# RAMS 2023 Advisory Board

## Integrating R&M throughout the Digital Engineering Ecosystem

R. Chris DeLuca
Director Specialty Engineering
Systems Engineering and Architecture
Office of the Under Secretary of Defense
   for Research and Engineering
January 25, 2023

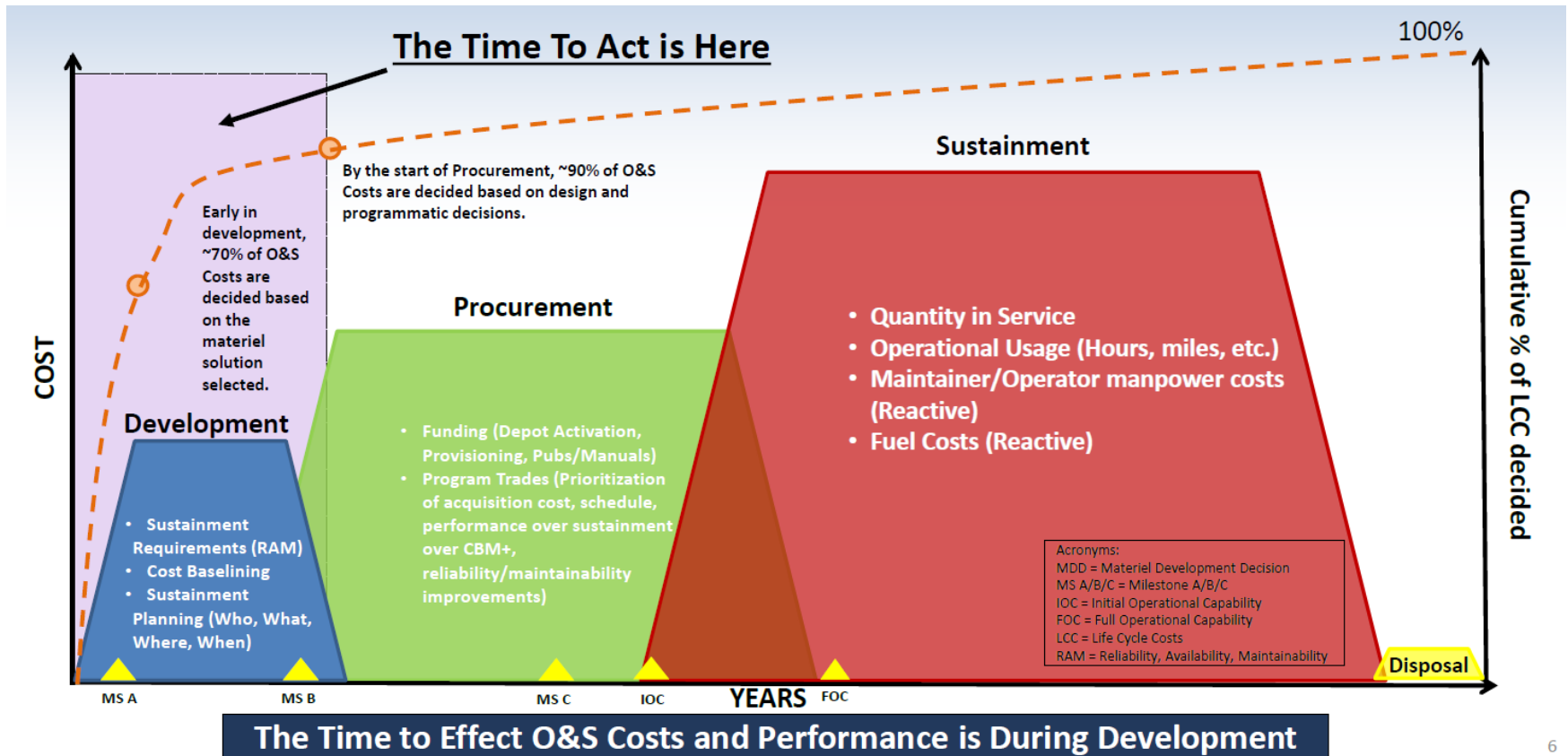# Digital Engineering Strategy

**Describes an integrated digital approach that uses authoritative sources of systems' data and models as a continuum across disciplines <u>to support life cycle activities</u> from concept through disposal**



