ptc

LIVEWORX

A NEW ERA IN PRODUCT LIFECYCLE INNOVATION

SESSION ID: PL1881B

# NASA'S DIGITAL ENGINEERING TRANSFORMATION


**Terry R. Hill**

*NASA Digital Engineering Transformation Lead*


May 15, 2023


# NASA's Digital Engineering Transformation

Terry R. Hill

May, 2023

"It is not necessary to change. Survival is not mandatory."

(W. Edwards - Deming Institute, 2019)

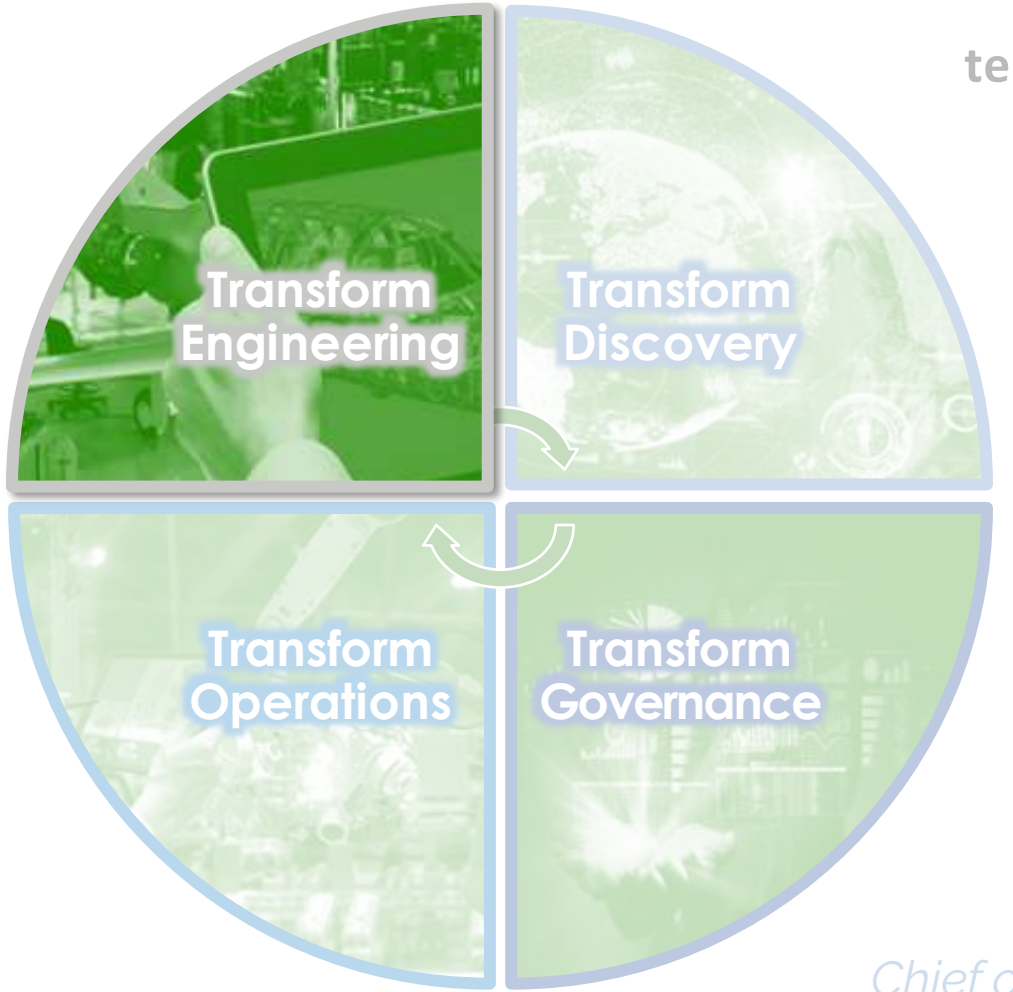
# AGENDA

- The Big Picture: DT and The Transformation of Engineering Quadrant
- Transformation of Engineering – It takes a village …
- Digital Engineering Framework
- Things which have been accomplished
  - Integrated Digital Engineering (DE)
  - Orion Digital Twin
  - MBSE
- The plan going forward
  - The Agency
  - Centers

# PROPOSED TRANSFORMATION TARGETS – DIGITAL LEVERS

**Enable agile multi-center/partner engineering teams to solve frontier problems**

*Executive Sponsors: MDs, OCE, OSMA, Centers*




Multiply science & technology breakthroughs by leveraging diverse global minds/advances

