
 - Seamless and efficient process integration – new exemplar standards/tools
 - All lifecycles are continuous and use appropriate iterative methods
 - But SE core lifecycle processes will remain with new practices
 - Significant workforce evolution needed
- Several SERC tasks support the community in this evolution



Workforce Development Planned FY22/23 SE Modernization Workshops/Webinars

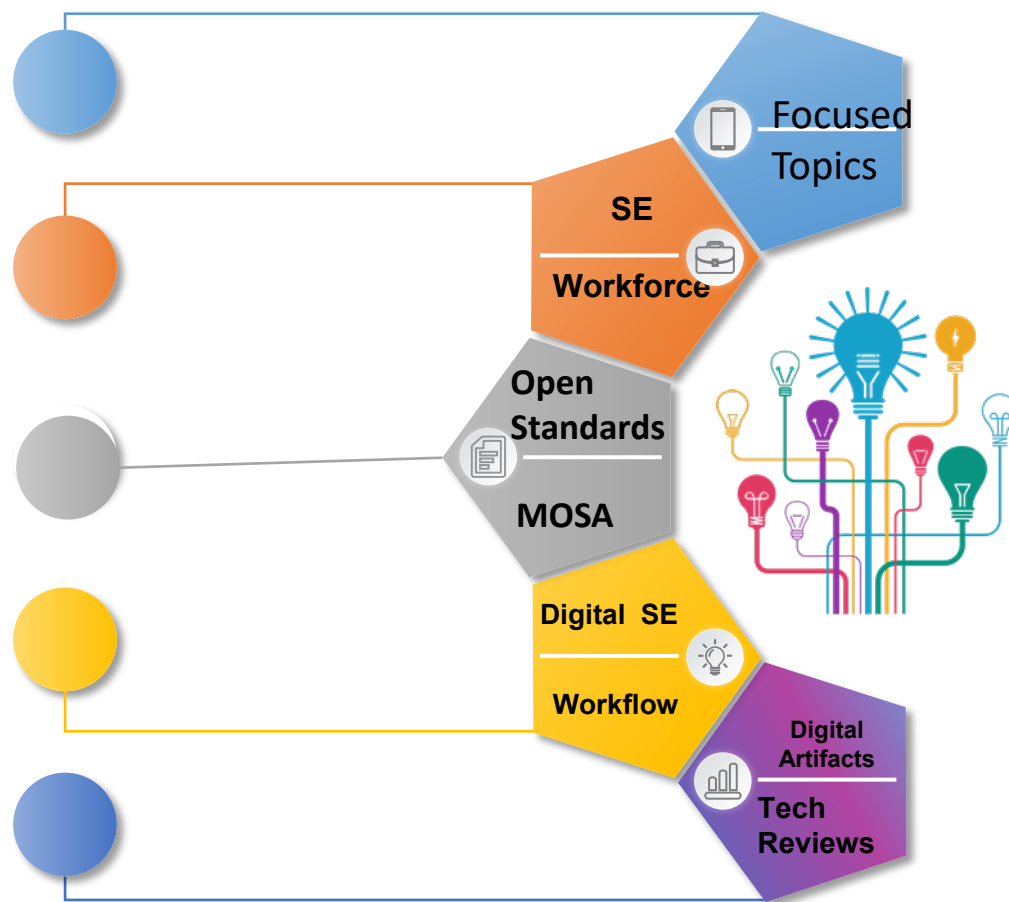
Specialty – **Focused Topics:** Digital T&E – R&M – Mission Engineering – Contracting for Digital Artifacts – Use of Reference Architecture

SE Boot Camp on Modernized SE Practices – Agile SE.