Source: DoD Digital Engineering Strategy, June 2018

# DE Leverages Data for Better Outcomes



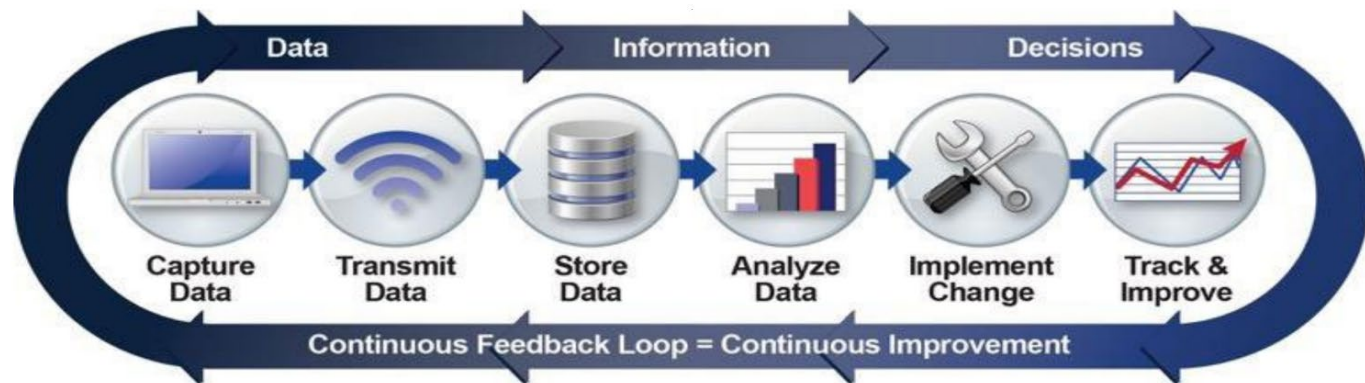Source: 2022 PSM Workshop, Principal Deputy Assistant Secretary of Defense (Sustainment)

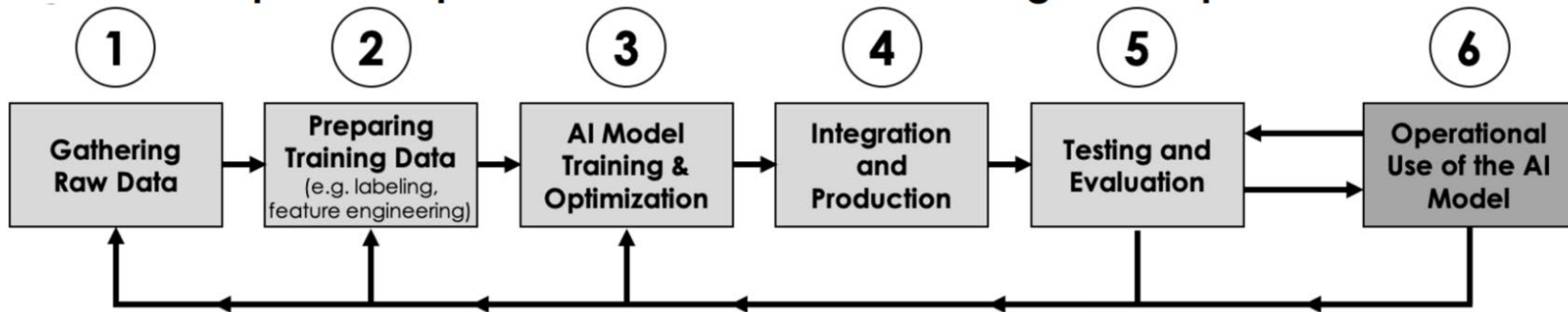# Condition Based Maintenance Plus (CBM+)



