Model-Based Quality & Mission Assurance
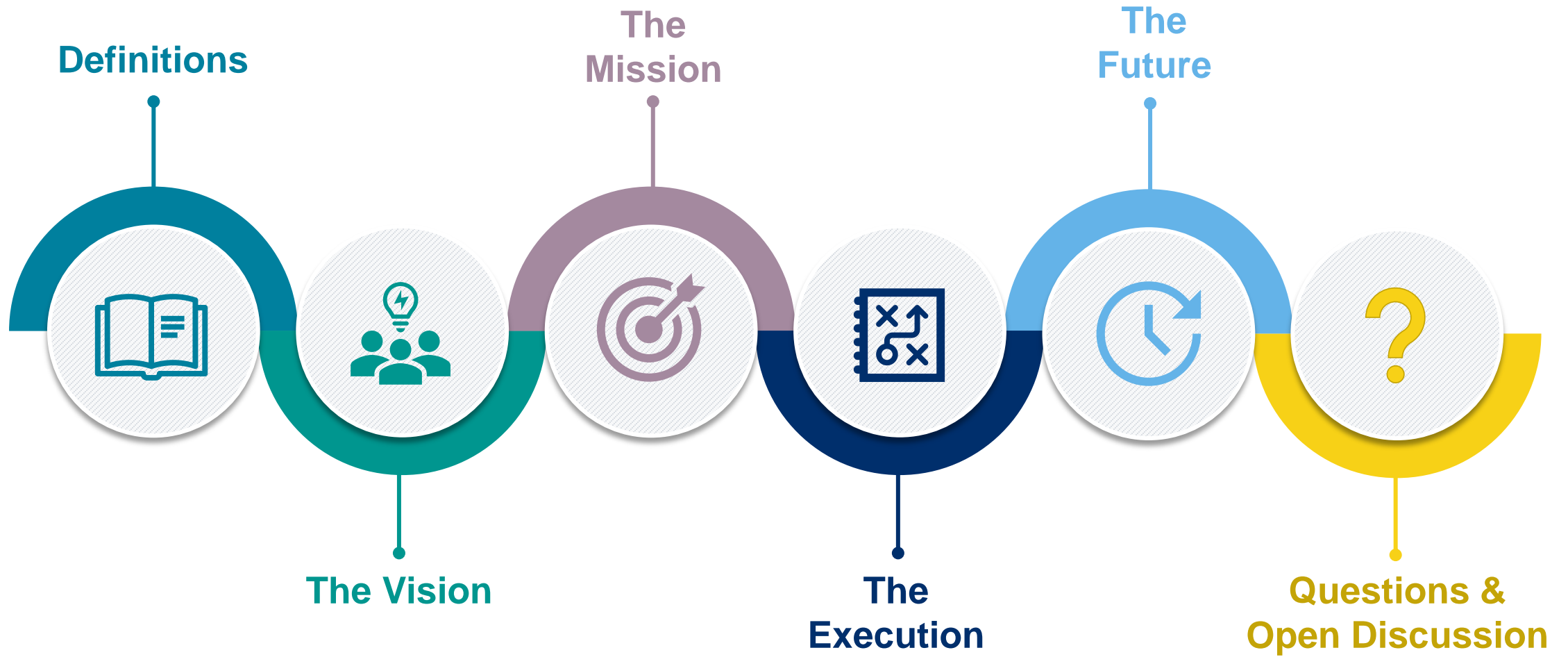
2024 CQSDI Forum Workshop

Disruptive Technologies in Quality

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Topics

Definitions

The Vision

The Mission

The Execution

The Future

Questions &
Open Discussion

Core Contributors

This CQSDI Presentation

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Joint Strategic Quality Council (JSQC) MBQ/MA Working Group Representation

- Department of Defense (DoD)
- Defense Contract Management Agency (DCMA)
- Elbit Systems of America
- Lockheed Martin
- Raytheon Technologies (RTX)
- National Aeronautics & Space Administration (NASA)
- Aerospace Industries Association (AIA)
- Pratt & Whitney
- Northrop Grumman
- University of Maryland

…and others

Definitions

Definitions

Digital thread - John Vickers in a 2010 NASA Roadmap Report wrote, "The connections between the physical version and the digital version include information flows and data that includes physical sensor flows between the physical and virtual objects and environments. The communication connection is referred to as the digital thread."[1]

Digital twin - John Vickers in a 2010 NASA Roadmap Report wrote, "The digital twin concept consists of three distinct parts: the physical object or process and its physical environment, the digital representation of the object or process, and the communication channel between the physical and virtual representations." [1]

Domain Overlay – A collection of constructs needed to support analysis for a domain specific concern using a standardized framework[2]

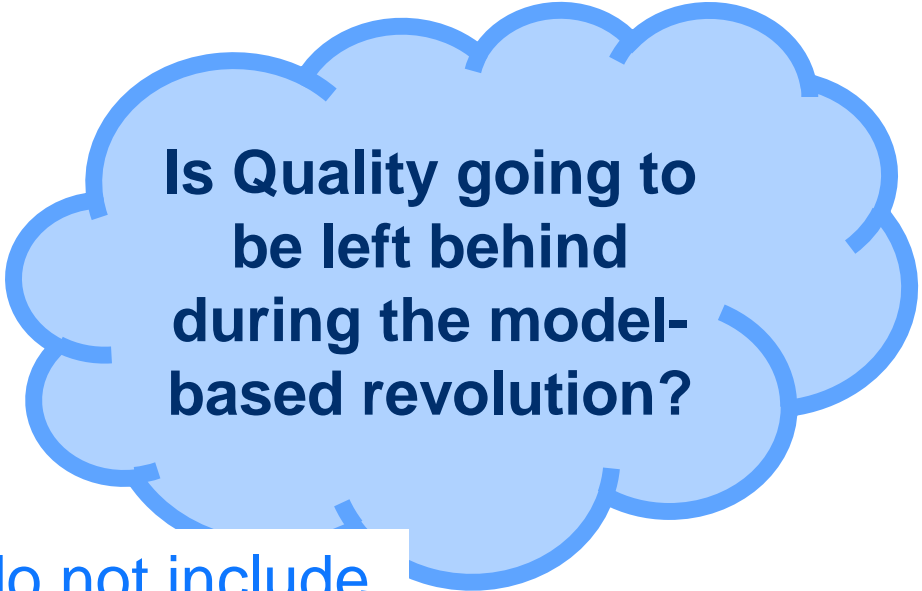**Model** - Digital representation of a product or process (requirements are inherent)

