

MBSE (SysML) and Digital Twin integration to support Engineering Analysis & Design

PM / Co-PI Info | Lui Wang, | Lui.wang@nasa.gov
Thomas Chen | Thomas.t.chen@nasa.gov

EXECUTIVE SUMMARY

Problem Statement:

The complexity of Gateway systems and of managing the integrated safety analysis have made traditional methods of engineering analysis and design increasingly challenging. To address these challenges, a prototype that integrate Model-Based Systems Engineering (MBSE) with Digital Twin technology has been developed to demonstrate the utilities and functions.

Project Goal: Develop a prototype of a Digital Twin Of Gateway ECLSS IMV system to enhance fault management analysis through collaboration, visualization, and simulation

Overall Project Results / Accomplishments:

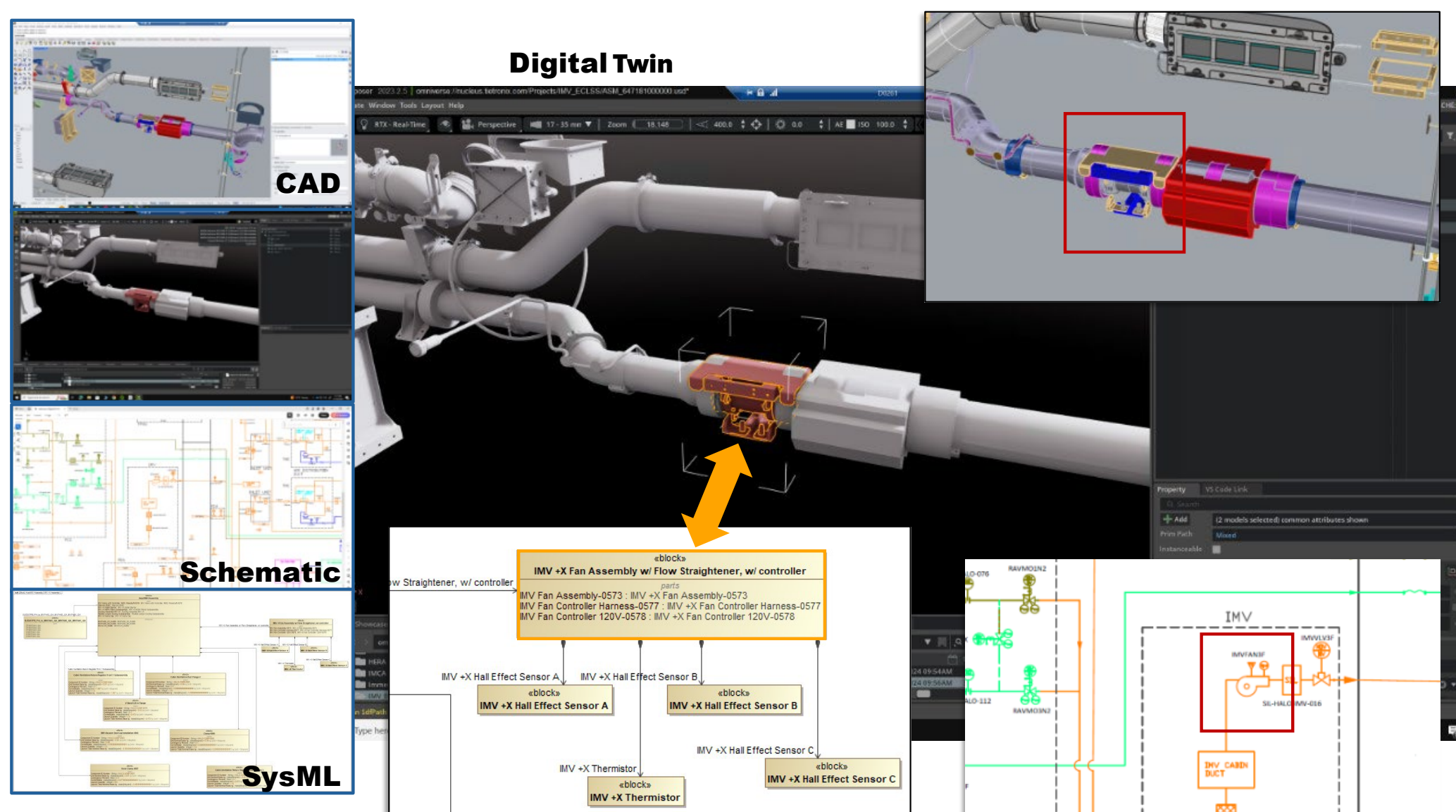
- Developed extension to streamline the integration of SysML models with the Digital Twin platform
- Demonstrated the capability to aggregate any relevant information and provide simulation integration within the DT prototype.
- Generated digital twin simulation using SysML Activity Diagrams
- Implemented a complex trade study use case based on the integrated SysML-Digital Twin infrastructure