Photo By: R. Nial Bradshaw
"Face of Defense: Youngest Maintainer Launches Youngest Jet at Red Flag", February 22, 2017



Source: The Office of the Under Secretary of Defense for Acquisition and Sustainment
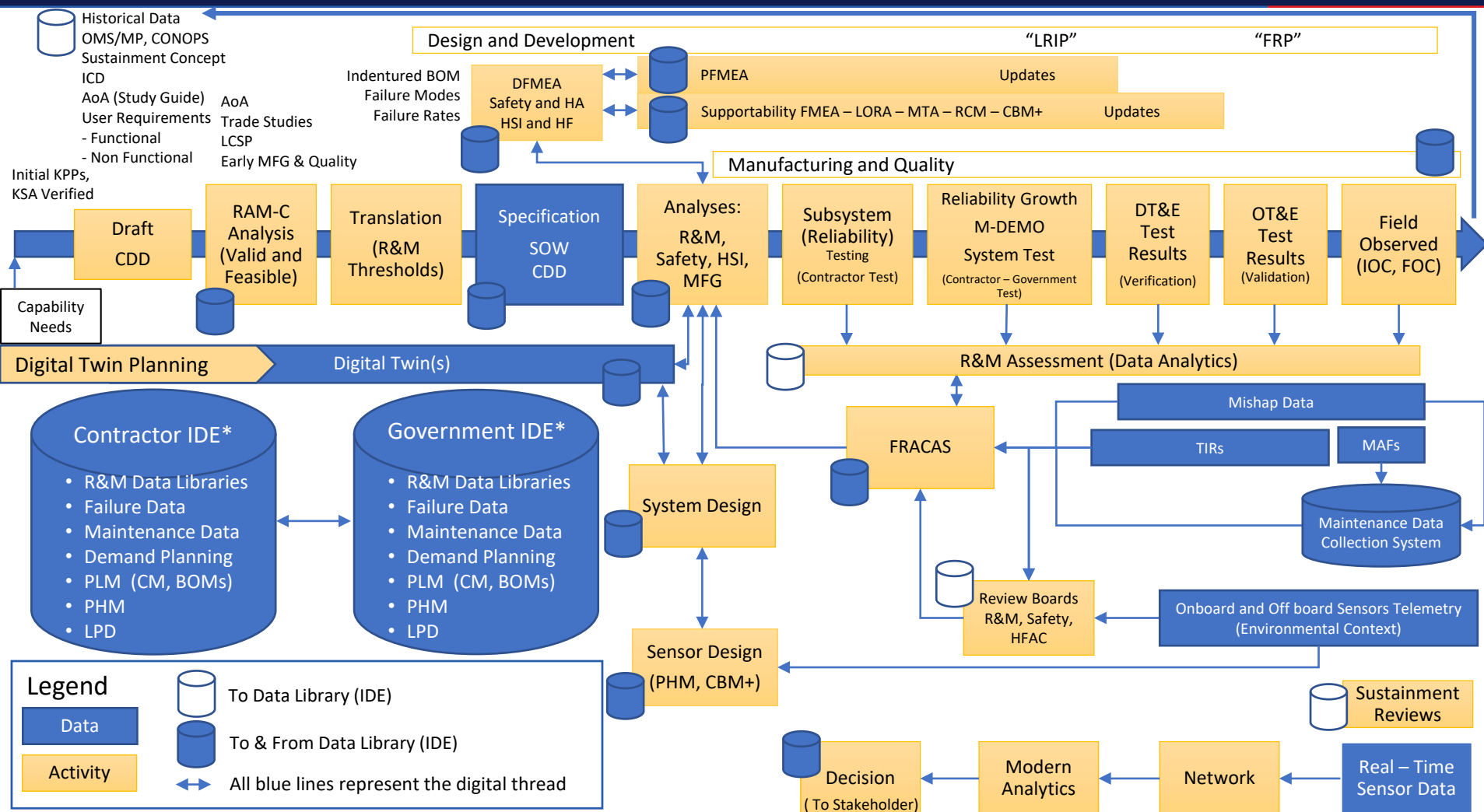


