HUMAN EXPLORATION SPACECRAFT TESTBED FOR INTEGRATION AND ADVANCEMENT

HESTIA
Model Based System Engineering with SysML

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Why Model Based Systems Engineering?

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- Spacecraft designers and operation stakeholders **create models and artifacts** of the **same system** with **different processes, tools, and representations.**

- These **uncoordinated modeling approaches** create locally successful products **but** also create a **communication barrier** among the various stakeholders (the “Tower of Babel” Effect).

- The **same information** is **captured multiple times, in multiple places**, **with multiple representations**, creating a **maintenance challenge**.

HDU Artifacts by Multiple Stakeholders

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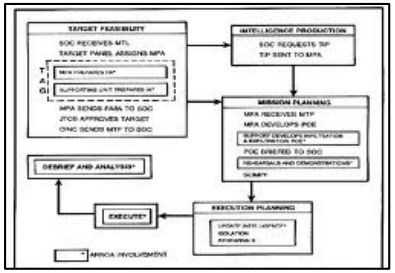
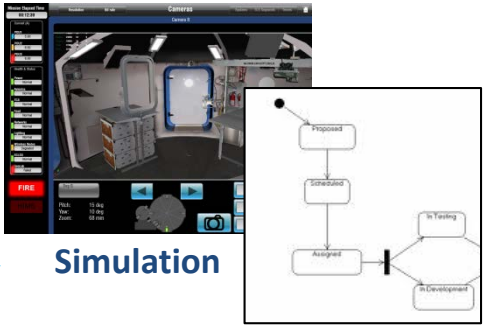
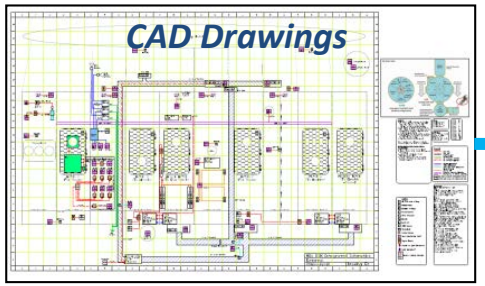
Telemetry and Command

