Architecting a Purpose-Driven Roadmap for Impactful Digital Transformation

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February 20TH 2024
North Texas INCOSE Chapter

Author Information

Background Info

Carla Sayan Associate Director

~20 years Industry Experience

- F135 Digital Transformation Associate Director , Pratt and Whitney,
- Secure Sensor Systems- Raytheon Intelligence and Space (RIS)
- Effectors, MFRFS, Sensors, RF, Hypersonics – Raytheon Missile Systems (RMD)
- Systems of Systems Architecture - SDA
- Model Based Systems Engineering Founder and Instructor SAMI – RMD
- Full Lifecycle Experience: Directorate Lead Proposal SDA, FQT, Embedded SW, Cryptographic Libraries in ASICs/FPGAs, Model Based Engineering/ SysML/ UML/ Digital Engineering, SI, Advanced Technologies Portfolios, FEOTB, SoS

Before RTX

- Hampson Aerospace, Parker Hannifin, M&M Manufacturing

Awards and Recognitions

- 2 x Raytheon Technical Honors Distinction
- Raytheon Missile Systems Presidents Excellent Award
- SHPE National Most Promising Engineer Award
- Great Minds in STEM HENNAC Distinction
- 20+ Presentations/Publications/Conference Proceedings

Leadership

- Past Vice-President Raytheon Women's Network
- Founder RWEST Mentoring Program Presidents Excellence Award Winner
- Founder SAMI Model Based Certification Model (Best Practice)
- Inventor and Author, INCOSE CSEP, RCAP Trained Architect , TOGAF Certified

School

- Ph.D. Electrical and Computer Engineering, University of Arizona
- M.S. Systems Engineering University of Arizona
- B.S. Magna Cum Laude College of Engineering, University of Texas @ Arlington

<u>Favorite Things to Do:</u>

Family Adventure Travels

Researching and Academics

Work with things I can "Touch"

The Aerospace and Defense Industry is currently undergoing a paradigm shift recognized as digital transformation or digital engineering. Despite its prevalence and being introduced with considerable interest, the precise objectives of this paradigm shift remain elusive from other branches of engineering, fostering diverse interpretations within the industry's landscape.

We then explore whether this concept encompasses the widespread adoption of model-based systems engineering (MBSE), Model-Based Design (MBD) and others. Our inquiry extends to examining how these MB-X methodologies reshape traditional engineering practices, and whether digital engineering transcends beyond the realms of MBSE and MBD to include broader technological, procedural and organizational changes.

We will explore whether digital is simply a progressive refinement of longstanding practices on what the hardware (electrical and mechanical) discipline has already proven for decades; that prioritizing modeling and simulation before producing HW can yield an improvement in the development life cycle.

Aerospace and Defense Industry

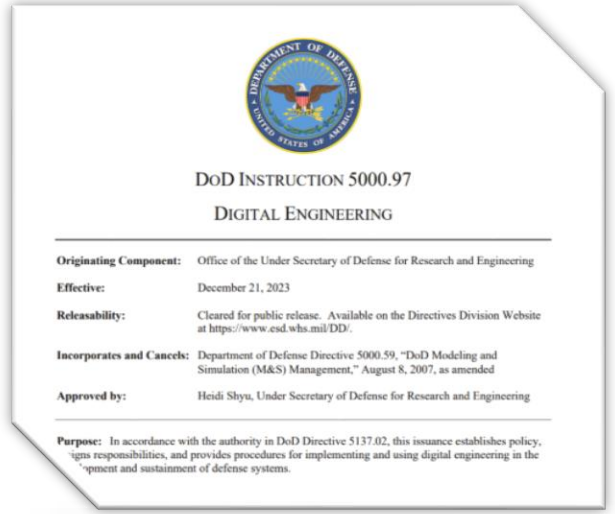
Recognition of the paradigm shift: DOD 5000.97 Released Dec 21, 2023

Applicability: Entire Department of Defense

Programs Initiated after this issuance (Dec 21,2023) “will incorporate digital engineering DE for the capability in development unless the program’s decision authority provides an exception.”

Programs initiated before this issuance (Dec 21, 2023) may incorporate digital engineering DE when it is practical, beneficial and affordable but are not required to do so.

“The directive requires the use of digital engineering methodologies, technologies, and practices **throughout the entire lifecycle** of defense acquisition programs.”

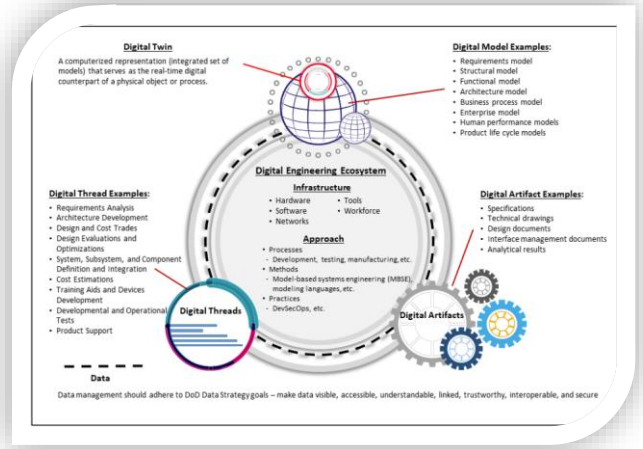


DoD INSTRUCTION 5000.97

DIGITAL ENGINEERING

Originating Component:	Office of the Under Secretary of Defense for Research and Engineering
Effective:	December 21, 2023
Releasability:	Cleared for public release. Available on the Directives Division Website at https://www.esd.whs.mil/DD/.
Incorporates and Cancels:	Department of Defense Directive 5000.59, “DoD Modeling and Simulation (M&S) Management,” August 8, 2007, as amended
Approved by:	Heidi Shyu, Under Secretary of Defense for Research and Engineering

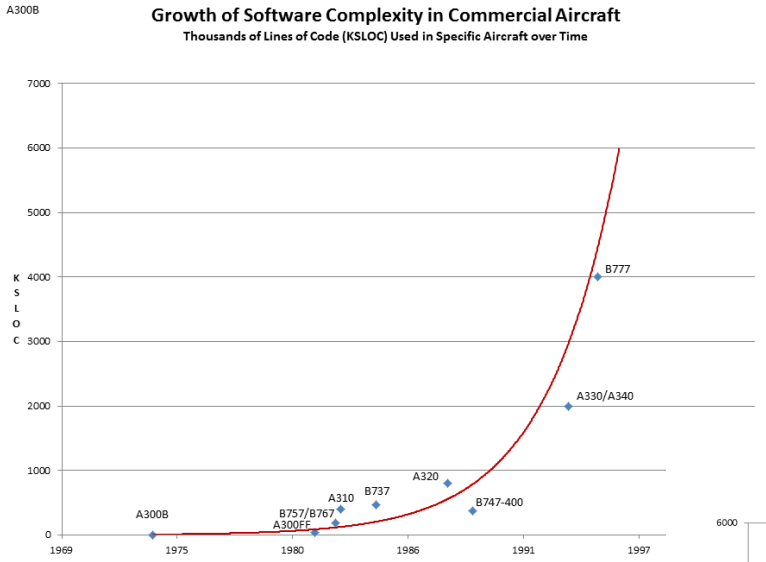
Purpose: In accordance with the authority in DoD Directive 5137.02, this issuance establishes policy, ...igns responsibilities, and provides procedures for implementing and using digital engineering in the ...opment and sustainment of defense systems.