Source: Understanding AI Technology, April 2020 (Figure 5)

# Engineering Data in a DE Ecosystem

Historical Data
OMS/MP, CONOPS
Sustainment Concept
ICD
AoA (Study Guide)    AoA
User Requirements    Trade Studies
- Functional    LCSP
- Non Functional    Early MFG & Quality

Initial KPPs, KSA Verified

Design and Development    "LRIP"    "FRP"

Indentured BOM    **DFMEA**    PFMEA    Updates
Failure Modes    Safety and HA
Failure Rates    HSI and HF    Supportability FMEA – LORA – MTA – RCM – CBM+    Updates

Manufacturing and Quality

**Draft CDD** — **RAM-C Analysis (Valid and Feasible)** — **Translation (R&M Thresholds)** — **Specification SOW CDD** — **Analyses: R&M, Safety, HSI, MFG** — **Subsystem (Reliability) Testing (Contractor Test)** — **Reliability Growth M-DEMO System Test (Contractor – Government Test)** — **DT&E Test Results (Verification)** — **OT&E Test Results (Validation)** — **Field Observed (IOC, FOC)**

Capability Needs

**Digital Twin Planning** — Digital Twin(s)

**R&M Assessment (Data Analytics)**

## Contractor IDE*
- R&M Data Libraries
- Failure Data
- Maintenance Data
- Demand Planning
- PLM  (CM, BOMs)
- PHM
- LPD

## Government IDE*
- R&M Data Libraries
- Failure Data
- Maintenance Data
- Demand Planning
- PLM  (CM, BOMs)
- PHM
- LPD

**System Design**

**FRACAS**

Mishap Data

TIRs    MAFs

Maintenance Data Collection System

**Review Boards R&M, Safety, HFAC**

Onboard and Off board Sensors Telemetry (Environmental Context)

**Sensor Design (PHM, CBM+)**

Sustainment Reviews

**Decision ( To Stakeholder)** ← **Modern Analytics** ← **Network** ← **Real – Time Sensor Data**

## Legend
| | |
|---|---|
| Data | |
| Activity | |

To Data Library (IDE)