*Executive Sponsors: OCS, OTPS, MDs, Centers*

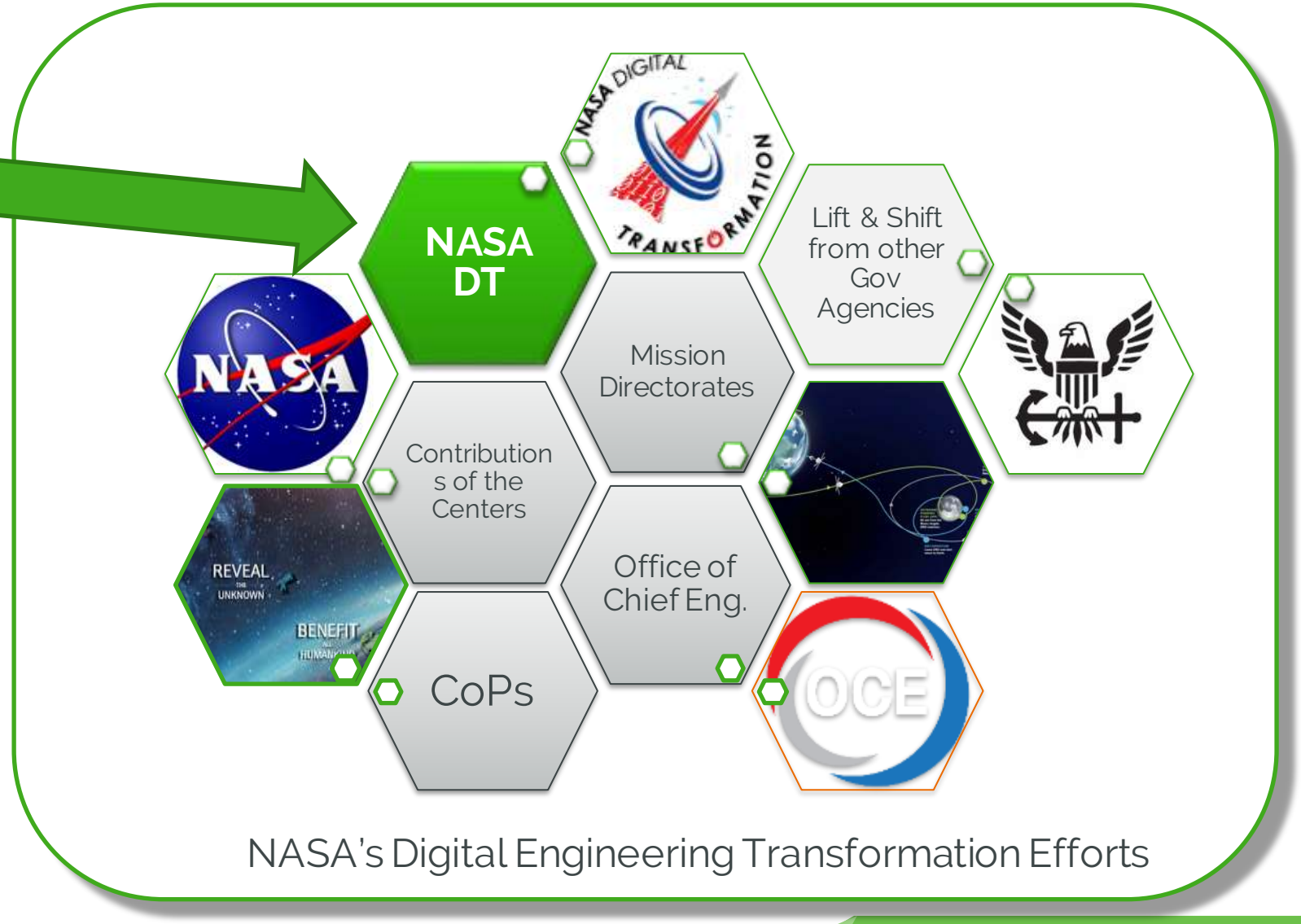
Optimize & synchronize our work environment to increase efficiencies & effectiveness between mission & mission support

*Executive Sponsors: MSD, Centers, MSEOs*

Accelerate risk-informed, self-consistent decision making

*Executive Sponsors: Chief of Staff/OES, CPMO, MDs*

# TRANSFORMATION OF ENGINEERING – IT TAKES A VILLAGE


NASA's Digital Engineering Transformation Efforts

# TRANSFORM ENGINEERING – AREAS OF FOCUS

## Need:


**Enable agile multi-center/partner engineering teams to solve frontier problems via integrated digital engineering**

## Goals (agreed to by EDs @ EMB 11-04-21):

1. Establish Engineering Ecosystem Across the Engineering Life Cycle, including Best Practices
2. Formalize the Development, Integration, and Use of Models
3. Provide Integrated Engineering Data
4. Develop protocols and IT tools to enable collaboration
5. Evolve Culture and Workforce