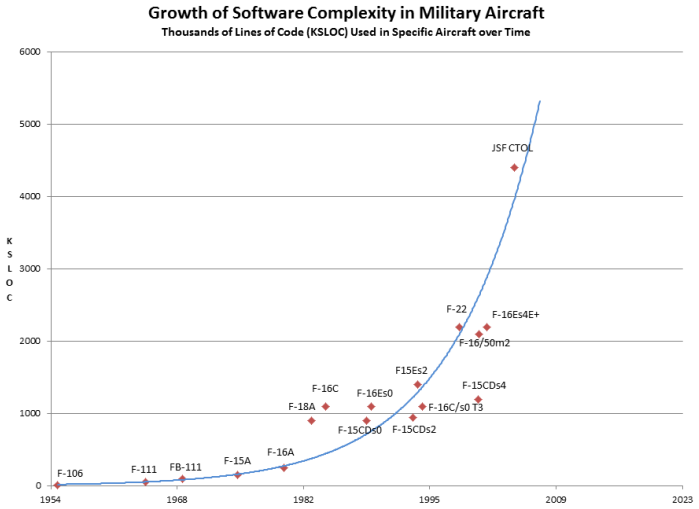
Sources [1] [2] : DoDI 5000.97, "Digital Engineering," December 21, 2023 (whs.mil)

Per Policy New programs will start off Digital!

Why Digital Transformation?



- **Applying industrial age processes to information-centric challenges**
- Mission Complexity
- System Emerging vs New Architecture
- Knowledge Still siloed



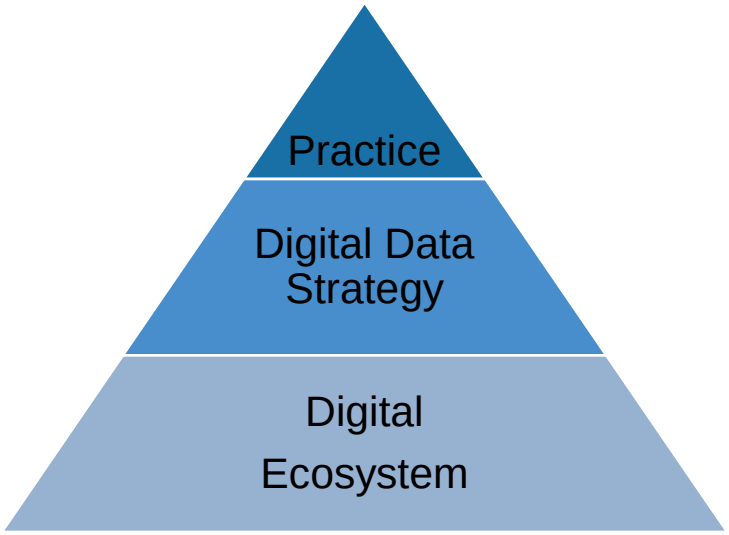
The Challenge: "Our current defense acquisition system applies **industrial age processes to solve information age problems**."
Lt Gen Robert D. McMurray, AFLCMC/CC

Our systems in the Future must be designed at a much faster speed, can they accommodate an ever-changing agile environment not only for the product but the mission itself will be changing.

Sources:
[1] https://www.incose.org/docs/default-source/default-document-library/niwc_atlantic_mbe_journey_incose_brief-31_may_2022_final.pdf?sfvrsn=43606fc7_0
[2] https://savi.avsi.aero/wp-content/uploads/sites/2/2015/07/Complexity-Military.png

Digital Engineering vs Digital Transformation

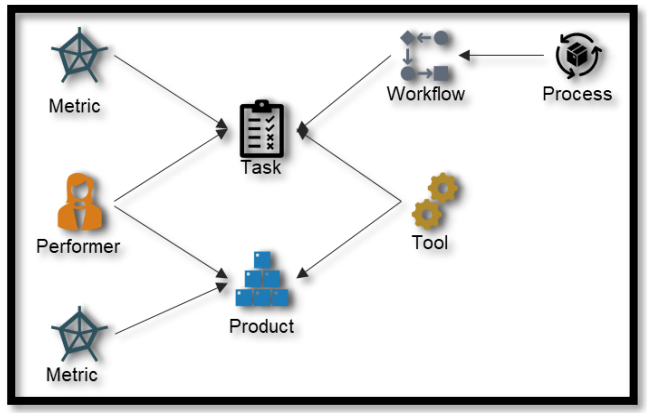
Digital Engineering
(Discipline FOCUS)



Digital Transformation
(Business FOCUS)

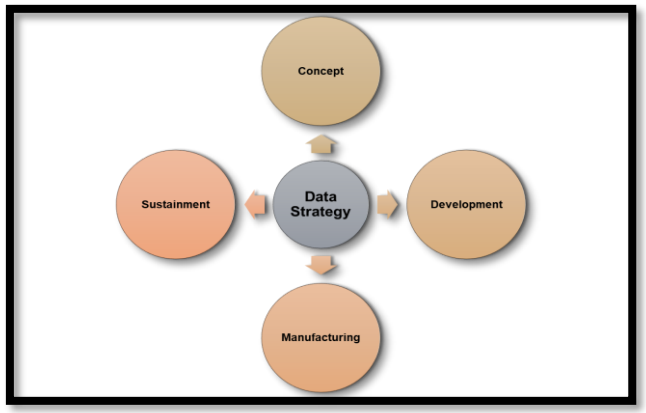
Knowledge Point: How to Fail in your Digital Transformation? Leadership Not Distinguishing between Digital Transformation and Digital Engineering resulting in a confused mixture of both. Let's dive deeper into this

Digital Transformation: Pillars Overview



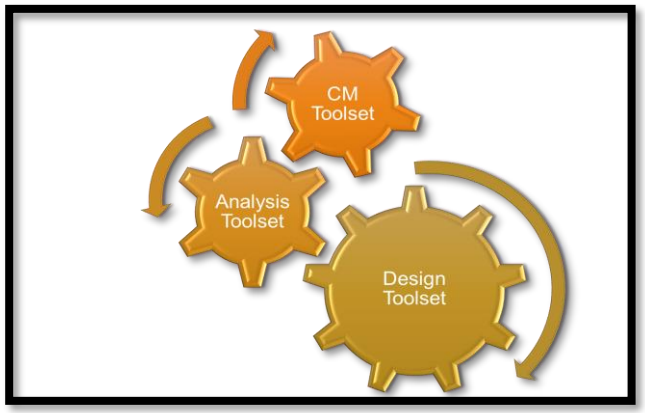
Practice and Enablers Business Level

- Processes, workflows methods to enable the execution of the cross functional practice.
- Guidance and Aids necessary to understand approaches to executing DE across different endpoints.
- W.I provides the procedural steps to execute DT approach
- Training and Resources enables the cadre of the future practitioners!



