What is Digital Engineering at NASA?

Terry R. Hill
NASA's OCE Digital Engineering Program Manager

Audience: FED DEF '24
Nov. 20, 2024

"It is not necessary to change. Survival is not mandatory."
(W. Edwards - Deming Institute, 2019)

Why Digitally Transform NASA?

Enduring Bold Mission…

…now in a Changing World

Increasingly bold & complex missions
Increasingly partnered
Increasingly fast
Increasingly affordable
Increasingly transparent
Increasingly inclusive

NASA DIGITAL TRANSFORMATION

Chart cleared for public release Jan 9 2024

NASA's DT Strategic Framework

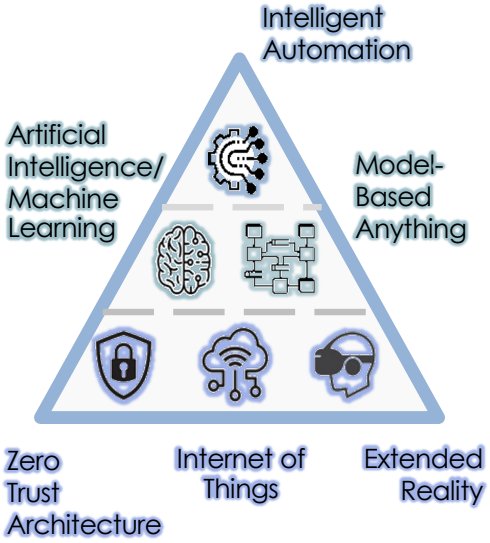
3 FUTURE STATE GOALS

4 TRANSFORMATION TARGETS

5 DIGITAL LEVERS

6 TECHNOLOGY FOUNDATIONS

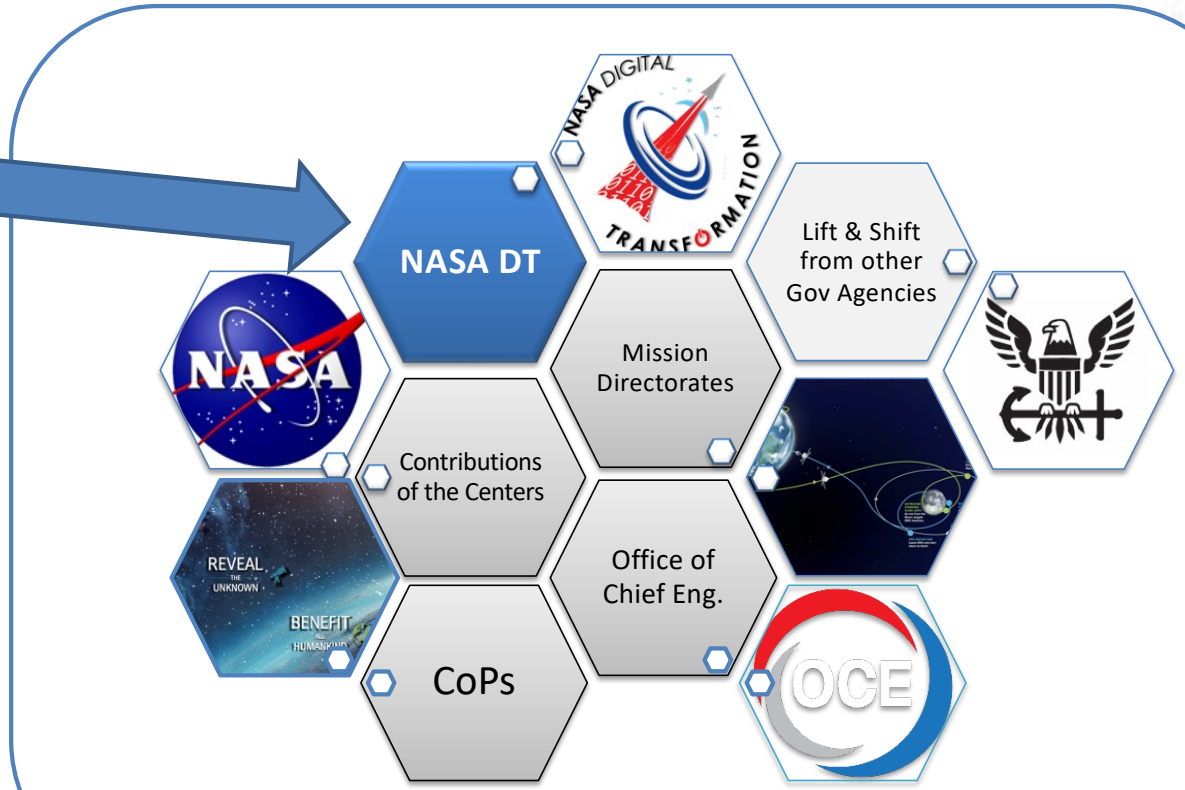
7+ MISSION OUTCOMES



One Future NASA

[NASA TM 20220018538]

Transformation of Engineering – It Takes a Village



NASA's Digital Engineering Transformation Efforts

Digital Engineering Transformation will be different for everyone

"Always remember that you are absolutely unique; just like everyone else." – Margaret Mead

If your Company / Org was born:

Each of these paths will be different…

In the last 5-8 years

You were "born digital"

Your processes are efficient & serial only when necessary. Therefore:

- Corporate information can be found in databases, data aggregators and data lakes
- Processes **create/access** information via federated sources of truth and can follow the data thread via tools which use industry standards for interoperability and data threads.

8-15 years ago

Software

Your processes can be serial, because you learned from your predecessors, but you have moments of efficiency. Therefore:

- Your processes are serial/parallel hybrid
- Corporate information can be found in electronic documents, databases, html pages, SharePoint lists
- Processes allow the **exchange** information via links to information/data

More than ~15 years ago

iPhone - 2007

HTLM 5 – 2008

Together they culturally changed how we interact with information

Your processes are largely serial, because they are effectively the same as they were when you were founded or have changed very little since then. Therefore:

- Your processes are serial
- Corporate information is largely locked in electronic (or paper) documents still
- Processes require people to **send/received** information via electronic documents via email, share drives, & PLMs

For the Old Timers Organizations Who were born More than 15 years ago

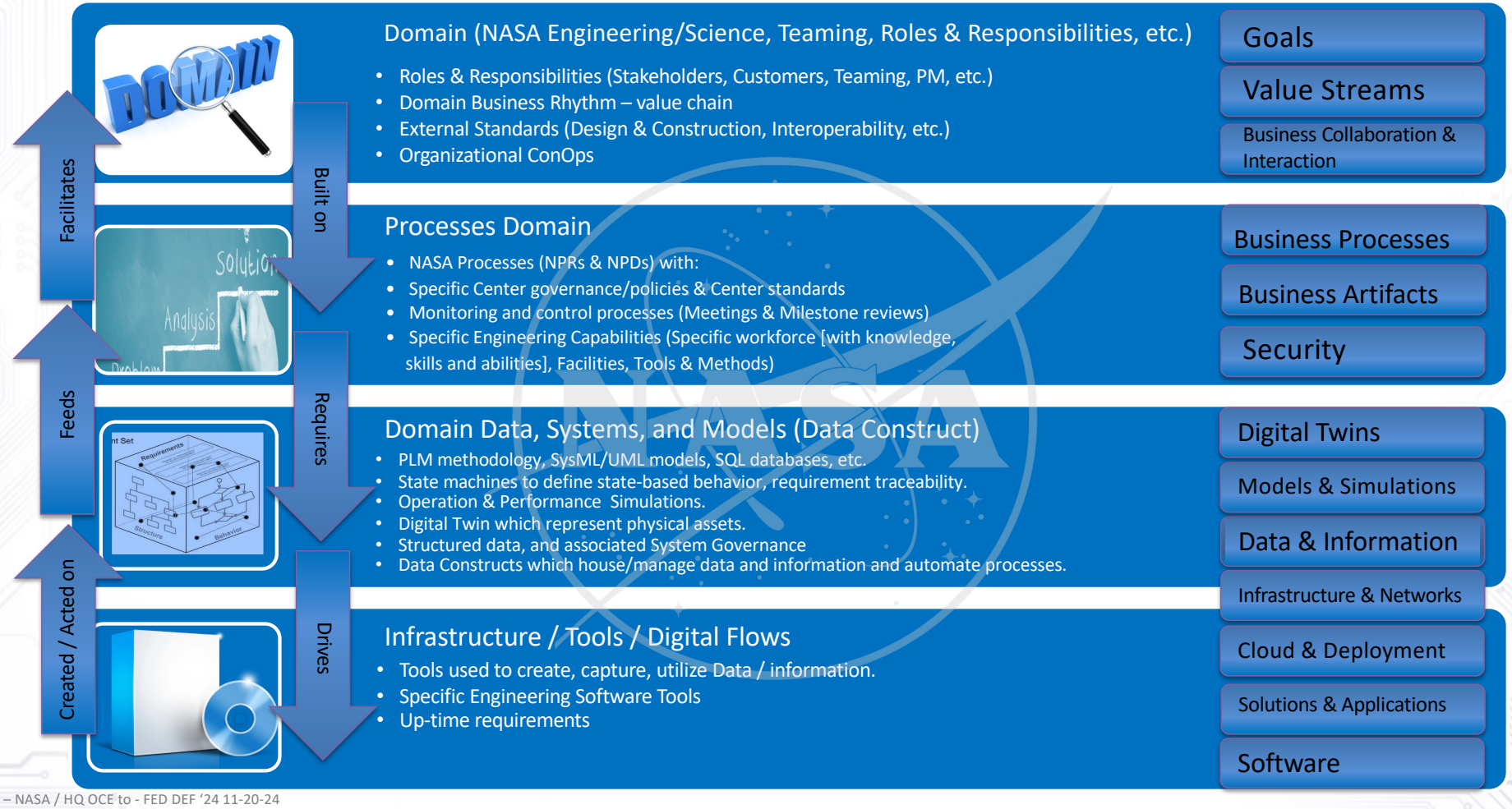
So where do we start?!?

NASA didn't invent digital engineering "sliced bread", but I'm going to tell you how we're slicing ours.

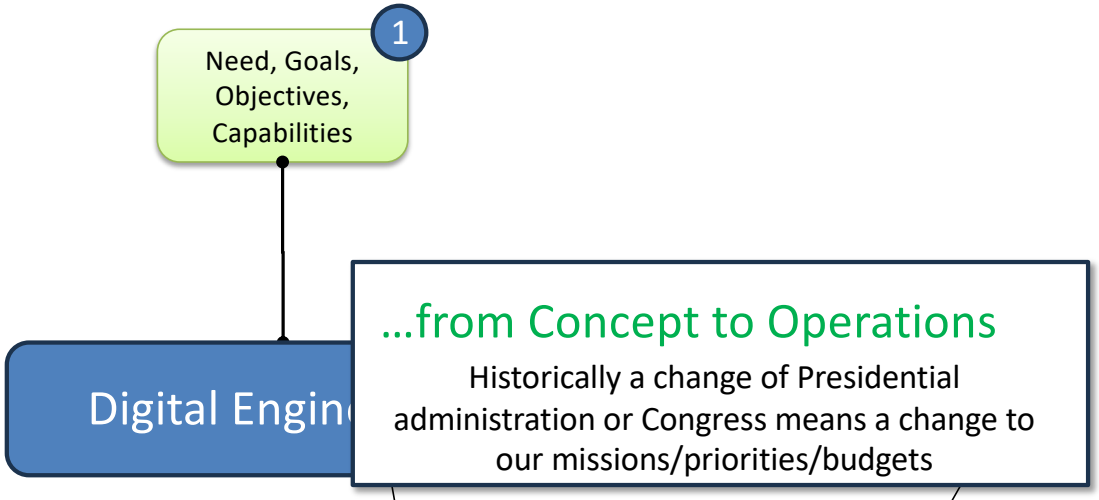
Transforming 65 Years of Engineering Legacy

The “4-Layer Cake” Analysis for Identification of Digital Transformation Opportunities