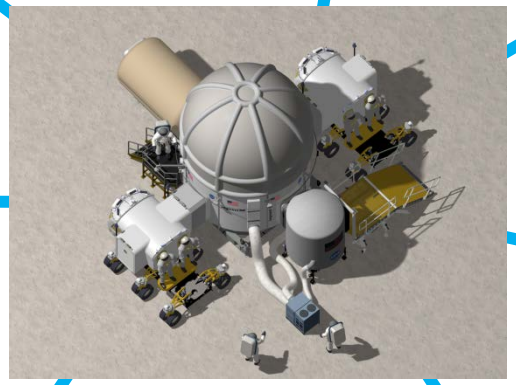


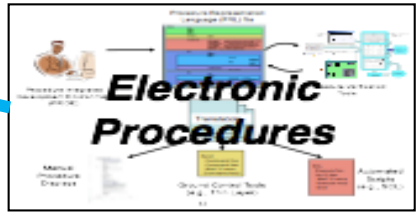
Mission Operation Planning

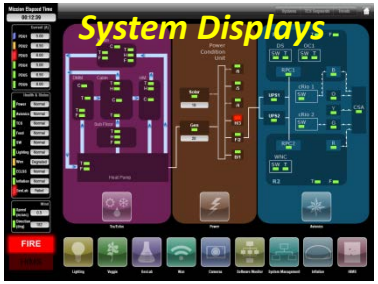


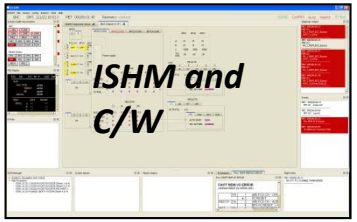
Simulation





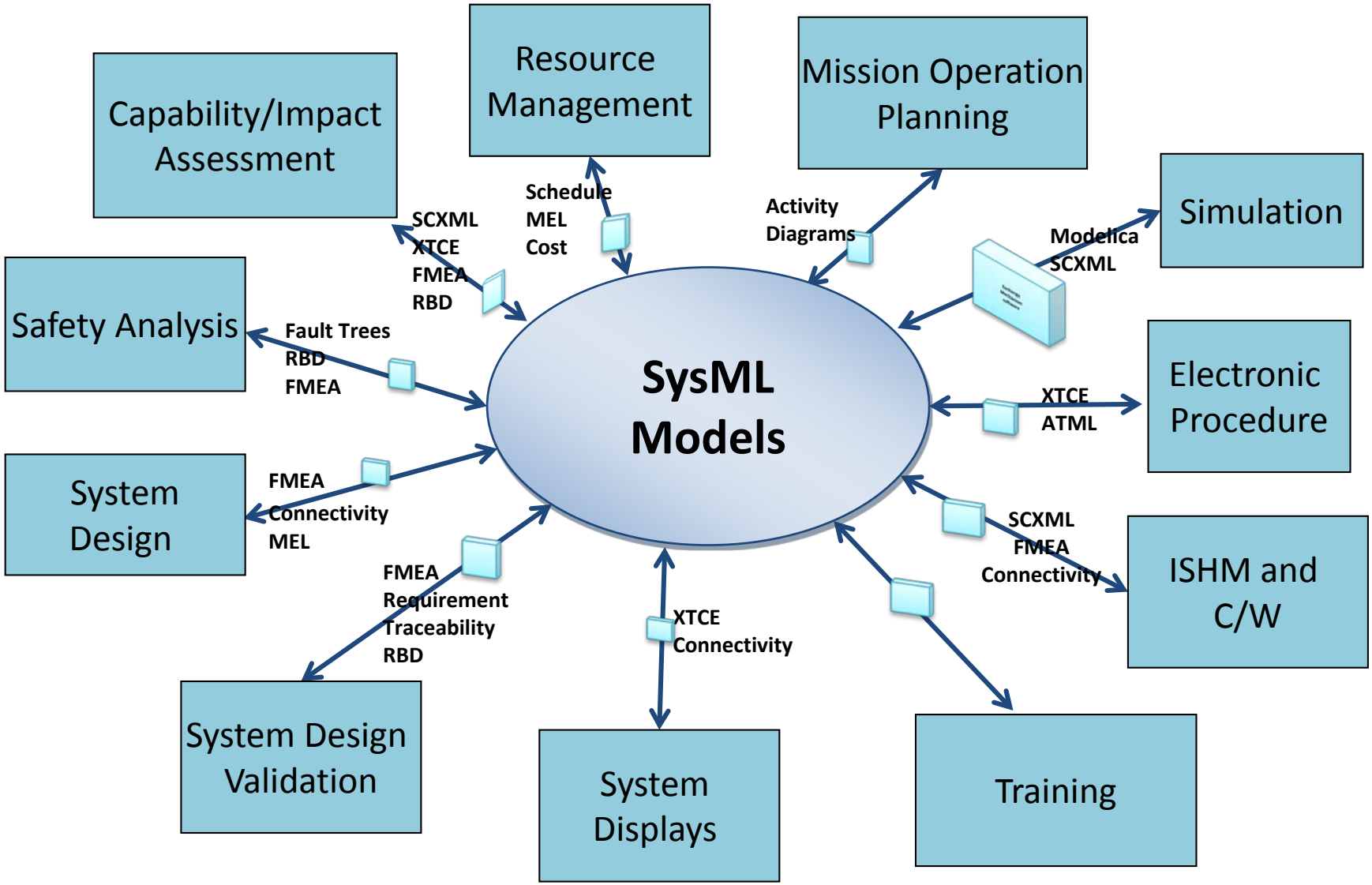






Uses of System Models

Model Once and Use Many Times



Modeling for Mars Life Support Notional Architecture

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- Model Mars Life Support Notional Architecture to support design trades.
  - Capture Requirements, Functional Breakdown, and Architecture

Architecture and Key Design Parameters

«subsystem»
Life Support Subsystem

values
/Habitable_Volume : m³ = 0{nonunique,unit = cubicMetre}
/Mass : kg = 0{unit = kilogram}
/Pow er : W = 0{unit = w att}
/Equipment_Volume : m³ = 0{unit = cubicMetre}
/Waste_Heat : W = 0{unit = w att}

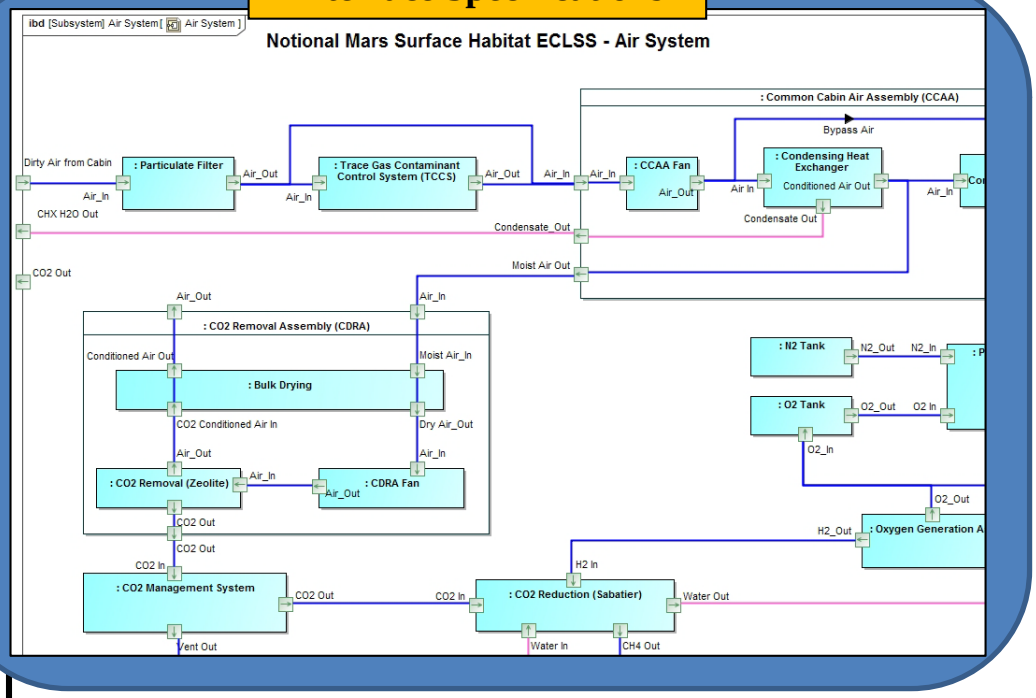
«subsystem»
Air System

values
/Habitable_Volume : m³ = 0{nonunique,unit = cubicMetre
/Mass : kg = 0{unit = kilogram}
/Pow er : W = 0{unit = w att}
/Equipment_Volume : m³ = 0{unit = cubicMetre}
/Waste_Heat : W = 0{unit = w att}