Digital Data Strategy Business Level

- Harness the power of data to drive decision-making, innovation and operational efficiencies.
- Establish data governance (policies, procedures and standards for data management)
- Defines a data architecture supportive of integration of data from various sources.



Digital Ecosystem Business Level

- Establish a supporting Infrastructure and Environment
- Support the execution of Activities
- Enables Collaboration and communication across Stakeholders.

Digital Transformation Transforms the Business and Seeks to Reduce Business Complexity

Digital Transformation: Challenges

bd

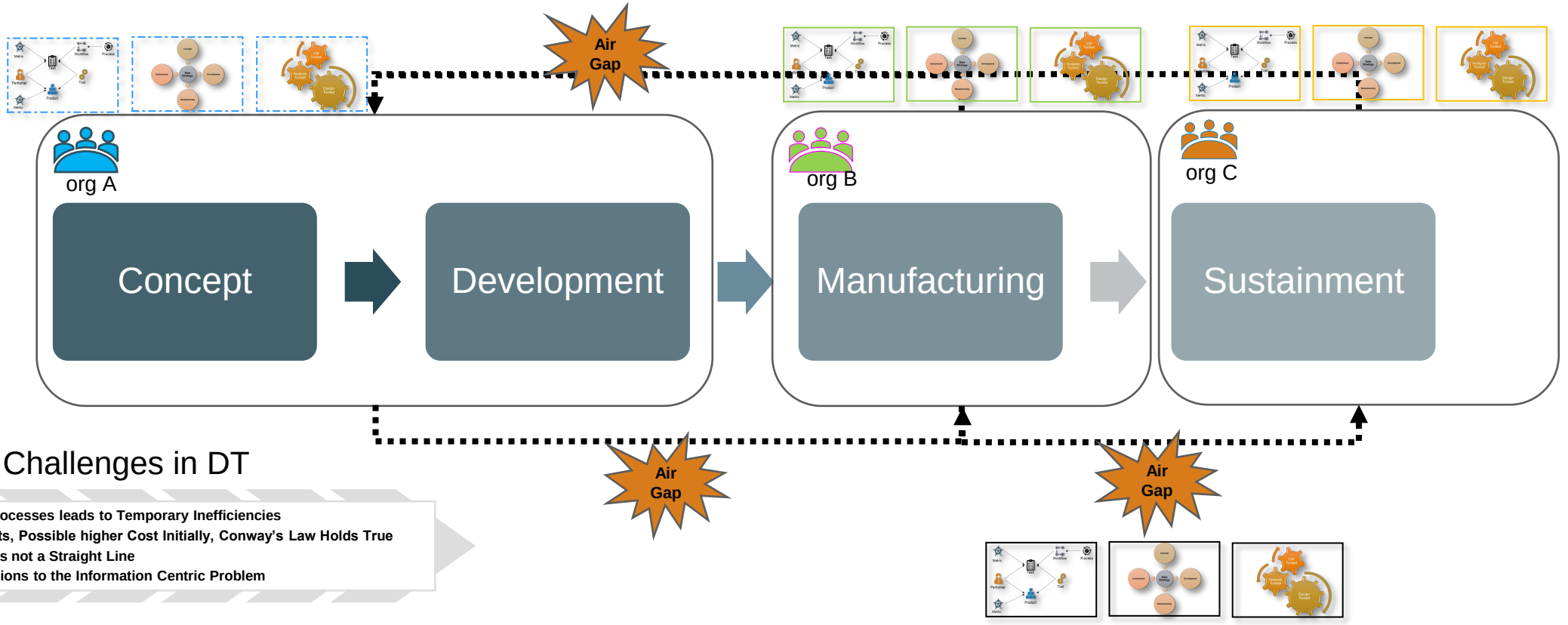
Conway's Law:

"any organization that **designs a system** will inevitably produce a design whose structure is a copy of the organization's **communication structure**".

"What was initially thought to be a simple process is in fact an incredibly complicated, intricate, and complex system that I've codified and organized into a few easy-to-follow rules that are more difficult to implement than you'd think." Source