Developed by the Office of Chief Engineer’s Digital Engineering Leadership Team

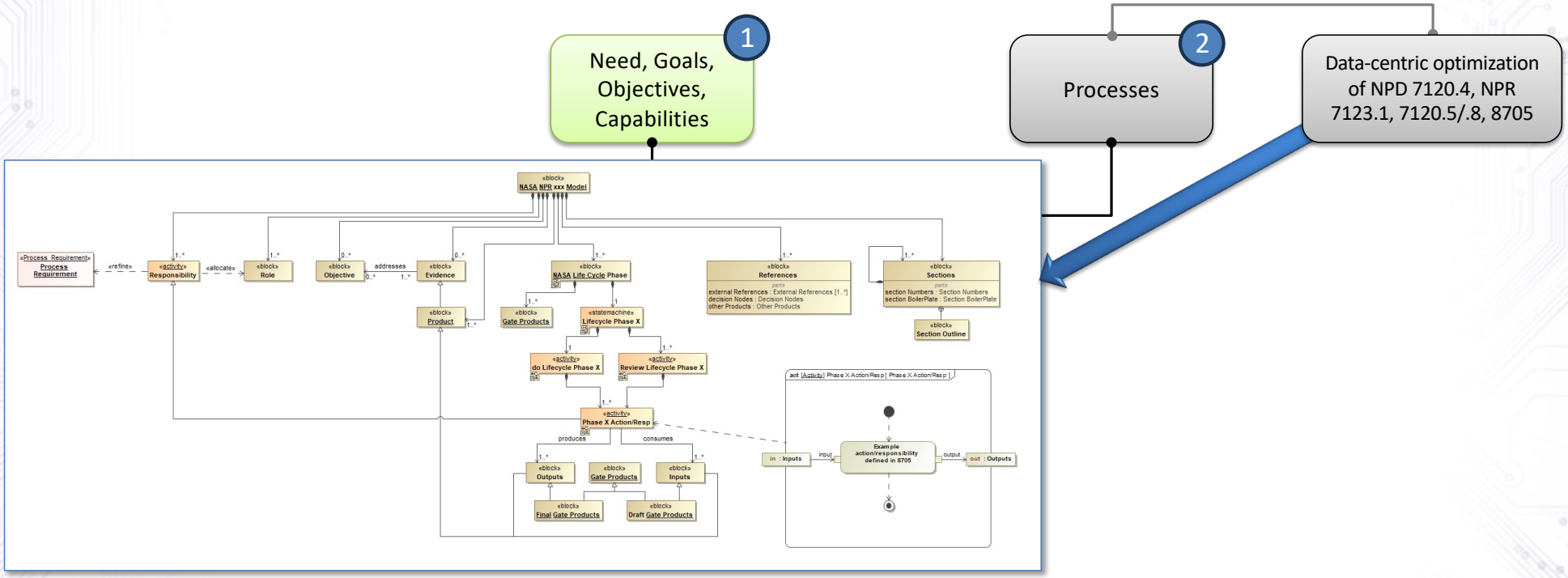


What is Digital Engineering at NASA

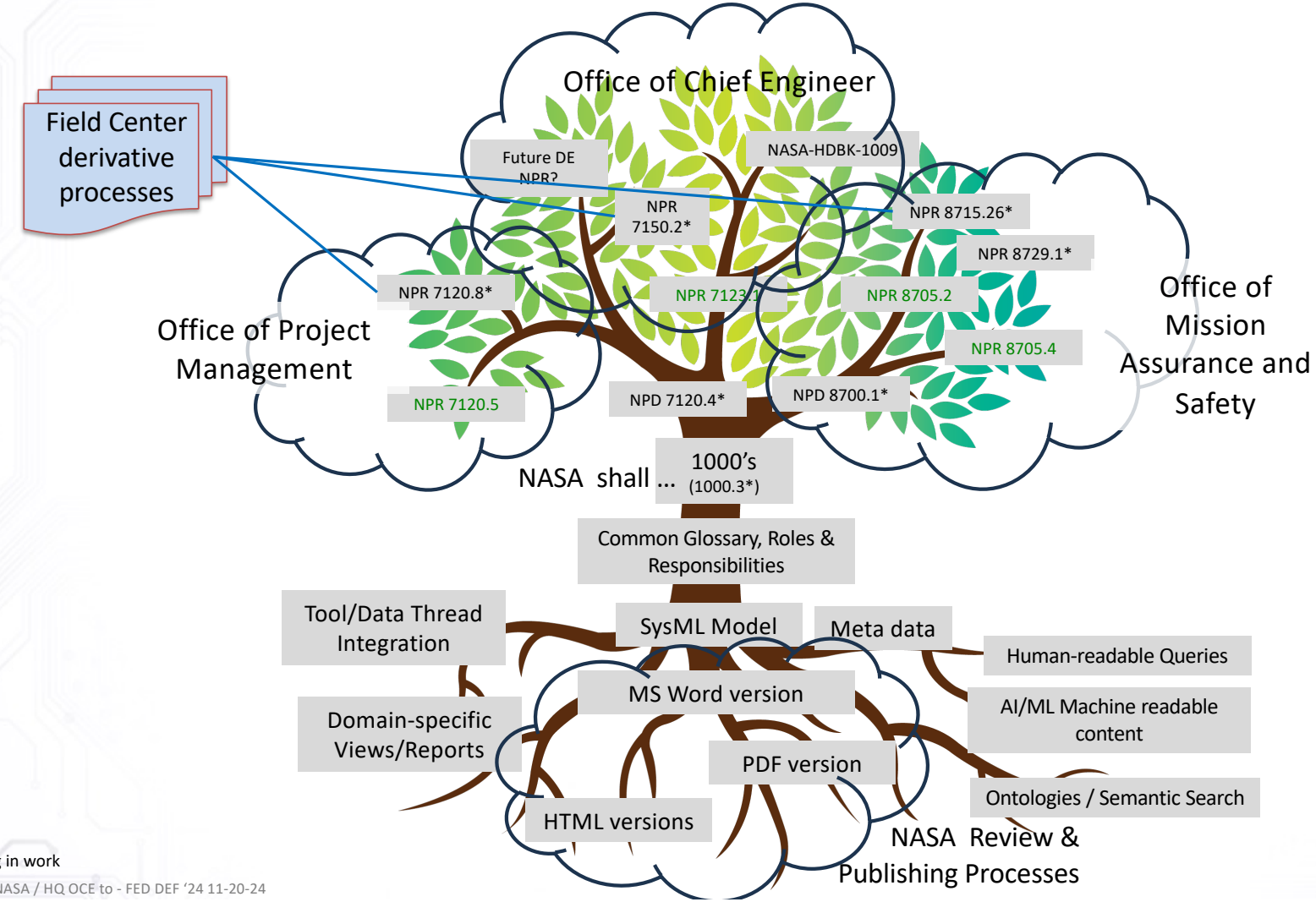


Improve how the Agency Engineering Domain operates over the entire NASA lifecycle by effectively managing complexity, reducing cost and schedule, and improving product integrity via the integration of processes, digital tools, and techniques along with seamless flow of information throughout the engineering system development life-cycle (concept development, design, testing and validation, manufacturing and operations).