To & From Data Library (IDE)
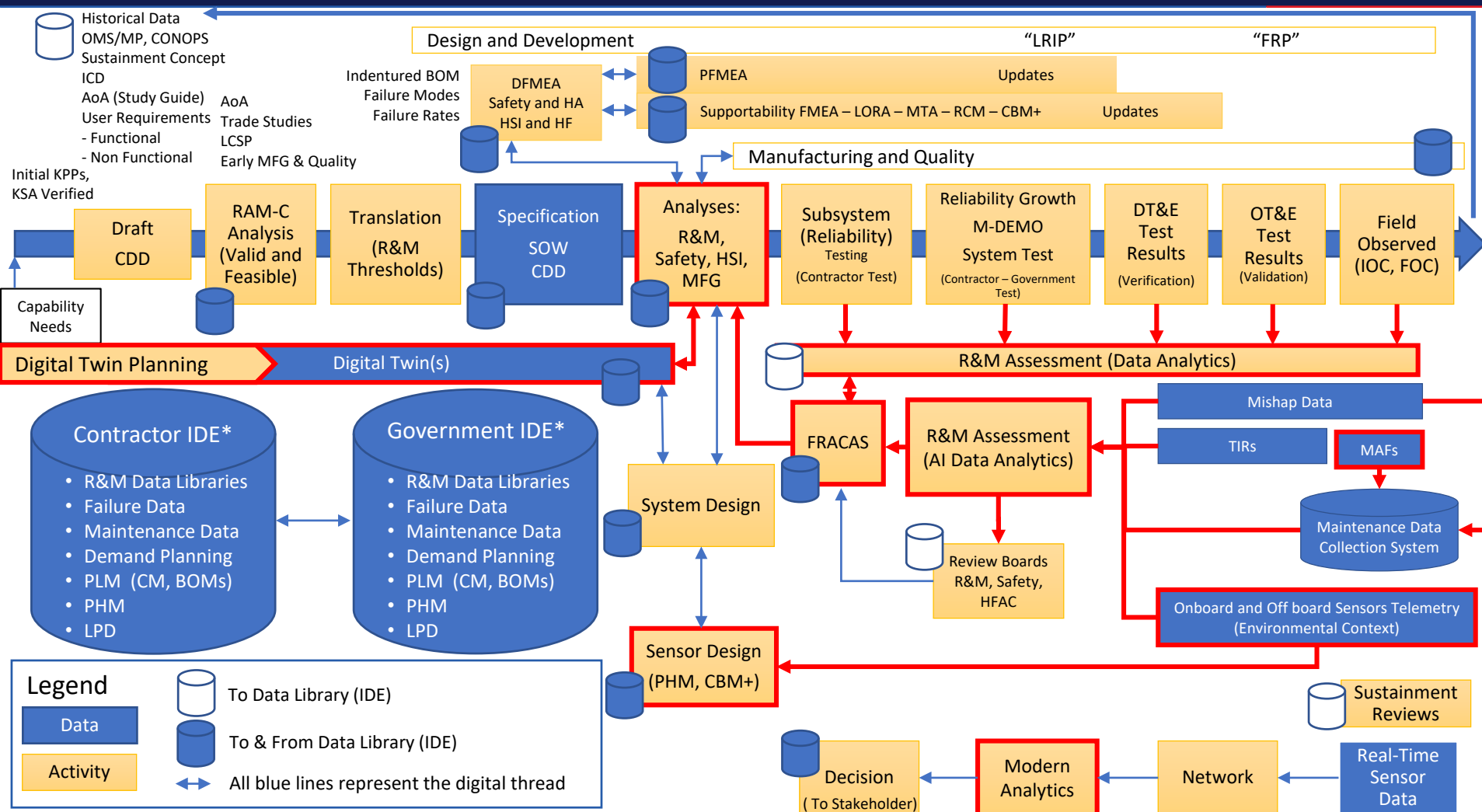
All blue lines represent the digital thread

**\*Contractually agreed to content, views, access, and delivery of data.**

Distribution Statement A: Approved for public release. Distribution is unlimited.