Executives
Perspective

Business
Across
Around
Vertically
Up
Down

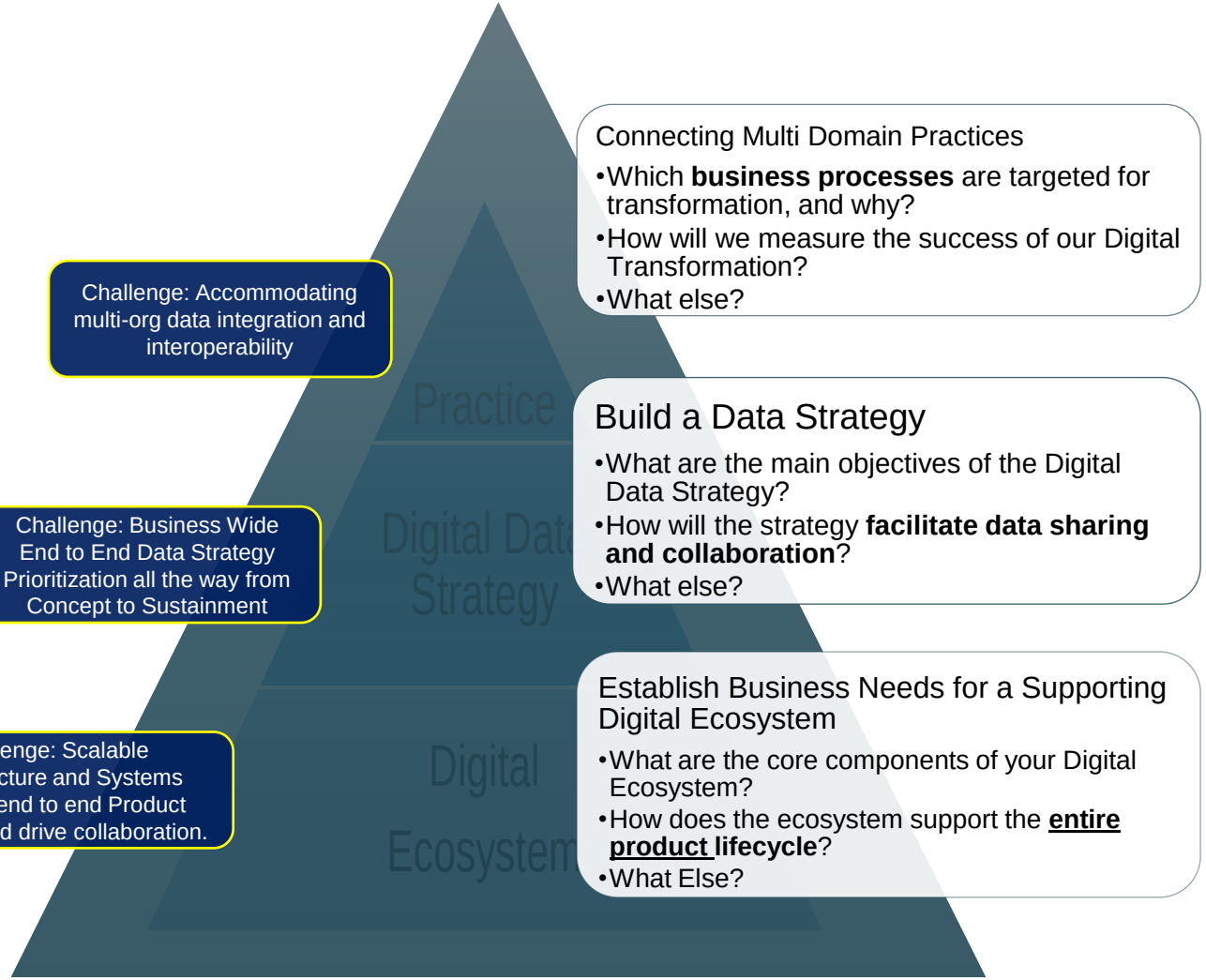


Challenges in DT

Changing fundamental Processes leads to Temporary Inefficiencies
Resistance in Some Efforts, Possible higher Cost Initially, Conway's Law Holds True
In this Communications, is not a Straight Line
There are various Dimensions to the Information Centric Problem

There exists and established process that in order to transform we must understand what is happening today day to day and then change - > difficult

Digital Transformation : Driving Knowledge



Challenge: Accommodating multi-org data integration and interoperability

Challenge: Business Wide End to End Data Strategy Prioritization all the way from Concept to Sustainment

Challenge: Scalable Infrastructure and Systems Support end to end Product lifecycle and drive collaboration.

Connecting Multi Domain Practices

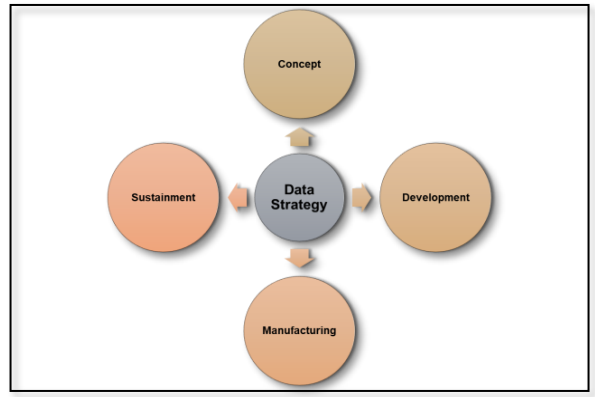
- Which **business processes** are targeted for transformation, and why?
- How will we measure the success of our Digital Transformation?
- What else?

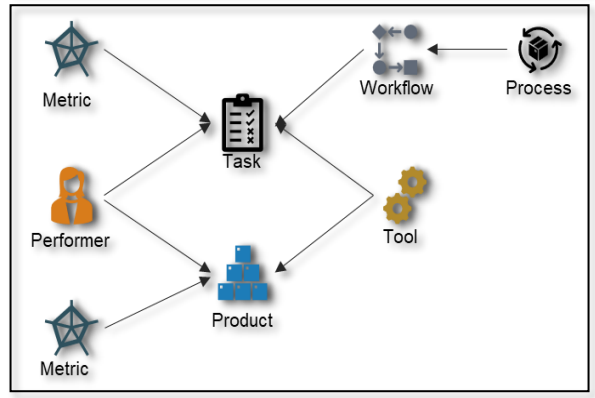
Build a Data Strategy

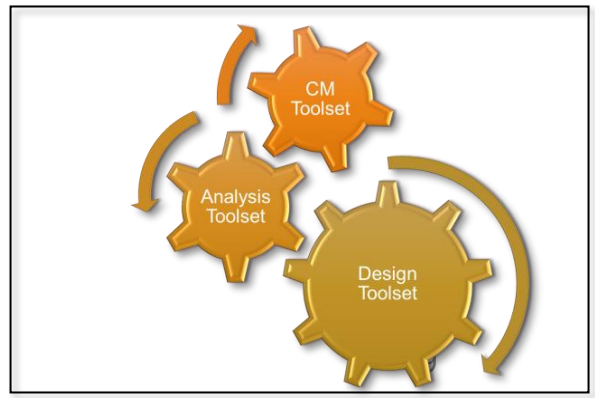
- What are the main objectives of the Digital Data Strategy?
- How will the strategy **facilitate data sharing and collaboration**?
- What else?

Establish Business Needs for a Supporting Digital Ecosystem

- What are the core components of your Digital Ecosystem?
- How does the ecosystem support the **<u>entire product</u> lifecycle**?
- What Else?