What is Digital Engineering at NASA

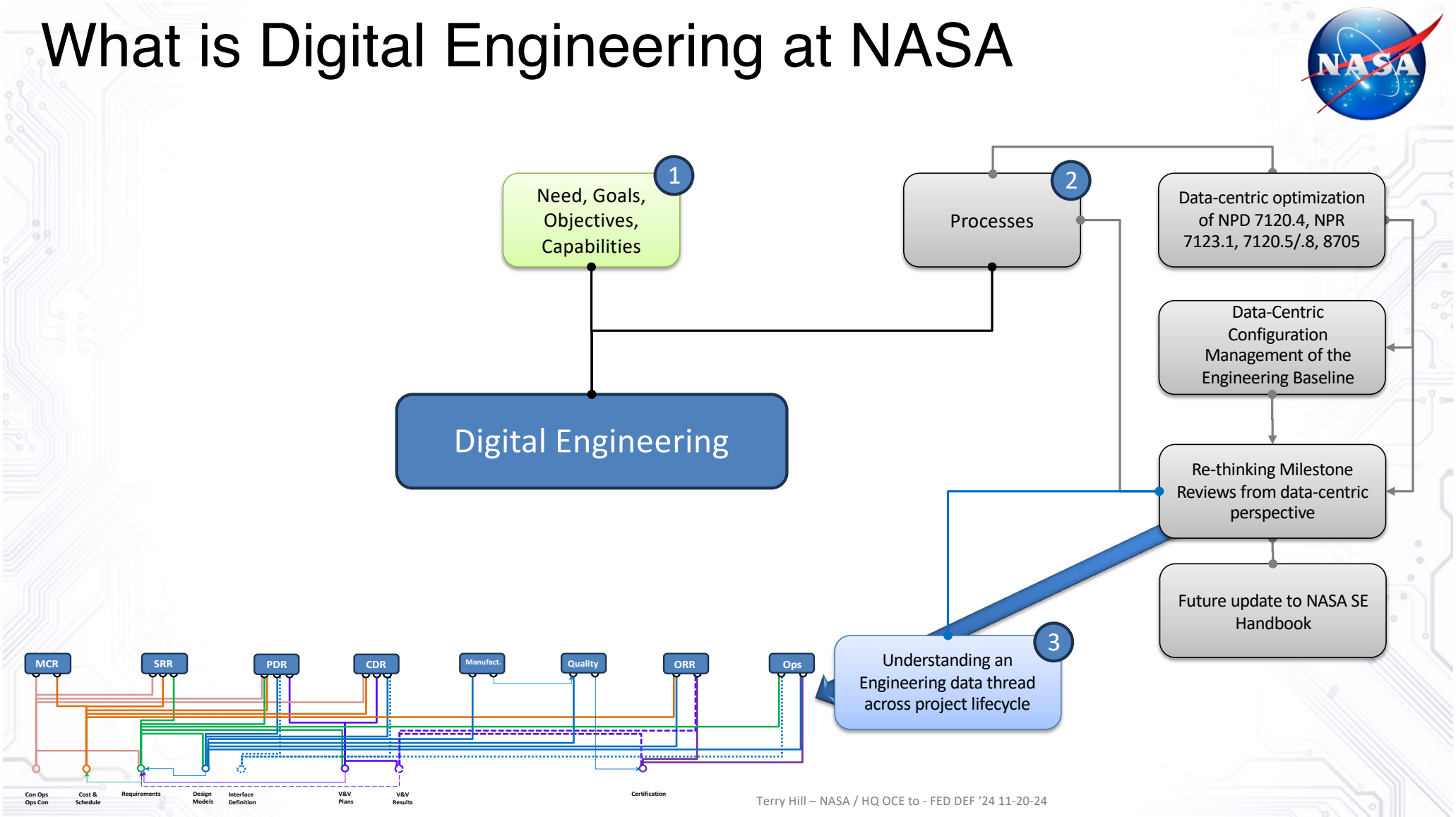


Linked Modes, Common Elements, & Artifacts



* Modeling in work

What is Digital Engineering at NASA



What is Digital Engineering at NASA

2 Processes

Data-centric optimization of NPD 7120.4, NPR 7123.1, 7120.5/.8, 8705

Data-Centric Configuration Management of the Engineering Baseline

Re-thinking Milestone Reviews from data-centric perspective

Future update to NASA SE Handbook

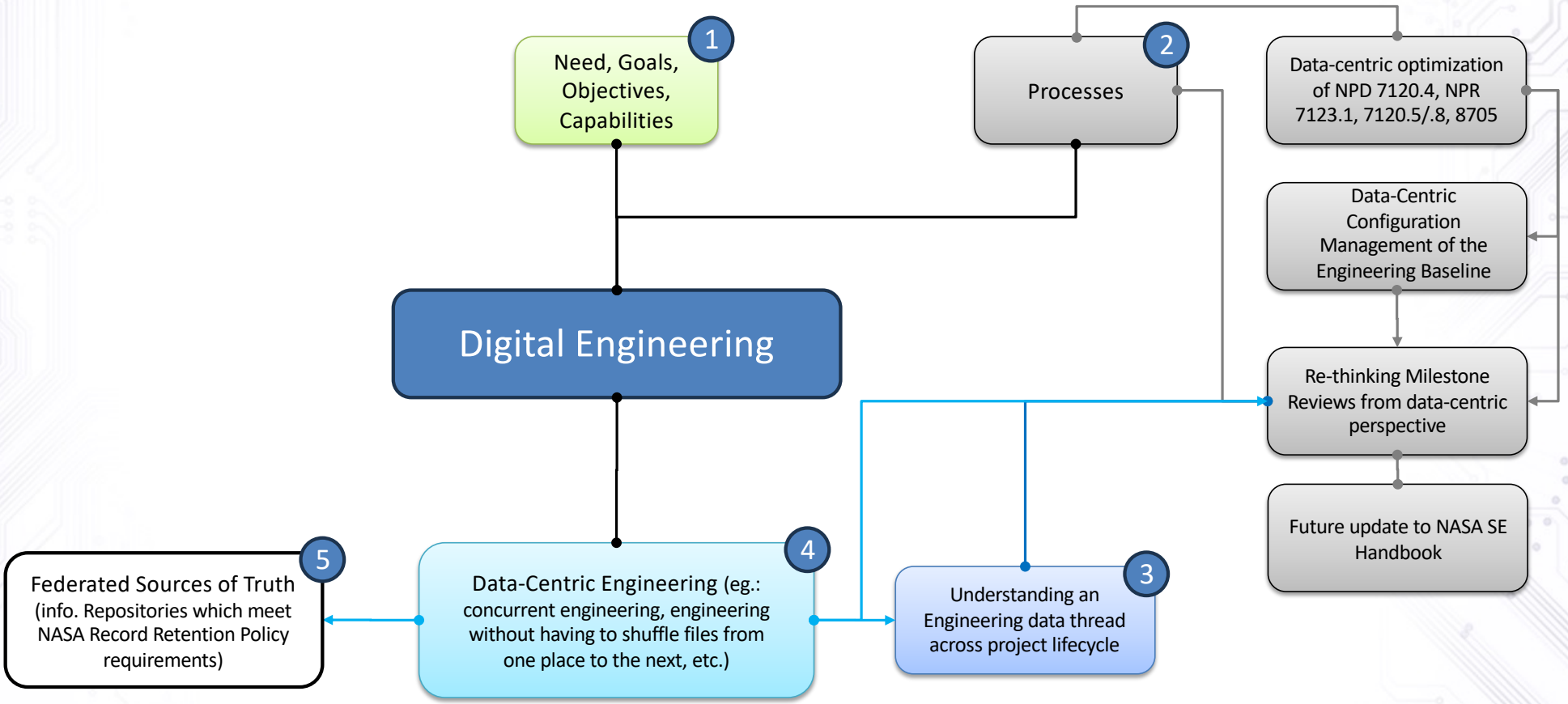
4 Data-Centric Engineering (eg.: concurrent engineering, engineering without having to shuffle files from one place to the next, etc.)

3 Understanding an Engineering data thread across project lifecycle

Data Thread Layers

Data/model Pedigree	• relation to design/testing CM
Configuration management	• Baseline release • Working version
Information	• Text • Meta data
Parameter	• alpha • numeric

What is Digital Engineering at NASA



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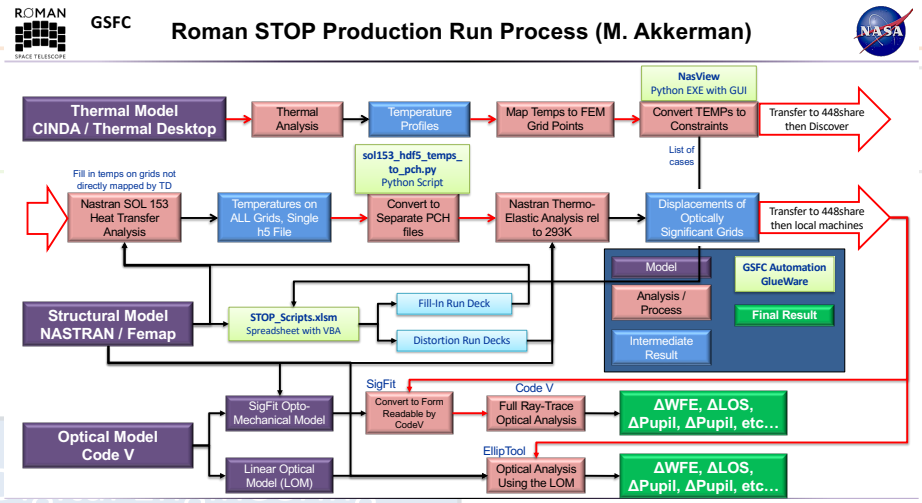
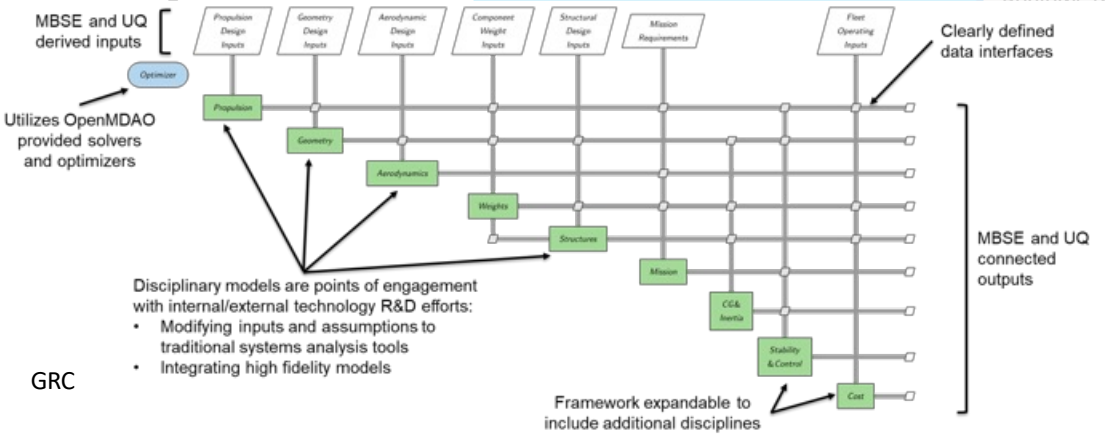




6 Toolchains (learning how, sharing Lessons Learned)

5 Federated Sources of Truth (info. Repositories which meet NASA Record Retention Policy requirements)

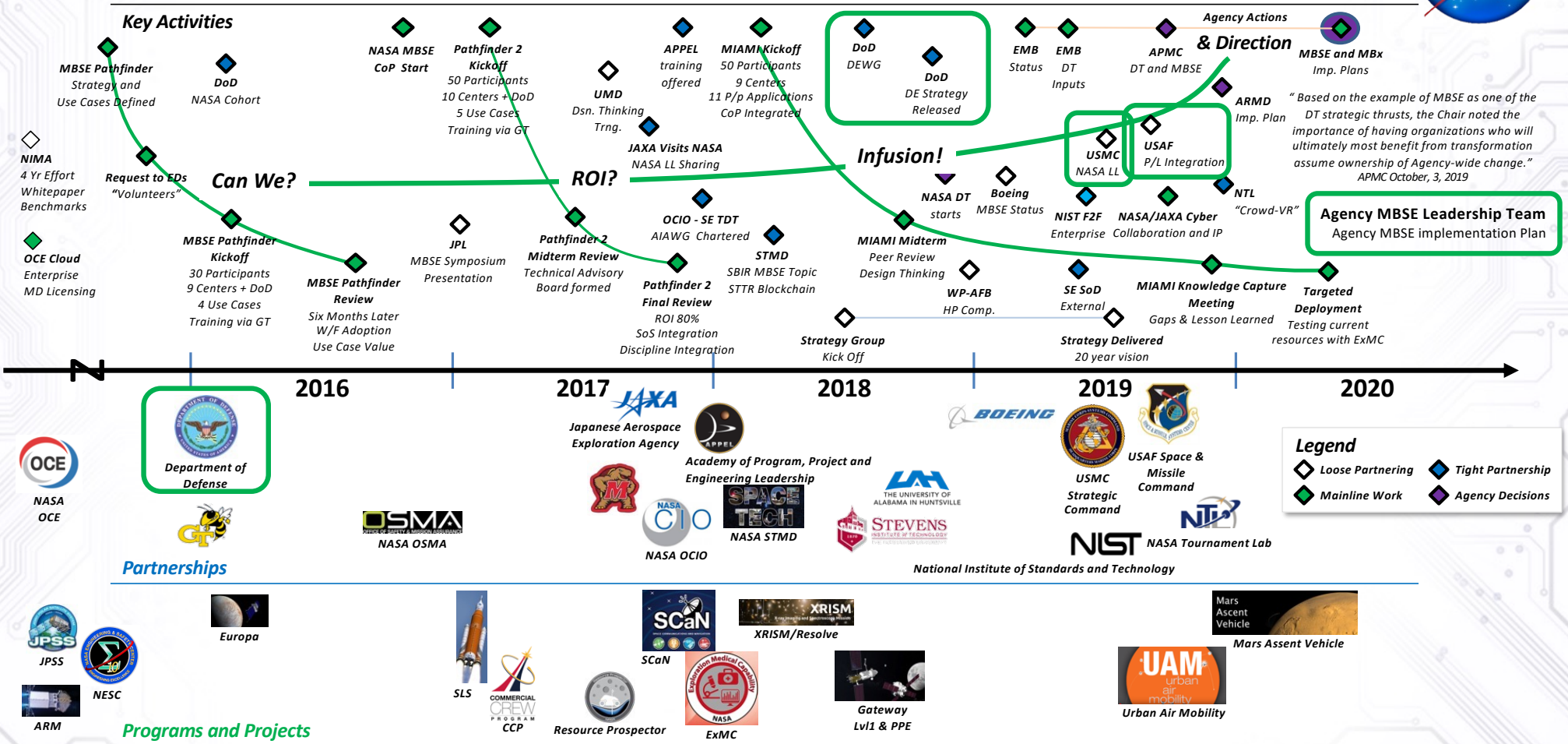
Data-centric optimization of NPD 7120.4, NPR 7123.1, 7120.5/.8, 8705

Data-Centric Configuration Management of the Engineering Baseline

Re-thinking Milestone Reviews from data-centric perspective

date to NASA SE andbook

MBSE Infusion at NASA



Systems Engineering/MBSE Accomplishments as part of NASA Digital Engineering Efforts

Utilizing workforce volunteer time

FY20

- Feb. '20 - MBSE Leadership Team (MLT) established by the Engineering Management Board per action from APMC
- NASA released its NASA-HDBK-1004 NASA Digital Engineering Acquisition Framework Handbook and includes contractual language for statements of work and provided information referencing topics such as Data Requirements Descriptions, model-based data definition, collaboration, architecture, interoperability standards, and general guidance for model-based product/data acquisition requirements.
- CY19 Office of Chief Engineering piloted MagicDraw (SysML modeling tool) with Teamwork Cloud (model management)

FY21

- Continued to build MLT with reps. from most centers
- Piloted the INCOSE MBSE Capability assessment to determine usefulness to NASA
- Initiated the MBSE/SysML (Systems Engineering Modeling Language) Orion Digital Twin to address insight concerns by Orion Chief Eng.