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# AI Application in Engineering Data
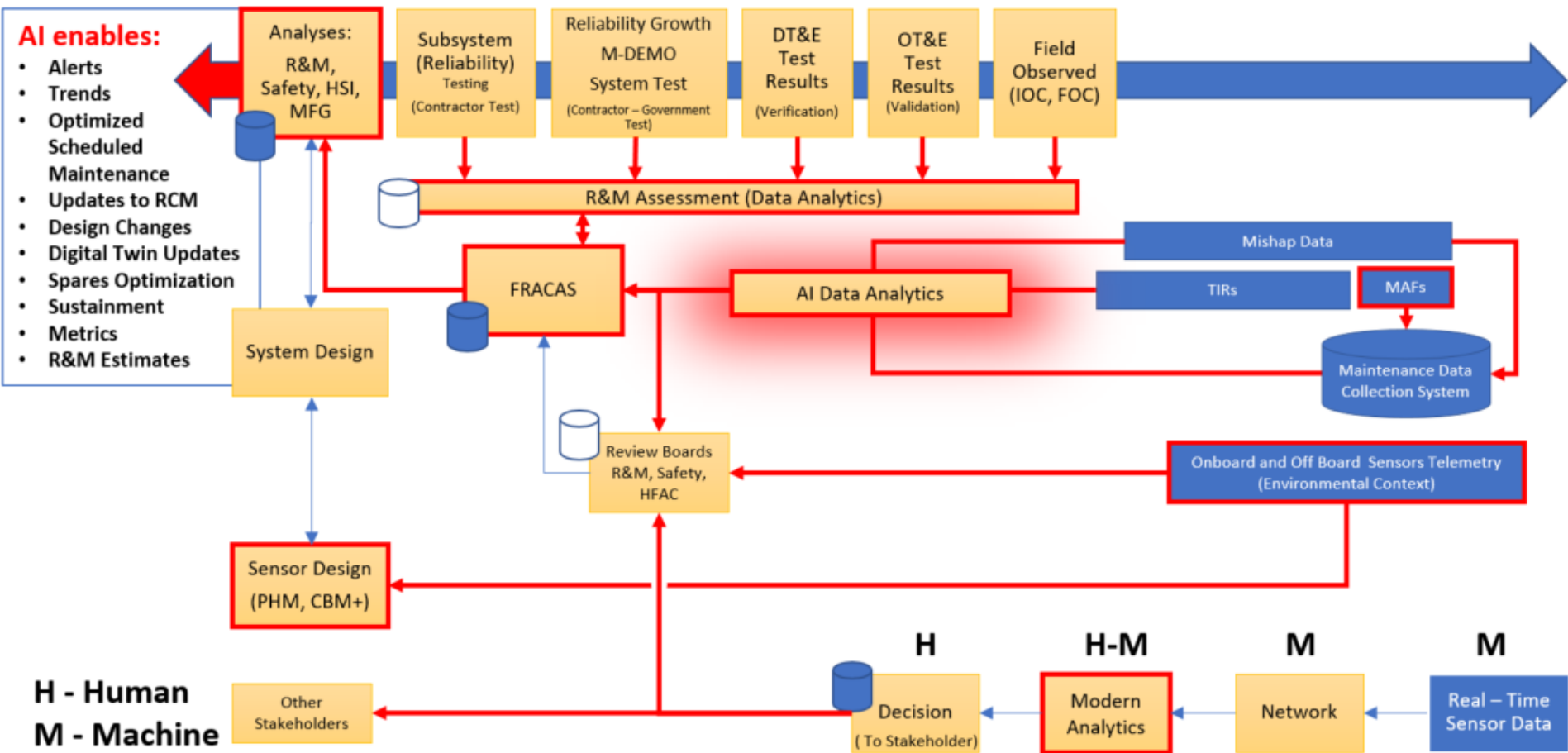
https://www.dau.edu/cop/rm-engineering/

Distribution Statement A: Approved for public release. Distribution is unlimited.

*Contractually agreed to content, views, access, and delivery of data.

# AI Application in FRACAS Data



**AI enables:**
- Alerts
- Trends
- Optimized Scheduled Maintenance
- Updates to RCM
- Design Changes
- Digital Twin Updates
- Spares Optimization
- Sustainment
- Metrics
- R&M Estimates

Analyses: R&M, Safety, HSI, MFG

Subsystem (Reliability) Testing (Contractor Test)

Reliability Growth M-DEMO System Test (Contractor – Government Test)

DT&E Test Results (Verification)

OT&E Test Results (Validation)

Field Observed (IOC, FOC)

R&M Assessment (Data Analytics)

Mishap Data

FRACAS

AI Data Analytics

TIRs

MAFs

Maintenance Data Collection System

System Design

Review Boards R&M, Safety, HFAC

Onboard and Off Board Sensors Telemetry (Environmental Context)

Sensor Design (PHM, CBM+)

H - Human
M - Machine

Other Stakeholders

**H**  **H-M**  **M**  **M**

Decision ( To Stakeholder)

