Architecting the Digital Thread Enabling the Digital Transformation (DTx) of Raytheon Missiles and Defense

Raytheon Missiles and Defense (RMD)
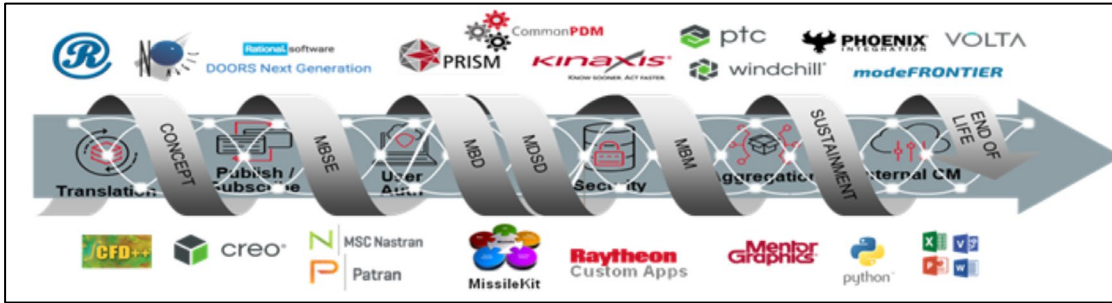
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What does a Digital Ecosystem do, and why architect it?

What is it?

- An ecosystem of digitally connected tools channeling data along a Digital Thread to achieve engineering and business goals.

- Digitally connected data…
  - Frees humans from tedious handling of data
  - Minimizes bottlenecks and delays
  - Minimizes misses due to stale, missing, or wrong data
  - Provides management for the Authoritative Source of Truth
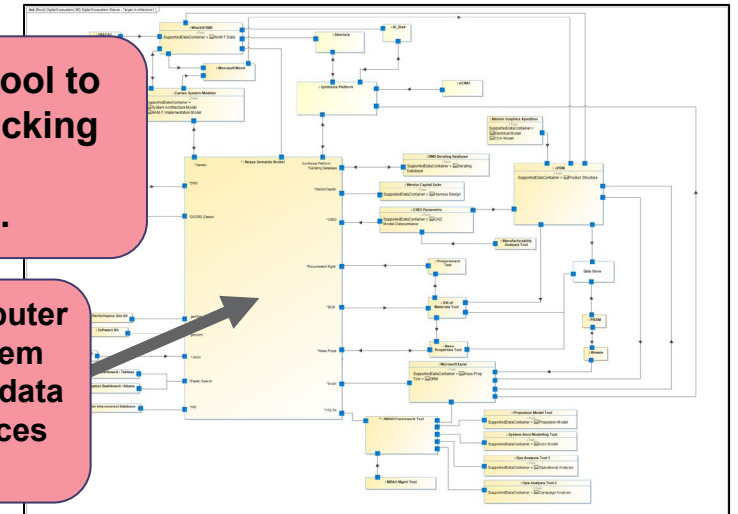
Why architect it?

- Develop exactly the connections needed.

- Focus resources on only required development.

- Ensure that teams can still perform all the tasks they need to do.

- Minimize swirl, go-backs, and re-work.

- Consistent and coherent terminology and ontology.

> Enables the transfer of data from tool to tool (process to process) while tracking the data's *purpose* and *Authoritative Source of Truth*.

> The Nexus Semantic Broker is a computer service in the Nexus Digital Ecosystem which provides for transformation of data elements between the tool namespaces and the Nexus namespace.