Implementing **MOSA & Open Standards** in a Digital Environment

Engineering Workflow in a Digital Environment. (DAU Acquisition Thread)

Technical Reviews & Digital SE Artifacts in a Digital Environment



Ongoing collaboration with Engineering Technical Management Functional Integration Team to develop SE Credentials

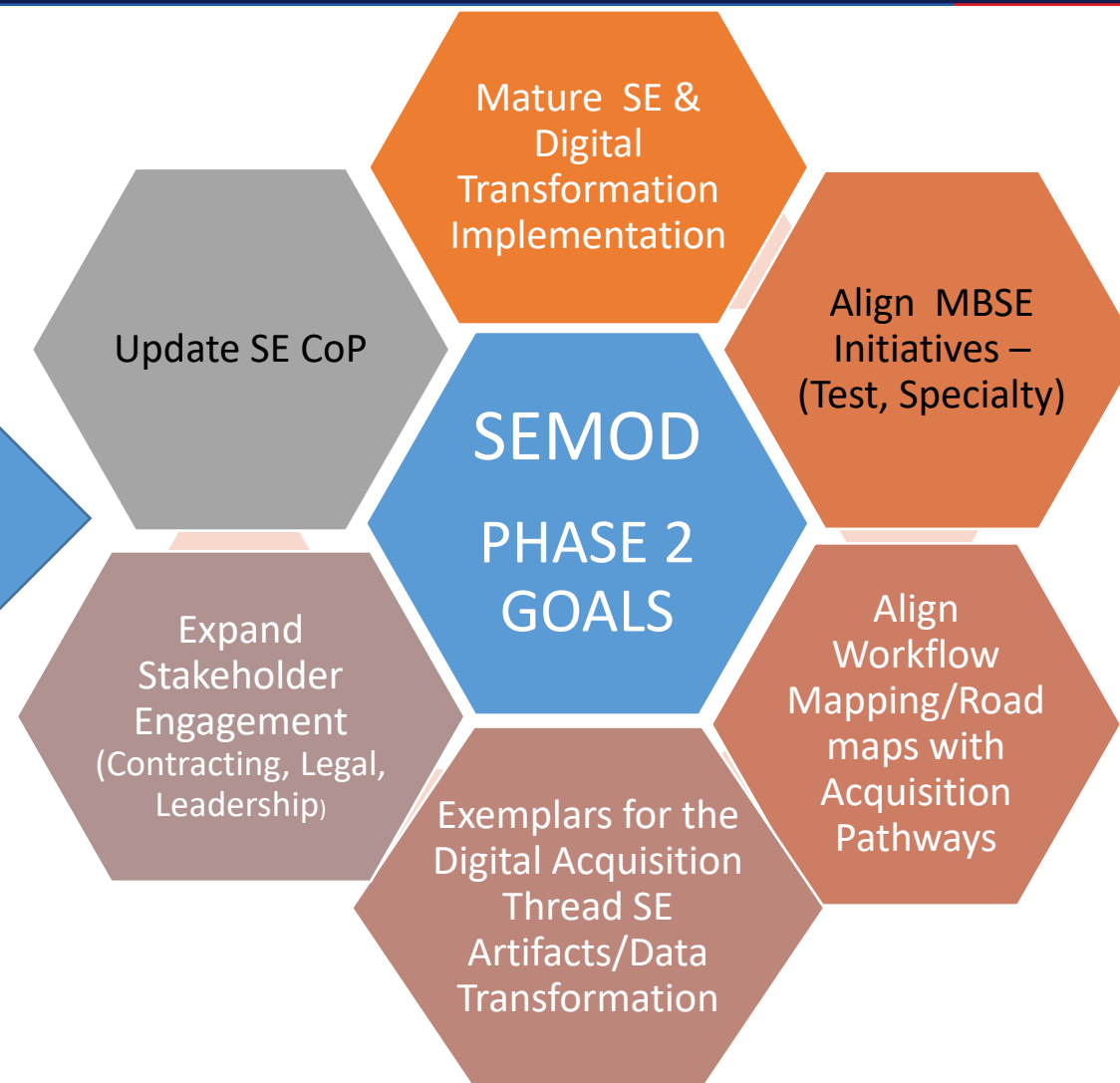
WORKSHOPS WILL INFORM BoK, UPDATES TO POLICY & WORKFORCE GUIDANCE



SEMOD Path Forward for Phase 2

Complete Phase 1 SERC Deliverables

- ✓ **Lessons Learned Database**
- ✓ **Ontology** guide for SEMOD policy and guidance
- ✓ **Workforce, education and training** recommendations
- ✓ Present **Policy gaps & recommendations**
- ✓ **Recommend** additional focus area integration