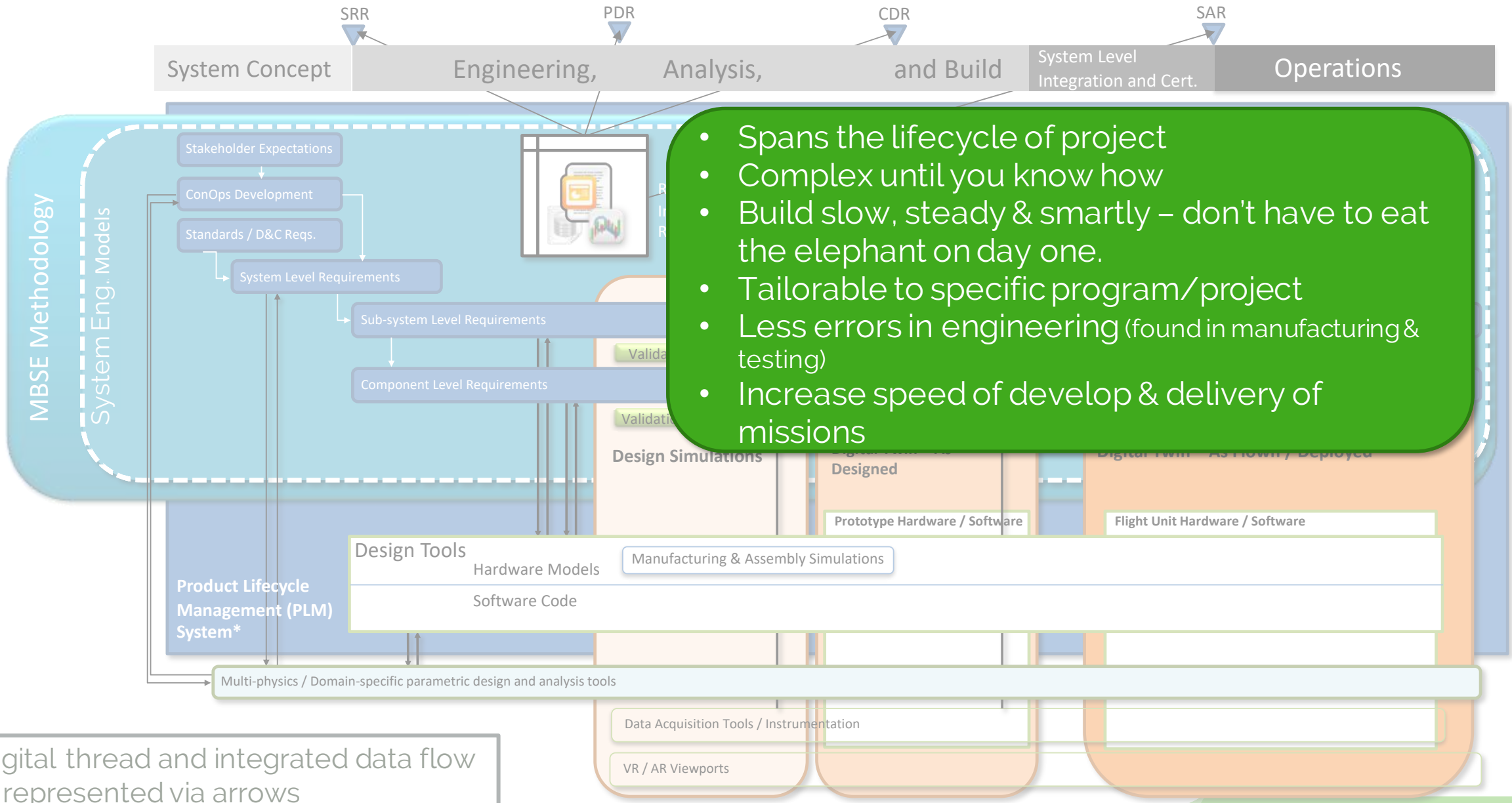
## Objectives:

- Inclusive, integrated **multi-center/partner teams**
- Shared **interoperable development environment** that enables agile interdisciplinary modsim/test, rapid learning & diverse mission-driven approaches
- **Integrated cross-org, configuration managed, data-centric processes** to rapidly & affordably develop/evaluate options & close complex designs
- **Authoritative, discoverable design/analysis/test artifacts** with integrated **confidence measures, and common taxonomies/ontologies.**
- **Multi-fidelity digital twins** to enable rapid concept-design-develop-build-test-evaluate-operate **life-cycle** engineering solutions & partner efforts

## Approach:

- Tailorable to programs/projects
- Address current Pain points
- Achieve needed efficiencies
- Fill capability gaps needed today and for tomorrow

# Integrated Digital Engineering Framework per Lifecycle of a Project




- Spans the lifecycle of project
- Complex until you know how
- Build slow, steady & smartly – don't have to eat the elephant on day one.
- Tailorable to specific program/project
- Less errors in engineering (found in manufacturing & testing)
- Increase speed of develop & delivery of missions

Digital thread and integrated data flow is represented via arrows

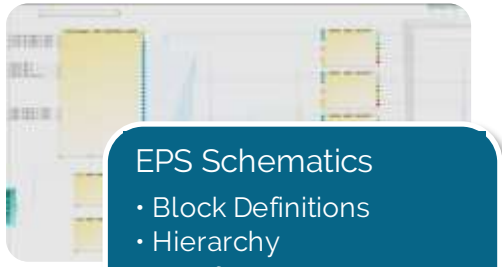
* Some PLM systems may integrate with multi-physics tools and/or store analysis results.