INNOVATION

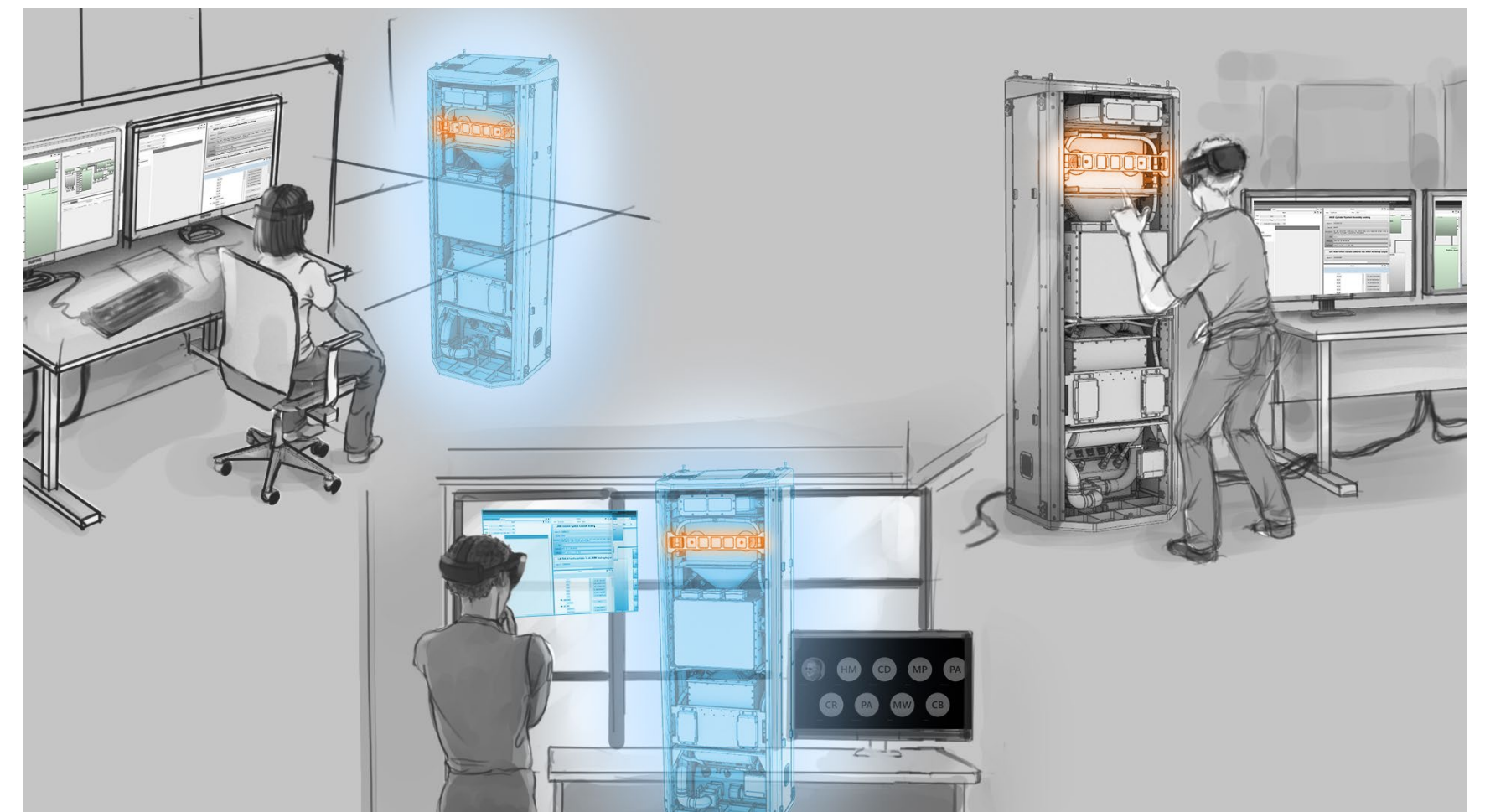
- **Customize Integration of SysML model & Digital Twin for analysis support:** Linking of Gateway System Engineering models and 2D schematics with the 3D model, converting 2-D data into immersive 3D space.
- **Seamless Collaboration:** Enables real-time interaction among system designers and engineers, using various XR devices.
- **Space Tech Innovation:** Simplifies complexities, enhances cooperation, setting new standards for space exploration.
- **Artemis Engineering Development:** Designed to elevate support for upcoming Artemis missions, redefining collaborative exploration.