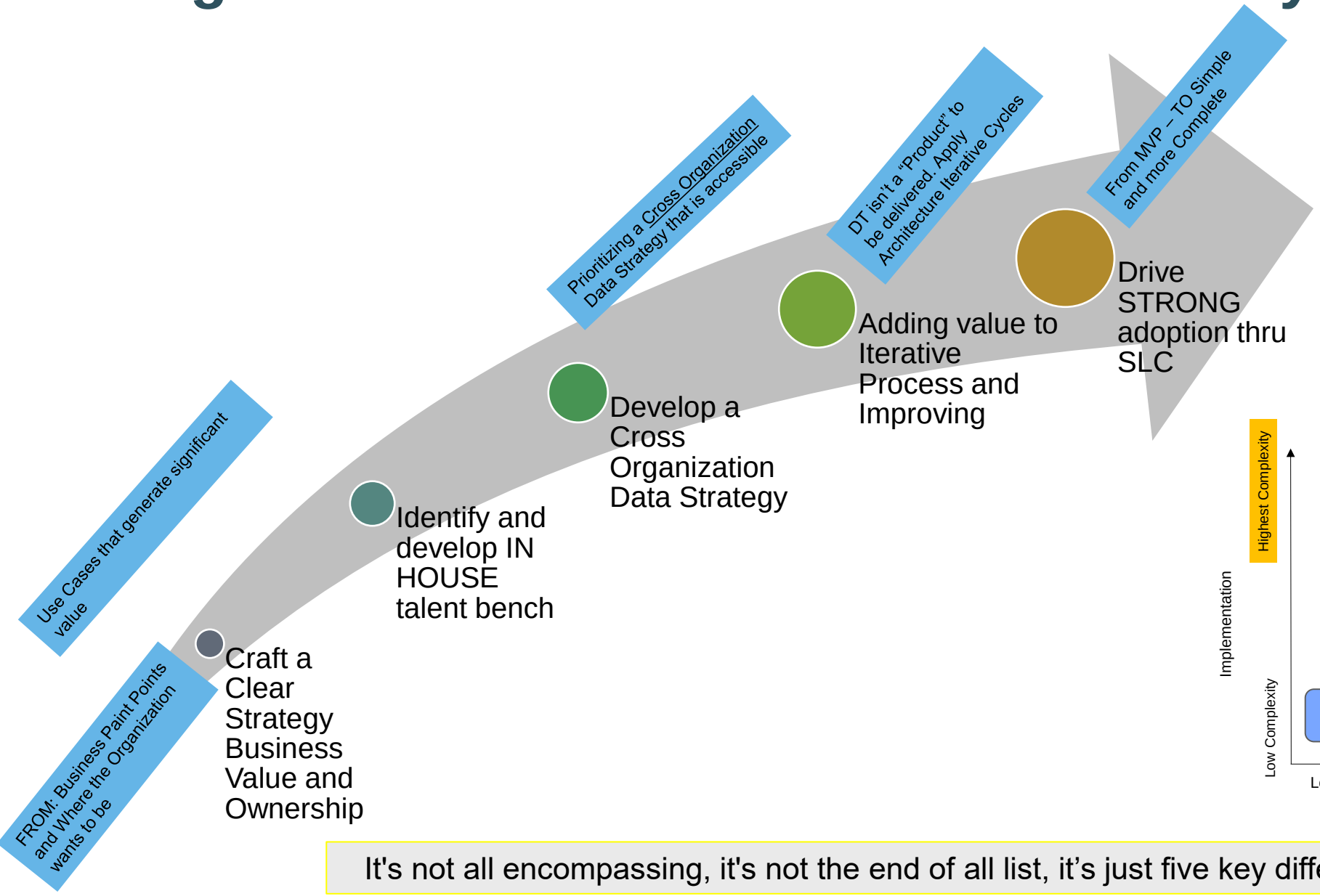


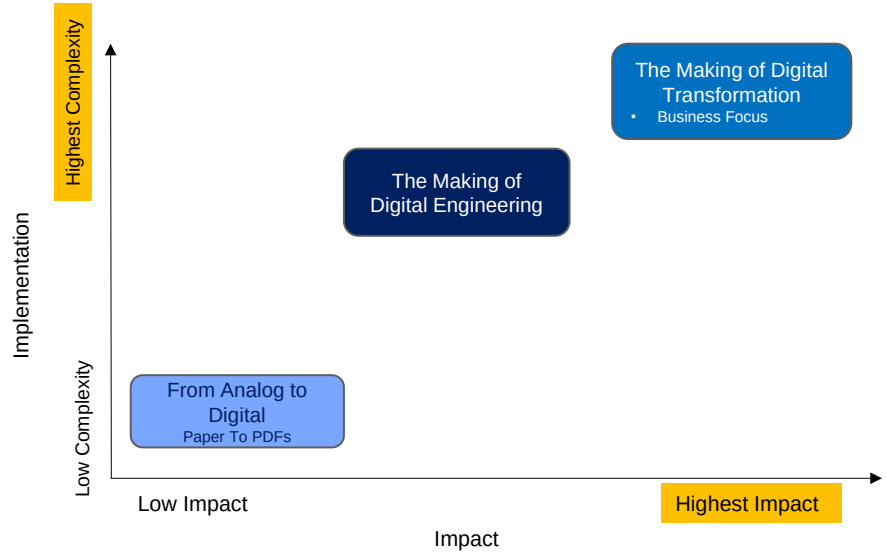




DT communicates across the entire business these related challenges with cross functional teams e.g. Manufacturing, Sustainment, Maintenance, Repair, Internal Suppliers, etc.

Digital Transformation : An Evolutionary Roadmap

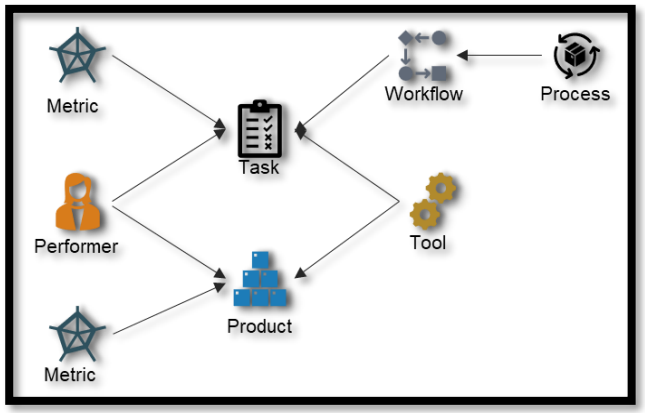


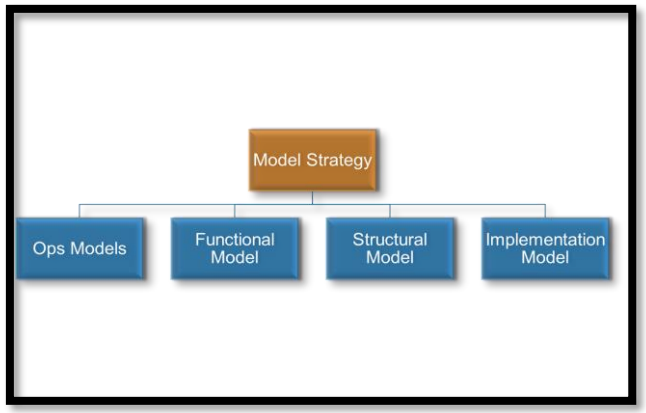


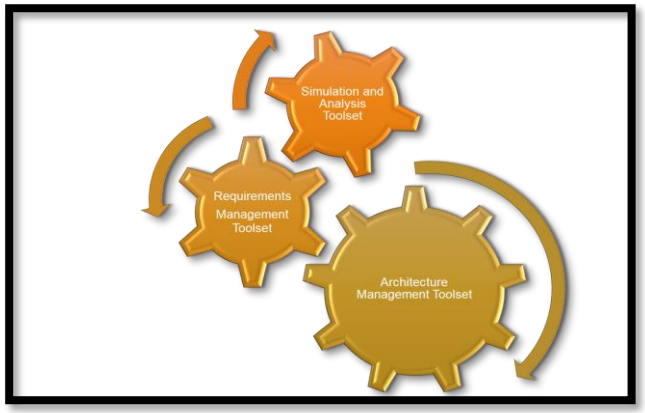
It's not all encompassing, it's not the end of all list, it's just five key differentiators.

Digital Engineering: MBSE and MBD Focus

You can apply DE to various Disciplines.
Today our Abstract focus is on MBSE and MBD







Practice and Enablers

- Integrate with our existing systems engineering processes
- Establish modeling languages and standards that will be used for system representation to ensure consistency and interoperability
- Processes, workflows methods to enable the execution of the practice.
- Identify the essential models (e.g., structural, behavioral, requirements) and views (e.g., operational, system, technical) to be created for comprehensive system understanding.

Model Strategy

- Develop models with a Purpose to answer questions.
- Identify model architecture that supports system lifecycle and system development capabilities.
- Define model management practices and governance.