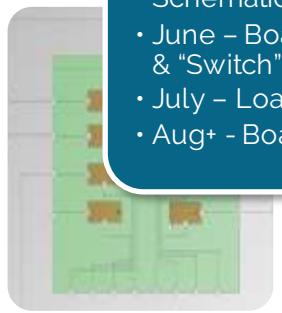
# Orion DT Project 2021-2022 Plan & Milestones

FY2021 | 2022

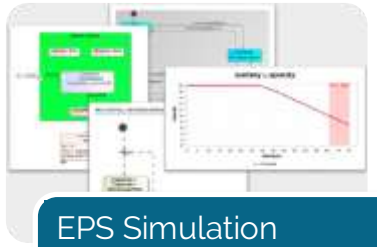
March | April | May | June | July | August | September | October | November | December | January | February | March | April | May | June | July | August | September

## Development
- Prototype
- Depth Trade
- Domain Research





## EPS Schematics
- Block Definitions
- Hierarchy
- Interfaces
- Schematic Integration
- June – Board interfaces & "Switch" details
- July – Loads
- Aug+ - Board internals



## EPS Simulation
- Define Sim Scenario
- Define behavior model
- Develop GUI for live mission scenario

## EPS Twin Integration
- Telemetry Interface
- Operational Data Interface
- Parameter Definition

## Artemis I Test Case
- Feedback from live mission use by EPS engineering team

## EPS Digital Twin Validation/Evaluation
- Model-Based Review
- Live Reviews
- Automated Audits

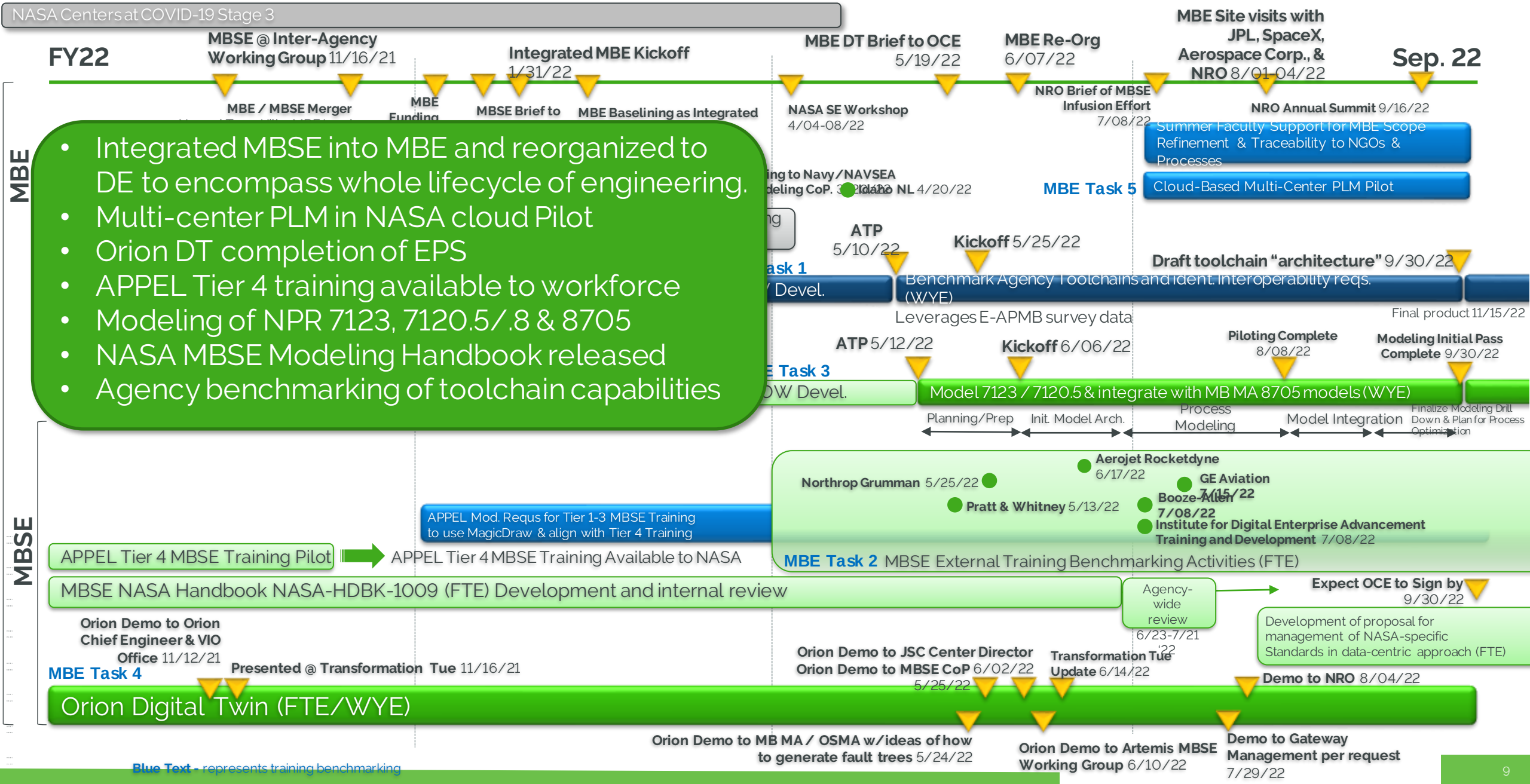
## Further Subsystem Development
- Multi-Domain Simulation
- Tool Integration
- Comprehensive Digital Twin Framework

Initial proposal included 10 months of modeling and 8 months of validation per system.