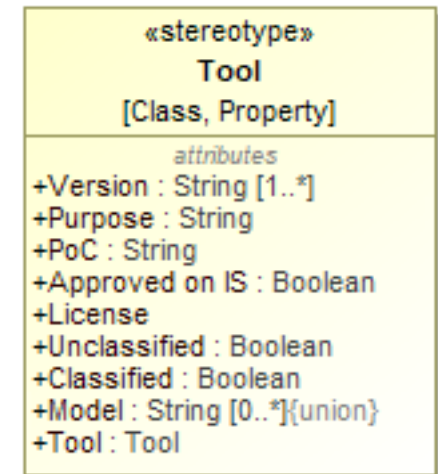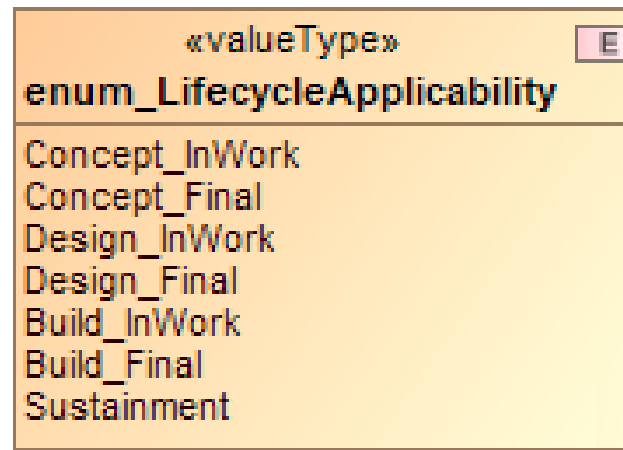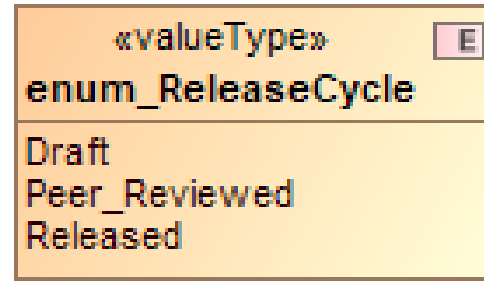**Utilizing Architecture best practices can save time & money.**

What does the architecture need to show?

- Digital Ecosystem Definition
  - Tools in the Digital Ecosystem
  - Tool-to-Tool connections and Tool-to-"semantic broker" connections
    - Network protocols for the data exchange
    - Details of Data exchanged
      - List of data items (not shown here)
      - Tags on Data:
        - Authoritative Source of Truth
        - Author, Tool, Date, Assumptions, Intended Purpose
        - Relationship to other data items
        - Data Usage Details
          - Fidelity, Granularity, Format
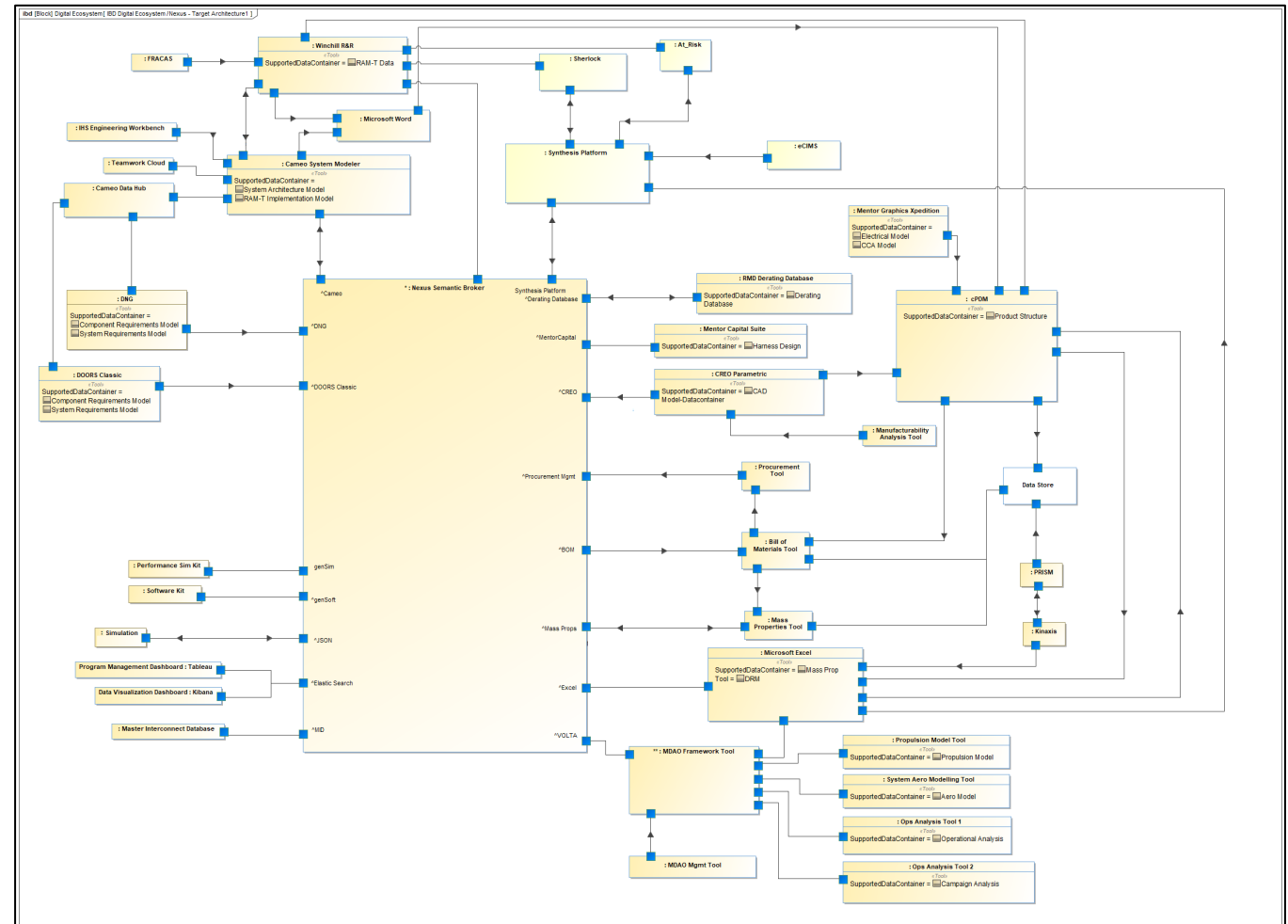
The architecture needs to answer the questions of the Digital Ecosystem developers.

