National Aeronautics and Space Administration

Transformation Portfolio (TxP)
Cloud and Computing Services (CCS)

NASA Digital Ecosystem Pilot

Lessons Learned

Aaron Comis
NASA Goddard Chief Engineer for Digital Engineering
Digital Engineering Ecosystem (DEE) Project Manager
Office of the Chief Information Officer

BLUF

- Existing NPR-7120.7A (NASA Procedural Requirements for Information Technology Program and Project Management) processes are primarily document-based
- Recent updates made to support an Iterative Lifecycle approach (vs traditional), but documentation and board reviews are still primarily document-based
- The Digital Engineering Ecosystem (DEE) pathfinder attempted to fit modern Digital Engineering practices into the boundaries of document-based review structure
  - The following charts are excerpts from various completed Gate Reviews and KDPs using the NASA OCIO (Office of Chief Information Officer) Iterative Lifecycle Review Template (ILRT)
- Efficiencies gained using Digital Engineering processes enabled a single part-time Project Manager to successfully satisfy NPR-7120.7A governance at an accelerated timetable*
- Further efficiencies can be achieved by integration engineering applications to for project-scale synergies
  - This is the intent of the Digital Engineering Ecosystem (DEE) pathfinder itself, specifically to unlock the potential of NASA-industry partnership and collaboration

*at time of publication

Project Executive Summary (All Releases)

Problem / Purpose

Start/FAD Date: 12/3/2024 **End/PCR Date: 12/30/2025**

Background/Problem Statement

- NASA currently lacks a comprehensive digital ecosystem that can seamlessly integrate applications, manage identities, and facilitate collaboration across projects with external partners. This deficiency hinders NASA's ability to implement data-centric, digital engineering capabilities effectively.

Project Purpose

- The Digital Engineering Ecosystem (DEE) will serve as a strategic pathfinder that demonstrates critical technologies required for NASA engineering project collaboration through a common, publicly accessible front door. This project will provide a foundational proving ground for the HQ Office of the Chief Engineer (OCE) vision towards the realization of a data-centric, digital engineering capability for NASA. Existing OCIO infrastructure will be used where possible/practical, with an intentional focus on hosting applications within the Mission Cloud Platform (MCP).
- One critical identified gap is VPN-less federated credentialling with portable identity across connected source systems and applications, which is a long missing critical project need to enable seamless NASA-to-partner collaboration. ICAM EAM EntraID solution will be critical path for user-to-app and app-to-app authentication, as well as external partner onboarding.