«subsystem»
Water System

values
/Habitable_Volume : m³ = 0{nonunique,unit = cubicMetre
/Mass : kg = 0{unit = kilogram}
/Pow er : W = 0{unit = w att}
/Equipment_Volume : m³ = 0{unit = cubicMetre}
/Waste_Heat : W = 0{unit = w att}

Interface Specifications



Modeling for Test Support
(Capturing facility, existing and new technology)

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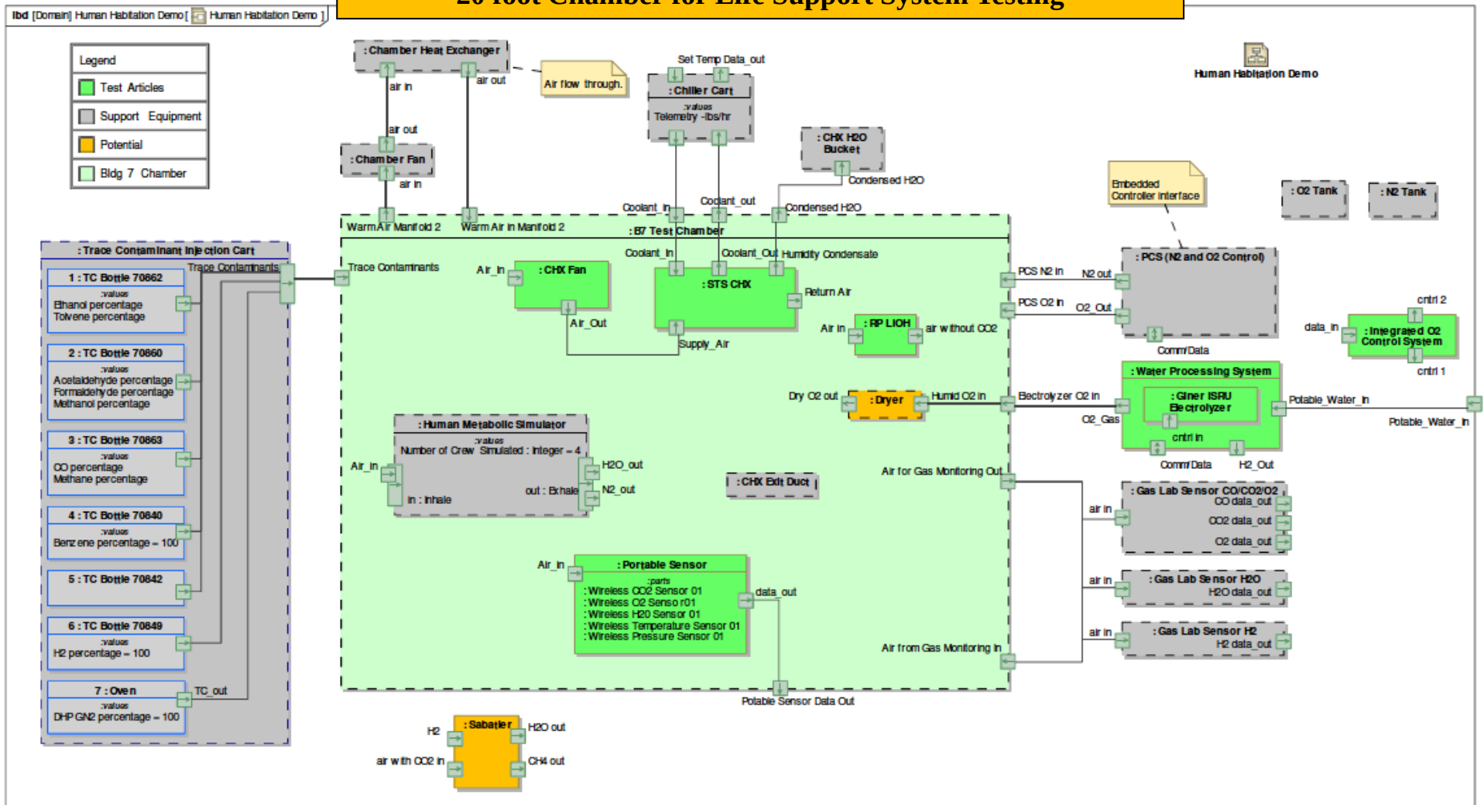
Model the Life Support Test Setup Architecture