- Project Execution: Team finished modeling and initiated script-based verification in Dec-Jan '22 per plan. Spring of '22 performed internal checks of the content that couldn't be verified using scripts, and delivered models, scripts and lessons learned to the NASA CoP.

## Package for Agency Wide Use
- Lessons Learned
- Sanitized Model
- Script Library
- Reusable Components

# YEAR 1 (FY22) DIGITAL ENGINEERING ACTIVITIES



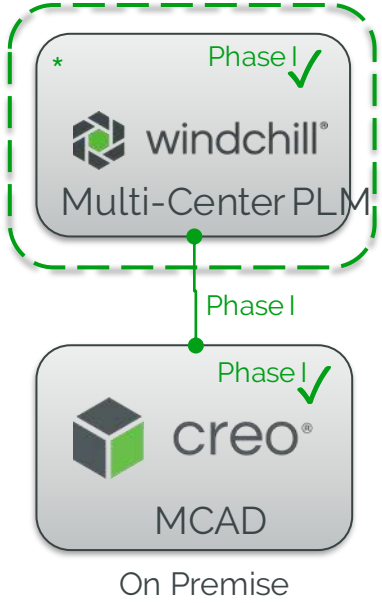

- Integrated MBSE into MBE and reorganized to DE to encompass whole lifecycle of engineering.
- Multi-center PLM in NASA cloud Pilot
- Orion DT completion of EPS
- APPEL Tier 4 training available to workforce
- Modeling of NPR 7123, 7120.5/.8 & 8705
- NASA MBSE Modeling Handbook released
- Agency benchmarking of toolchain capabilities

# PHASED INTEGRATION PILOT OF COMMONLY USED ENGINEERING TOOLS

Phase I – FY22

## Multi-Center PLM System Goals

- Provide cloud-based repository to manage drawings, models and all project baselined artifacts including a release process workflow
- Improve data accessibility
- Integrate with agency systems and processes
  - (Launchpad, NAMS)
- Broaden usage across centers improving system utilization
  - Manufacturing, Quality, EDCC users
- Improve system security through consolidation
  - Reduce cost by only having one security plan