System Architecture
System Description

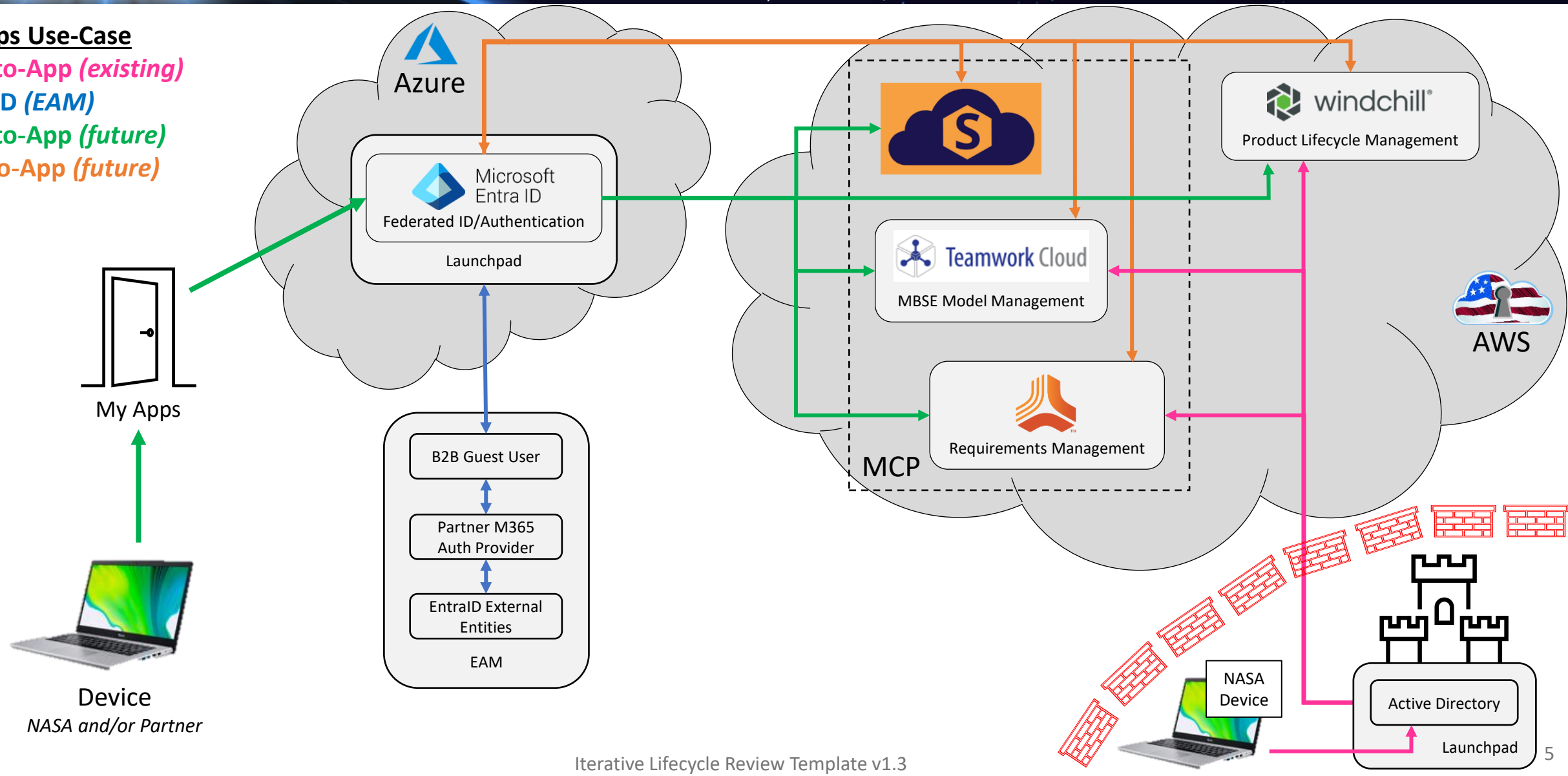
ConOps Use-Case

User-to-App *(existing)*

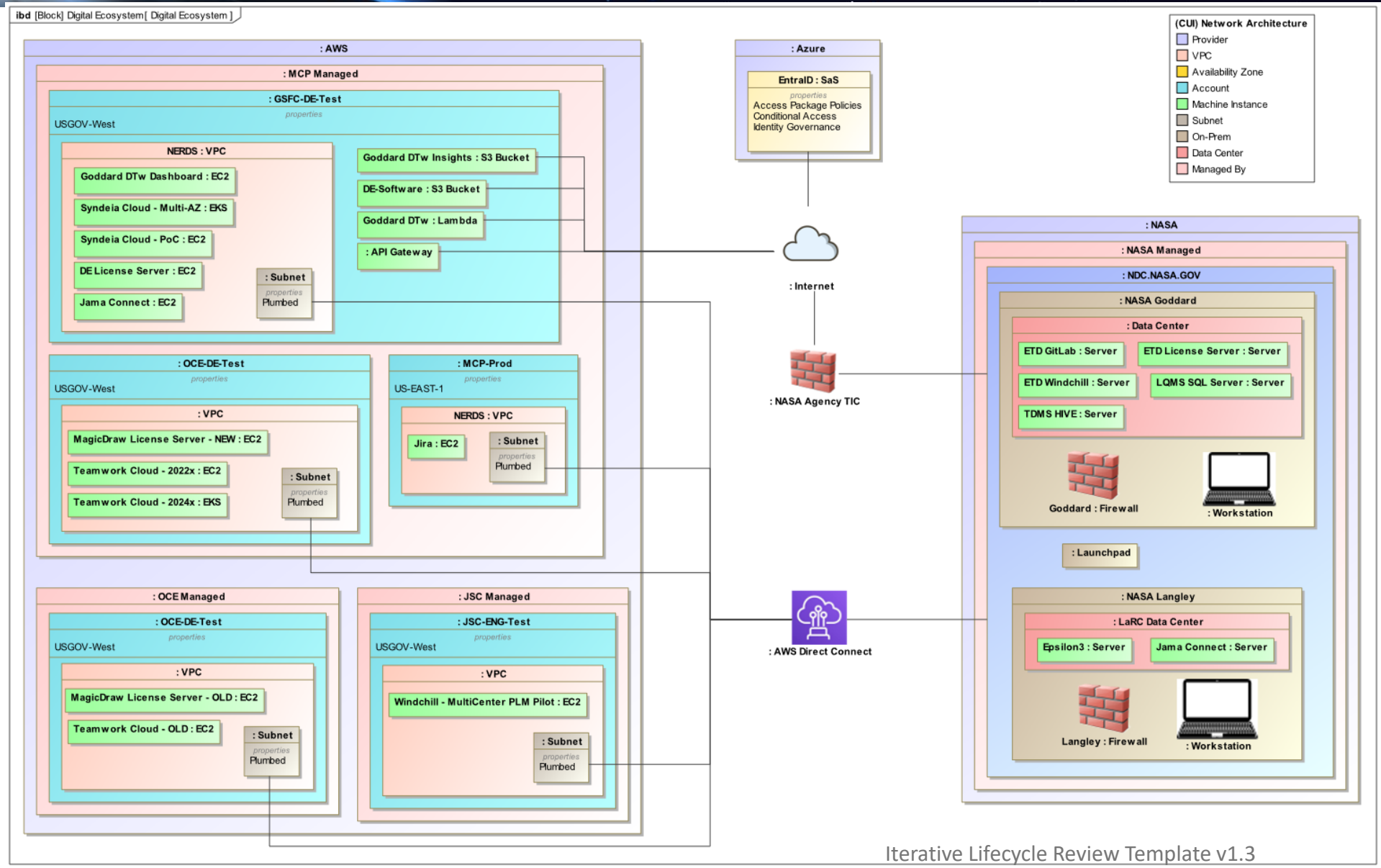
EntraID *(EAM)*

User-to-App *(future)*

App-to-App *(future)*



System Architecture
System Description



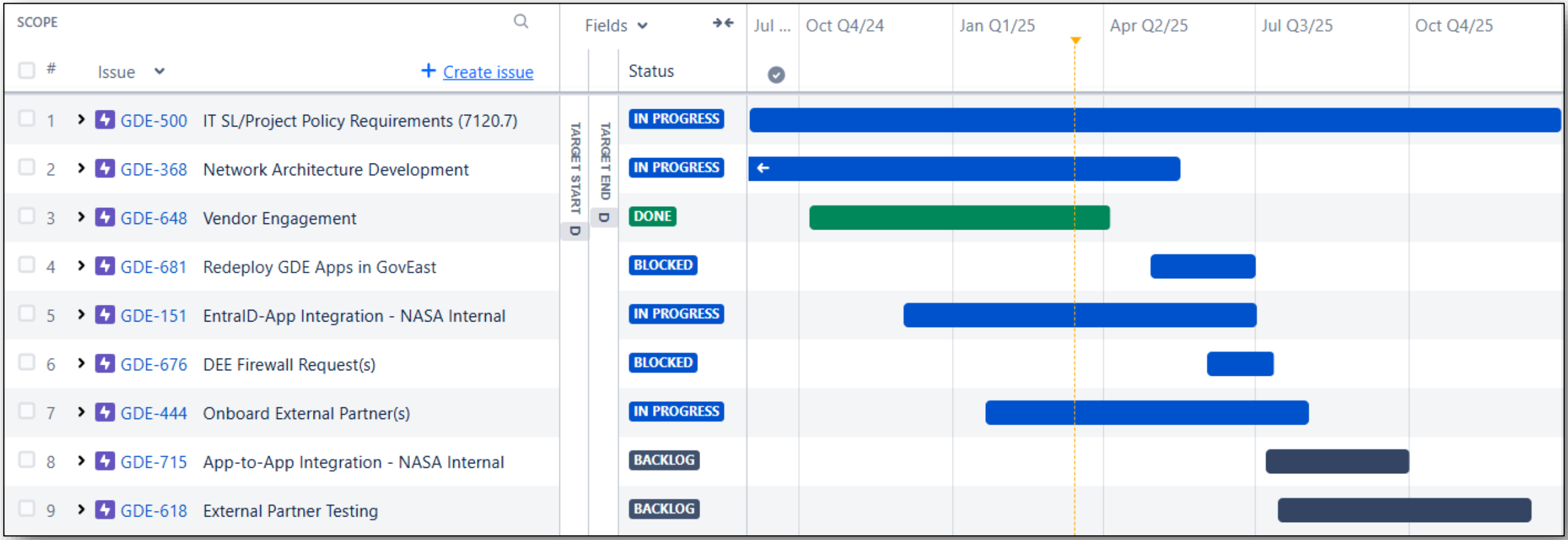
Scope

- This project will build out the foundational elements required to prove out at a small scale the technical viability for a potential digital engineering enterprise capability, in direct alignment with NASA's Office of the Chief Engineer.
- Minimally viable capabilities for the Digital Engineering Ecosystem include:
  - Fully operational Syndeia tool within standard staging-production environments, using production-ready provisioned resources.
  - Integration of Syndeia, Windchill, Teamwork Cloud, and Jama.
  - Instructions on how to request NAMS access to the Digital Thread.
  - Instructions on how to setup local clients and plug-ins.
  - Instructions on how to setup a new project, as well as how to connect to an existing project.
  - Technical feasibility for external partner to authenticate into publicly accessible 'front door' and access connected applications without VPN.