[1] Piascik, R., et al., *Technology Area 12: Materials, Structures, Mechanical Systems, and Manufacturing Road Map*. 2010, NASA Office of Chief Technologist.

[2] Hart,L., Actionable Architecture Using Aspect Modeling, 2018; Hart, L., Anderson, R., OMG UAF Model-based Acquisition Analytic Viewpoint Overlays, 2022; Ongoing work from the Object Management Group (OMG) Model-Based Acquisition (MBAcq) effort

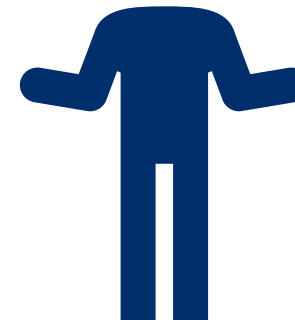# The Vision

Current State of the Industry

Is Quality going to be left behind during the model-based revolution?
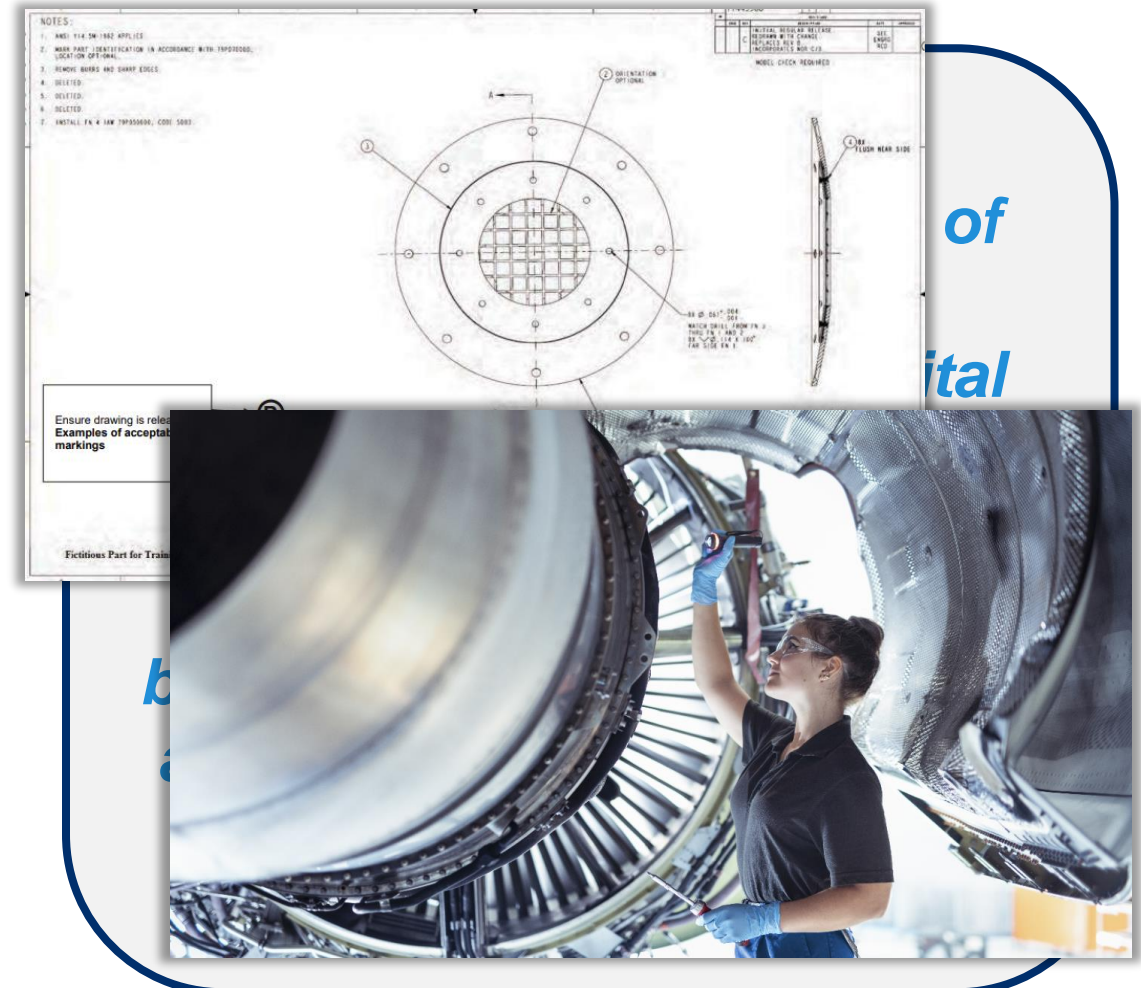
PROBLEM: Digital models do not include integration of standardized quality data throughout the product lifecycle