Modern Analytics

Network

Real – Time Sensor Data

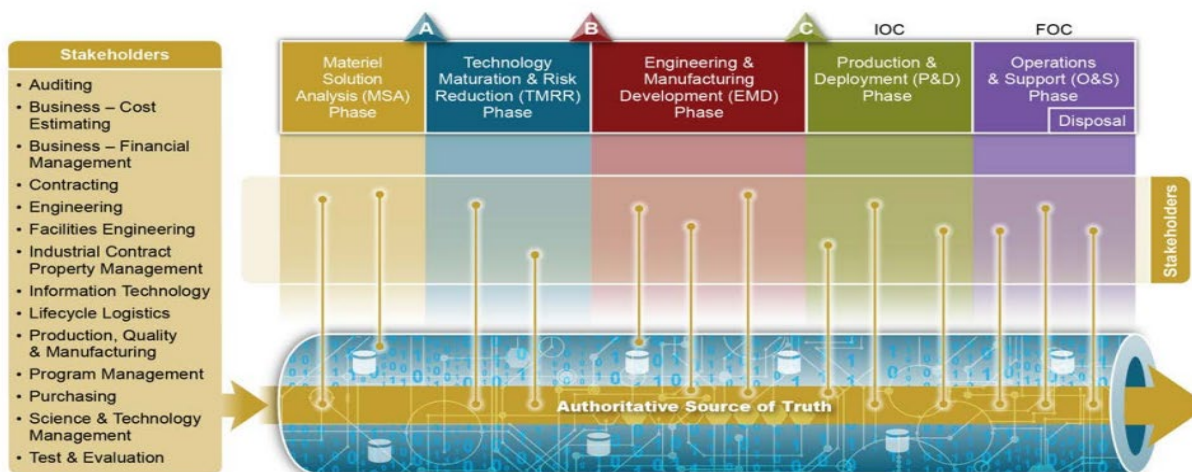Distribution Statement A: Approved for public release. Distribution is unlimited.

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# Infrastructure Enables Digital Thread



U.S. Air Force photo by Jill Pickett
HIGH MACH, Vol 67, No 12



Source: Authoritative Source of Truth, DoD Digital Engineering Strategy, June 2018