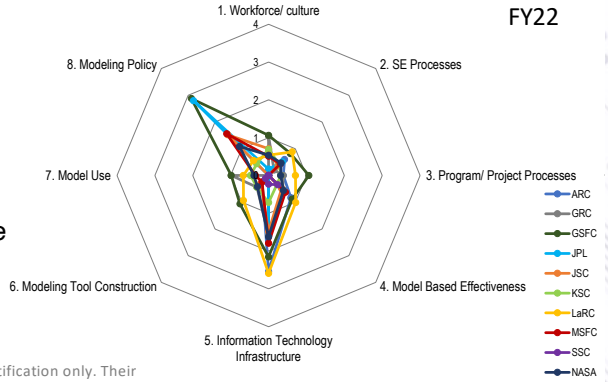
FY21

Model-Based Capability Categories	NASA Average	ARC	GRC	GSFC	JPL	JSC	KSC	LaRC	MSFC	SSC
1. Workforce/ culture	0.5	0.1	1.0	1.1	0.2	0.7	0.7	0.5	0.5	0.0
2. SE Processes	0.5	0.6	0.2	0.8	0.5	0.4	0.4	0.9	0.4	0.0
3. Program/ Project Processes	0.3	0.4	0.4	1.1	0.0	0.0	0.3	0.7	0.0	0.0
4. Model Based Effectiveness	0.6	0.8	0.5	0.9	0.0	0.5	0.3	1.0	0.6	0.3
5. Information Technology Infrastructure	1.6	2.5	1.6	2.2	1.5	1.5	0.7	2.6	1.8	0.2
6. Modeling Tool Construction	0.4	0.2	0.4	1.1	0.0	0.3	0.4	0.9	0.2	0.1
7. Model Use	0.4	0.0	1.0	1.0	0.0	0.0	0.5	0.7	0.3	0.0
8. Modeling Policy	1.1	0.0	0.0	2.9	2.8	1.5	0.4	0.6	1.6	0.0

FY22

- Incorporated the MLT into the larger NASA Digital Engineering (DE) Agency team.
- Performed initial high-rez MBSE Capability assessment & collected center priorities and vanguard examples.
- NASA Released NASA-HBK-1009 MBSE Modeling Handbook
- APPEL offered 4 of the 5-tiered MBSE Course from beginner to expert via requirements from MLT
- Completed the MBSE/SysML Orion Digital Twin
- Initiated the modeling of NPR 7123, 7120.5/.8 & 8705 in SysML to assess changes from a data-centric perspective
- Benchmarked 6 large industry partners in how they performed internal MBSE training.
- Began meeting monthly with the NRO MBSE team to share information.
- Using Systems Engineering principals, created the "Four Layered Cake" process to identify opportunities for investment for digital transformation given limited resources.

FY22

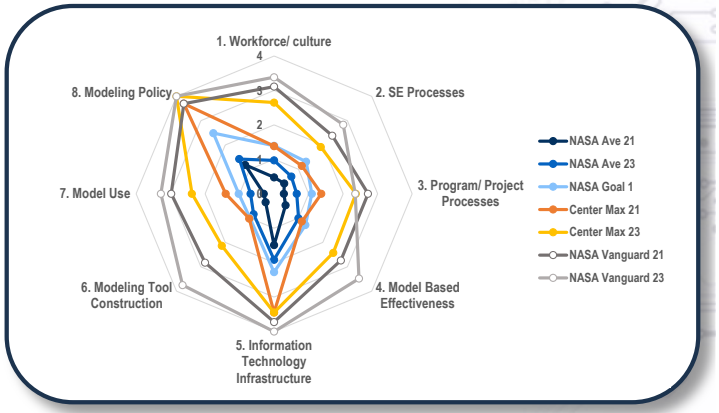


Systems Engineering Accomplishments as part of NASA Digital Engineering Efforts

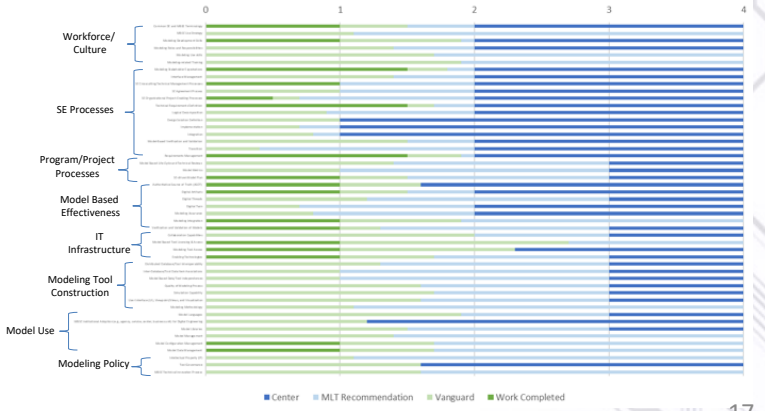
Utilizing workforce volunteer time

FY23

- Used standard SE approach to define what DE means for NASA: NGO's to Capabilities
- Aggressive engagement with DoD, DoE, Intelligence and FAA on DE and SE topics
- Modeling & Data-centric analysis of NPR 7123, 7120.5/.8 & 8705
- Agency benchmarking of toolchain capabilities concluded (included SE toolchains)
- RFI to Industry released which requested input from Industry as to how they want work, collaborated, and exchange info with NASA (Systems Engineering included)
- Added focus area of Interoperability / data exchange standards for engineering data thread which will create the backbone of digital SE.
- Tier 5 MBSE Training requirements defined and provided to APPEL – see backup chart
- Performed second high-rez MBSE Capability Assessment across the Agency. Used the INCOSE MBSE Assessment tool to create Agency / Center development plan
- MLT's INCOSE International Symposium paper on Orion MBSE Digital Twin won Best Paper in Model/Simulation category



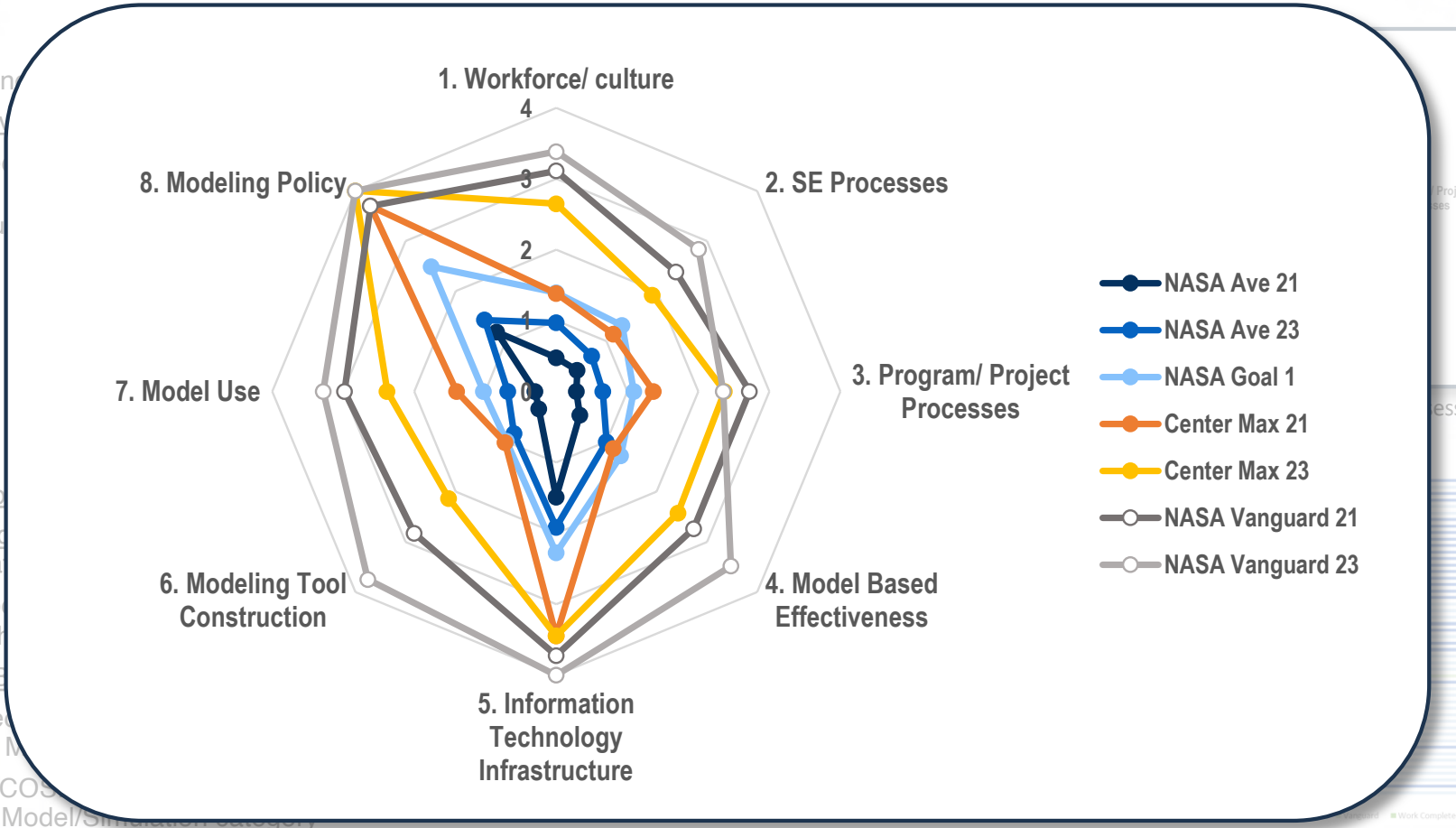
Growth of MBSE Capability seen in FY23 Assessment scoring.



Agency vs Center MBSE Capability Development Plan

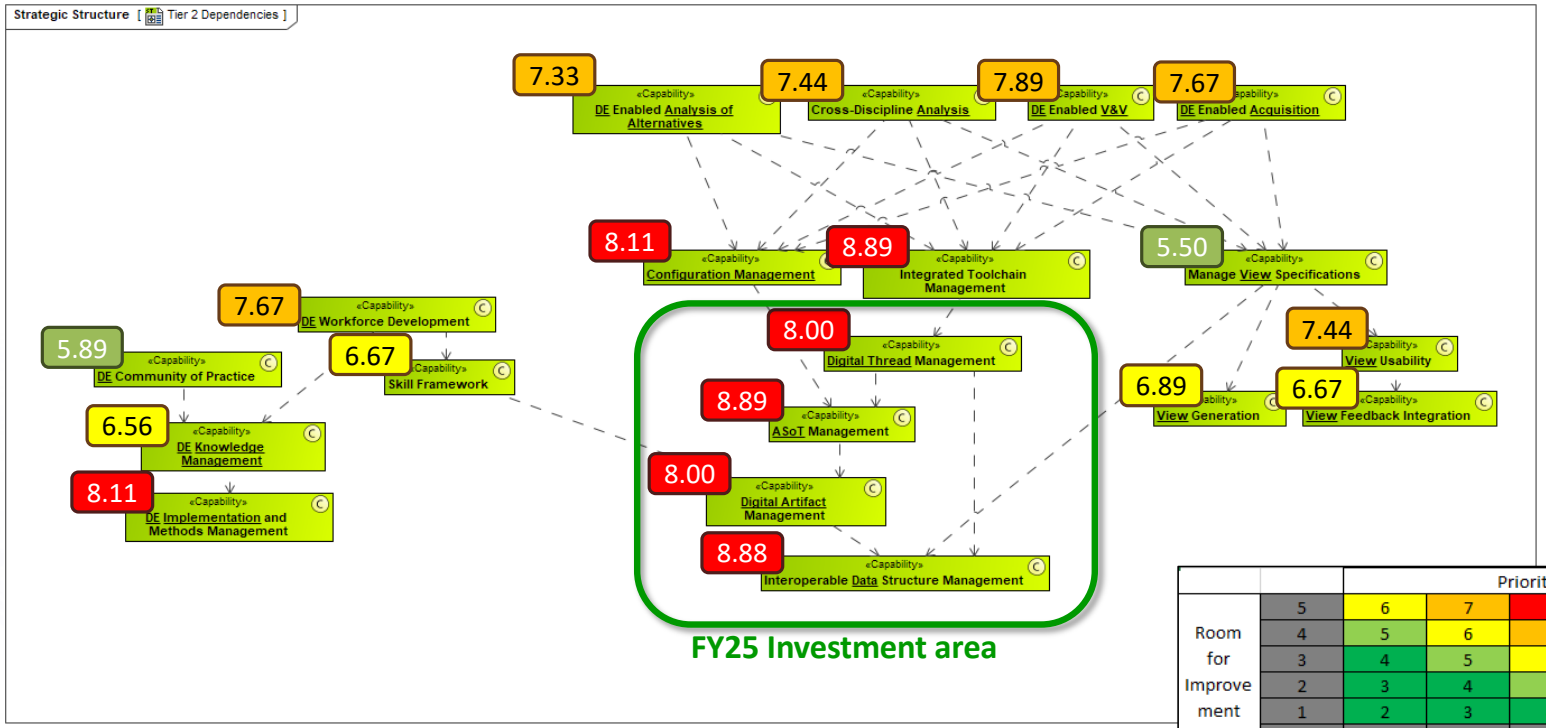
Systems Engineering Accomplishments as part of NASA Digital Engineering Efforts