Integrating quality data

- Reduce the risk burden contributed by variability of quality

- Enable optimization of customer oversight
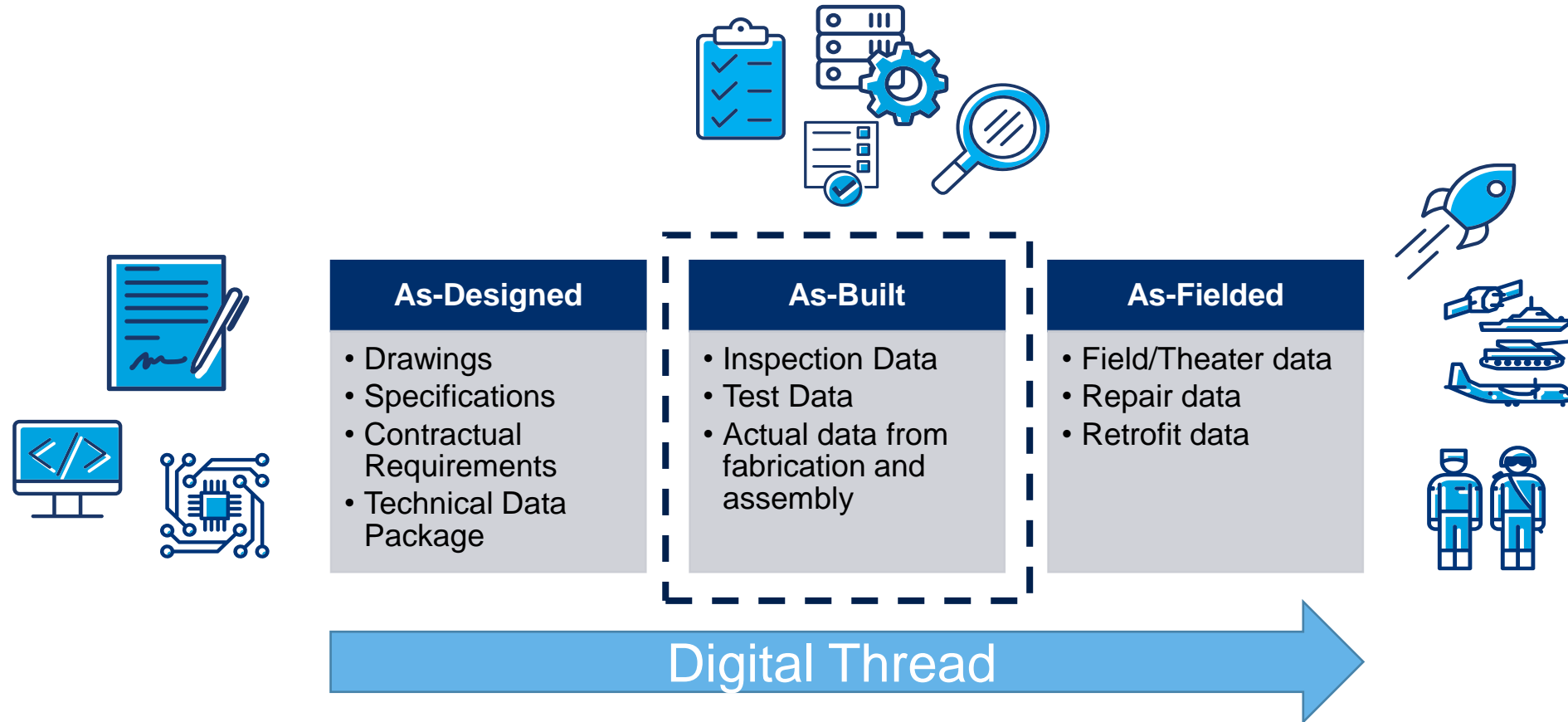
But in order to get **THERE...**

...We have to start **HERE....**
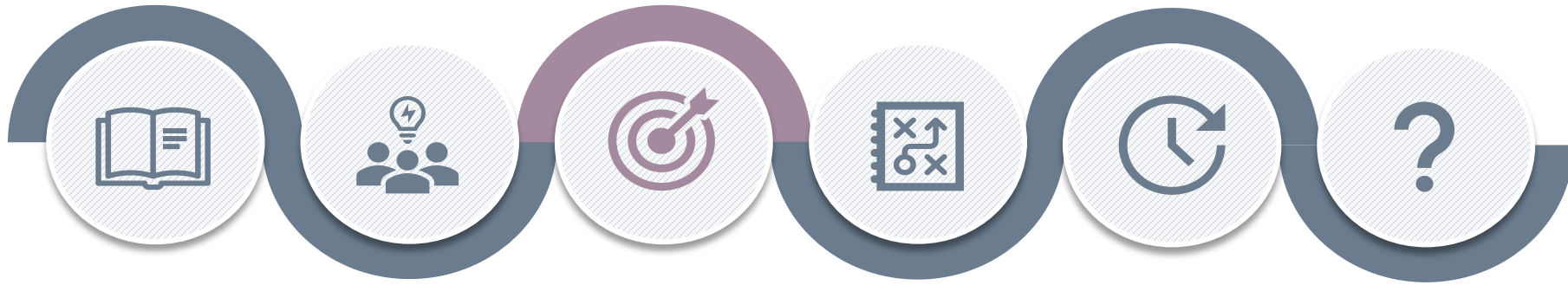
What is "Model-Based Quality"?