Photo By: Air Force Staff Sgt. Keith James Defense.gov/News

> **"Warfighters at all echelons require tested, secure, seamless access to data across networks, supporting infrastructure, and weapon systems out to the tactical edge."**
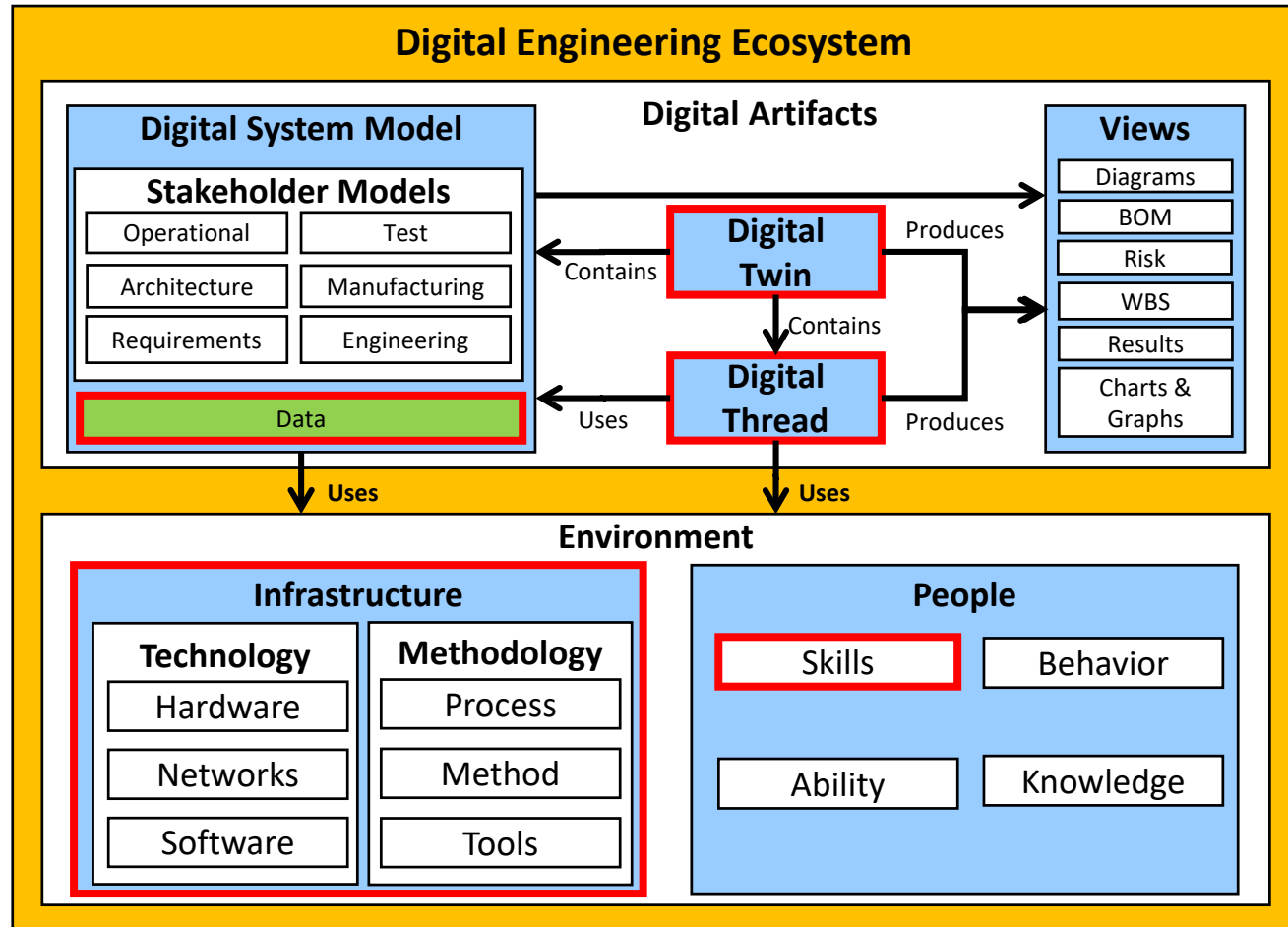> DoD Data Strategy, 2020

# Digital Engineering Ecosystem

## Infrastructure includes:

- Compute & Storage
- HVAC
- DevSecOps Tools
- AI/ML/DT Tools
- Simulation Tools
- MLS/CDS Security
- Authority to Operate
- Budget

## Skill sets include:

- IT, OT, PIT
- Information Assurance
- Data Engineers & Scientists
- System Admins
- High Performance Compute
- SW Developers
- Scrum Masters
- Security ISSO
- System Engineers
  - SysML
  - Digital Engineering Modeling & Simulation
- HW Designers
- Specialty Engineers
- Budget



**Digital Engineering Ecosystem**

**Digital Artifacts**

**Digital System Model**

**Stakeholder Models**

| Operational | Test |
| Architecture | Manufacturing |
| Requirements | Engineering |

Data

**Digital Twin** — Contains

Contains

**Digital Thread** — Uses — Produces

**Views**
- Diagrams
- BOM
- Risk
- WBS
- Results
- Charts & Graphs

Produces

Uses

**Environment**

**Infrastructure**

| **Technology** | **Methodology** |
| Hardware | Process |
| Networks | Method |
| Software | Tools |

**People**

| Skills | Behavior |
| Ability | Knowledge |

Distribution Statement A: Approved for public release. Distribution is unlimited.

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DoD image VIRIN:195294-P-UOR35-506.jpg, available at
https://www.defense.gov/observe/photo-gallery/igphoto/2001135702/

# For Additional Information

Office of the Under Secretary of Defense for
Research and Engineering

osd.r-e.comm@mail.mil

https://www.cto.mil