20 foot Chamber for Life Support System Testing



Maintaining Traceability between Notional Architecture and Testing

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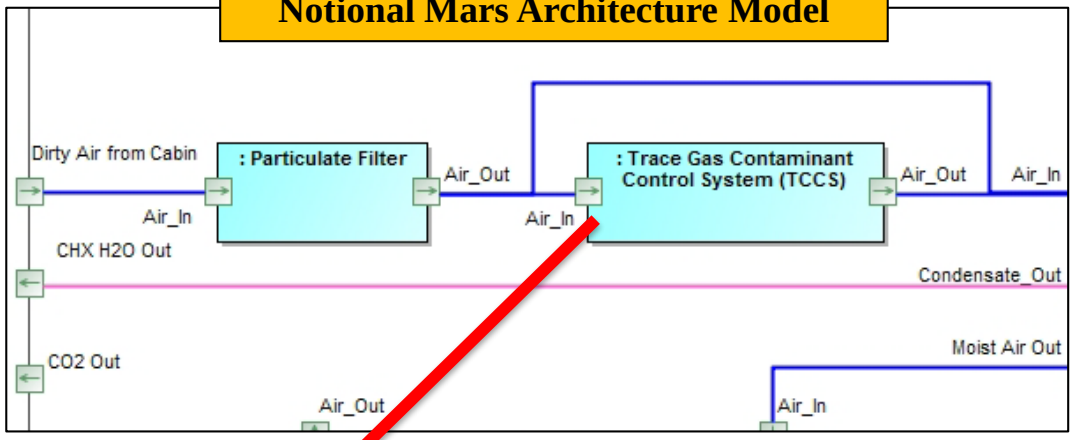
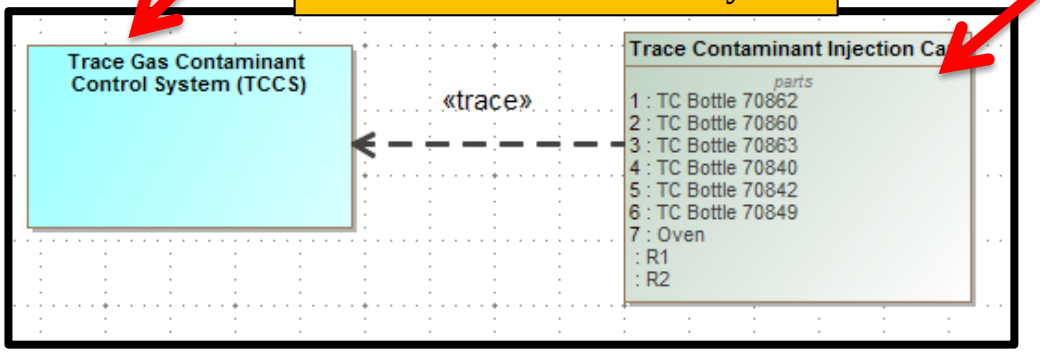
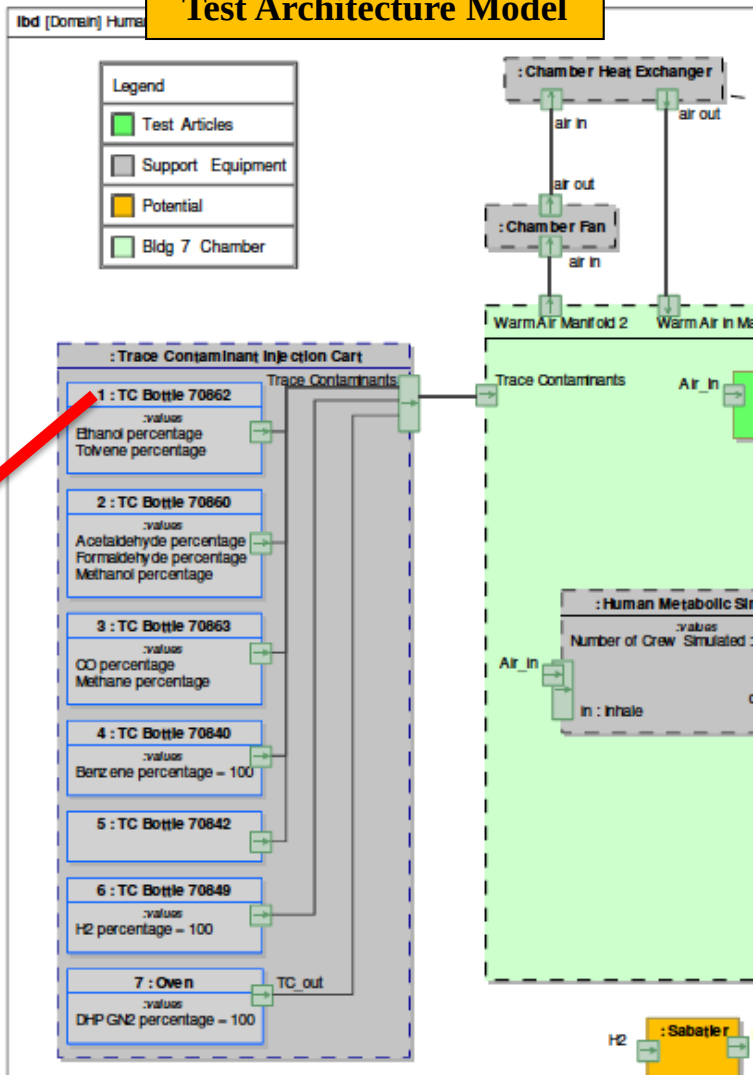
Notional Mars Architecture Model