Model Based Quality (MBQ)

The application of quality parameters to the digital model(s) throughout the product and process lifecycle

Sources of Truth & the Digital Thread

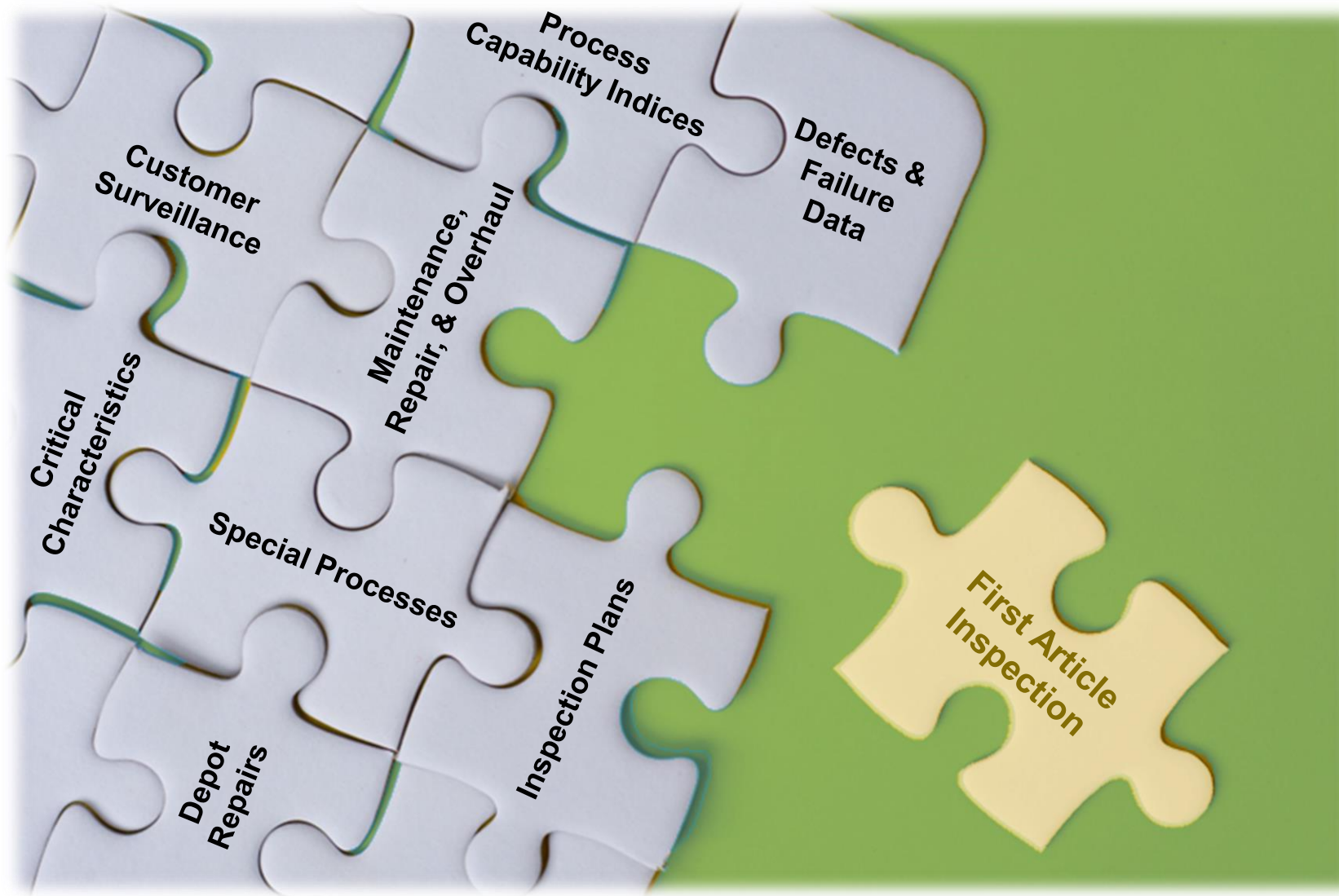| As-Designed	As-Built	As-Fielded
• Drawings • Specifications • Contractual Requirements • Technical Data Package	• Inspection Data • Test Data • Actual data from fabrication and assembly	• Field/Theater data • Repair data • Retrofit data

Digital Thread →

The digital thread weaves the data of all models together into one unified picture

The Mission

What are we doing?

The JSQC team chose to focus on one aspect of quality in the digital thread, and selected **First Article Inspection** (FAI) as the pilot

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The Execution

First Article Inspections (FAIs)

- FAIs are traditionally required per Contract Line Item Numbers (CLINs) or per company policy or customer flow downs

- FAIs are usually documented in accordance with AS9102 and then reviewed by the purchasing organization

    - Form 1, 2, & 3

    - Supporting documents (CoC's, test reports, etc.)