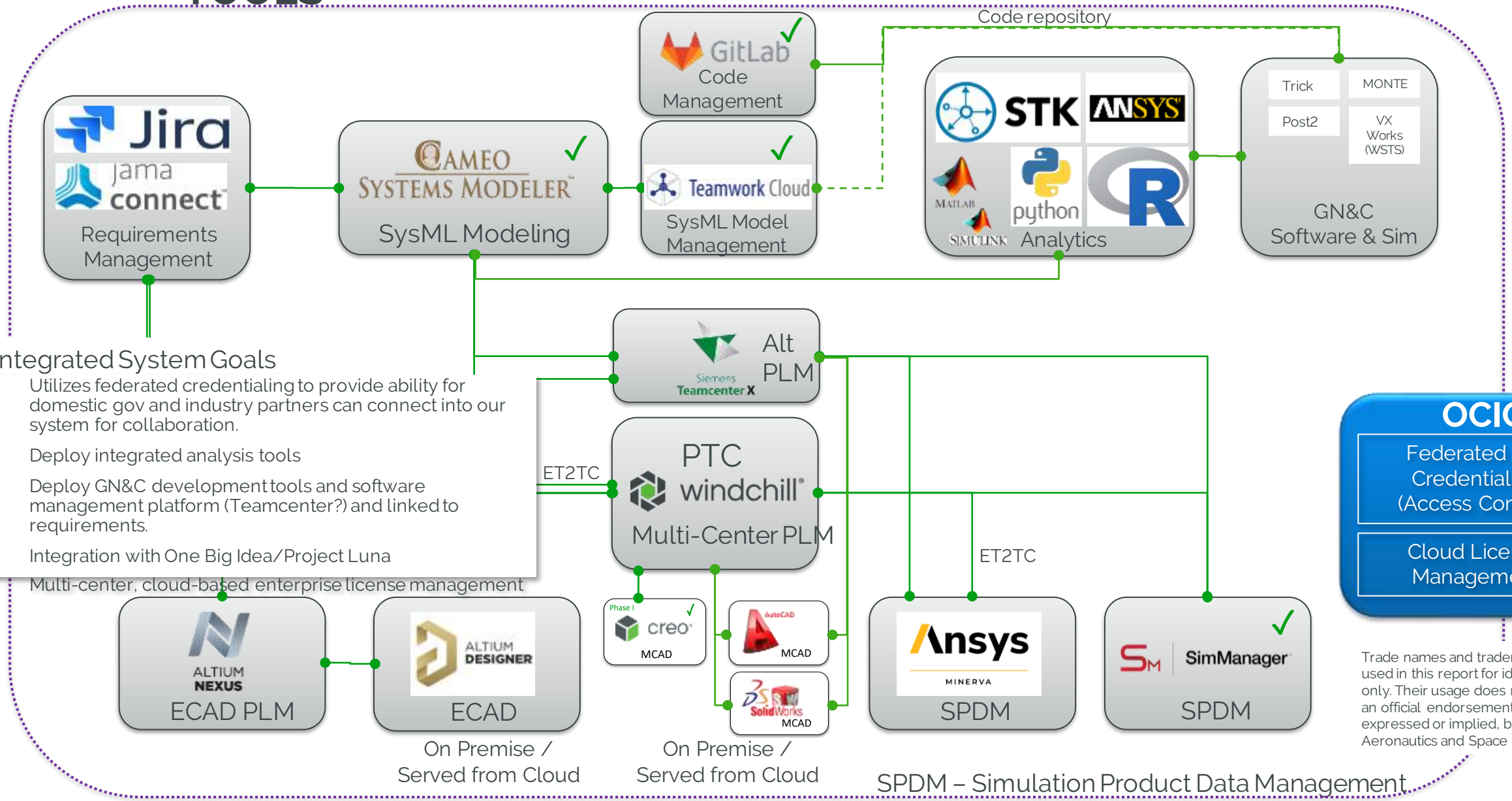



Participating Centers:
- KSC
- JSC
- GRC



* Any mention of specific vendor tools doesn't imply endorsement by NASA

# PHASED INTEGRATION PILOT OF COMMONLY USED ENGINEERING TOOLS



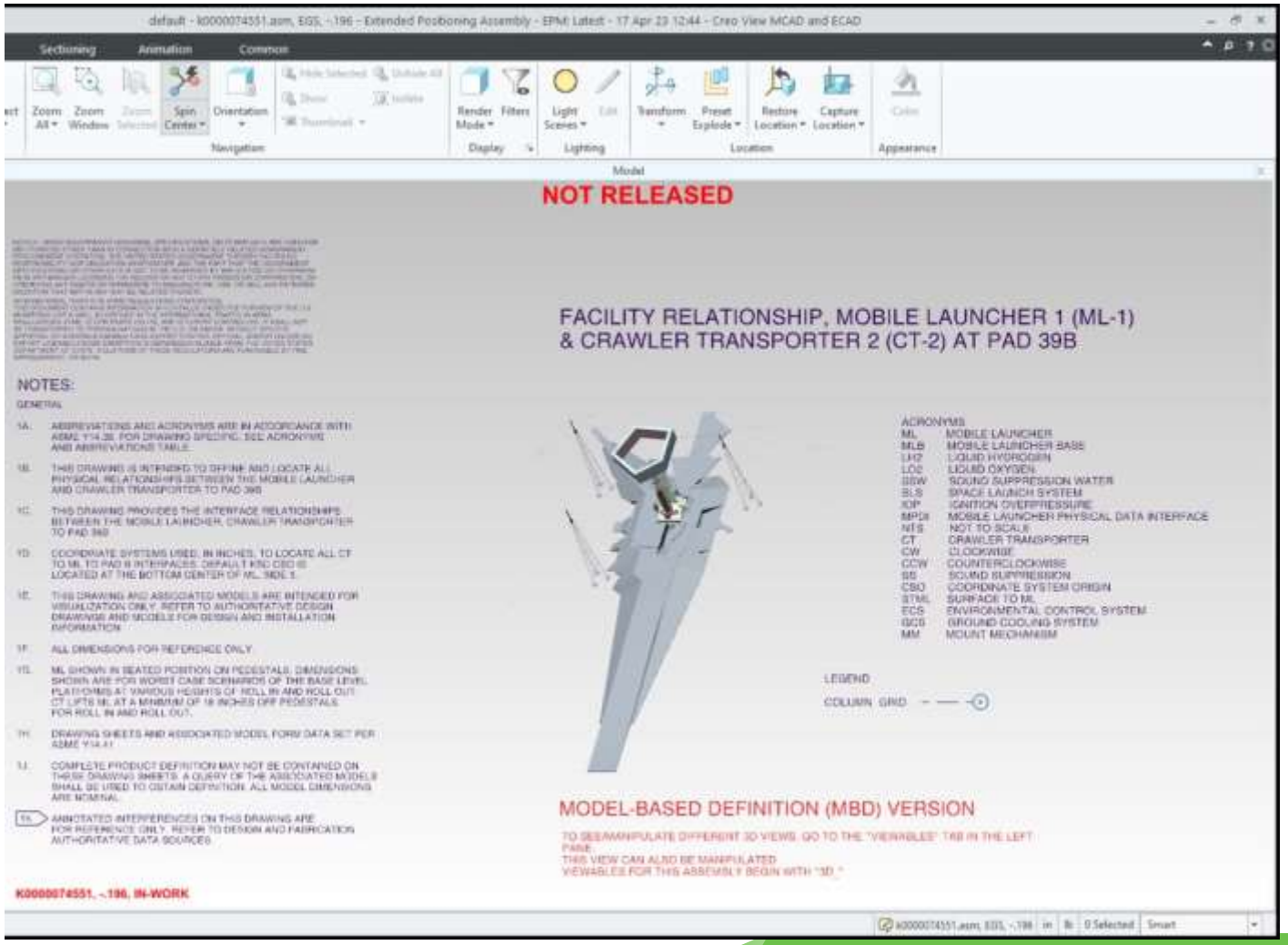



ET2TC - Exiting tool to tool connector

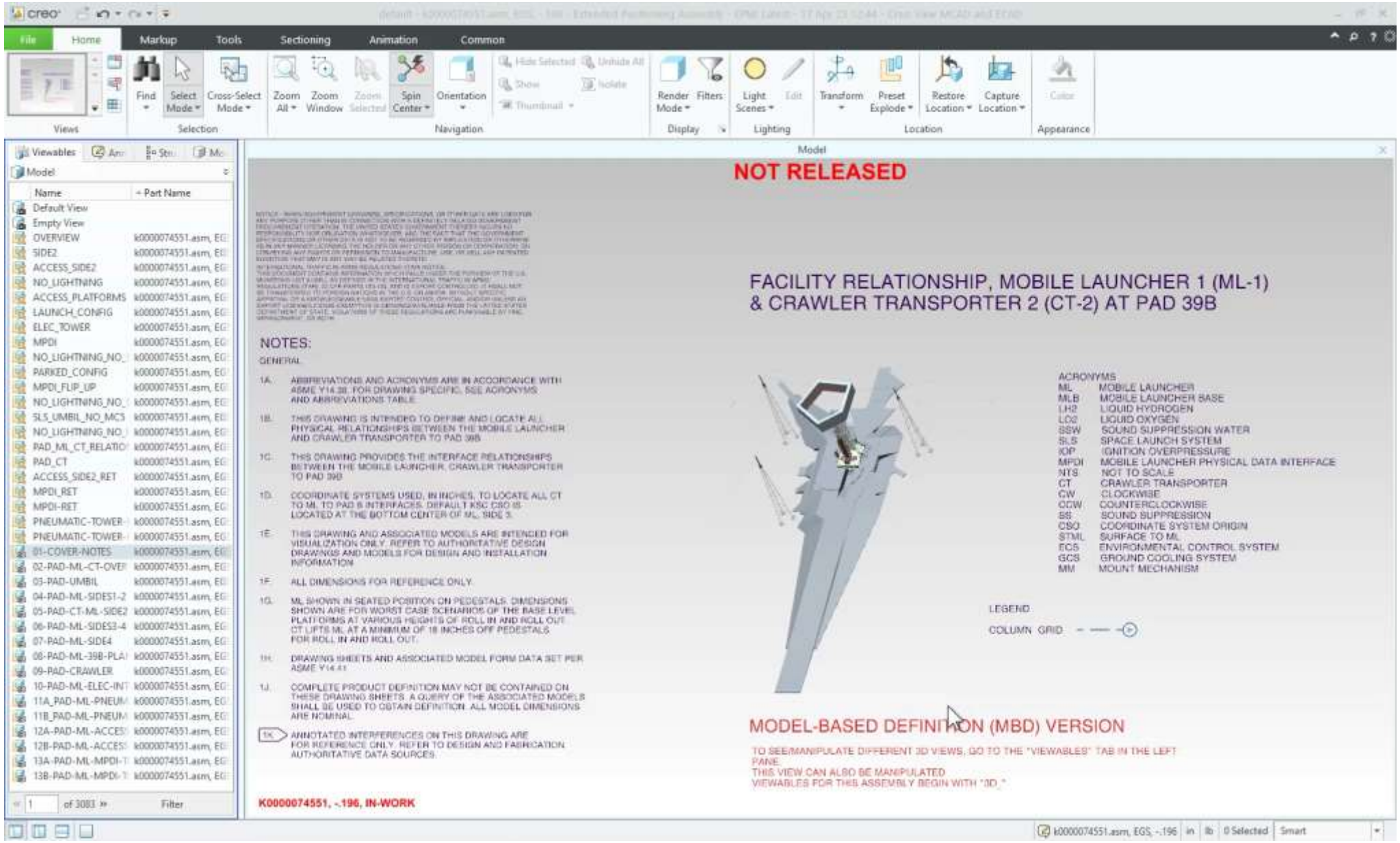
# VERY LARGE 3D MODEL USAGE

## Kennedy Space Center

- Launch Pad model created from scanned point-cloud
- Volumetric SLS model
- As-Designed crawler and Launch Tower



# VERY LARGE 3D MODEL USAGE



# GOING FORWARD

# FY23 DIGITAL ENGINEERING PLAN

## Close Partnership with the Center Engineering Directorates:

- Direct involvement to better understand current capabilities, where they want to get to.
- Leverage current capabilities of Centers with other Centers in need of the capability.
- Formulate a plan for pilot projects which advance a Center's needs and those of other Centers.

**Complete Agency Process Mapping** and perform Data-centric optimization, formulate interoperability requirements, and recommended toolchain with short list of tools per domain per project/program lifecycle.

## Domestic Partners:

- Release a RFI for recommendation for successful digital engineering toolchains to solution providers, to inform NASA's internal recommendations in the event there are unknown unknowns to NASA in this area.
- Release a RFI to domestic partners regarding how they would like to do business with NASA, collaborate, exchange data via contractual mechanisms to shape NASA's near-term capabilities.

## International Partners:

- Engage to develop capability to securely collaborate and exchange information seamlessly.