Example Data attributes for Maintaining Knowledge of Authoritative Source of Truth (ASoT)

«stereotype»
DataContainer
[Class]

attributes
+ApprovalAuthority : ApprovalAuthority [1]
+ConfigurationControlTool : Tool [1..*]
+LifeCycleApplicability : enum_LifecycleApplicability
+Purpose : String [1..*]
+Author : String [1..*]
+ReleaseCycle : enum_ReleaseCycle
...

«valueType» E
enum_ReleaseCycle

Draft
Peer_Reviewed
Released

«valueType» E
enum_LifecycleApplicability

Concept_InWork
Concept_Final
Design_InWork
Design_Final
Build_InWork
Build_Final
Sustainment

«stereotype»
Tool
[Class, Property]

attributes
+Version : String [1..*]
+Purpose : String
+PoC : String
+Approved on IS : Boolean
+License
+Unclassified : Boolean
+Classified : Boolean
+Model : String [0..*]{union}
+Tool : Tool

Maintaining the Authoritative Source of Truth for data elements is a critical capability of a Digital Ecosystem

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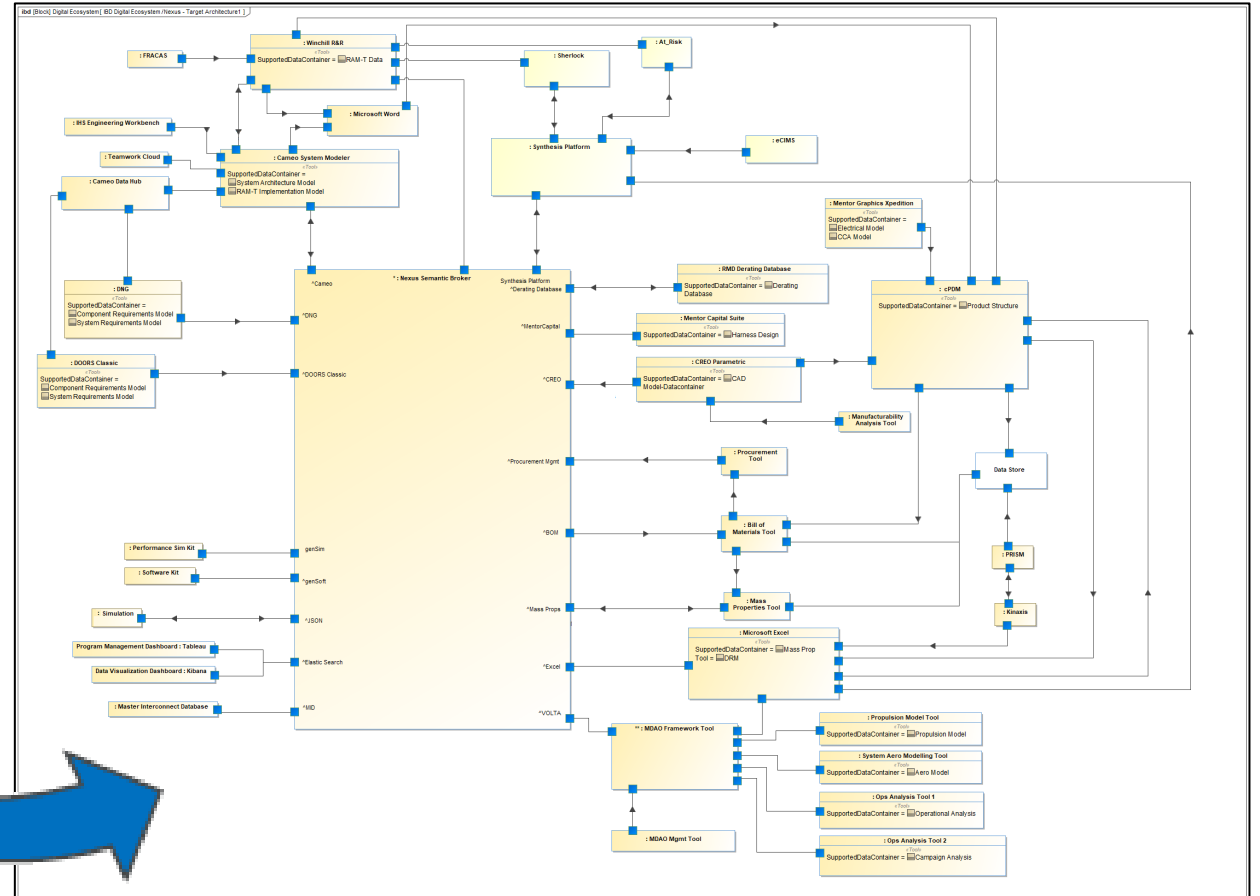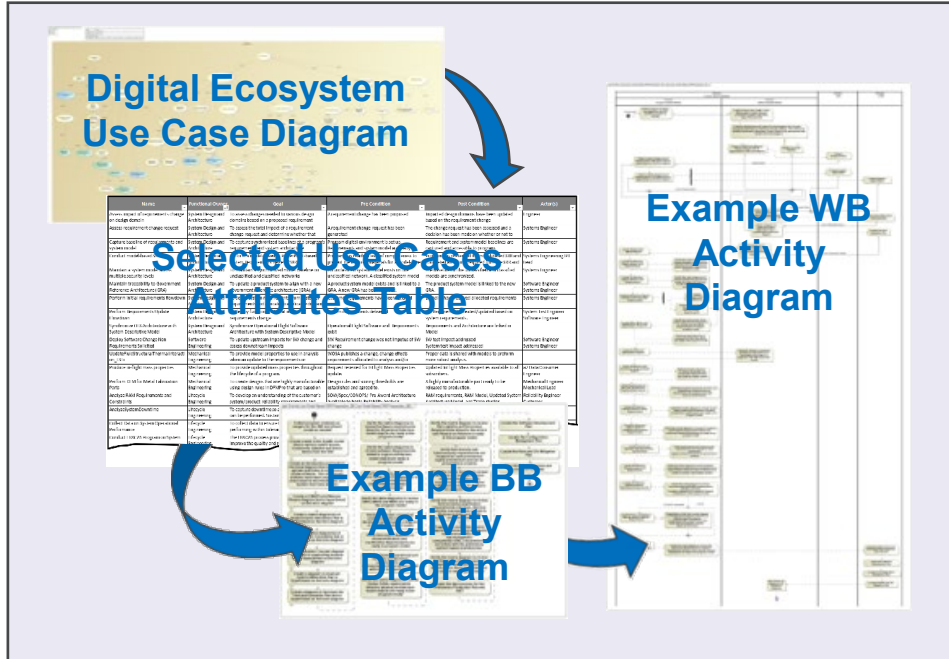# Overview of the DTx Architecture Development Process

- **Identify Use Cases; select Use Cases to develop**
  - Value Stream Mapping can identify Use Cases with the best return on investment.
- **For selected Use Cases, identify Use Case Attributes**
  - Who owns this Use Case? Who performs it? What is the purpose, starting point, end state, etc.?
- **Develop Black Box Activity Diagrams**
  - What are the required steps to perform the Use Case?
- **Develop White Box Activity Diagrams**
  - Which roles and tools are needed to perform the required steps, and how does data flow between the tools?
- **Update the Nexus Internal Block Diagram with new Connections**
- **Support the Deployment!**
  - Update the architecture if new information is discovered.
  - Ensure data can be managed to maintain the Authoritative Source of Truth.
  - Ensure Nexus Ontology supports all the connections.
  - Maintain Transition and Target architectures if needed.