Using SysML Model to Maintain Traceability



Test Architecture Model



Model Usage Examples

- Use the model to support design trades on key design parameters
  - Mass, Power, Thermal etc…
  - ConOps Simulations
  - CDS example
- Integrate the model with immersive 3D environment
  - HDU example

Use SysML to Support Design Trades on Key Design Parameters

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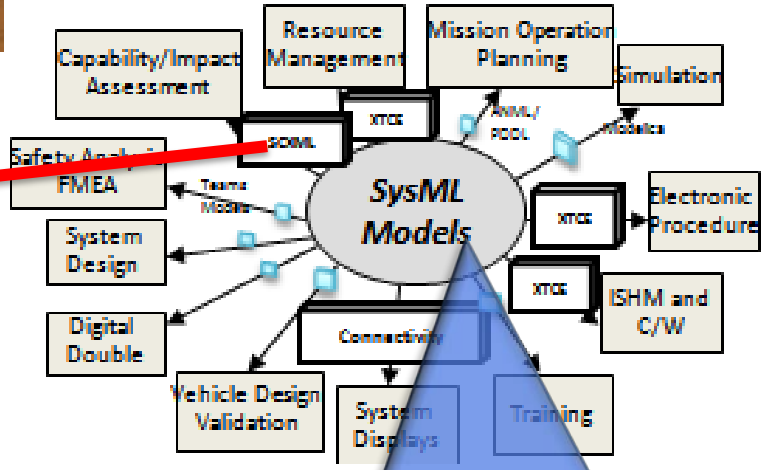
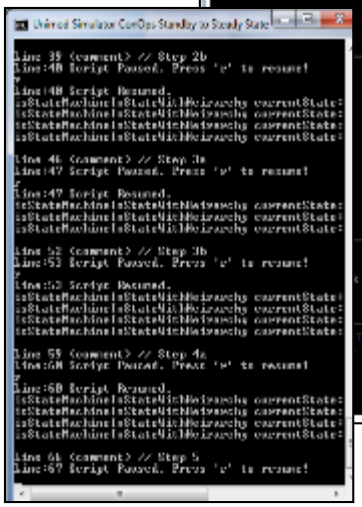
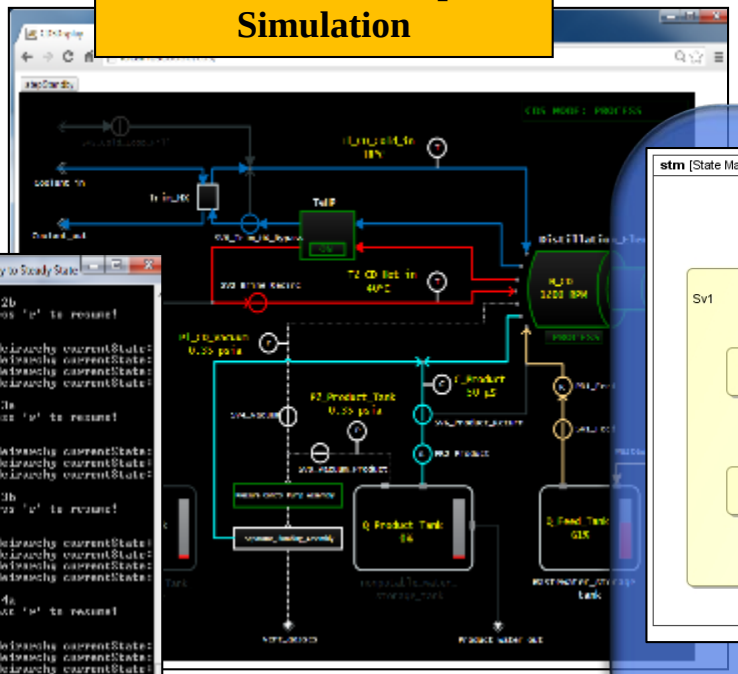
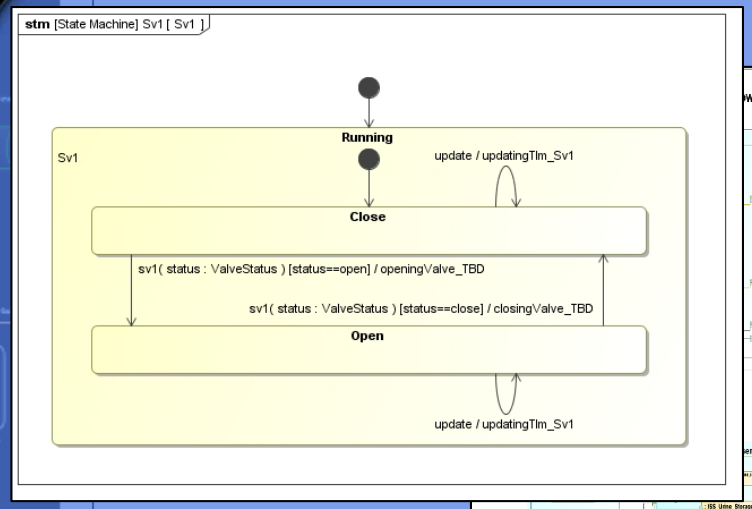
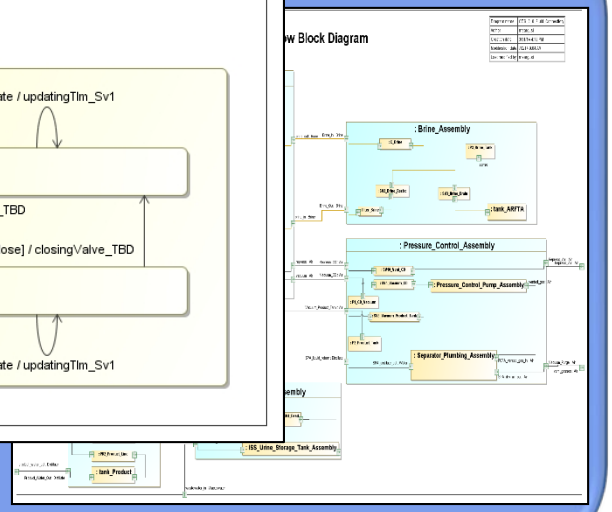