Utilizing workforce volunteer time



DE Capability Ranking

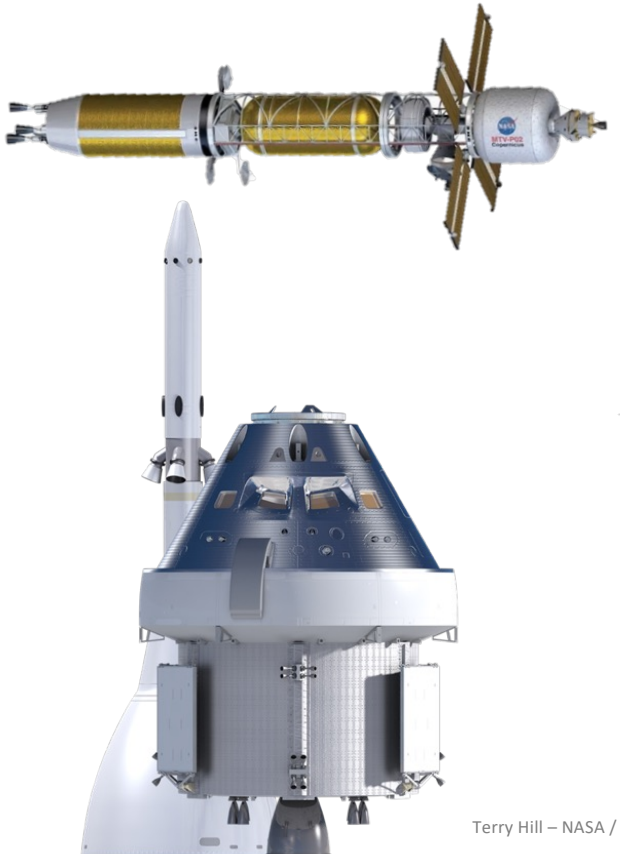
DE Center Reps were asked to rank current opinion on DE Capability importance to use as a measure of effectiveness of the tool, but also to get first prioritization ranking for use in FY25 planning



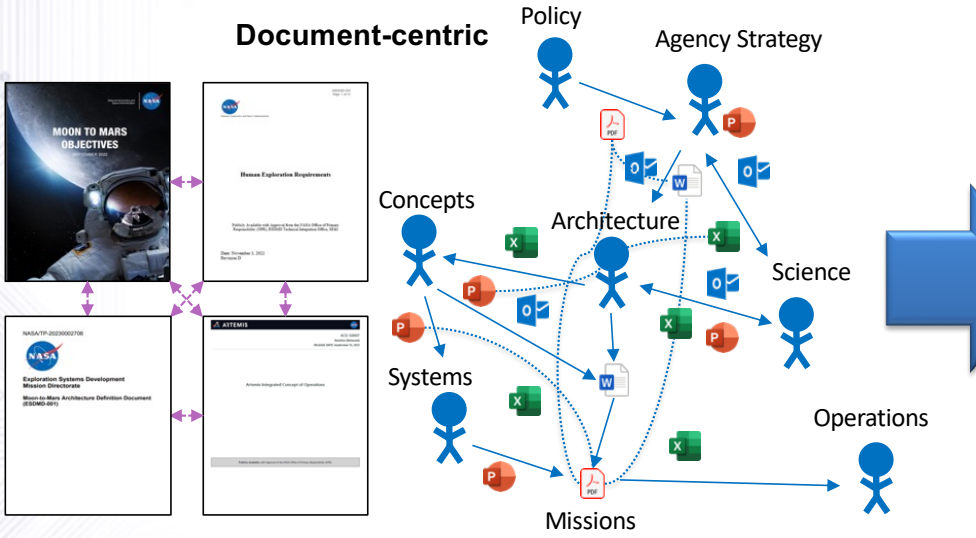
MBSE Is Now Mainstream in NASA

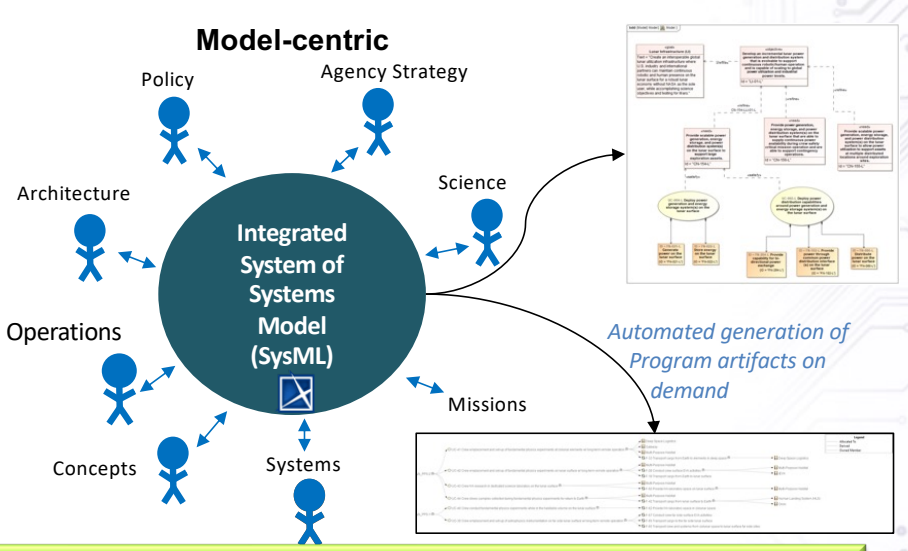
MBSE / SYSML USAGE WITH ARTEMIS CAMPAIGN

Missions to Campaigns to Capabilities



Document-centric to Model-centric Architecture Data Management



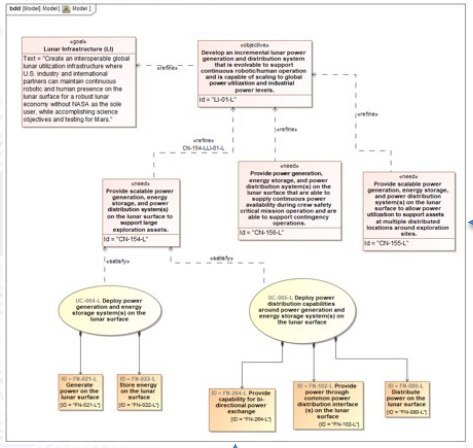


- Many documents that describe the M2M architecture and associated data are managed by different teams
- Info in these docs all relate to each other, but aren't directly connected in any way or updated in sync
- Causes discrepancies, redundancies, gaps in info

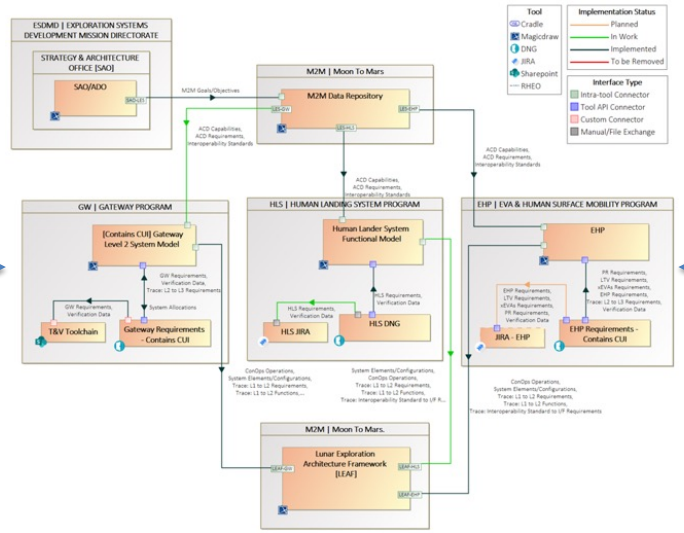
Importing data into a model allows for

- Traceability
- Gap analysis
- Propagated updates of data
- Consistency
- Reduces human error and overall risk
- Allows for easy exportability and shareability