Architect efficiently along a careful process to minimize gaps and misses.

The DTx Architecture Development Process:
Identifying Use Cases and Developing Workflows

- List/Diagram Use Cases

- Pick Use Cases to Develop

- Fill out Attributes
  - **Talk to Subject Matter Experts (SMEs) & Actors**
  - Actors, pre-conditions, post-conditions

- Create a Block Box (BB) activity diagram
  - Identify actions and workflows
  - **Peer review with SMEs & Actors**

- Create a White Box (WB) activity diagram
  - Identify Digital Ecosystem tools
  - Assign actions to swim lanes
  - **Peer review with SMEs & Actors**

Digital Ecosystem Use Case Diagram

Selected Use Cases Attributes Table

Example BB Activity Diagram

Example WB Activity Diagram

Accurate, realistic Architecture requires input from the intended users of the Digital Ecosystem!

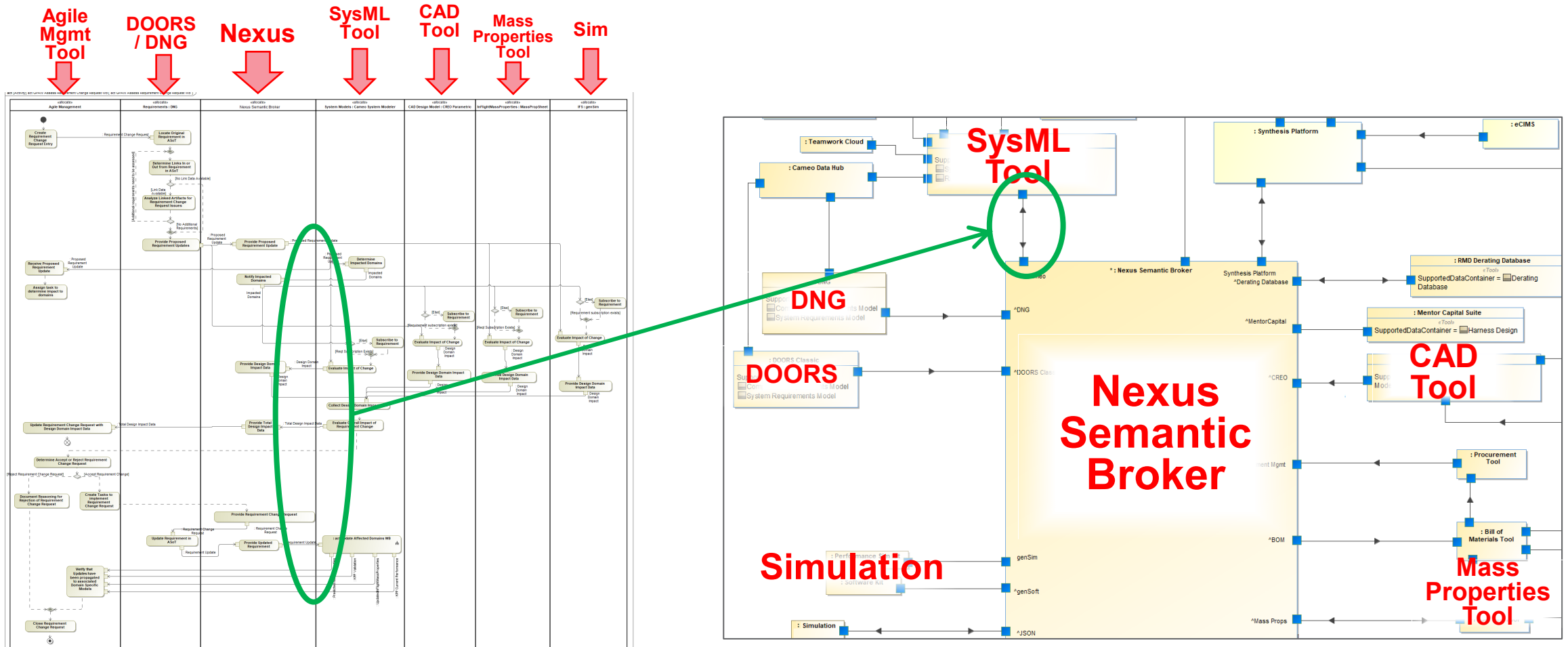# The DTx Architecture Development Process:
Update Connections in the Nexus Internal Block Diagram (IBD)

- White Box Activity diagrams define connections and data transfers of the Digital Ecosystem.