COLLABORATION

1. Gateway Subsystem Designers and Module Providers
2. Artemis Gateway Vehicle System Integration Office – MER Ops Support



ECLSS Inter-Module Ventilation (IMV) System Digital Twin Transformation



Engineering Development Digital Twins

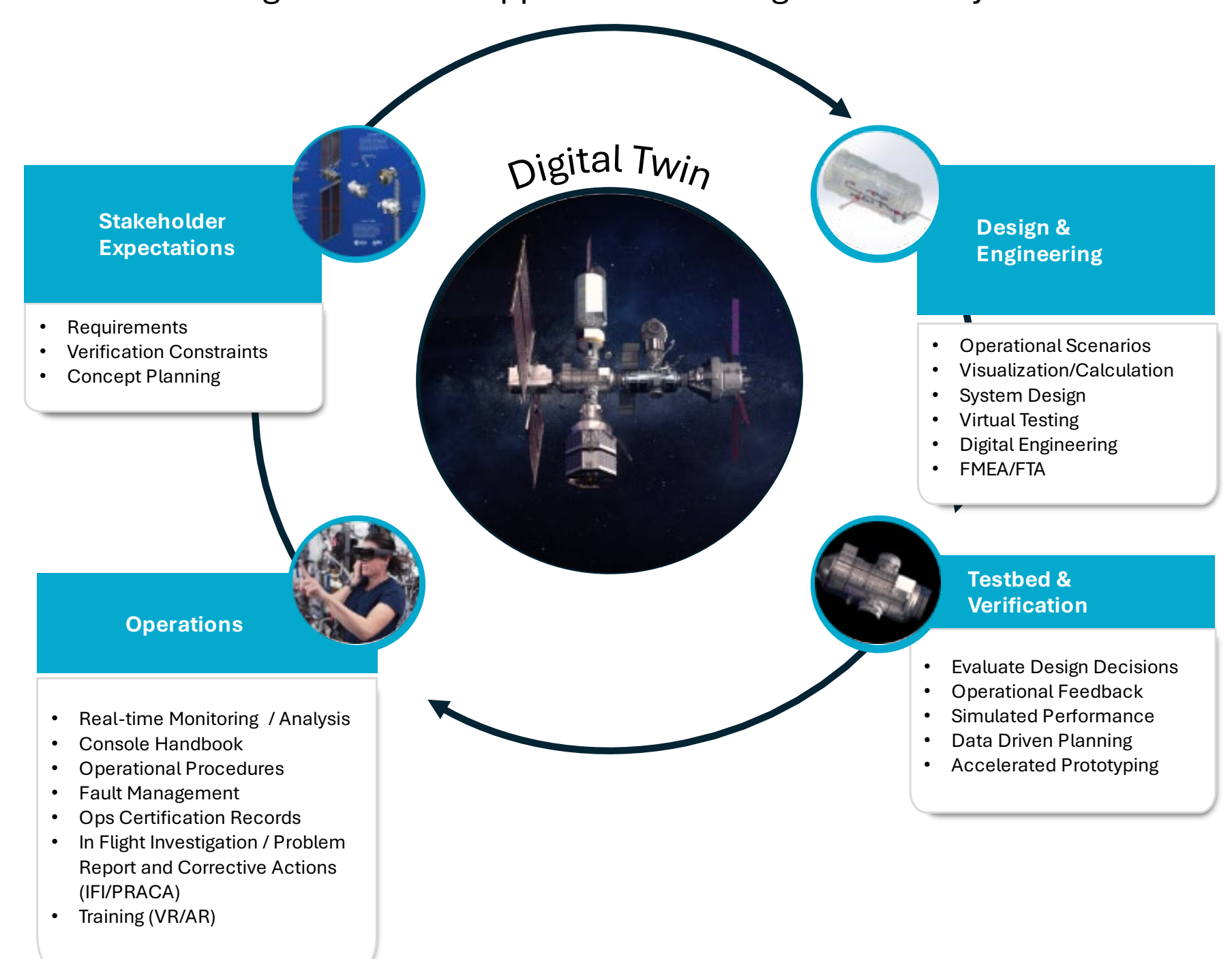
OUTCOMES & INFUSION

- Demonstrated the current prototype to ECLSS system designers
- Potential connection of prototype to real time telemetry through MCC Message Queuing Telemetry Transport (MQTT) protocol
- Planned to demonstrate DT prototype to Project Luna Team
- Planned to develop proposal to Gateway VSI Office for Gateway MER operations support

FUTURE WORK

- Demonstrate DT concept prototype to multiple disciplines
- Obtain feedback from SMEs to convert prototype to actual operational Digital Twin tool within the MCC as part of the
- Collect & curate additional operational artifacts such as Problem Report Corrective Action (PRACA), In-Flight Investigation (IFI), Discrepancy Report (DR), Quality Assurance Record Center (QARC), Anomaly Report (AR), to provide ops support including anomalies and trending analysis

Digital Twin to Support Fault Management Analysis



DAA#

NTR#(s)