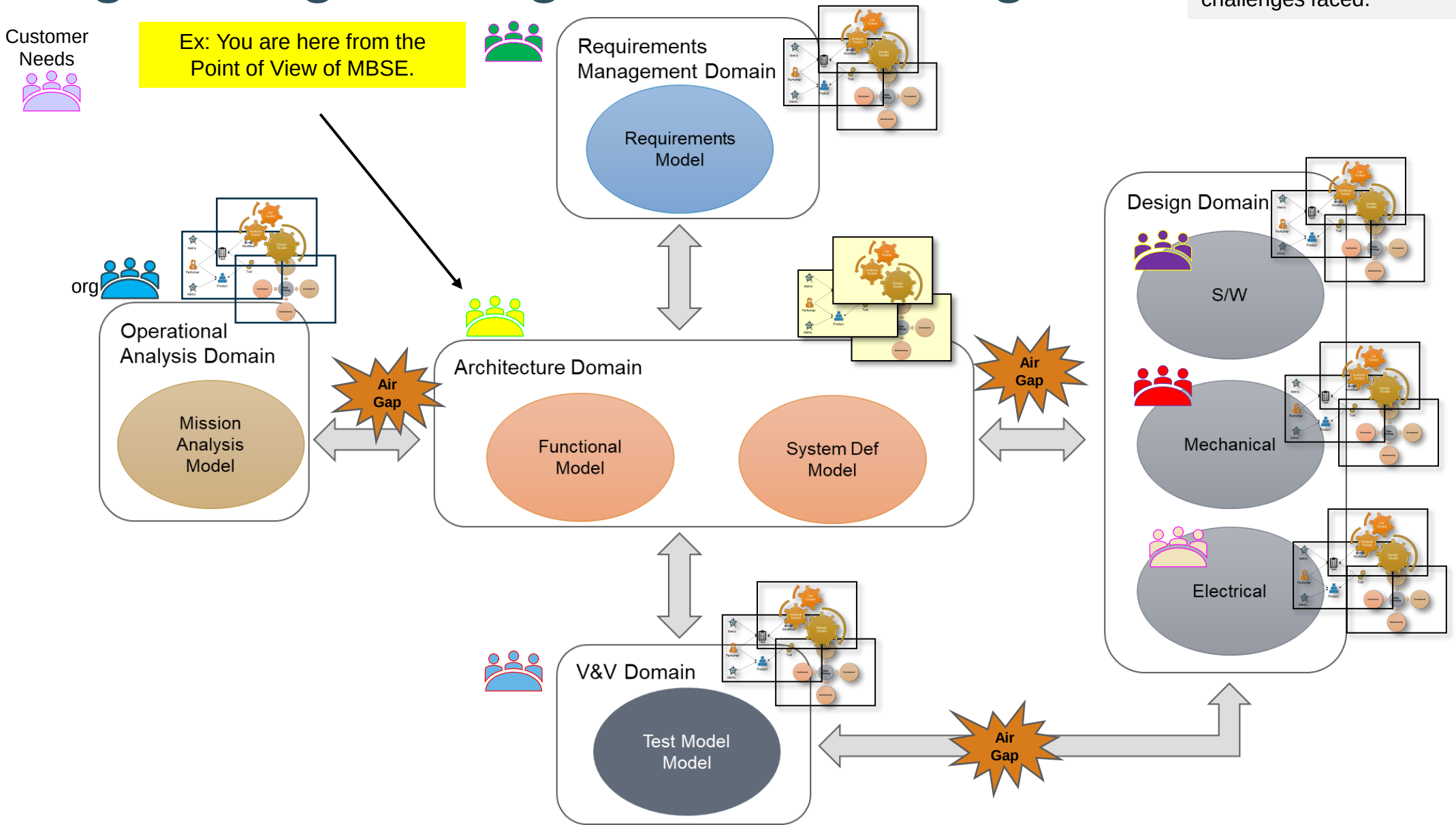
Digital Engineering Ecosystem

- Establish a supporting **MBSE and MBD** Infrastructure and Environment
- Integrate tool tools that support your chosen modeling standards and frameworks.
- Tools that integrate well with other tools and systems in your environment.

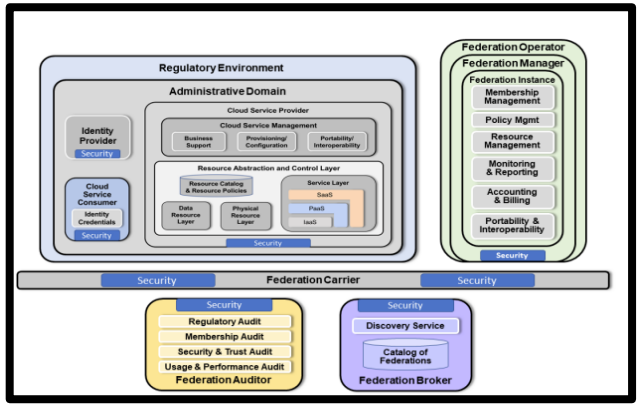
*Not Focus for todays presentation.

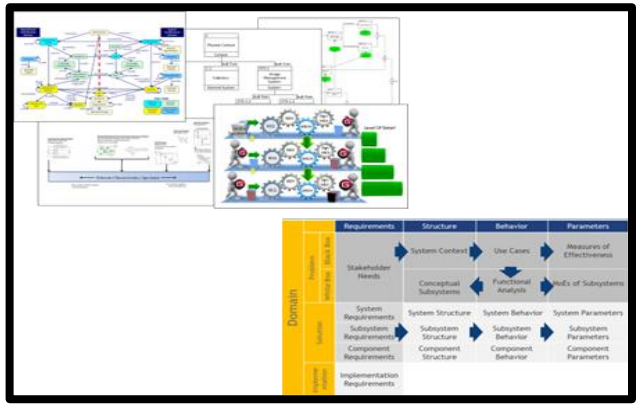
Digital Engineering: MBSE Challenge

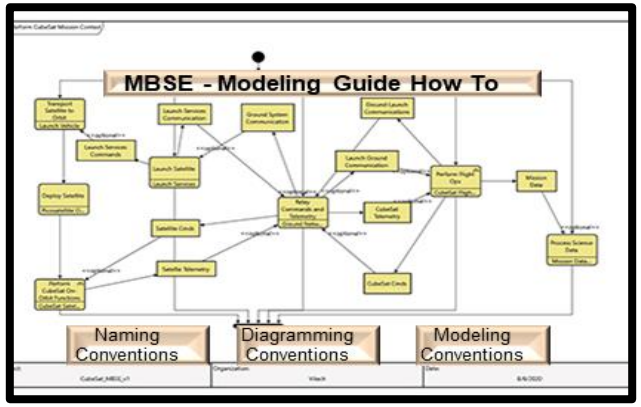
Objective: Can we succinctly identify DE Craftsman Challenges through the Lens perspective of MBSE and what are the challenges faced.