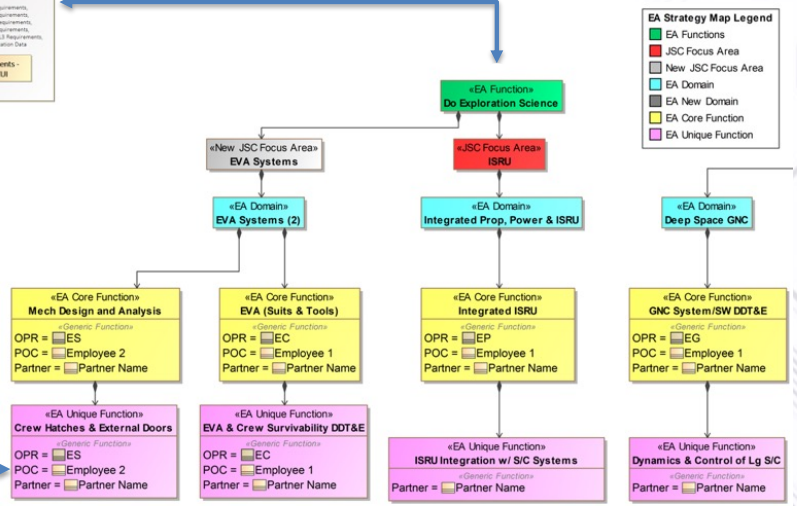
Missions



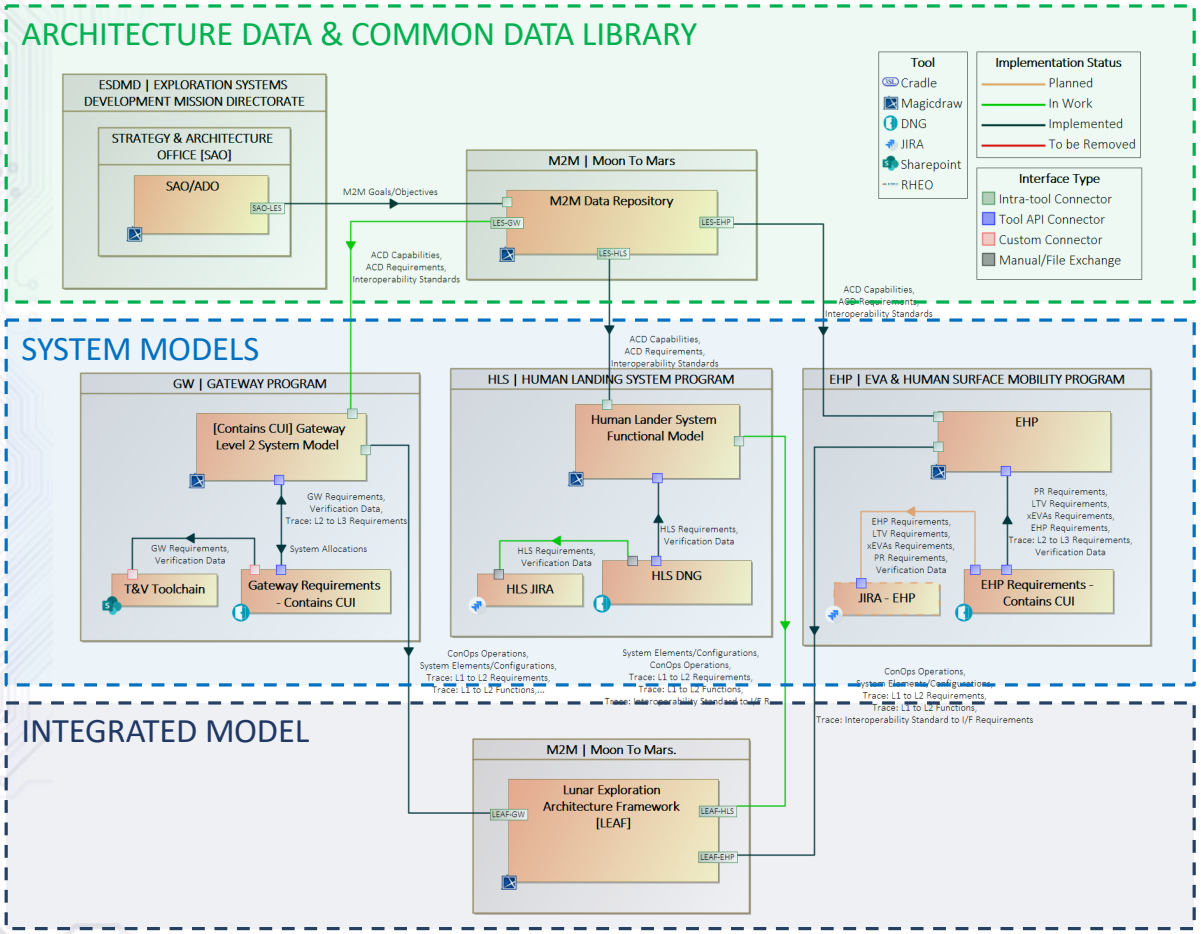
to Campaigns



to Capabilities



Campaign System of Systems Model Federation



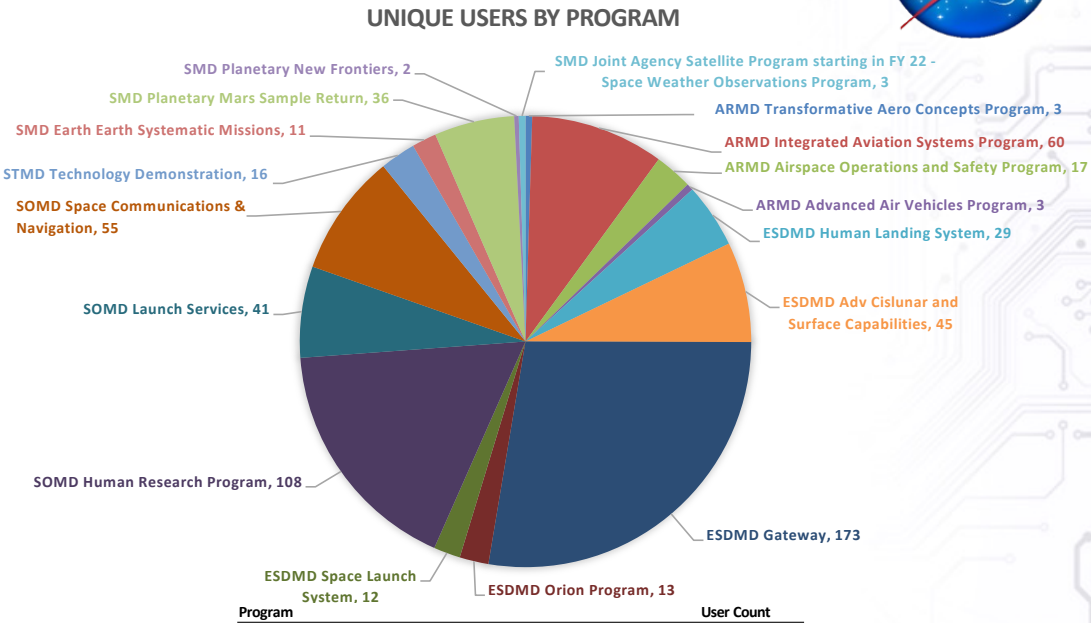
The Model Federation Architecture enables integration across the system of systems.

- ***Architecture Data & Common Data Library***: *Enterprise Data Library including level 1 requirements baseline, design reference mission definition, and capability architecture*
- ***System Models:*** *System description model for systems in the architecture. This includes system requirements, functional, and structural architecture*
- ***Integrated Model:*** *Artemis campaign model leveraged to support integrated product development. Allows for both isolation & integration of system information*

OCE Agency-level MagicDraw license server and Teamwork Cloud (model management)

Number of Models & Users by Mission Directorate and Program (at end of FY23)

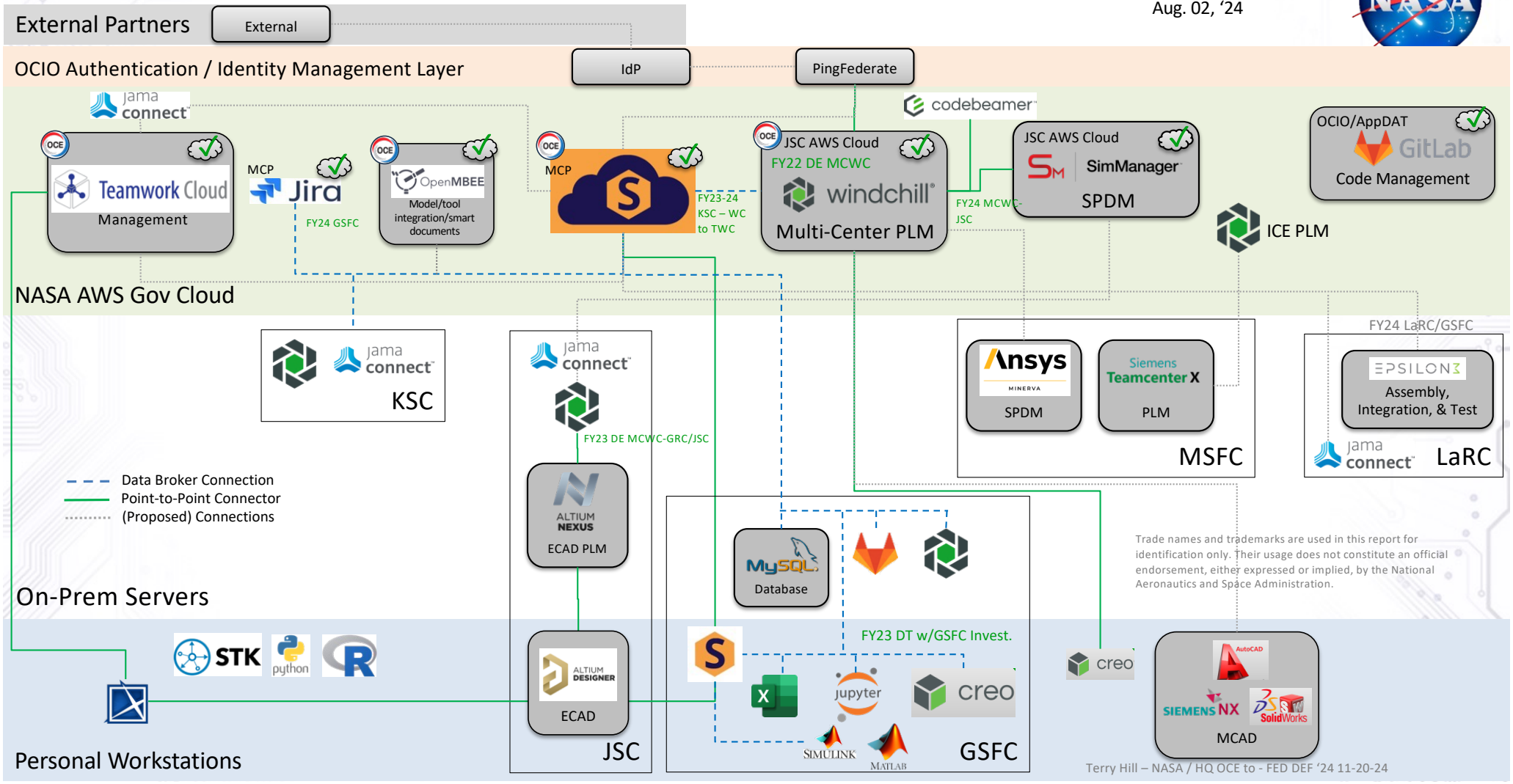
- With support from NASA's Office of Chief Engineer since FY15, MBSE methodologies /SysML modeling are used across five mission directorates on most all of the large programs and projects.
- Used by almost 700 unique users from across all Centers in FY23.
- Over 1.4k models created and managed on the OCE Teamwork Cloud



Program	User Count
ARMD Transformative Aero Concepts Program	3
ARMD Integrated Aviation Systems Program	60
ARMD Airspace Operations and Safety Program	17
ARMD Advanced Air Vehicles Program	3
ESDMD Human Landing System	29
ESDMD Adv Cislunar and Surface Capabilities	45
ESDMD Gateway	173
ESDMD Orion Program	13
ESDMD Space Launch System	12
SOMD Human Research Program	108
SOMD Launch Services	41
SOMD Space Communications & Navigation	55
STMD Technology Demonstration	16
SMD Earth Earth Systematic Missions	11
SMD Planetary Mars Sample Return	36
SMD Planetary New Frontiers	2
SMD Joint Agency Satellite Program starting in FY 22 - Space Weather Observations Program	3
Unknown	65
Total	692

Phased Integration Demonstration of Commonly Used Engineering Tools

Aug. 02, '24



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DE Toolchain Dashboard

- Work performed by Stratada Inc.

As part of NASA's Integrated Digital Engineering Transformation initiative, NASA Engineering Directorates needs a comprehensive understanding of all software applications in use for engineering across all of NASA, and the workflows they support.

- A collaborative application enabling stakeholders to input and maintain the tools and tool chain information
- A method to interactively visualize the data to support various needs including:
  - Understanding the current tool usage
  - Prioritizing tools and tool workflows for upgrade
  - Identifying opportunities to eliminate redundant tools
  - Finding ways to make data flows more efficient
  - Supporting future tool selection for new processes

Built in MS PowerApp (for user input) with an interactive Power BI Dashboard

Data Broker Survey

In Place means the capability is included in the construct.
Limited means that the ecosystem is vendor specific.
Promising means that capability is under development.