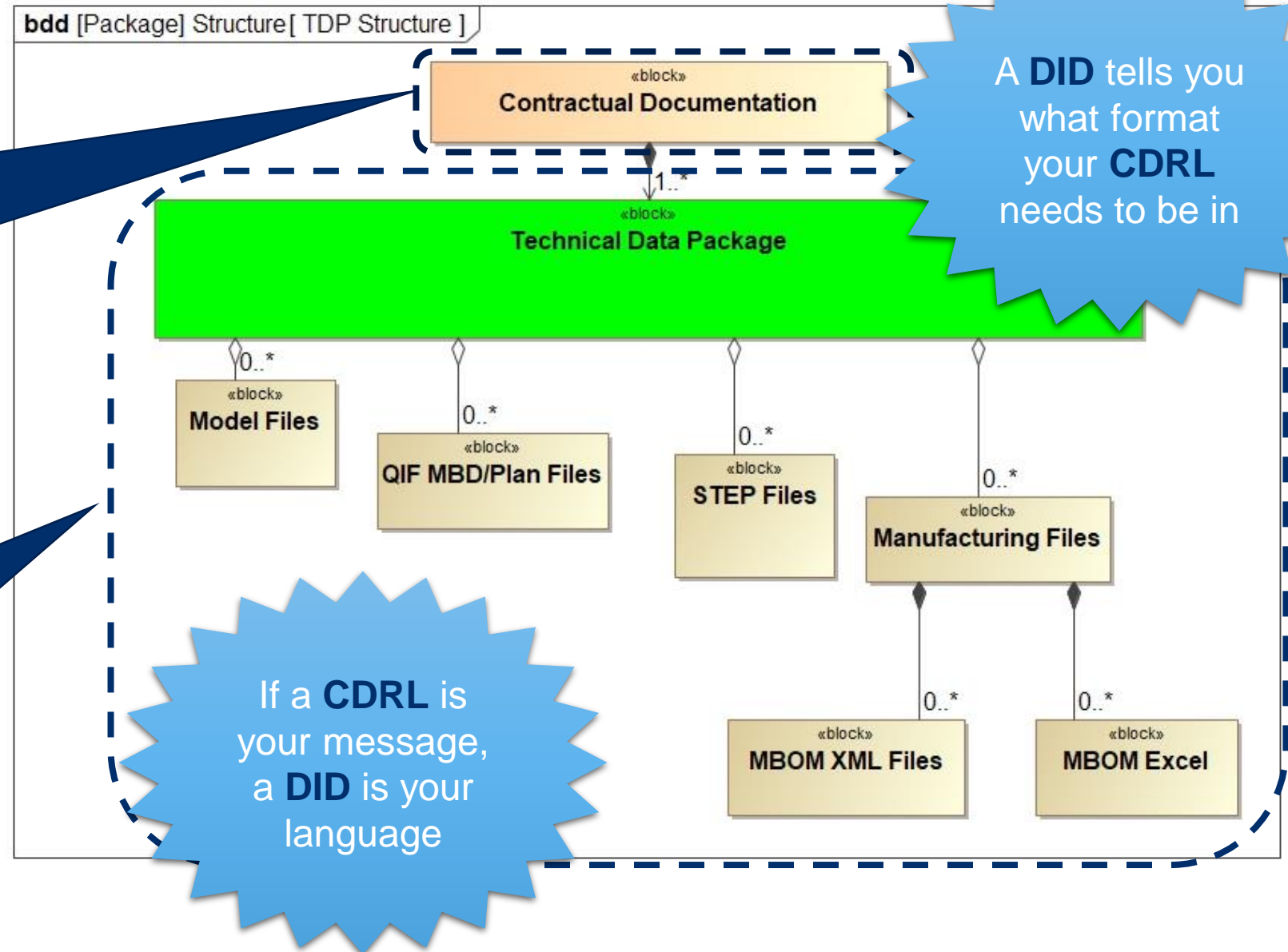**How do you integrate all of the FAI data sources with the digital thread?**
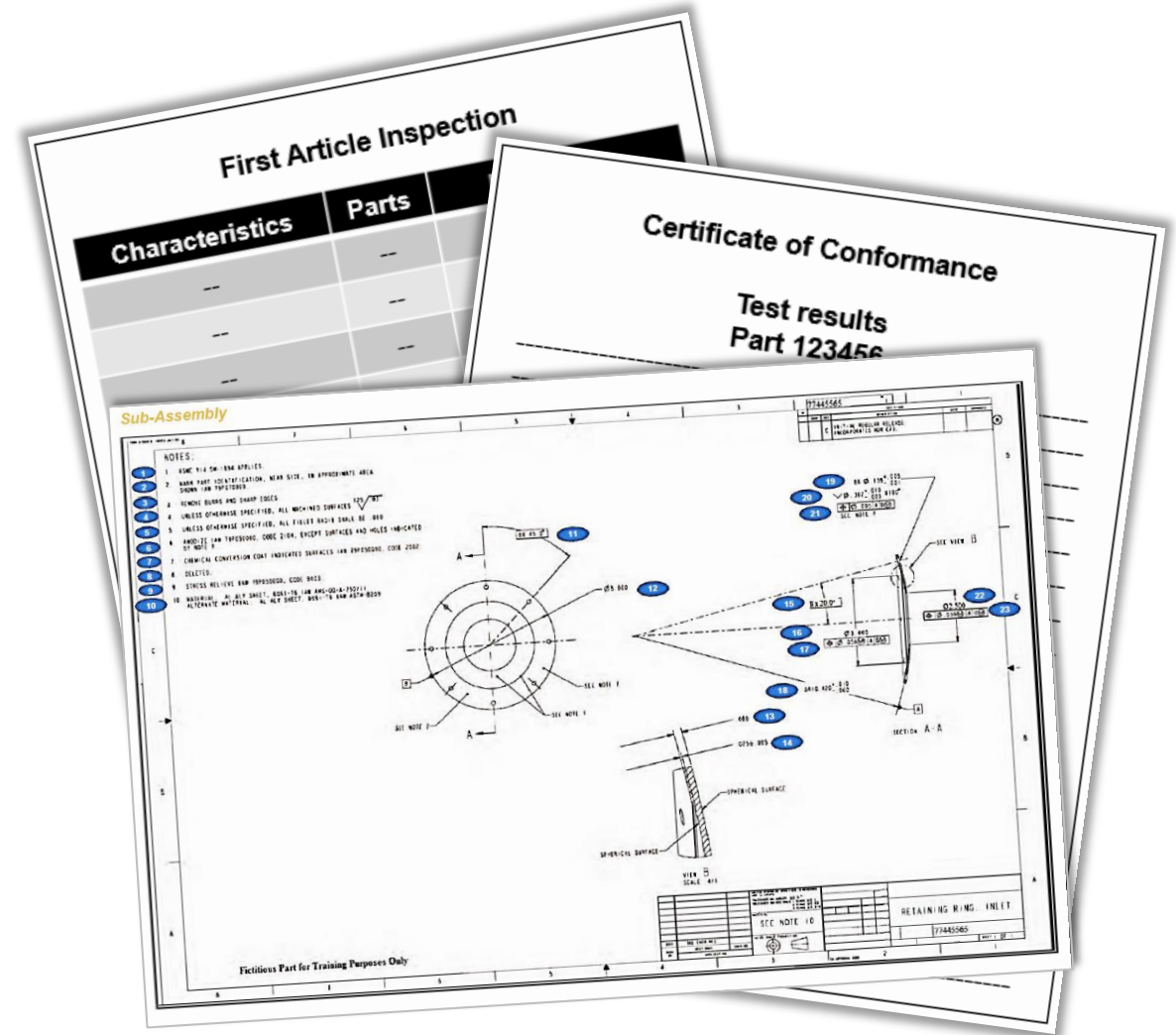
First, you need to digitize your technical data package….