Digital Engineering: MBSE Practice Focus







Reference Architectures

- Provides common information guidance, reusable components and direction specific area.
- Conveys the technical direction to guide and constrain the solution architectures

MBSE Methodology

- Focused on the creation and definition of digital artifacts, relationships and consumable views across the layers of abstraction.
- Define inter and intra layer of abstraction digital artifacts traceability map.
- Define methodology specific validation rules and metrics to assess evolution of the model.

Model Building Practices and Enablers

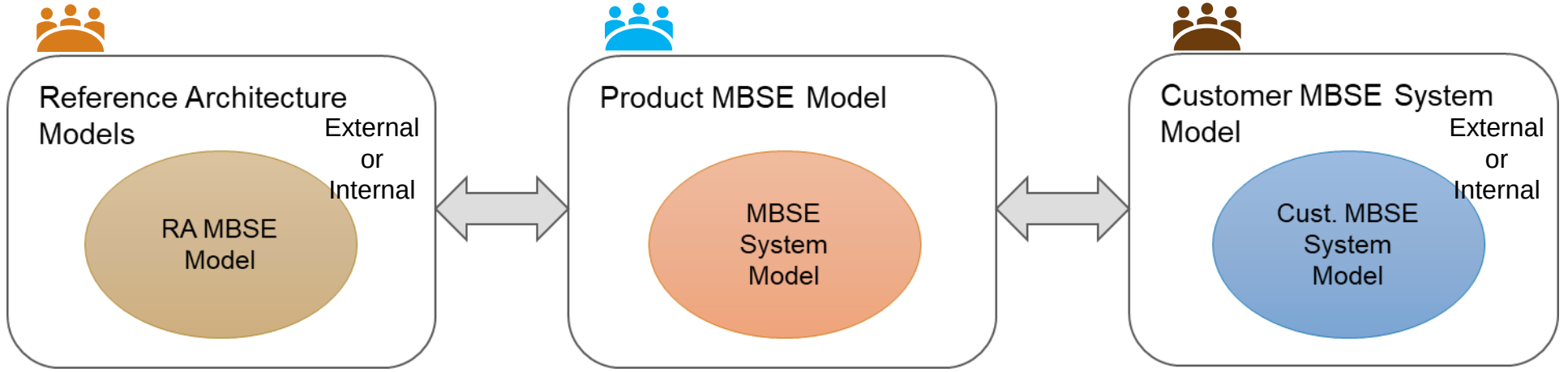
- Enhance clarity, facilitate understanding and communication of MBSE models to stakeholders and team.
- Drive semantic consistency across models/projects.
- Establish a template and validation rules to facilitate standardization.
- Style Guides drive best practices.

Source 1 NIST Cloud Federation Reference Architecture SP 500-332
Source 2.1 Features - MBSE Primer - Zuken Vitech
Source 2.2 Magic Grid Framework
Source 3 Mod-SysML Activities in GENESYS

Digital Engineering: MBSE Practice Challenge – Reference Architecture Driving Knowledge

Reference Architecture: A high-level system design free of implementation details; a strawman architecture for a certain domain.

Context: Provides common information, guidance, requirements, reusable components, and direction specific area. Provides a starting place, includes appropriate standards



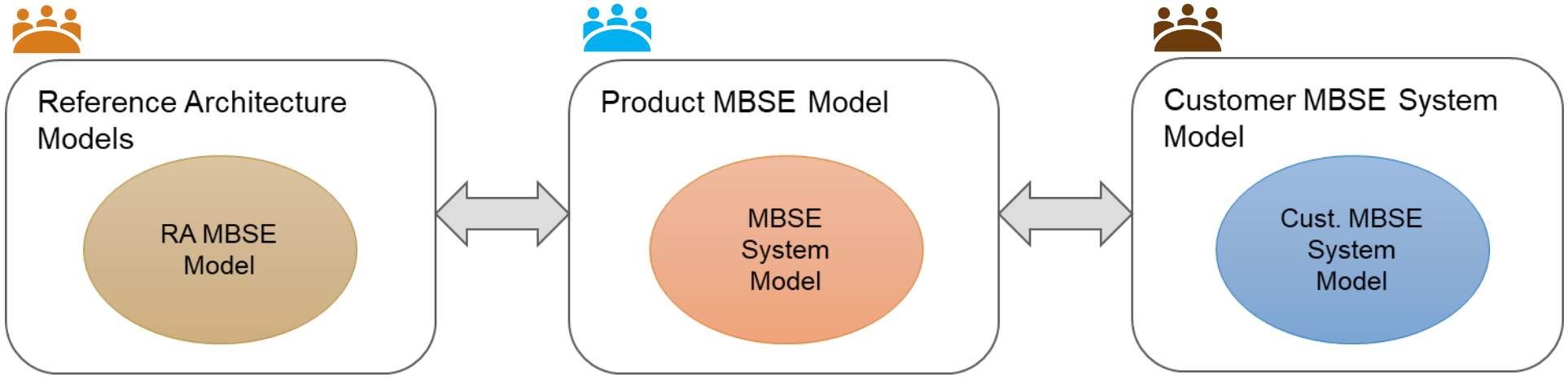
- **Managing Reference Architecture**
  - Dealing with Conflict. Pushing Change to the RA
  - Does the Reference Architecture Changes?
    - How often does it change? And when it changes how fast you need to comply?
- **Reference Architecture Frameworks Profile Management**
  - What specific frameworks and profiles are used to support them.
  - What is the impact of using Reference architecture in your modeling environment?

- **Consumption and Compliance**
  - How do we show compliance to a Reference Architecture? (by trace or attribute or both)
  - How do you consume the Reference Architecture in your model? (a direct vs indirect model usage)

Digital Engineering: MBSE Practice Challenge – Methodology

MBSE Methodology: A Collection of related processes and methods.

Context: Several Methodologies exist like IBM Harmony, CORE, OOSEM, Magic Grid, etc. **Note: Some are Tool dependent, and some are Process dependent.**



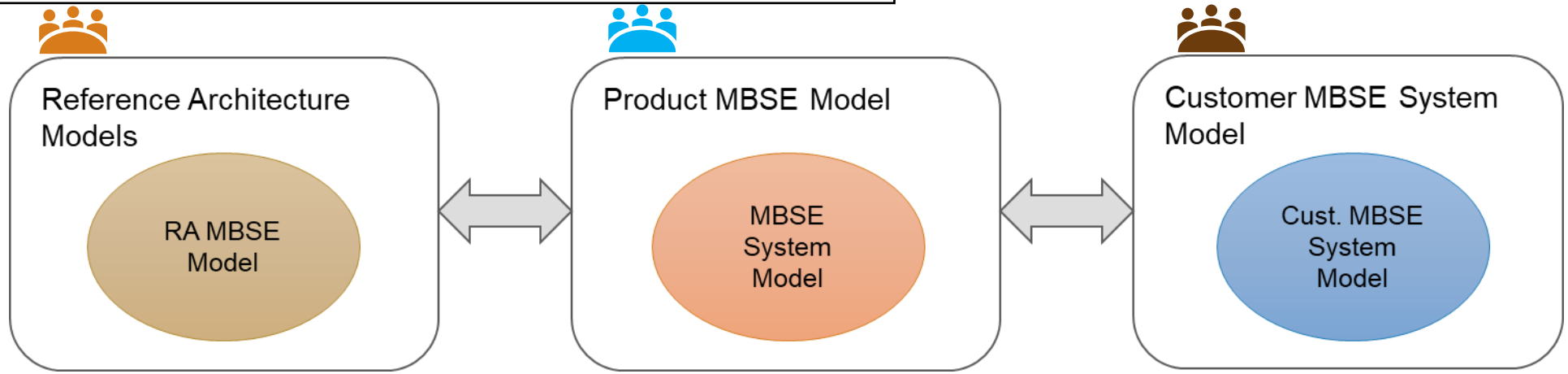
- **Modeling Meta-Model Awareness**
  - What MBSE Methodologies are accepted and supported by external and internal communities?
  - Do we understand the meta-model behind the chosen methodology? From traceability and layers of abstraction definition.
  - Have we tailored the methodology given the program/project needs?