- Minimally marketable capabilities for the Digital Engineering Ecosystem include:
  - Instructions on how to establish new Digital Thread tool integrations.
  - Matrix showing tool integration and authentication status.
  - Commented Jupyter Notebooks (Python), with starter template scripts for querying.
  - Demonstration of ability for external partner to authenticate into publicly accessible 'front door' and access connected applications using authentication protocols required for production systems, without VPN.

Events & Governance

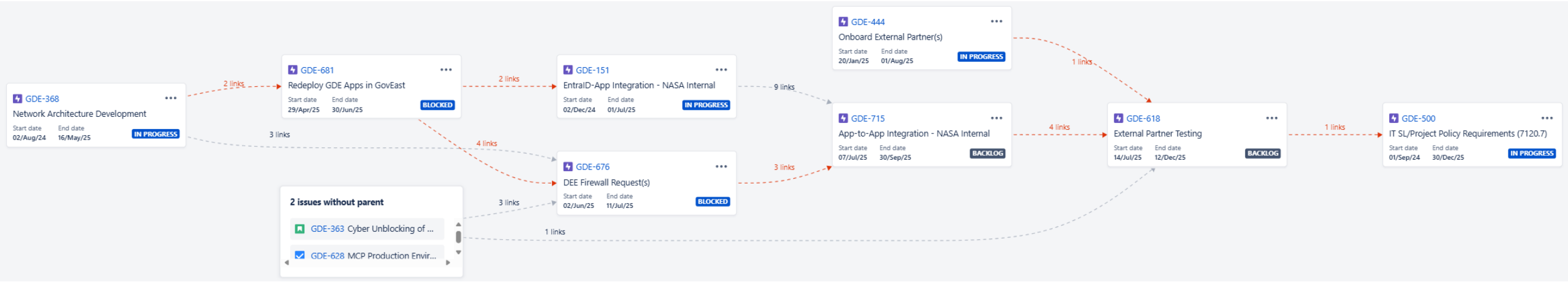
Review	Waived Or Combined [Justification Req'd]	Board	FAD Notional Date	Actual Date
KDP Formulation		ITOB	12/3/2024	12/3/2024
System Requirements Review (SRR)		TRB	1/21/2025	TBD
Release 1 Plan Review		TRB	1/21/2025	TBD
KDP Implementation	TBD by KDP-I	CCS SL Board	2/15/2025	2/18/2025
Release 1 Operational Readiness Review	TBD by KDP-I	TRB	TBD by KDP-I	TBD
Release 1 KDP-Operations	TBD by KDP-I	CCS SL Board	TBD by KDP-I	TBD
Release 1 Deployment Start (DS)	TBD by KDP-I	-	TBD by KDP-I	TBD
Release 1 Deployment Complete (DC)	TBD by KDP-I	-	TBD by KDP-I	TBD
Decommission Review	Waived	TRB	N/A	N/A
KDP Decommission	Waived	ITOB	N/A	N/A
Completion Review (PCR)		TRB	12/30/2025	TBD