FAI Inputs

Your **Contractual Documentation** is what you are required to submit to your customer, often in the form of **Contractual Data Requirement Lists (CDRLs)** governed by **Data Item Descriptions (DIDs)**

Your **Technical Data Package (TDP)** encompasses all of the requirements that go into your part or assembly. This establishes the baseline that your FAI results will be compared against

bdd [Package] Structure[TDP Structure]

«block»
Contractual Documentation

«block»
Technical Data Package

«block»
Model Files

«block»
QIF MBD/Plan Files

«block»
STEP Files

«block»
Manufacturing Files

«block»
MBOM XML Files

«block»
MBOM Excel

A **DID** tells you what format your **CDRL** needs to be in

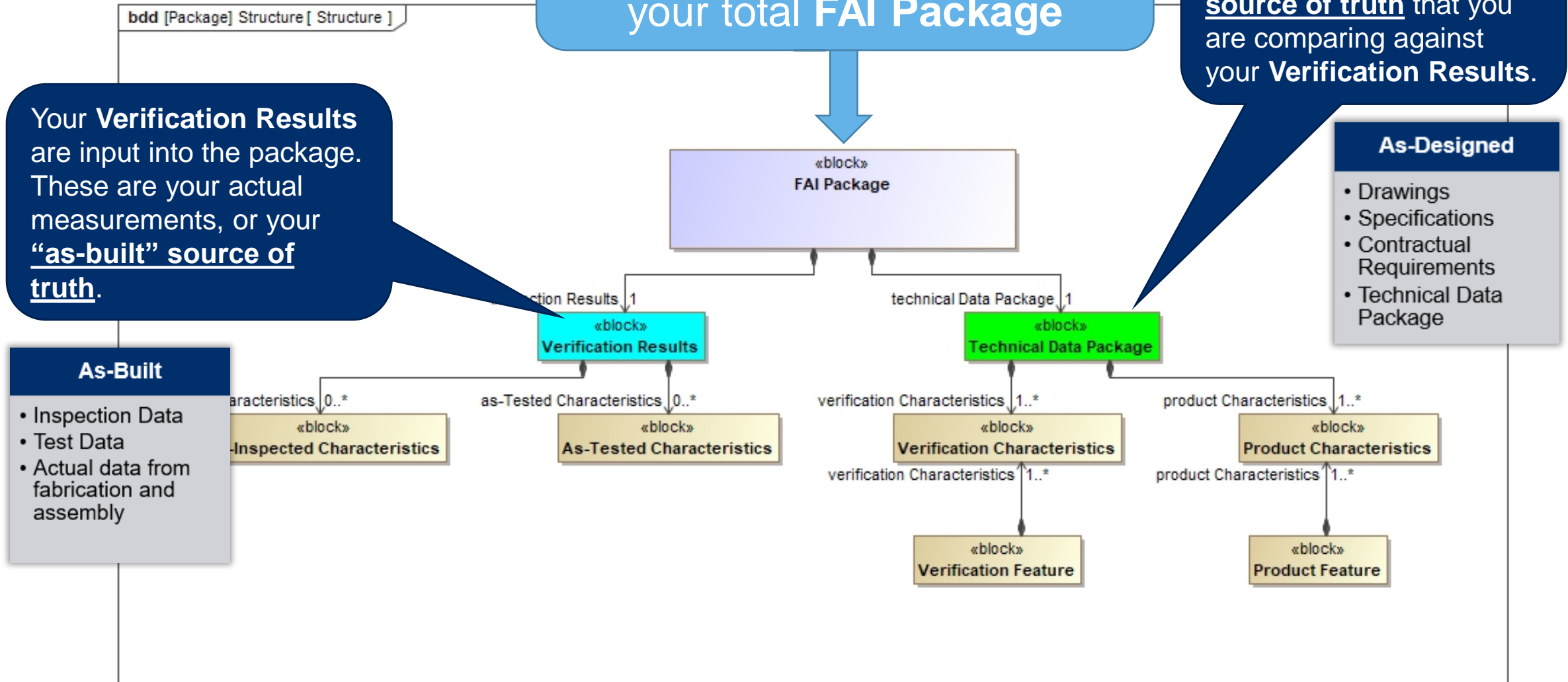If a **CDRL** is your message, a **DID** is your language

FAI Package

Together, your **TDP** and **Verification Results** become your total **FAI Package**

The **TDP** is now one half of the whole FAI. This is your **"as-designed" source of truth** that you are comparing against your **Verification Results**.