Extracted ConOps Simulation

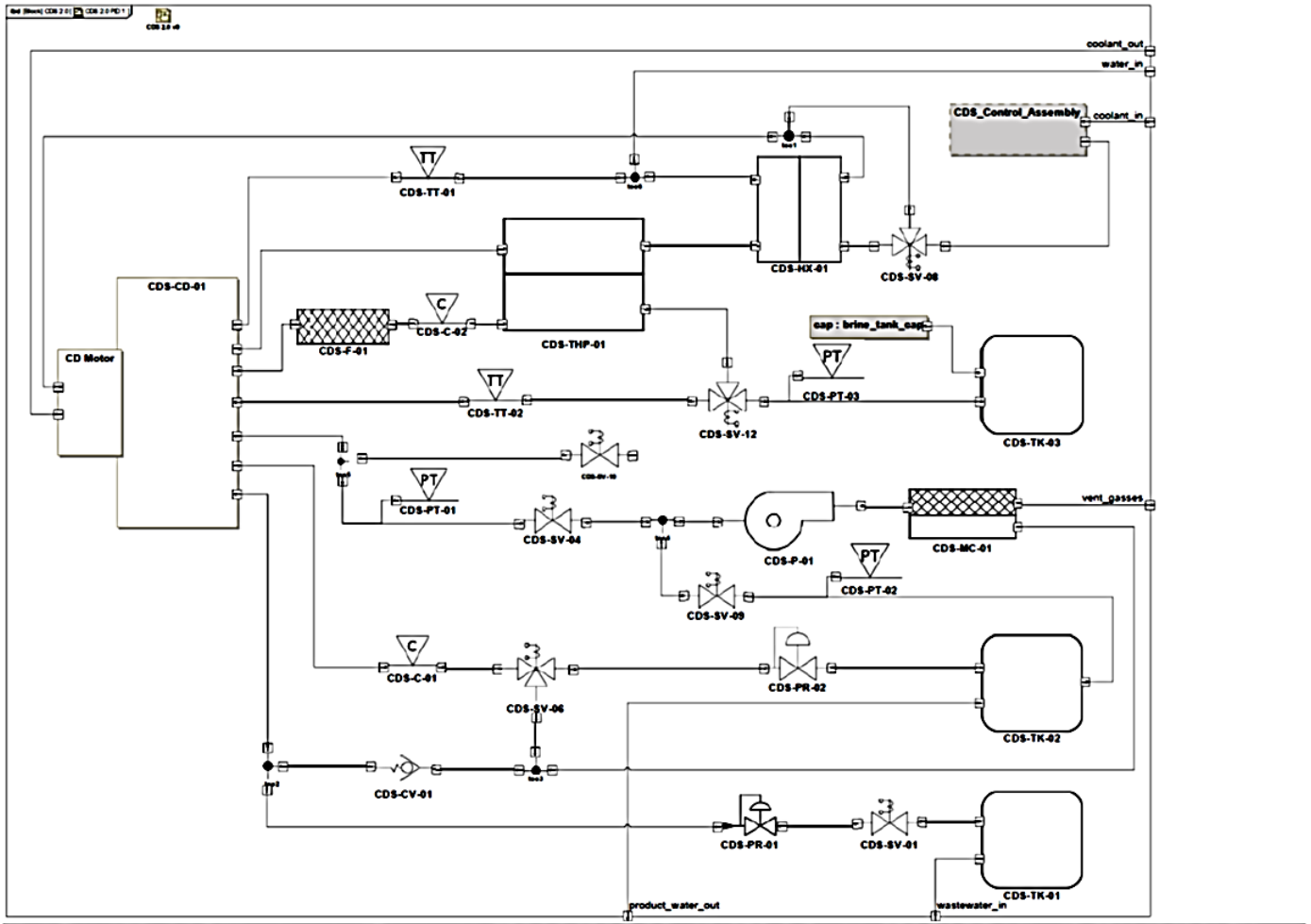








Demonstrated Technology on CDS 2.0



MagicDraw UML, 1-1 C:\Users\msargusi\Documents_CDS 2.0\CDS 2_0 SysML\CDS_2_0.mdzip CDS 2.0 PID 1 Nov 13, 2014 12:30:21 PM