- **Consumable Views and Metrics**
  - What consumable views are necessary to support model development and consumption?
  - What metrics are important to assess the metamodel conformance?
- **Cross Customer/Organization Model Compatibility**
  - Are customers able to consume/integrate your models using your methodology?

Digital Engineering: MBSE Practice Challenge – Modeling Practice and Enablers

Modeling Practice and Enablers: Models can be used to describe product functions, performance structural decomposition and interfaces.

Context: Identifying the Purpose of your Model

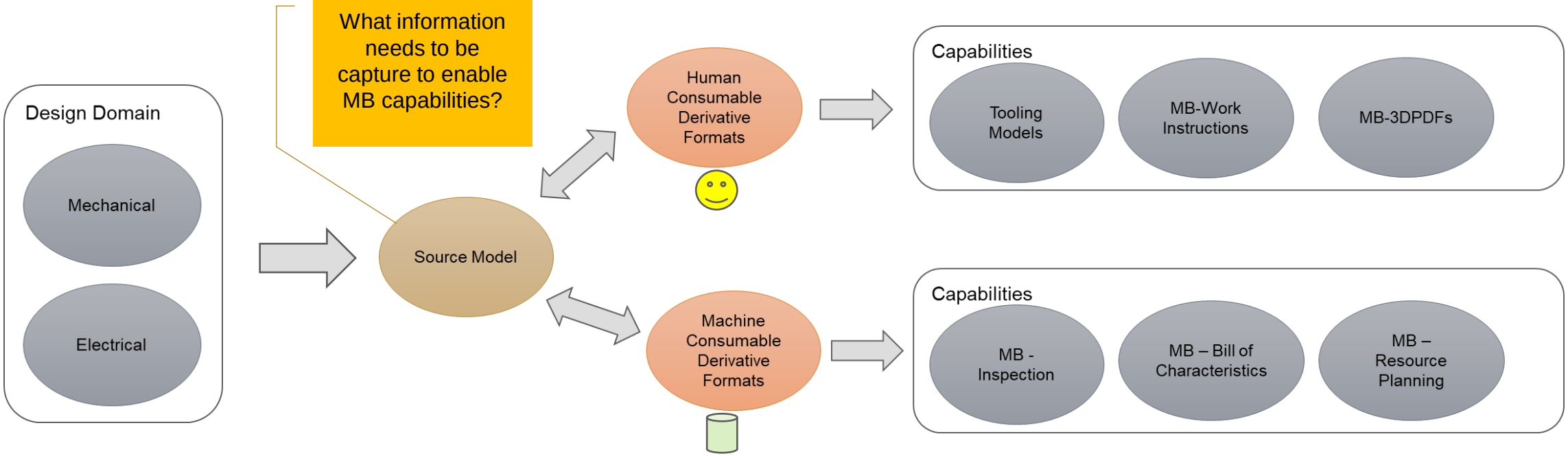


- **Identifying the Purpose**
  - What aspects of the systems technical baseline will be maintained within the model?
  - What engineering decisions can we make from that model? Is this the right model for the question we are trying to answer?
- **Model Configuration Management and Change Management**
  - How do we maintain, and version control the ASOT within our models?
  - How do we perform model reviews?
  - How can we increase understanding of how a proposed change might affect elements?

- **Defining the boundaries between implementation and design**
  - A model can contain a System Technical Baseline, but to what extent?
  - When do we stop between layers of abstraction?
  - When do we decide to model design element vs integrating information from the design domains?
- **Model Coverage and Quality**
  - How do we Perform Requirements Coverage Analysis?
  - How can we achieve Model Quality?

Digital Engineering: MBD and Digital Thread Capability Enablers

Model-based Definition - an approach to creating 3D models so that they effectively contain all the data needed to define a product.



- Quality Information Framework ANSI standard
- QIF addresses interoperability between SW applications in design, manufacturing and quality inspection.

Digital Engineering : Debut Roadmap

Craft a Clear Model Development Plan Strategy

Identify Practice, Enablers and Environments that SCALE with expected Collaboration

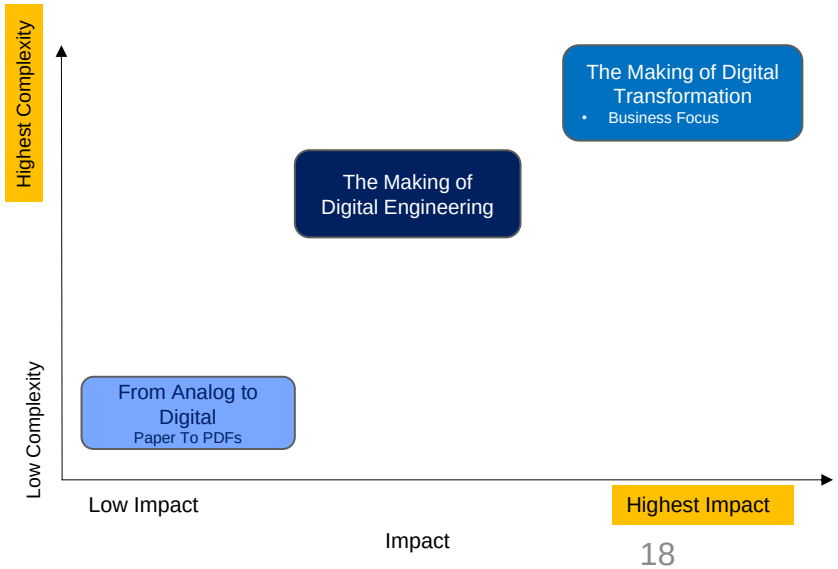
Identify the Level of Digital Engineering Integration appropriate to support Model Architecture and Strategy to connect across Disciplines/Domains

Drive STRONG Adoption by ENHANCING Existing process…if possible

Train Your People

Difference between Generic Training vs This is How We Do It. Provide Tangible Examples.

Implementation



Thank You

References

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- Features - MBSE Primer - Zuken Vitech
- Magic Grid Framework
- Mod-SysML Activities in GENESYS
- Source Cartoon