Your **Verification Results** are input into the package. These are your actual measurements, or your **"as-built" source of truth**.

bdd [Package] Structure [Structure]

«block»
FAI Package

ction Results 1

«block»
Verification Results

technical Data Package 1

«block»
Technical Data Package

As-Designed
- Drawings
- Specifications
- Contractual Requirements
- Technical Data Package

As-Built
- Inspection Data
- Test Data
- Actual data from fabrication and assembly

aracteristics 0..*

«block»
-Inspected Characteristics

as-Tested Characteristics 0..*

«block»
As-Tested Characteristics

verification Characteristics 1..*

«block»
Verification Characteristics

product Characteristics 1..*

«block»
Product Characteristics

verification Characteristics 1..*

«block»
Verification Feature

product Characteristics 1..*

«block»
Product Feature
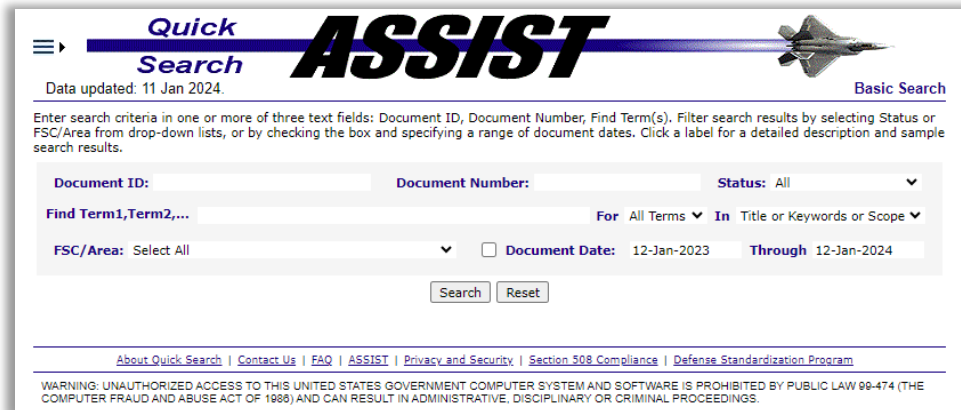
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FAI SysML Profile

- Developed SysML Profile to capture FAI Data Elements in a System Architecture Model

- Applied FAI Stereotype to the block that represents the physical component that is performing a First Article Inspection

- Populated model elements with data elements per Contractual Requirement

  - Part Number Details

  - Product Details – Materials, Special Processes, and Function Testing

  - Characteristic Traceability, Verification, and Tolerance Evaluation

SysML is the language of "talking about systems"
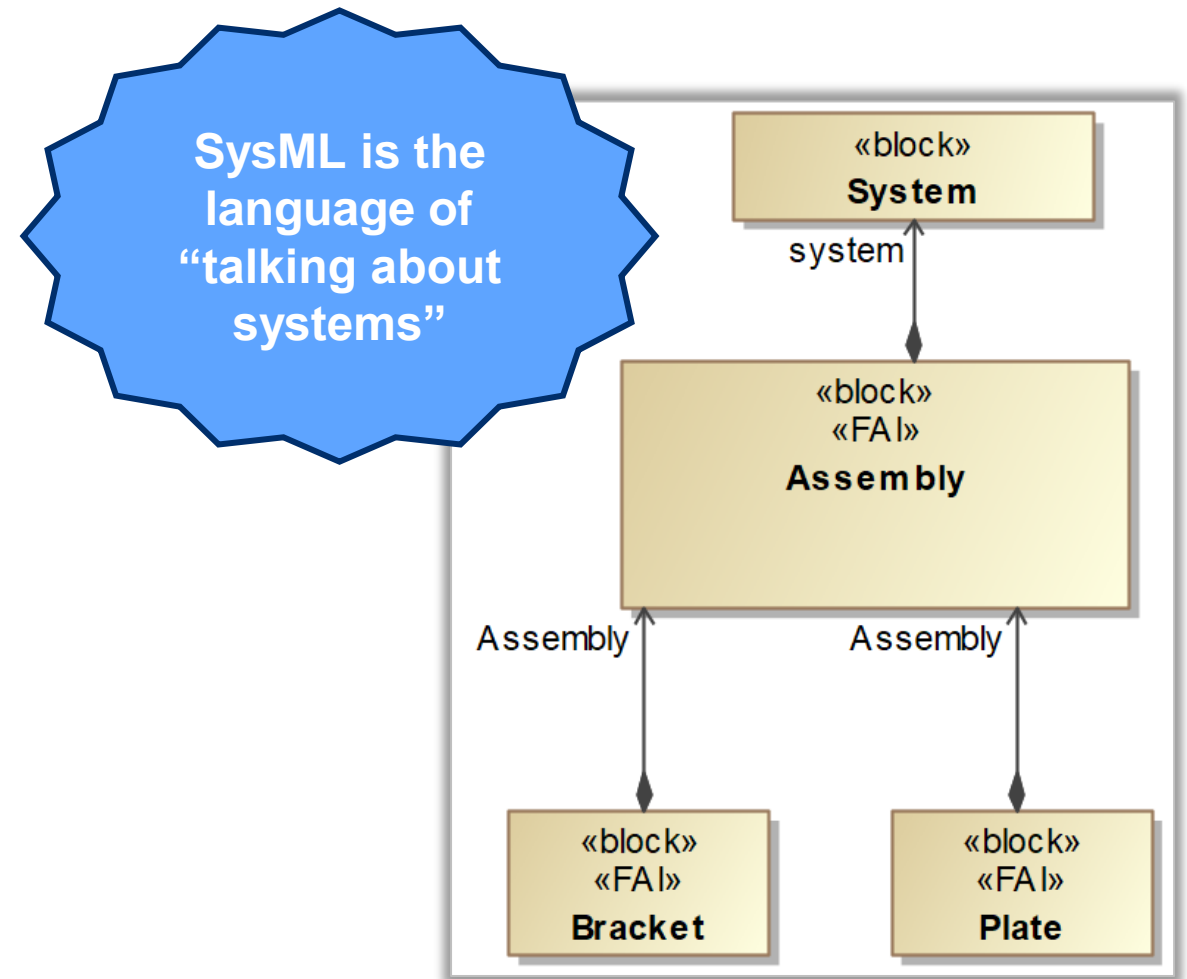
**SysML Profile allows for the capture of FAI data into Digital Thread**