Project Schedule
Roadmap



Project Schedule
Dependencies

Full Project Dependency Mapping *w/ Epic-Level Rollup*



Updated 1/17/25

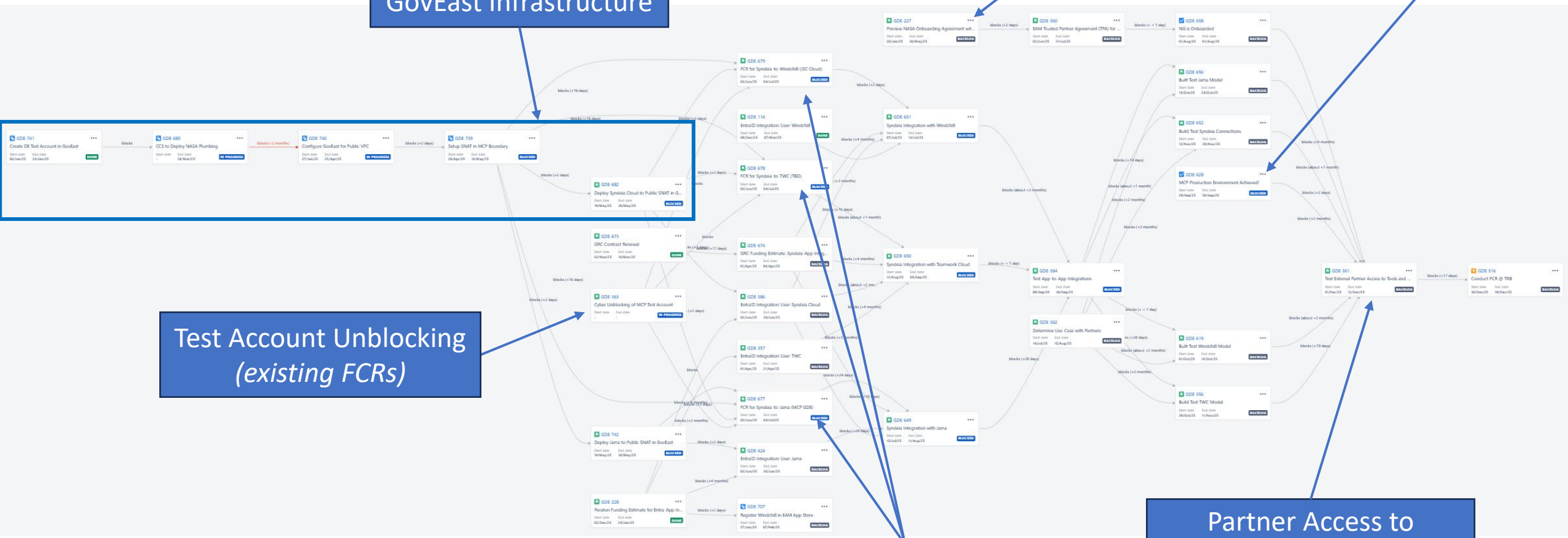
Project Schedule
Dependencies

Full Project Dependency Mapping *w/ Full Decomposition*

GovEast Infrastructure

Partner(s)Onboarding
(EAM r4 ORR)

Production MCP
Account Approval



Test Account Unblocking
(existing FCRs)

New FCR(s) Approval

Partner Access to
Engineering Applications
(EAM r5 TRR)