Defining workflows early lets the Digital Ecosystem development team focus on just the connections needed.

The DTx Architecture Development Process
Example: Assessing a Requirement Change Request *(Slide 1 of 4)*

This Use Case defined a need for the Nexus connection to Cameo.

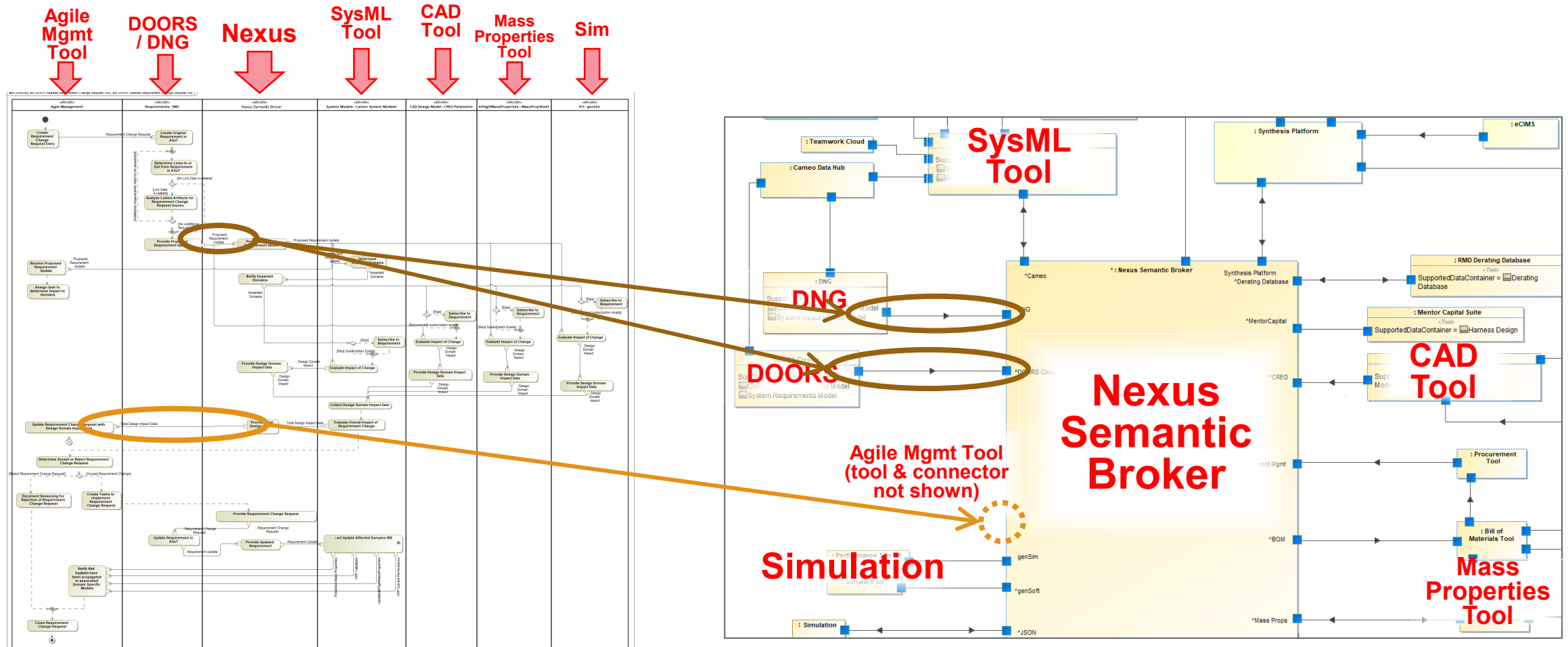# The DTx Architecture Development Process
Example: Assessing a Requirement Change Request (Slide 2 of 4)
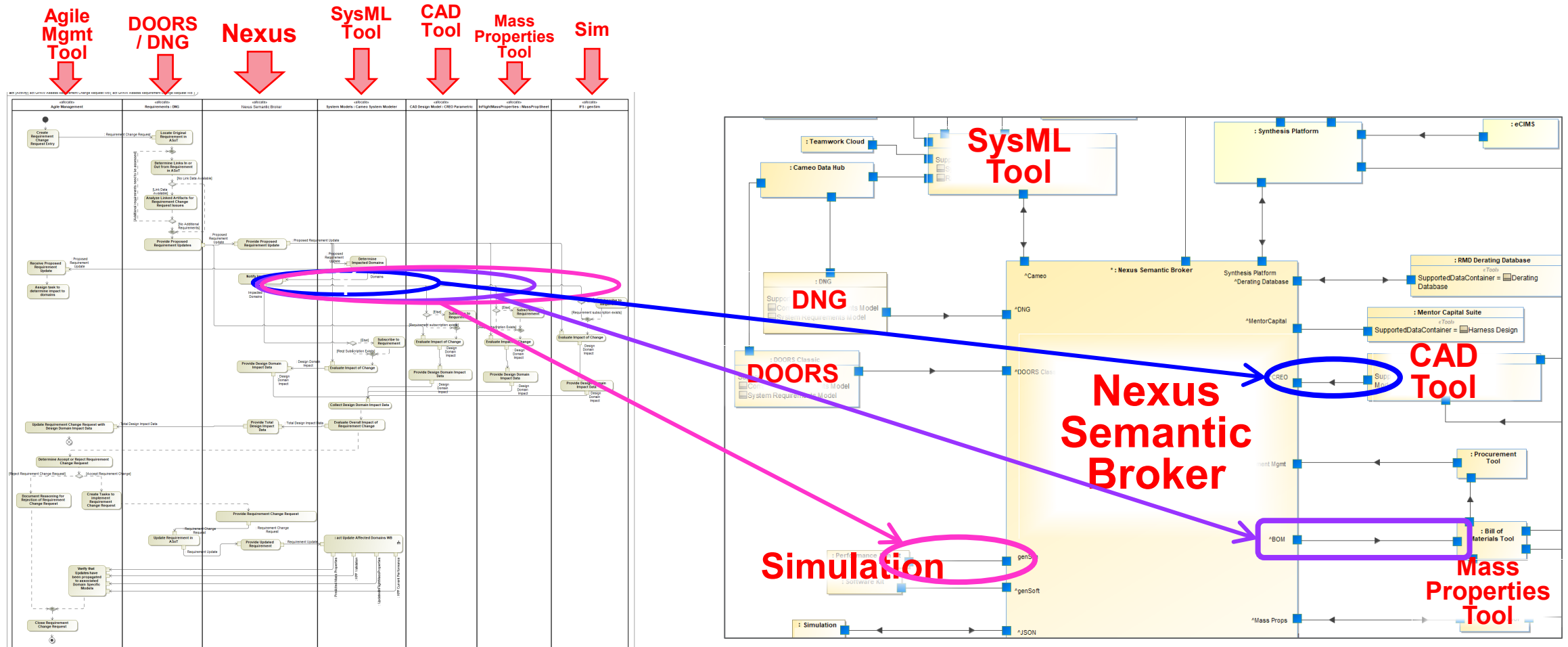
This Use Case defined a need for Nexus connections to Design Tools, Sim, and Mass Properties tool.