Contact

Office of the Under Secretary of Defense for
Research and Engineering

osd.r-e.comm@mail.mil | Attn: SE&A

<https://www.cto.mil>

<https://ac.cto.mil/engineering>



Backup charts



INCOSE IW 2022 STRATEGY SESSION SUMMARY (2 WORKSHOPS)

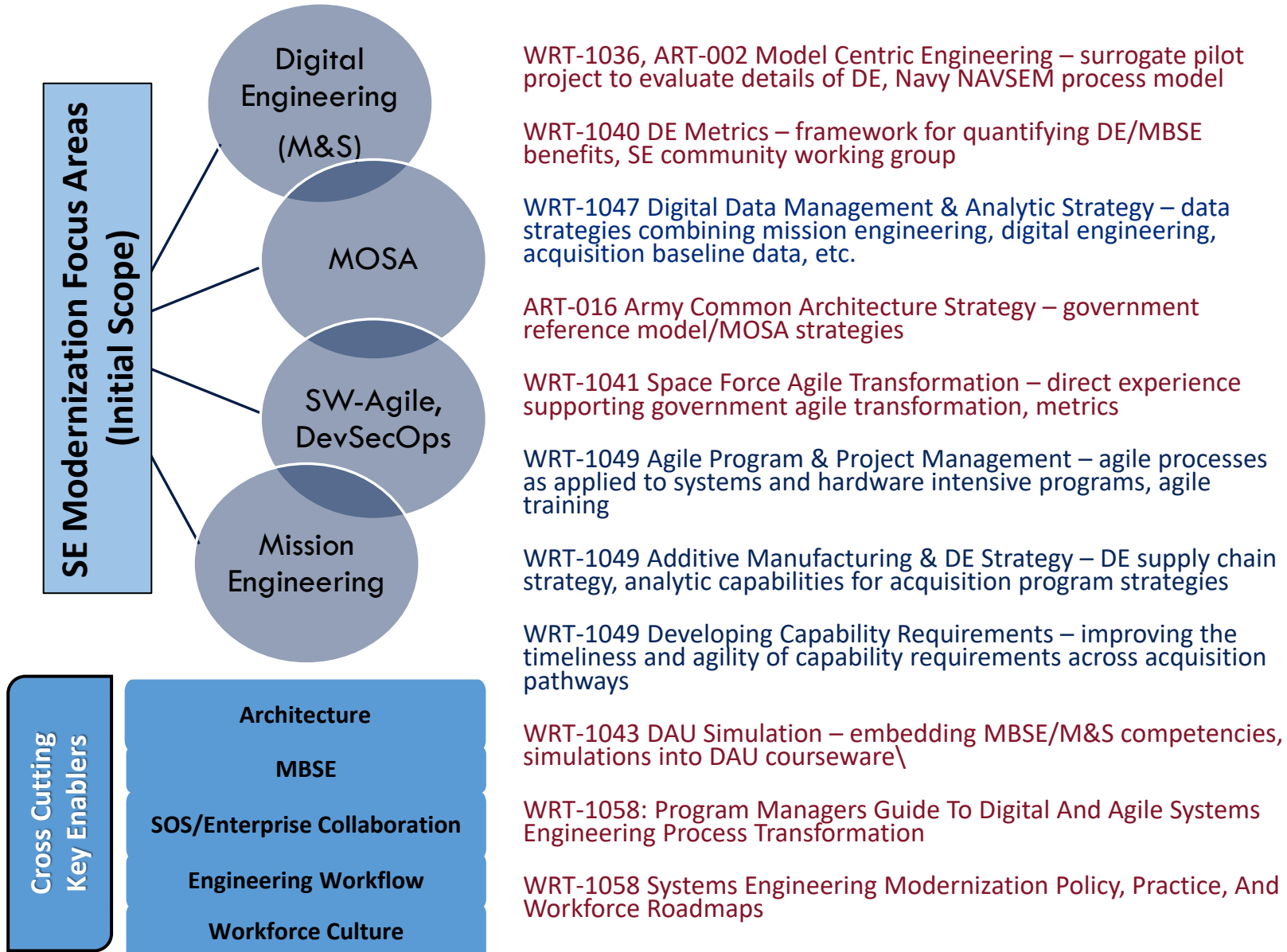
What is the Current State?	How do we increase collaboration & knowledge sharing?	What is the Future State?
Lack integration of engineering and other competencies (science, safety, software, security, programmatics)	Leaders not managers, need to recognize this is a digital transformation linking SE and other disciplines through data	Seamless interoperability and integration of all engineering disciplines
Hard to create collaboration , continuously, in digital environments; funding is a barrier	SE job is to communicate! Funding allocations don't promote collaboration	Continuous engineering across the globe – communicating seamlessly and remotely
Lack of governance approaches for data and models, ingrained paper CM/DM mindset	Apply automation , remove drudge work, focus on build	Digital twin(s) that is holistic for a system over its entire life cycle
Historical approaches dominate, lack change momentum	Recognize limits of the digital technologies, build incrementally & continuously	Greater (digital) integration of SE and other disciplines including project management
Engineers lose dynamic content as the design progresses, artifacts become more static, stale	Leverage SW processes that could improve SE; build iterative, collaborative teams	The equivalent of a DevOps revolution cutting across disciplines & lifecycle
Need to move away from a static view of the system toward model-based reviews; shortage of experienced practitioners	Training and exposure for everyone	"How to model" is a core competency for more than just the engineering community
Need to know system changes are not breaking something else, not seeing full scope Lack a digital process flow handbook(s), a digital workflow with traceability to domains	Interoperability standards, tools, clouds, data across boundaries , norms for working together Recognize limits of the digital technologies, build incrementally & continuously	Tool maturity: more open, interoperable, usable, standardized