Concept of Operations/ Simulation

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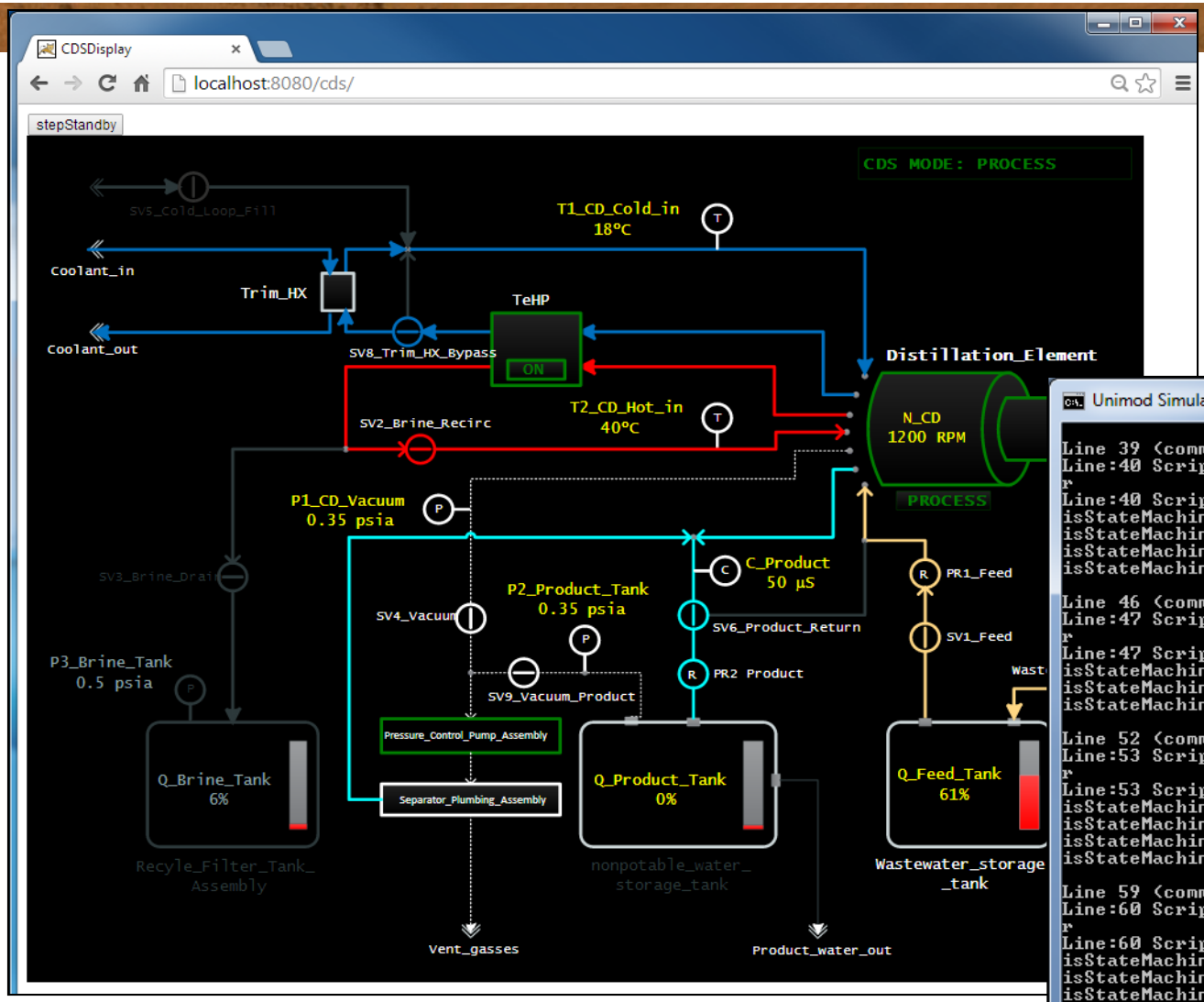