Updated 1/17/25

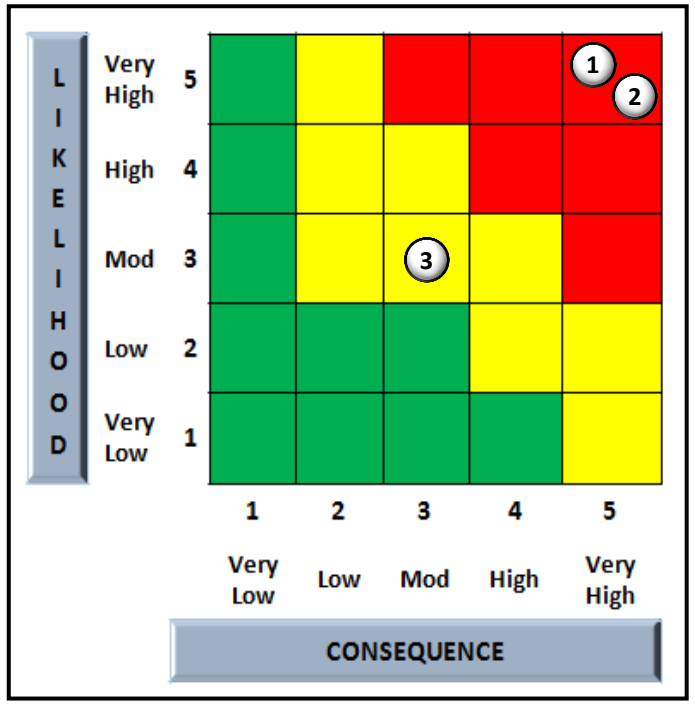


Benefits of…

Model-Based Project Planning

- **Enhanced visual representation**: Model-based methods provide clear, intuitive visual representations of project timelines, tasks, and dependencies. This visual approach makes it easier for team members to understand the project structure and progress at a glance, compared to text-heavy documents or complex spreadsheets.
- **Dynamic dependency management**: Agile model-based tools excel at mapping and managing dependencies between tasks and project components. This capability allows teams to quickly identify potential bottlenecks, adjust timelines, and optimize project flow, which is often challenging with static document-based planning.
- **Scalability and flexible granularity**: Model-based methods allow for seamless transitions between high-level overviews and detailed breakdowns of project components. This scalability enables stakeholders to zoom in on specific areas or zoom out for a broader perspective, all within the same system.
- **Real-time updates and status tracking**: Agile model-based tools typically offer real-time status updates and progress tracking. This feature ensures that all team members have access to the most current project information, fostering better decision-making and reducing the risk of working with outdated data.
- **Improved collaboration and integration**: Model-based methods often leverage collaborative platforms that integrate various aspects of project management into a single, cohesive system. This integration facilitates better team communication, streamlines workflows, and provides a centralized hub for project-related activities, which is often lacking in document-centric or spreadsheet-based approaches.

Top Project Risks

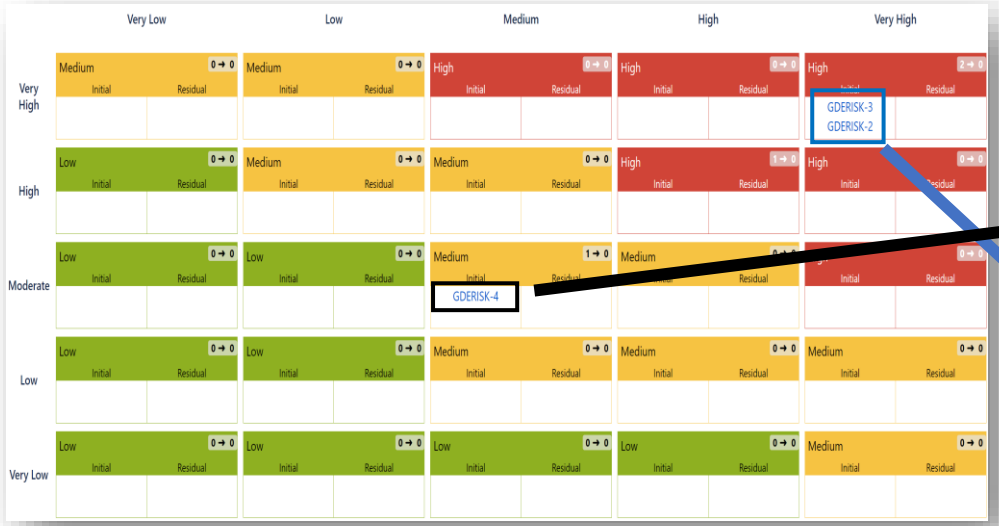


Criticality	Trend	Handling Strategy
High	Decreasing (Improving) ⬇	M = Mitigate
Medium	Increasing (worsening) ⬆	W = Watch
Low	Steady (Unchanged) ➡	R = Research
	New (Since last review) ▭	A = Accept
		E = Elevate

Note: Project complies with OCIO Risk Management Policy; top risks reported monthly on OCIO Portal Project page.

Risk Seq #	Risk ID	Trend	Risk Statement	Handling Strategy R,W,M,A,E
1	DE.1	➡	Given that existing External Access Management (EAM) roadmap doesn't meet OCE schedule or technical capability needs, There is a possibility that the EAM solution will not be delivered by the need date, Which can lead to project failure to meet MVP requirements within project performance period, causing a ripple effect of pilot implementation delays.	R
2	DE.2	➡	Given that the target environment has two outstanding firewall requests on hold for 10+ months, There is the possibility that firewall requests may not be approved/implemented in the timeframe required for this project, Which can lead to project failure to meet MVP requirements within project performance period, causing a ripple effect of pilot implementation delays.	M
3	DE.3	➡	Given that Cloud Engineering is in high demand there is possibility that Cloud Infrastructure support may not be available which will delay the implementation of the pilot.	M

Top Project Risks
Modeled Risks Mapped to Activities



ID#	RISK	SUMMARY	PROBABILITY	SEVERITY	TRACEABILITY
GDERISK-4	Medium	High demand for Cloud Engineering resources may limit available infrastructure support, potentially causing pilot project implementation delays.	3	3	Show Links
GDERISK-3	High	Long-pending firewall requests (8+ months) for the target environment threaten timely project execution, risking missed MVP requirements and subsequent pilot implementation delays.	5	5	Hide Links is mitigated by GDE-334 GDE Account (MCP) Path-to-Production IN PROGRESS GDE-71 LaRC Firewall Requests IN PROGRESS ~~GDE-379~~ Submit Firewall request to open across NASA WILL NOT BE DONE GDE-100 LQMS Firewall Request (GSFC On-Prem) BLOCKED GDE-677 FCR for Syndeia-to-Jama (MCP GDE) BLOCKED GDE-678 FCR for Syndeia-to-TWC (TBD) BLOCKED GDE-679 FCR for Syndeia-to-Windchill (JSC Cloud) BLOCKED GDE-684 FCR for Syndeia-to-NASA Workforce BLOCKED
GDERISK-2	High	NASA Goddard's External Access Management (EAM) roadmap misalignment with OCE schedule and technical needs risks delayed solution delivery, potentially causing missed MVP requirements and cascading pilot implementation delays.	5	5	Hide Links is mitigated by GDE-360 EAM Trusted Partner Agreement (TPA) for NG BACKLOG GDE-619 Built Test Windchill Model BACKLOG