SEMOD Collaboration with INCOSE

- SERC led two strategy sessions to discuss:
 - Is there a strong need to “modernize”?
 - What focus areas should we tackle first?
 - How are emerging and relevant practices integrated into SE discipline?
 - How should the overall practice of systems engineering shift over time? These are all questions that must be addressed by INCOSE.
- Goals of the session:
 - Document the current state of SE with respect to evolving markets and methods,
 - Identify focus areas for INCOSE that we should address with respect to evolving practice,
 - Develop a set of prioritized actions or perhaps simple roadmaps, and
 - Recommend/Identify key enablers that are essential to a modern approach to SE (for example reference architectures, SoS collaboration environments, etc.).

SE MODERNIZATION: BROAD SYNERGY WITH OTHER SERC/AIRC EFFORTS



**A Framework
to Guide
Decisions for
Program
Managers and
PEOs**



Digital Acquisition Thread (DAU Led)

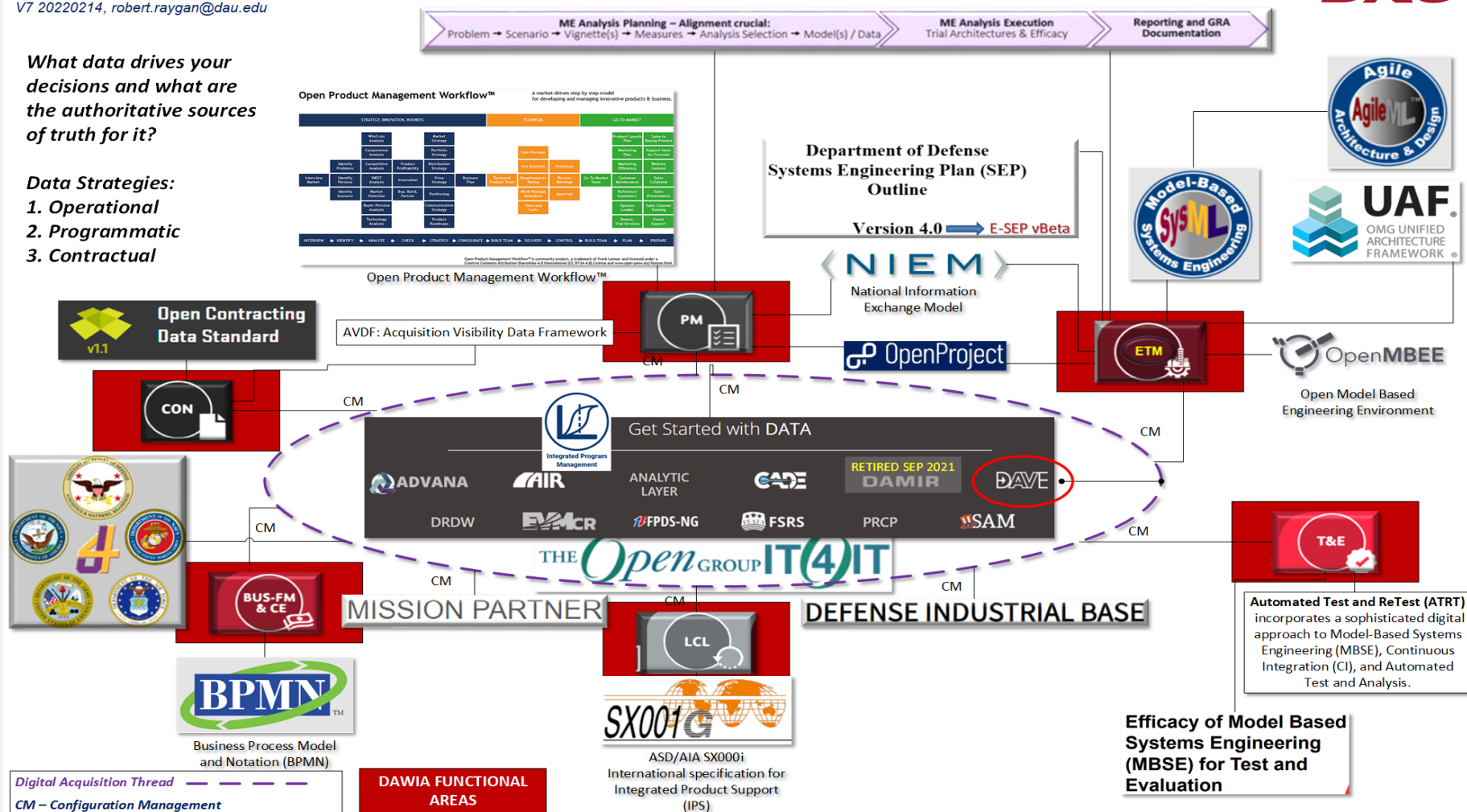
DoD Digital Acquisition Thread Reference Architecture Concept

V7 20220214, robert.raygan@dau.edu

What data drives your decisions and what are the authoritative sources of truth for it?

Data Strategies:

1. Operational
2. Programmatic
3. Contractual



“Exemplar Digital Acquisition Thread” Challenges and Results



Mission and Purpose	Desired Results	Stakeholders / Sponsors / Collaborators
<p>Why “Exemplar Digital Acquisition Thread” project? <u>SE Modernization pain points:</u></p> <ul style="list-style-type: none">A. Digital Processes and Products (Digital Acquisition / E-Programs)B. Enterprise Systems Engineering approach integrating:<ul style="list-style-type: none">1. Five key areas: DE/MOSA/SWE/CID/ME2. Collaboration and Data Sharing challenges between Government and Industry3. Digital Tools / Methods4. Role of Reference Architecture <p>Desired Result: A Digital Acquisition Thread Reference Architecture and Examples with Digital Artifacts for each RA Element.</p>	<p>GOALS:</p> <ul style="list-style-type: none">A. Create a government reference architecture for a cross-continuum digital acquisition thread.B. Collect exemplar reference architecture elements from mission partners, industry, and academia.C. Share exemplar acquisition thread with the community for education, training, and re-use.D. E-SEP: native digital systems engineering plan model with mission critical interfaces for data sharing <p>SUCCESS STATEMENT:</p> <ul style="list-style-type: none">A. Deliver a digital acquisition thread reference architecture hosted on DoD web site and incorporated into training materials and workshops for the community.B. Reference architecture element models, formats, interfaces, etc. are collected and hosted on appropriate sources of truth.	<p>Customer: OUSD R&E, Nadine Geier</p> <p>Who Benefits? DoD Acquisition Teams, ASD(A), DoD CIO</p> <p>Team: OUSD R&E, SERC, DAU, NDIA SED Committees, Mission Partners, and other DoD Agencies.</p>

Measures of Success	Accomplishments
<ul style="list-style-type: none">1. SERC SEMOD workshops established survey questions and guidance for broader audience offering and feedback2. DoD ASoT owners are identified with interface APIs cataloged. (NDAA21 Tasker 804.c.)3. Digital Acquisition Thread Pilot with exemplar mission partners.4. NDIA Project Team & OUSD R&E iteratively develops Digital Acquisition Thread Reference Architecture5. NDIA delivers a digital acquisition thread reference architecture6. Collected exemplar digital artifacts are hosted by DoD for education, training, and re-use.7. 25th Annual Systems and Mission Engineering Conference (india.org) Panel Discussion: Systems Engineering Modernization (SEMod) Key Enablers for System Development on DoD Programs on lessons learned and next steps for continuous improvement (11/3 1100-1200 Eastern)	<ul style="list-style-type: none">1. DAU Systems Engineering Modernization (SEMod) - Defense Acquisition University (dau.edu) Series added to DAU Events for webcasts and training reuse.2. DAU SEMod Key Enabler Workshops: WSE 028 Mission Engineering (ME) Awareness and Planning (dau.edu) and WSE 027 Modular Open Systems Approach (MOSA) Awareness and Planning Workshop (dau.edu) created in response to mission partner requests. CM workshop in development3. Exemplar Mission Partners: AFSOC MAC, MCSC, AFC DE Cop, NAWCAD, PEO-IEWS, PEO-EIS, PEO-AVN, NAVWAR, ASA (ALT), ASN (RDA), DISA, ...4. Big challenge for DoD, work around for training provided by NPS sharing their GitLab for “DoD Reuse and Sharing Training Program Artifacts”5. What needs work? DoD public sharing policy and process. (Update for digital artifacts)6. OMG UAF Working Group – Model Based Acquisition - RFP and Response plus7. NPS GitLab: To be shared – Skyzer, Silverfish, CUI WOSA.mdzip, MITRE 5000 model, DAU Bulldog8. What needs work? NDAA21 tasker: Were interface models considered rather than “documents?”

Deeper Learning

- [Defense Acquisition University](#)
- [Tools Catalog](#)
- [SE Brainbook](#)
- [Configuration Management](#)

[LOG 2040 Configuration Management](#)

[MIL-HDBK-61 07APR2020](#)

DIGITAL ENGINEERING

[CLE 084 Models, Simulations, and Digital Engineering](#)

[ETM 1070 Digital Literacy Fundamentals](#)

[ETM 2070V Digital Literacy for Practitioners](#)

[Digital Engineering \(DE\) Measurement Framework](#)

[Continuous Iterative Development \(Agile\) Measurement Framework](#)