Capability/STD.	Syndeia v3.5 SP2	Open MDAO	Open PDM	SBE Vision	WSTAT	DAKOTA	CATTENS (GSFC)	Violet Labs
OSLC (Partial)	●	↑★	●	●	●	●	●	●
Connectivity via REST API	●	↑★	●	●	●	●	●	●
Dynamic Queries	●	●	↑★	●	●	●	●	●
Security (OAuth 2.0, SAML 2.0, SSO)	●	●	●	●	●	●	●	●
Cloud Services	●	●	●	●	●	●	●	●
Visualizations	●	●	●	●	●	●	●	●
Digital Thread	●	●	●	●	●	●	●	●
SDK Adapter (Python, C#, Java)	●	●	●	●	●	●	●	●

● = In Place ↑ = Activity ★ = Promising ● = Limited Capabilities ● = Without Capability

*Results as of Sep. '24 - Supporting report / white paper will be made available in FY25

Assessment scoring is based upon commercially available offerings and doesn't include capabilities which may have been developed for specific customers

Data Broker Survey

In Place means the capability is included in the construct.
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Engineering Tool Types	Syndeia v3.5	Open MDAO	OpenPDM	SBE Vision	WSTAT	Dakota	CATTENS GSFC	Violet Labs
MBSE (Teamwork Cloud, Rhapsody, etc.)	●	●	●	●	●	●	●	●
Product Life Cycle Mgmt. (PLM)	●	★	●	●	●	●	●	●
Requirements (DOORS, JAMA, etc.)	●	●	●	●	●	●	●	●
Application Life Cycle Mgmt. (ALM)	●	●	●	●	●	●	●	●
Analysis/Simulation	●	●	●	●	●	●	●	●
CAD/DTM	●	●	●	●	●	●	●	●
Test (AI&T)	●	●	●	●	●	●	●	●
Database (AsOT)	●	●	●	●	●	●	●	●

● = In Place ↑ = Activity ★ = Promising ● = Limited Capabilities ● = Without Capability

*Results as of Sep. '24 - Supporting report / white paper will be made available in FY25
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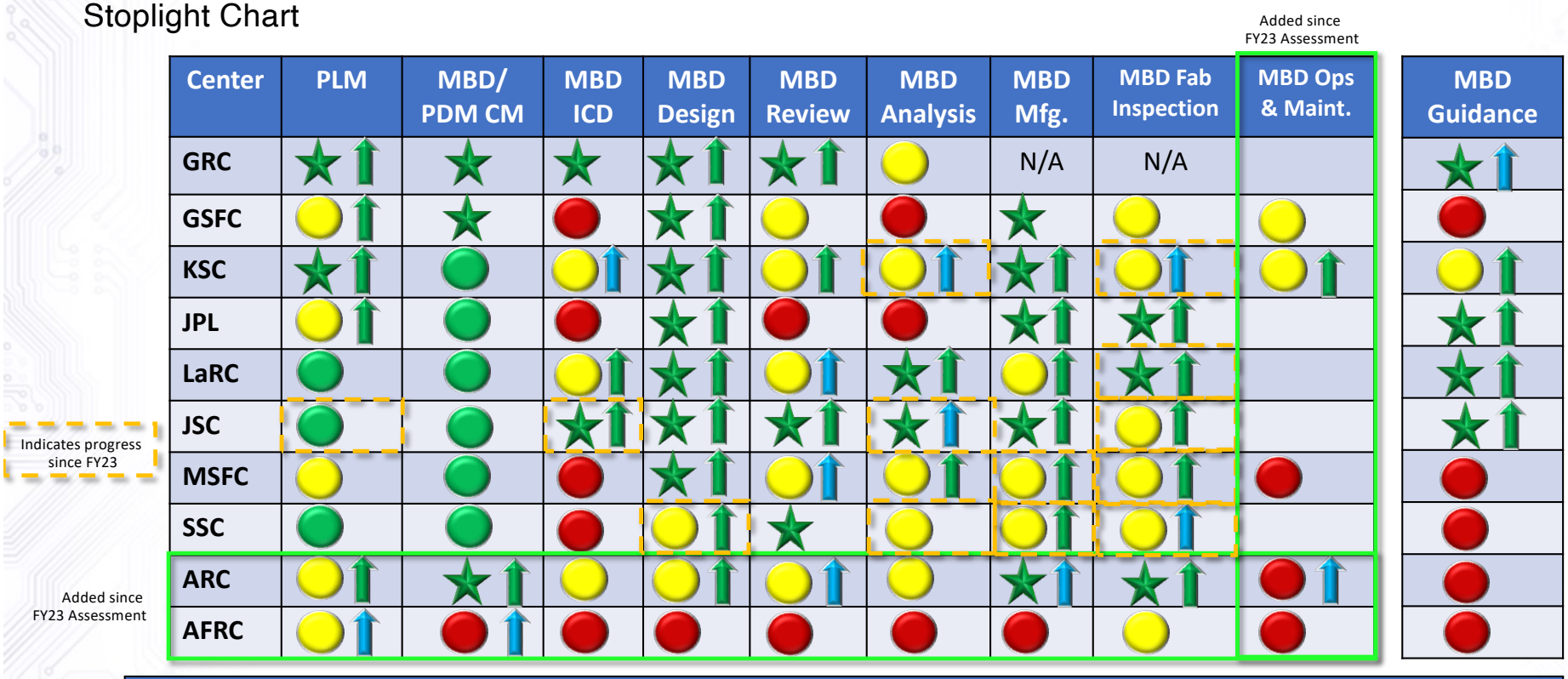
Model-Based Design, Manufacturing & Inspection Capabilities at a Glance

Stoplight Chart



In Place does not mean all activity utilizes the capability.

DE = Digital Engineering
MB = Model-Based
MBD = Model-Based Definition

ICD = Interface Control Document
CM = Configuration Management
PLM = Product Lifecycle Management

Connecting Tool ‘How To’ Articles

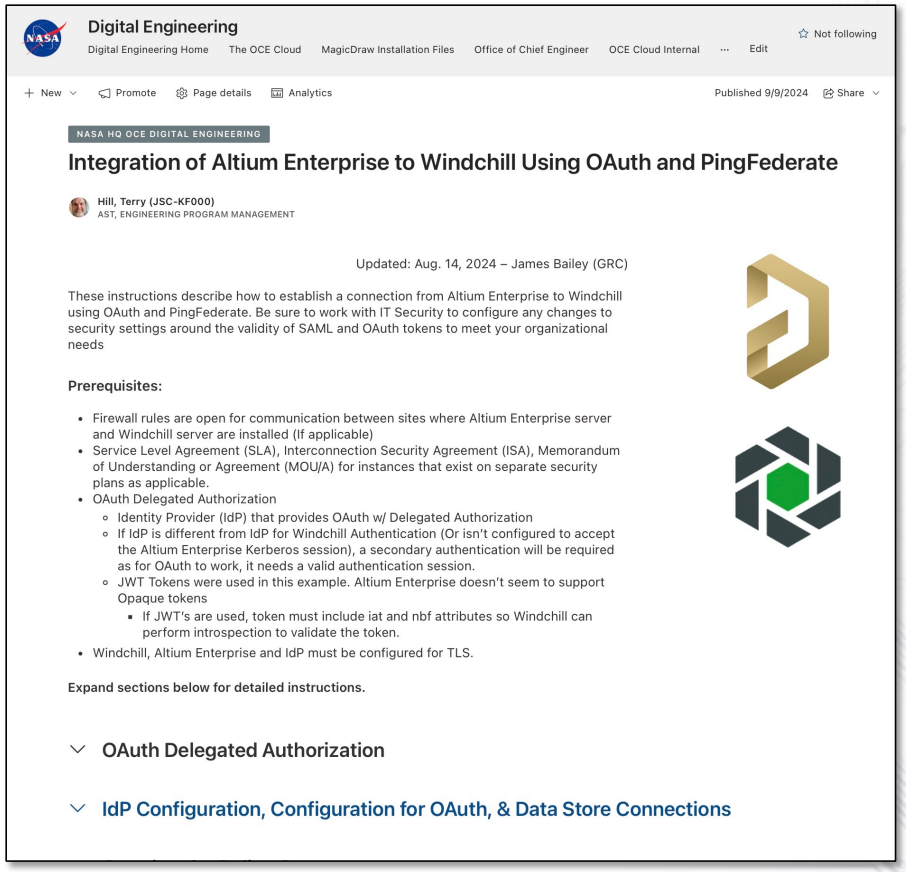
- Altium (ECAD PLM) to Windchill (Project PLM) Connection

As part of NASA’s digital Engineering tool chain discovery effort, when tools are successfully connected, the DE team is documenting how it is done and will make those instructions available to anyone within NASA.

The first was in connecting the Altium (ECAD) system with the Windchill (Project PLM) system, such that now ECAD, MCAD, and any desired Project artifact can now be associated and baselined in one location for a project.

https://nasa.sharepoint.com/sites/MBEng/SitePages/Integration-of-Altium-Enterprise-to-Windchill.aspx

More are on the way …



Digital Engineering

Digital Engineering Home | The OCE Cloud | MagicDraw Installation Files | Office of Chief Engineer | OCE Cloud Internal | ... | Edit

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NASA HQ OCE DIGITAL ENGINEERING

Integration of Altium Enterprise to Windchill Using OAuth and PingFederate

Hill, Terry (JSC-KF000)
AST, ENGINEERING PROGRAM MANAGEMENT

Updated: Aug. 14, 2024 – James Bailey (GRC)

These instructions describe how to establish a connection from Altium Enterprise to Windchill using OAuth and PingFederate. Be sure to work with IT Security to configure any changes to security settings around the validity of SAML and OAuth tokens to meet your organizational needs

Prerequisites:

- Firewall rules are open for communication between sites where Altium Enterprise server and Windchill server are installed (If applicable)
- Service Level Agreement (SLA), Interconnection Security Agreement (ISA), Memorandum of Understanding or Agreement (MOU/A) for instances that exist on separate security plans as applicable.
- OAuth Delegated Authorization
  - Identity Provider (IdP) that provides OAuth w/ Delegated Authorization
  - If IdP is different from IdP for Windchill Authentication (Or isn’t configured to accept the Altium Enterprise Kerberos session), a secondary authentication will be required as for OAuth to work, it needs a valid authentication session.
  - JWT Tokens were used in this example. Altium Enterprise doesn’t seem to support Opaque tokens
    - If JWT’s are used, token must include iat and nbf attributes so Windchill can perform introspection to validate the token.
- Windchill, Altium Enterprise and IdP must be configured for TLS.

Expand sections below for detailed instructions.

OAuth Delegated Authorization

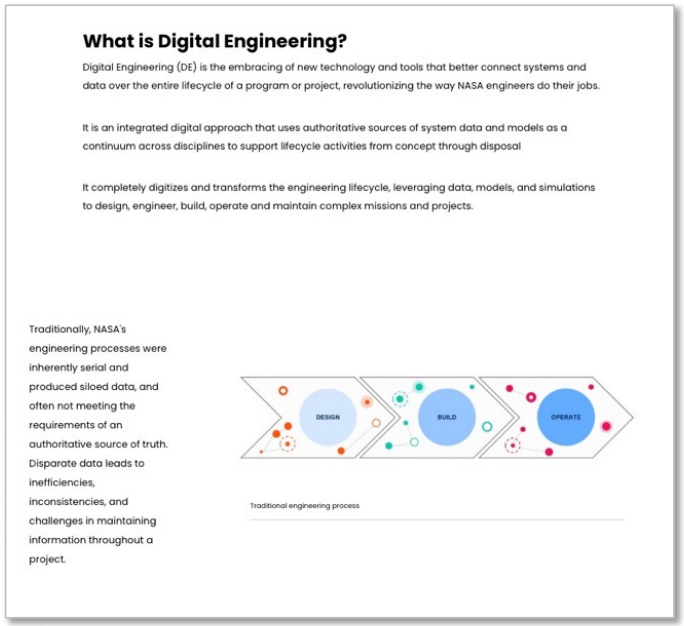
IdP Configuration, Configuration for OAuth, & Data Store Connections

DE Training

- OCE Created

NASA's Introduction to Digital Engineering

Launch Now



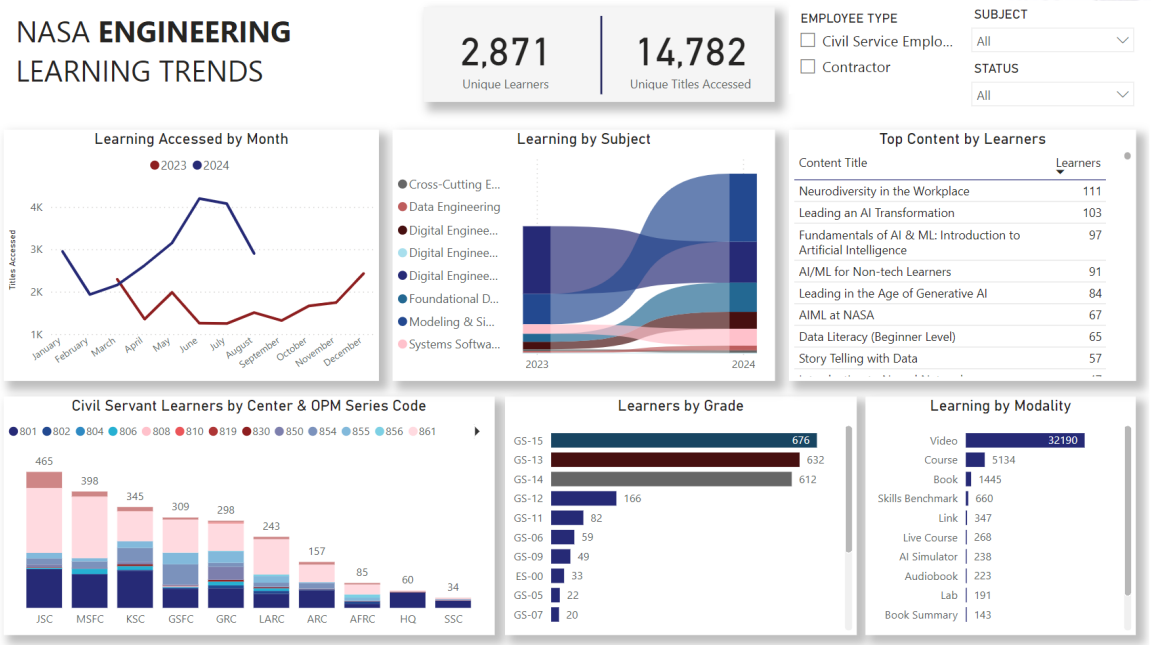
NASA's Digital Engineering Program Overview