The Execution

- The JSQC's Model-Based Quality & Mission Assurance working group is drafting a Data Item Description (DID) document

- Goal of the DID is to require contractors to submit FAI data via a CDRL in the standardized DID-defined model format

- Plan is to get this DID on a pilot contract by FY'25

DLA DID Repository: https://quicksearch.dla.mil/qsSearch.aspx

The DID will be structured to allow for integration into the Object Management Group (OMG) Model-Based Acquisition (MBAcq.) efforts as a Domain Overlay
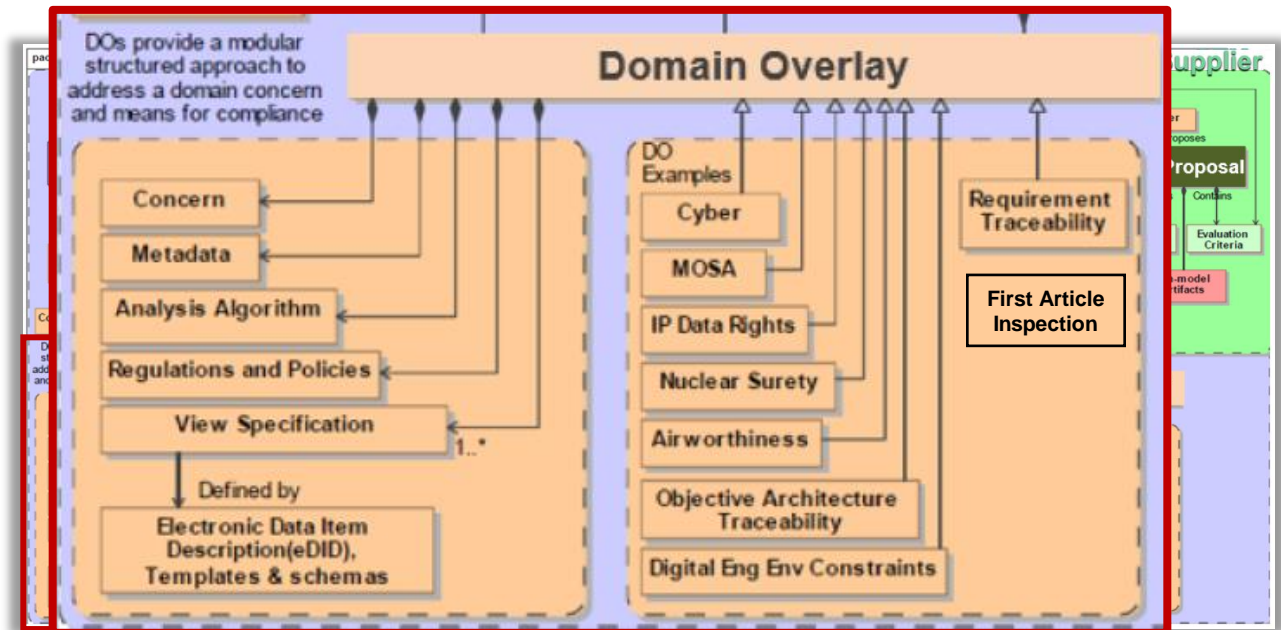
Ongoing work from the Object Management Group (OMG) Model-Based Acquisition (MBAcq.) effort

The Future

The Future

How does this fit in to the current contract framework?

Contractors will be required by contract to submit FAI data in the DID-defined model format. The plan is to get this on a pilot contract by FY'25. These efforts will support Model-Based Acquisition.
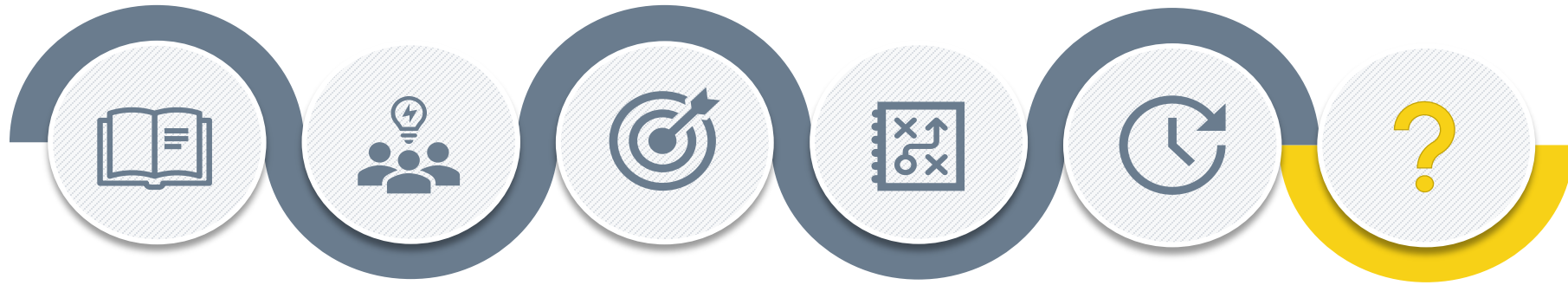
What does this mean for the future?

Long term this FAI data will be just one small data parameter fed into the digital thread, allowing for more accurate digital twins and AI-based decision making.
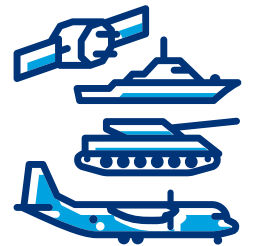
What does this mean for a Quality Professional?

Quality Professionals will become familiar and comfortable with reporting data in a machine-readable model-based format. Quality Professionals will eventually be removed from the FAI process almost entirely and will instead be able to direct their energies towards proactive quality initiatives such as identifying what product characteristics should receive verification.

Questions & Open Discussion