SYSTEMS ENGINEERING MODERNIZATION

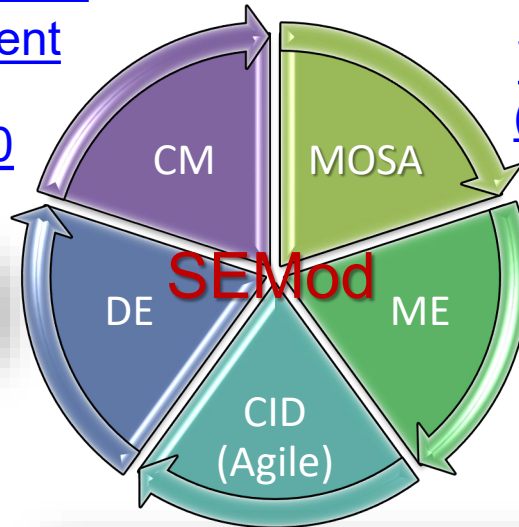
June 21, 2022

MODULAR OPEN SYSTEMS APPROACH

DEFENSE STANDARDIZATION PROGRAM
MAKING SYSTEMS WORK TOGETHER

[CLE 019 Modular Open Systems Approach](#)

[WSE 027 Modular Open Systems Approach \(MOSA\) Awareness and Planning Workshop](#)



DAU Agile, Cloud, Cyber and DevSecOps courses and workshops

MISSION ENGINEERING

[ETM 1020 Mission and Systems](#)

[Thinking Fundamentals](#)

[ETM 2020V Mission and Systems](#)

[Thinking for Practitioners](#)

[WSE 028 Mission Engineering \(ME\)](#)

[Awareness and Planning \(dau.edu\)](#)

[Systems Engineering Modernization Workbook | Rise 360 \(articulate.com\)](#)



DAU EVENTS SEMod SERIES

Systems Engineering Modernization (SEMod) - Join this series to learn about the key enablers to modernize Systems Engineering including digital engineering, mission engineering, modular open systems approach, continuous iterative development, modern software and development methods (Agile, DevSecOps, Scrum, SAFe), and lead systems integrator. Series format is delivered live with attendee questions & answers and discussion from participants and recorded for future use.

- Established April 2022 for first SEMod key enabler, “SCRUM Implementation for Army Lessons Learned,” Linda O. Jones, Ph.D. PM Defensive Cyber Operations (DCO) Cyber Analytics and Detection (CAD) Deputy Product Manager, CAD
- Second in series, “Government Lead Systems Integrator Benefits and Fundamentals,” Gerald Swift, Director, AIRWorks, Naval Air Warfare Center Aircraft Division, Christa Rodewald-Franz, Deputy Director, AIRWorks, Naval Air Warfare Center Aircraft Division, and Scott Hoffman, Chief Engineer, AIRWorks, Naval Air Warfare Center Aircraft Division
- **September 29th (1300-1430 Eastern) next in series**, “organic Lead Systems Integrator (oLSI),” David Hager, Technical Director, Naval Air Warfare Center Aircraft Division Webster Outlying Field, and Israel Jordan, Technical Initiatives & Strategy Director, Naval Air Warfare Center Aircraft Division Webster Outlying Field https://www.dau.edu/event/organic_Lead_Systems_Integrator
- Planning: NAVWAR CM Guidance, PEO-IEWS MOSA Guidance, MCSC ME Guidance, Boeing Global Sales BD/Navy-Gov Ops, MITRE
- Contact Robert.Raygan@dau.edu to become a part of the series.
- [Systems Engineering Modernization Workbook | Rise 360 \(articulate.com\)](#)
 - [WSE027 Modular Open Systems Approach \(MOSA\) Workbook | Rise 360 \(articulate.com\)](#)
 - [WSE 028 Mission Engineering \(ME\) Workbook - Overview | Rise 360 \(articulate.com\)](#)
 - [DAU Agile, Cloud, Cyber and DevSecOps courses and workshops - Overview | Rise 360 \(articulate.com\)](#)