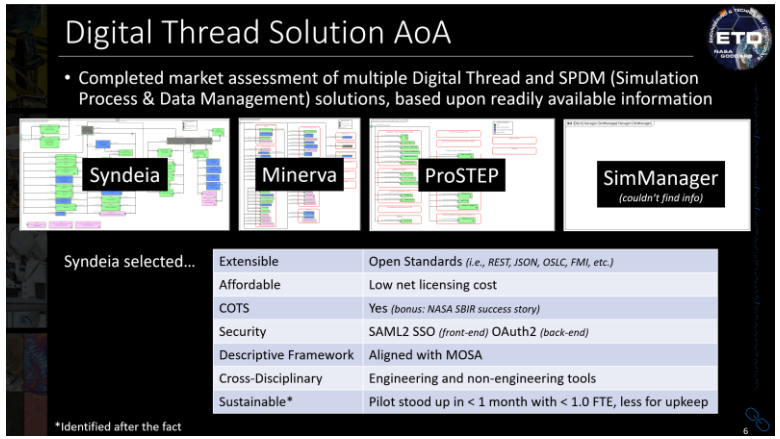
	GDERISK-2 NASA Goddard's External Access Management (EAM) roadmap misalignment with OCE schedule and technical needs risks delayed solution delivery, potentially causing missed MVP requirements and cascading pilot implementation delays.	GDERISK-3 Long-pending firewall requests (8+ months) for the target environment threaten timely project execution, risking missed MVP requirements and subsequent pilot implementation delays.	GDERISK-4 High demand for Cloud Engineering resources may limit available infrastructure support, potentially causing pilot project implementation delays.	
GDE-677 FCR for Syndeia-to-Jama (MCP GDE)			← is mitigated by	GDE-677 FCR for Syndeia-to-Jama (MCP GDE)
GDE-678 FCR for Syndeia-to-TWC (TBD)			← is mitigated by	GDE-678 FCR for Syndeia-to-TWC (TBD)
GDE-679 FCR for Syndeia-to-Windchill (JSC Cloud)			← is mitigated by	GDE-679 FCR for Syndeia-to-Windchill (JSC Cloud)

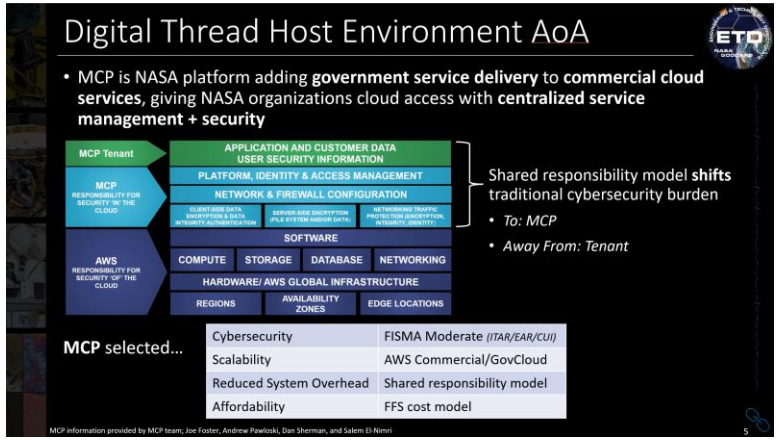
Model-Based Project Roadmap

- **Dynamic risk-task correlation**: Model-based risk management allows for direct mapping between identified risks and specific project tasks or stories. This integration provides a clear, visual representation of how risks impact various project components, enabling teams to quickly assess and prioritize risk mitigation efforts in the context of the overall project structure.
- **Real-time risk assessment and tracking**: The integrated approach facilitates continuous, real-time updates to risk status and impact. As project tasks progress or change, the associated risks can be automatically re-evaluated, providing up-to-date risk profiles throughout the project lifecycle. This dynamic assessment is far more efficient than manual updates in static documents or spreadsheets.
- **Enhanced decision-making and resource allocation**: By visualizing the dependencies between risks and project tasks, stakeholders can make more informed decisions about resource allocation and risk mitigation strategies. This integrated view allows for a more holistic approach to project management, where risk assessment directly informs project planning and execution, leading to more effective risk management and improved project outcomes.

Analysis of Alternatives (AoA) Activities Contributing to System Concept

- Scope of effort is to build upon existing Goddard Digital Thread solution by incorporating External Partner access to engineering model-based collaboration
  - Digital Thread AoA completed as part of Digital Transformation Office (DTO) Pathfinder Project in late FY23





- Digital Engineering Leadership Team (DELT) selected applications per OCE priority
  - Windchill (PLM)
  - Teamwork Cloud (MBSE)
  - Jama (Requirements Management)
- ICAM EAM (External Access Management) Solution
  - OCIO-developed Federated Identity (FedID) solution, since NMC (NASA Mission Cloud) isn't ready today