NEW Launch Now

DE Training

Procured Self-Directed (Percipio)

- In FY24 the NASA DE Leadership Team made available almost **1000 online learning items (digital engineering training modules and digital books)**
  - Aligned with the NASA definition of digital engineering mapping of desired skill capabilities
  - Via COTS training platform
- Content area Managers identify and curate digital engineering resources from Agency training courses, other government learning providers, and private sector off-the-shelf courses and training videos
- Collecting these resources in one location provides a helpful entry point for personnel learning basic skills as well as those with more DE experience who need support to understand a particular tool or practice.
- **In FY24 (10/1/23 - 8/8/24) 1,378 NASA learners have accessed 581 unique learning items of the 1000 aligned with the NASA definition of digital engineering mapping of desired skill capabilities 2,870 times.**



* Only reflects people with engineering series code

Over 1000 on-line DE Training modules, ebooks, videos, etc.: NASA Digital Engineering

DE RFI to Industry Summary

RFI 1: Approach to RFPs, proposals, and contracts per traditional, or model-based acquisitions. If your preferred or recommended approach is via a model-based approaches, please provide:

- Objective measures as to the value and/or return on investment or increased capabilities the approach provides over the traditional,
- Past, sharable, examples of success stories and associated models/metamodels in native formats if applicable
- Past government customers (POCs) who can attest to the benefit and would be willing to share their perspective and lessons learned with NASA

RFI 2: Approach for future contractual engineering, quality, and safety data/informational deliverables, model assurance and assurance requirements to provide insight and inform critical decisions to support certification, operations support, operational anomalies, program, architecture, or mission integrations when elements, products, or services may be provided my numerous industry partners.

RFI 3: Approach to NASA/industry partner collaborative environments, collaborative engineering/integration/simulation/ digital twin environments. Please indicate the nature of engagement and/or lifecycle phases of a program/project you would typically value collaborating/integrating designs with NASA.

RFI 4: Approach to integration of engineering toolchain to form digital thread(s) from concept to operations. Recommendations on appropriate/recommended interfaces between models, systems, etc. when providing contract required data/information and/or collaboration with NASA.

RFI 5: Recommended commercial off-the-shelf solution(s) (COTS) for integration of your toolchain(s) with pros and cons.

RFI 6: Recommended industry data interoperability standards (or non-baselined "needed" standards) per engineering subdomain (e.g. ReqIF for requirement management software) and why.

RFI 7: Recommendations of what you would like to see common/consistent across the US government when it comes to digital engineering, procurement/acquisitions supporting engineering deliverables, and safety.

Summary:

- 42 Responses – 27 met minimum expectations
- 1 company responded via SysML models
- 4-5 considered very informative

DE RFI to Industry Summary

- Majority indicate MB Acquisition saves time and increases quality of all aspects of the process.
- Significant experience with integration of tools, forming the digital thread, and needed interoperability protocol standards.
- DoD, and industry in turn, are emphasizing the use of MOSA (Modular Open Systems Approach) and it is required by United States law Title 10 U.S.C. 4401(b), states all major defense acquisition programs (MDAP) are to be designed and developed using a MOSA (https://www.dsp.dla.mil/Programs/MOSA/):
  - Employs a modular design that uses modular system interfaces between major systems, major system components and modular systems;
  - Is subjected to verification to ensure that relevant modular system interfaces comply with widely supported and consensus-based standards; or are delivered pursuant to the requirements established in FY21 National Defense Authorization Act Section 804 (a)(2)(B)
- Toolchain: proposed COTS digital backbone solutions with bidirectional interoperability, extensibility and cross-project connectivity (including non-engineering needs), and with diverse vendor toolset (avoid vendor lock) for robust and customizable COTS toolchain
- Gov. should:
  - Establish standardized digital engineering frameworks and guidelines that can be adopted across government agencies.
  - Develop a unified procurement framework for government projects that integrates digital engineering principles.
  - Promote cross-agency collaboration and information sharing to facilitate the adoption of common digital engineering standards and procurement practices.

FY25 NASA Integrated Digital Engineering Transformation Team

Nov. 2024

Champions:
Charles Cockrell (LaRC) – DE Champion
Tony Sanders (GSFC) – DE Dep. Champion
Jonathan Ransom (LaRC) – Inter-Disciplinary Digital Engineering Co-lead & Champion

NASA Org Reps:
Tony Diventi (HQ) – OS&MA Rep
Christina Haymes (DT Architecture) – DT Rep.
Beth Sheridan (JSC) – NASA CM/DM CoP Lead
Trevor Grondin (LaRC) – NASA MBSE CoP Lead
Edward Mclarney (LaRC) – AI/ML Lead/Rep to DE
Phil Augustine (JSC) – Human Health & Performance

EMB IT WG
Pat McDuffy (MSFC) – Lead
- John Baca (AFRC)
- Paresh Bhavsar (ARC)
- Bob Zalewski (GRC)
- Michelle Longo (GSFC)
- Cindi Kingery (JPL)
- Jamie Payne (OCIO SLAM)
- Greg Stiggins (JSC)
- Tommy Mack (KSC)
- Chris Thames (LaRC)
- Dawn Davis (SSC)

OCE Cloud Team
George Plattsmier (MSFC) – Lead
Murali Raju (MSFC)
Lee Martin (MSFC)

Center Reps:
(Center Actions & Reporting)
- AFRC
ARC: Scott Miller – Rep
GRC: Derrick Cheston – Rep
GSFC: Aaron Comis – Rep
JSC: Greg Pierce – Rep
JPL: Chris Delp – Rep
KSC: Dan Sparling – Rep
LaRC:
- Amanda Cutright (LaRC) – Rep
- Anna-Maria McGowan (LaRC)

MSFC: Justin Pociask – Rep
SSC: Zachary Lewton – Rep

Terry Hill – OCE/HQ DE Program Manager
Trish Nicoli (KSC) – Deputy Manager
Tom Engler (KSC) – Associate Manager

Systems Engineering & Integration
Trish Nicoli (KSC) – DE SE&I Lead / MLT Lead
- Karma Snyder (SSC) – DE Integration Lead
- Josh Heeren (JSC) – DE SE / Modeling Lead
- ?? – DE Smart Review Lead
- NPR Modeling –
  - Rob Morgenstern (GSFC)
  - Edie Parrott (GRC)
  - David Chiras (KSC)

MBSE Leadership Team - Trish Nicoli (KSC) – Lead
Trevor Grondin (LaRC) – MBSE CoP Lead
Beth Sheridan (JSC) – NASA CM/DM CoP Lead
Josh Heeren (JSC) – Modeling Lead

Processes Group
- Edie Parrott (GRC)
- Rob Morgenstern (GSFC)
- Steve Cornford (OSMA)

Tools Group
- Samantha Infeld (LaRC) – Lead
- Alberto Blanco (LaRC)
- Brian Ferguson (LaRC)
- Paul Gill (MSFC)

Stephen C. Waterbury – PEDS Rep.
Christina Haymes – DT Int. Lead
Tony Diventi – OSMA Rep
Jon Holladay – OCE SE TDL

Workforce Group
- Tim Schuler (GRC) – Lead
- Frank Gati (GRC)
- Zachary Lewton (SSC)

Center Reps
- Christopher Acuff – AFRC
- Greg Pierce – (JSC)
- Dan Sparling – KSC
- George Plattsmier – MSFC
- Scott Miller – ARC

DE Training
??
Jess Deibert – Communication / Education / Training

Integrated Toolchain / Data Thread
DE Toolchain Lead – Albert Blanco (LaRC)

- PLM Lead - Tim Stiglets (SSC)
  Active Members:
  - GRC – Jim Bailey, Bob Zalewski
  - JSC – Jeff Reilly, Chris Hare
  - KSC – Stephen Deblois, Trish Nicoli
  - LaRC – Nick Vitullo, Shawn Taylor, Jan Puchalski
  - SSC – Thang Le

  Center POCs:
  - AFRC – Joseph Gonzalez
  - GSRC – Al Goncer, Laura Ingram
  - MSFC – Steve King (ICE), David Whitten
  - HQ Logistics – Vince Cappello
- MBSE Tools Lead - ??
- Design to Manufacturing Lead - David Whitten (MSFC)
  - AFRC – Joseph Gonzales
  - ARC – TBD
  - GRC – Jack Dalzell, James Bailey
  - GSFC – Al Goncer, Ryan McClelland
    - Supporting: Aaron Comis, Oneal Cunanan, Laura Ingram, Brian Simpson
  - JPL – Eduardo Dorantes
  - JSC – Sean Miller, Robert Blaine
    - Supporting: Kelly Bryant
  - KSC – Adam Dokos, John Ingalls
    - Supporting: Curtis Dugger, Brian Kryszczynski,
    - Stephen DeBlois
  - LaRC – Jared Fell, Nick Kemp
    - Supporting: Scott Hill, Greg Phillips
  - MSFC – Jim Meehan
    - Supporting: Robby Bilbrey, Zach Taylor
  - SSC – Jonathan Dickey
    - Supporting: Tim Stiglets
- Greg Pierce (JSC) – SysML Digital Twin Lead
- Steven Arnold (GRC) – Advanced Materials Devel. w/AI
- Inter-Disciplinary Digital Engineering Lead – Aaron Comis (GSFC)
  - Co-leads: Jonathan B. Ransom (LARC), Michael M. Madden (LARC), Thomas Chen (JSC)
  - AFRC – Wesley Li
  - ARC – Nathan Benz
  - GRC – Steven Arnold, Karl Vaden, Robert Falck, Shira Nadile
  - GSFC – David J. Benson
  - JPL – Gregory Davis
  - KSC – Curtis Dugger, Hannah Jarrett, Brian R. Kryszczynski, John Ingalls, Doug Willard, Craig Fortier, Stephen DeBlois, Patricia Nicoli
  - JSC – James Smith, Lui Wang, Jeffrey Michel, Benjamin Quasius
  - LaRC – Bil Kleb, David H. Covington
  - MSFC – Christopher J. Spencer, Jaganathan Ranganathan
  - SSC – Paula L. Hensarling
  - HQ-OCE – Robert Moreland
  - Generative Design CoP – Ryan S. Mcclelland (GSFC)
  - Uncertainty Quantification CoP –
    - Giuseppe Cataldo (GSFC)
    - James E. Warner (LARC)
- ?? – Generative Topological Optimization Lead
- Tanya Andrews (MSFC) – AR/VR Lead

Yellow text indicated open position. Green text indicates multiple duties.


REACH
NEW
HEIGHTS
REVEAL
THE
UNKNOWN
BENEFIT
ALL
HUMANKIND
NASA DIGITAL
TRANSFORMATION
Questions?
Chart cleared for public release Jan 9 2024