This Use Case defined a need for the Nexus connections to DOORS, DOORS Next Generation (DNG), and the Agile Management Tool (not shown).

The DTx Architecture Development Process
Example: Assessing a Requirement Change Request (Slide 4 of 4)
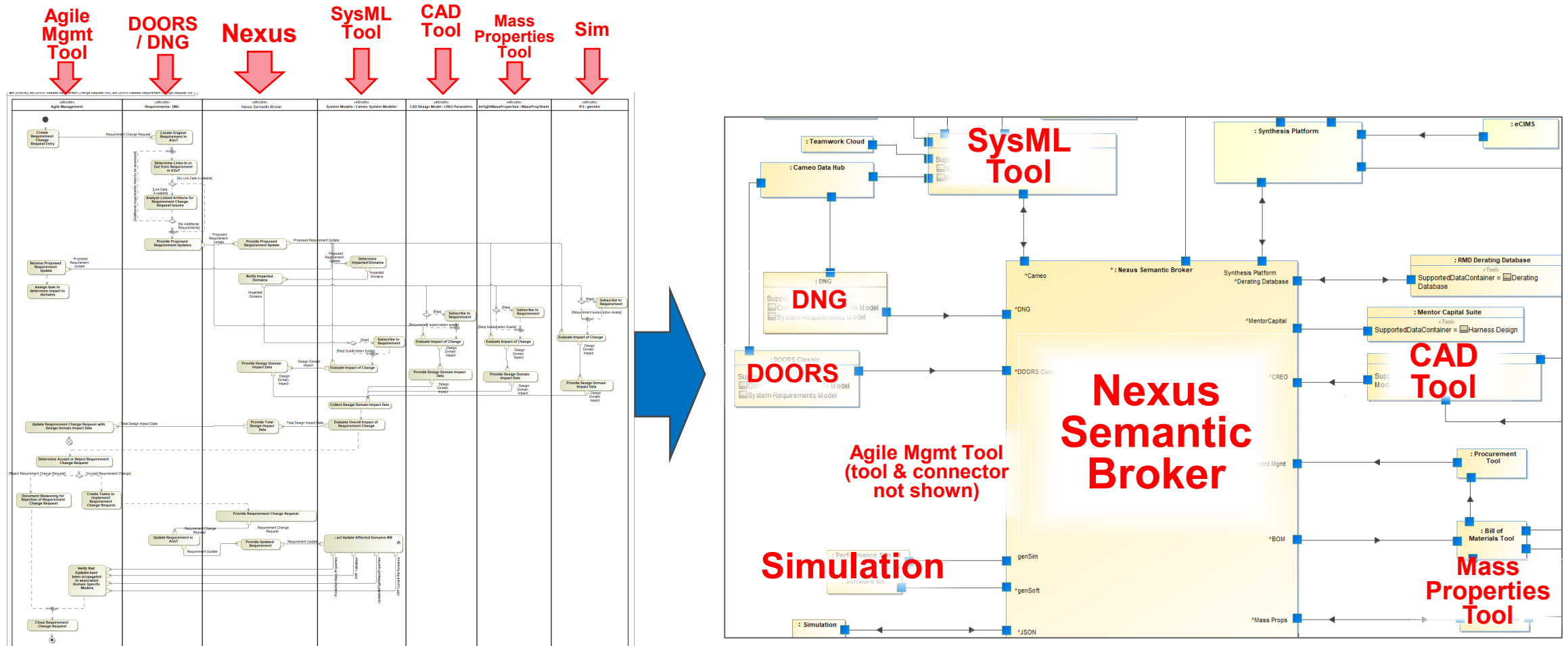
The Nexus architecture is the result of developing many Use Cases to define required connections.

Thank you.

Backup

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Author Information

Presenters:

Tara Trumbull is a Senior Principal Systems Architect with 23 years of experience at Raytheon Missiles and Defense (RMD), and is currently the Architecture Lead for RMD's Digital Transformation (DTx). Her career in systems engineering and architecture has spanned the defense product lifecycle from proposal through production, beginning with parametric analysis, simulations, electro-optical sensor modeling, and algorithms. She now focuses on novel technologies, digital engineering, and system-of-systems architecture. She holds a B.S. in Engineering Physics from U.C. Berkeley and a M.S. in Optical Science from the UofA.

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Abstract

The Raytheon Missiles and Defense (RMD) Digital Transformation (DTx) effort is paving the way to more efficient engineering and business processes by implementing a Raytheon-developed digital thread infrastructure, Nexus, to seamlessly connect applications and processes for numerous workflows. The complex digital ecosystem connected by Nexus incorporates numerous engineering and business tools and interconnectivity to enable the digitally-connected engineering and business workflows of the future. Determining the architecture early and accurately for this complex ecosystem is critical to ensure efficient, seamless development of a useable digital thread. We stress the importance of avoiding architectures which are unavailable until "after-the-fact" or which fail to be informed of real tools and processes; non-ideal architecting can be an unnecessary expense that, worse, can lead to further unnecessary expense.   Given these inherent concerns, we will present our efforts to ensure that our architecture is relevant, realistic, and readily accessible. We will discuss our diagrams and artifacts that communicate the digital ecosystem architecture, how we develop our Digital Ecosystem Architecture Model using SysML in Cameo. We will describe our methodology for illustrating this ambitious architecture including workflows, connections, and internal data flows; how we work with SMEs and our own Digital Transformation teammates, and how architecture fits into the processes that implement and deploy the Nexus digital thread.

Architecture of the Digital Ecosystem facilitates efficient development of this critical capability.

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