DEE MVP
Level 1 & 2 Requirements

Lvl	Requirement	Release	Met / Partially Met / Did Not Meet
1.	**Digital Ecosystem hub-and-spoke architecture is integrated using Digital Thread (DTh) as the hub.**	1.0	TBD
1.1	Digital Thread solution (Syndeia) hosted within MCP.	1.0	TBD
1.2	CAD PLM application (Windchill) integration with Syndeia	1.0	TBD
1.3	Requirements management application (Jama) integration with Syndeia	1.0	TBD
1.4	MBSE PLM application (Teamwork Cloud) integration with Syndeia	1.0	TBD
1.5	Production environment in MCP	1.0	TBD
2.	**External partner access to NASA-hosted application(s)**	1.0	TBD
2.1	Select partner(s) can leverage their corporate ID to authenticate into NASA environment	1.0	TBD
2.2	Select partner(s) can access NASA-hosted applications and shared model(s)	1.0	TBD
3	**Approved for Moderate data (ITAR/EAR/CUI)**	1.0	TBD
3.1	All applications are approved for Moderate data	1.0	TBD
3.2	App-to-app integrations are approved for Moderate data	1.0	TBD

Non-Functional Requirements
Enterprise Levied

#	Category	Summarize Requirements Approval Status
1.0	Program/Project Management	Accepted
2.0	NASA Enterprise Architecture	Accepted, Tailored-Modified (x12)
3.0	Information Security Policy and Procedural Requirements	Accepted
4.0	Information and Information Systems Security Standards	Accepted
5.0	Records Management	Accepted
6.0	Privacy	Accepted
7.0	Paperwork Reduction	Tailored (modification)
8.0	Capital Asset Identification and Treatment	Tailored (modification)
9.0	Information and Communications Technology Accessibility	Accepted
10.0	NASA Software Engineering Requirements	Accepted
11.0	Incremental Development	Tailored (modification)
12.0	Service Line Non-Functional Requirements	N/A

Non-Functional Requirements
Project Specific

#	Category	Summarize Requirements Approval Status
13.0	Architecture	N/A
14.0	Dependencies	N/A
15.0	Documentation	N/A
16.0	Information Management	Accepted
17.0	Interfaces	Accepted
18.0	Migration & Deployment	Tailored (modification)
19.0	Policy & Regulation (Other)	N/A
20.0	Quality	Accepted
21.0	Safety	N/A
22.0	Security & Privacy	Accepted, Tailored-Modified (x1), Tailored-Rejected (x9)
23.0	System Life Cycle Sustainment	Accepted, Tailored-Modified (x1), Tailored-Rejected (x1)
24.0	Training, Adoption, and Support	Accepted, Tailored-Rejected (x3)
25.0	Usability	N/A
26.0	Other Project Specific Non-Functional Requirements (not otherwise specified)	N/A

Test Plan
Verification & Validation Plan

- V&V plan has full traceability across:
  - Test cases (x23)
  - Methodology
  - Verification method
    - Inspection, test, demonstration, analysis
  - Success criteria
  - Requirement(s)
    - FR and NFR

T-2. CAD PLM Integration Test

Title: Windchill-Syndeia Integration Verification

Description: Validate the integration between Windchill a

Requirements Mapping:

- FR 1.2: CAD PLM application integration
- NFR 16.4: Data Management
- NFR 20.2: Performance
- NFR 20.5: Compatibility

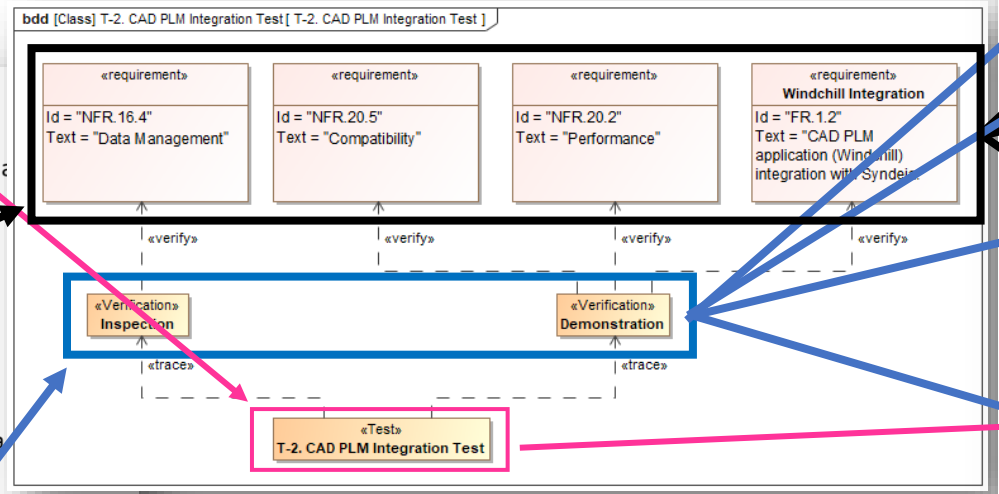
Methodology:

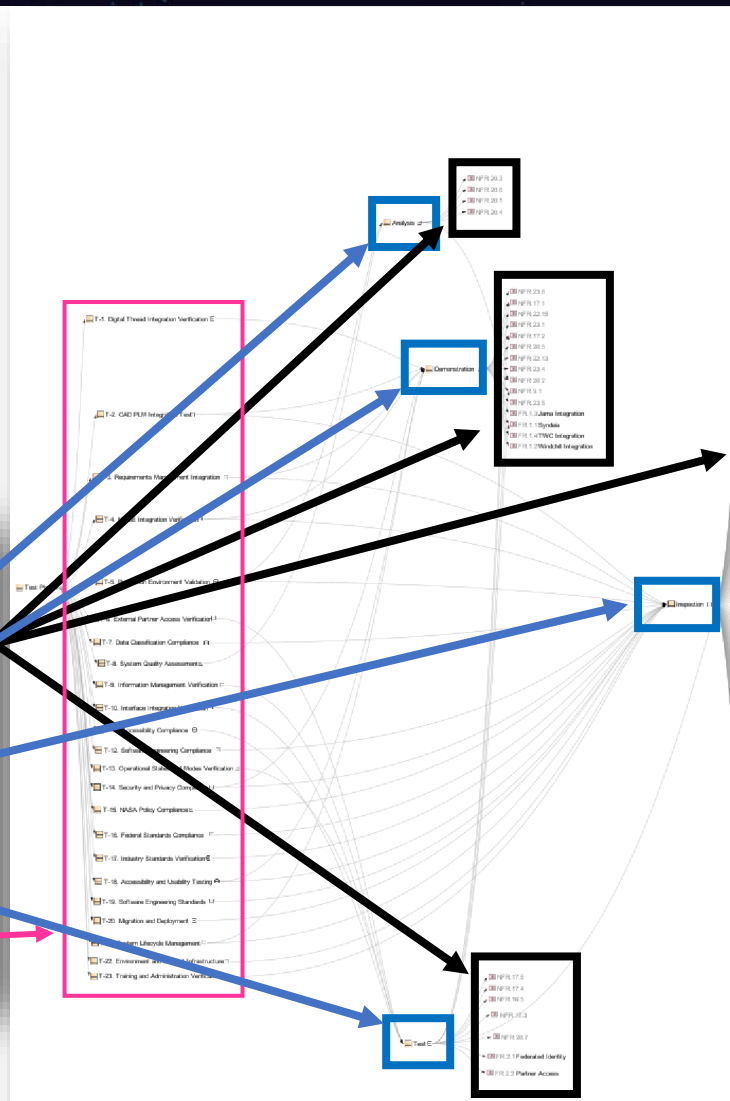
1. Create test CAD models in Windchill.
2. Verify bidirectional synchronization with Syndeia
3. Test data consistency across systems.

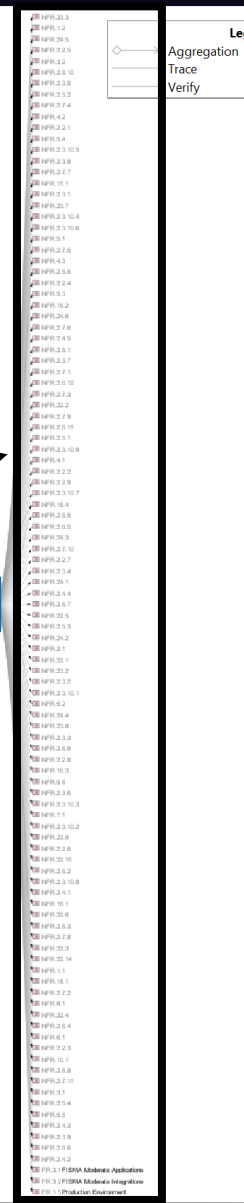
Verification Method: Demonstration, Inspection

Success Criteria:

- Successful data exchange between Windchill and Syndeia.
- Accurate representation of CAD data.
- Performance meets specified standards.







Model-Based Requirements and V&V

- **Enhanced traceability**: Model-based approaches provide comprehensive traceability across test cases, methodology, verification methods, success criteria, and requirements (both functional and non-functional). This interconnected structure allows for easier navigation and understanding of relationships between different elements of the test plan.
- **Visual representation of relationships**: The use of block definition diagrams (BDD) in SysML allows for a clear, visual representation of the test plan structure. This graphical approach makes it easier to understand the relationships between requirements, test cases, and verification methods, improving overall comprehension of the test strategy.
- **Dynamic view generation**: MBSE tools enable the creation of dynamic views that can show different aspects of the test plan, such as traceability between test cases, requirements, and verification methods. This flexibility allows stakeholders to focus on specific areas of interest and generate custom reports as needed, which is more challenging with static documents or spreadsheets.
- **Consistency and maintainability**: By using a model-based approach, changes made to one element of the test plan (e.g., a requirement) can automatically propagate to related elements (e.g., associated test cases). This ensures consistency across the entire test plan and reduces the risk of errors that can occur when manually updating multiple documents or spreadsheets.
- **Integration with other system models**: MBSE tools allow for seamless integration of the test and V&V plan with other system models, such as requirements models or system architecture models. This integration provides a more holistic view of the entire system development process, enabling better decision-making and more efficient allocation of testing resources.

Transforming Project Management and Engineering via *Digital Engineering Ecosystem (DEE)*

- Enhanced Project Visualization and Execution
  - Project management has implemented a dynamic, visual project roadmaps for complex missions, which has streamlined project planning, risk management, and V&V processes seamlessly
  - DEE will expand upon this through the integration of additional capabilities
- Leveraging Digital Thread Technology
  - DEE will enable comprehensive project-scale insights for novel informed decision-making, by aggregating additional traditionally disparate source systems
- Advancing Next-Generation Project Management
  - Project management transitioned from static documentation to interconnected model-based systems to lower overhead associated with project planning, upkeep, and execution
- Pioneering NASA-Industry Collaboration
  - DEE will catalyze enhanced partnerships by providing partners with direct access to engineering applications for true boundaryless public-private partnership and collaboration

The **Digital Engineering Ecosystem** (DEE) represents a significant leap forward in our approach to space exploration project management and transdisciplinary engineering, fostering integration, collaboration, and innovation across the entire mission lifecycle.