# FY23-25 DE TRANSFORMATION PLAN

## Notional / Pre-Decisional

Theme or Major initiative
Agency Activity
Agency Planning Activity
Recommended Center Activity

**Digital Transformation Workshop (Gov only) @ LaRC**
10/25-27/22

**RFI for how to do DE with NASA to Industry**
12/XX/22

**DE EMB at Face 2 Face**
11/30/22

**DE EMB Status** 11/10/22

**Sep. 25**

**DE**

Understand lift-&-shift ops w/DoD
Plan lift-&-shift w/DoD
Execute lift-&-shift w/DoD

Eng. Digital Toolchains

Understand Center's capability gaps – devel. Lift-&-shift ops.
Finalize Agency Phase I toolchain baseline survey
Finalize Center agreements of their contribution to
Identify other tools which benefit multiple centers cloud
ining gaps / infuse newly identified needed
nt integrated digital engineering as baseline approach
indings &

**Capabilities in 3 Years:**

- Cloud-base PLMs
- Broad utilization of MBSE
- Data-centric engineering workflows
- Broad utilization of integrated Eng. toolchains
- Federated Authoritative Sources of Truth

**Cloud-Centric Solution Space**

Cloud-Based Multi-Center PLM Governance & Sustainable business model
Support planning for centers interested in migrating

**Data & Processes**

Centers understand where their ASoT are & data
Centers understand core processes – map/model/ analyze for data centricity
Centers integrate toolchains and structured data constructs for ASoT

**Provide Recommendations for update of NPRs**
04/xx/23

**MBSE**

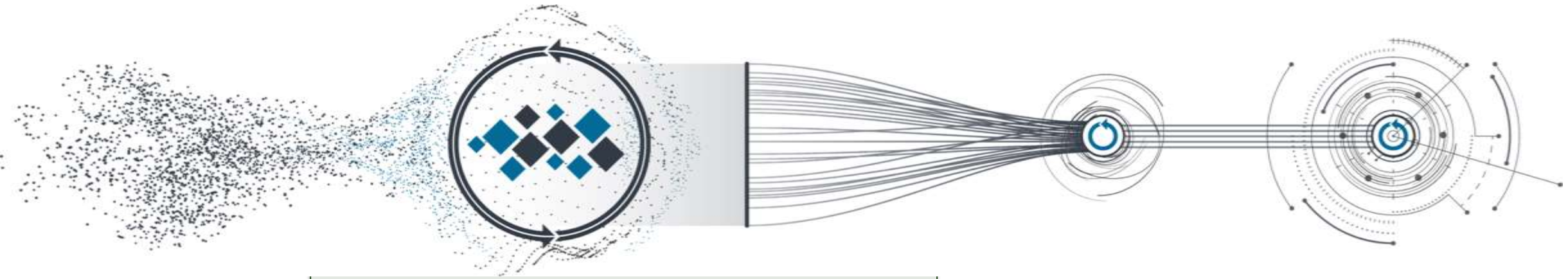
Model & analyze 7123 / 7120.5 & integrate with MB MA 8705 models
Update of approved changes to NPRs
Finalize interoperability and data format requirements
Explore unification of 7123, 7120.5/.8 & 8705 into centralized model flagged by discipline.
Update of approved changes to NPRs & training
Support flow down modeling of Center processes from parent NPRs
Support flow down modeling of Center processes from parent NPRs

Understand lift-&-shift ops w/INCOSE
Execute lift-&-shift w/INCOSE
Understand lift-&-shift ops w/DoD
Execute lift-&-shift w/DoD

MBSE Capability Maturation

Perform rev 3 of MBSE Cap Asses.
Centers update local processes/documentation
Devel. Tier 5 APPEL Reqs.
Pilot Tier 5 MBSE APPEL Course
Update NASA-HDBK-1004
Update NASA-HDBK-1009
Centers implement MBSE as baseline approach on projects – hybrid approach for project reviews (models which produce trad. artifacts

# SIMPLIFIED DIGITAL ENGINEERING IMPLEMENTATION APPROACH



**Today's practices**

Identify your processes & tools by function and domain, and data repositories

**2023**

**Model processes and baseline toolchains**

Identify which primary tools are available to multiple people (server/cloud noted by blue circle). Identify needed interoperability between data repositories.

**Common host tools and link/pass data with minimal effort**

Data exchange between primary tools is automated or with minimal mouse clicks

**2024**

**Link in specialty / parametric tools**

Secondary / analytic tools are available in enterprise solution and are linked in with primary tool chain and digital twins

**2025**

**Domain fully-integrated tool chain and data-centric processes and data constructs**

Consistent Digital Engineering Across the Agency

Seamless Data-centric Integration, collaboration, data exchange with Domestic and International Partners.

**Shift in Agency/Eng. Culture**


REACH
NEW
HEIGHTS
REVEAL
THE
UNKNOWN
BENEFIT
ALL
HUMANKIND
NASA DIGITAL
TRANSFORMATION
Questions?


## Please fill out the session survey.

Take your post-session survey(s) either in the event mobile app or via email post-event.

Your feedback provides us with valuable information on how to shape future content strategy for the event!

# PROVIDE SESSION FEEDBACK

ptc

LIVEWORX

A NEW ERA IN PRODUCT LIFECYCLE INNOVATION

# THANK YOU

LIVEWORX.COM | **#LIVEWORX**

ptc.com