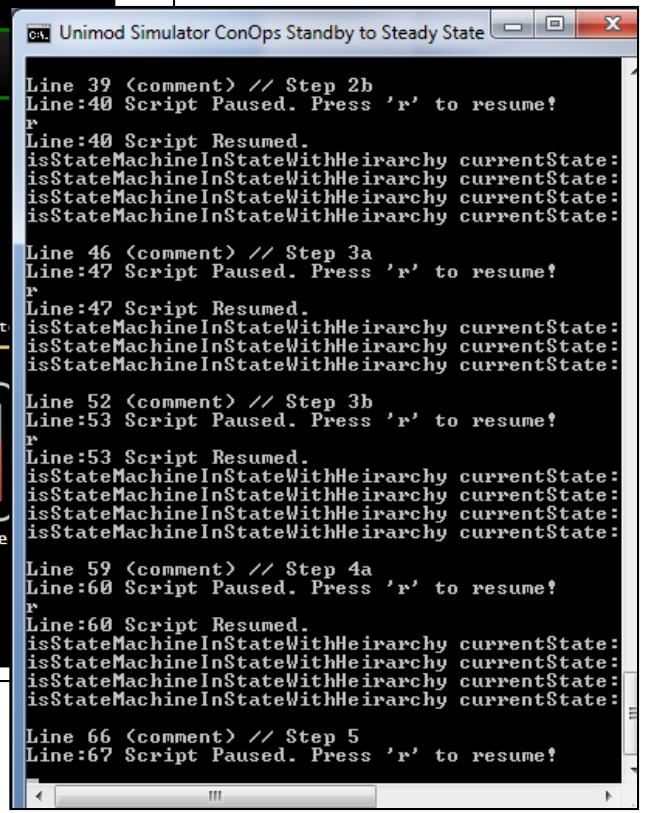

HDU SysML Model Usages

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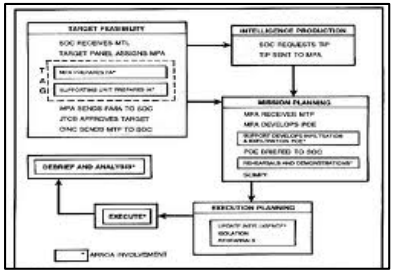
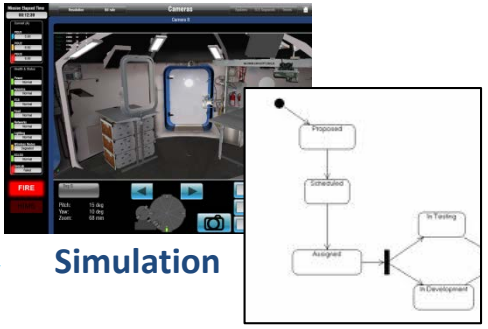
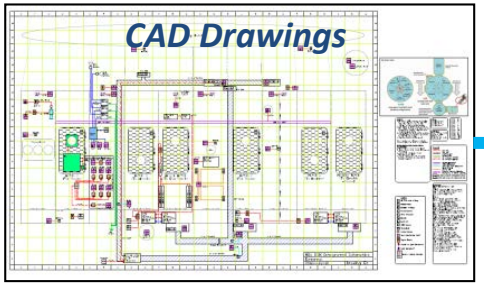
Telemetry and Command



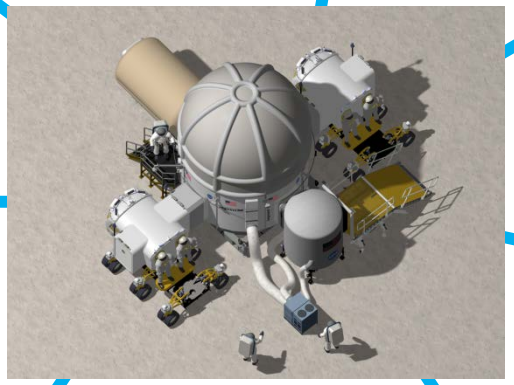
Mission Operation Planning

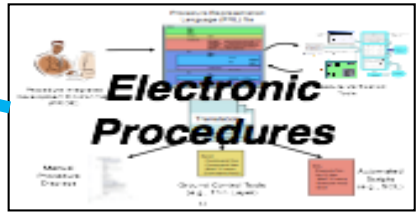


Simulation

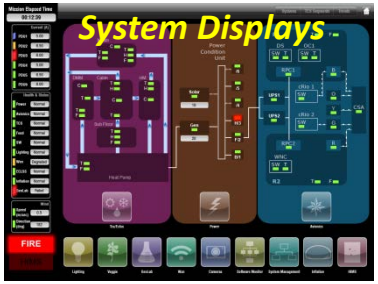


CAD Drawings

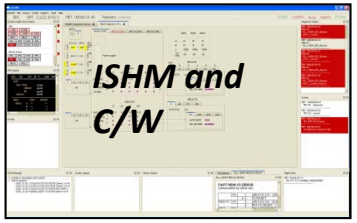




Electronic Procedures



System Displays



ISHM and C/W

Integrate the Model with Immersive 3D Environment

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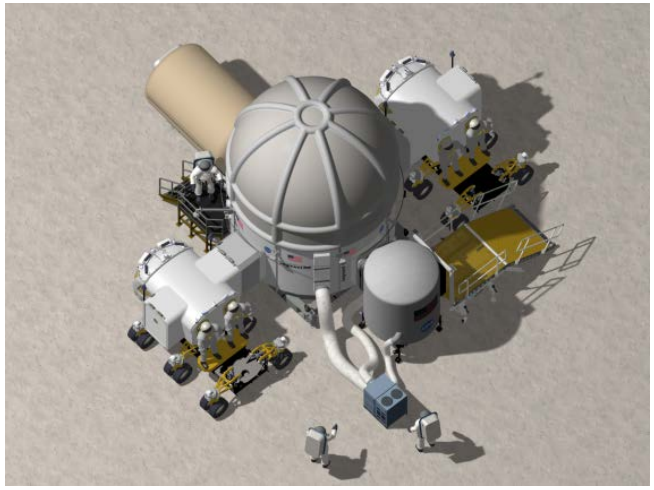
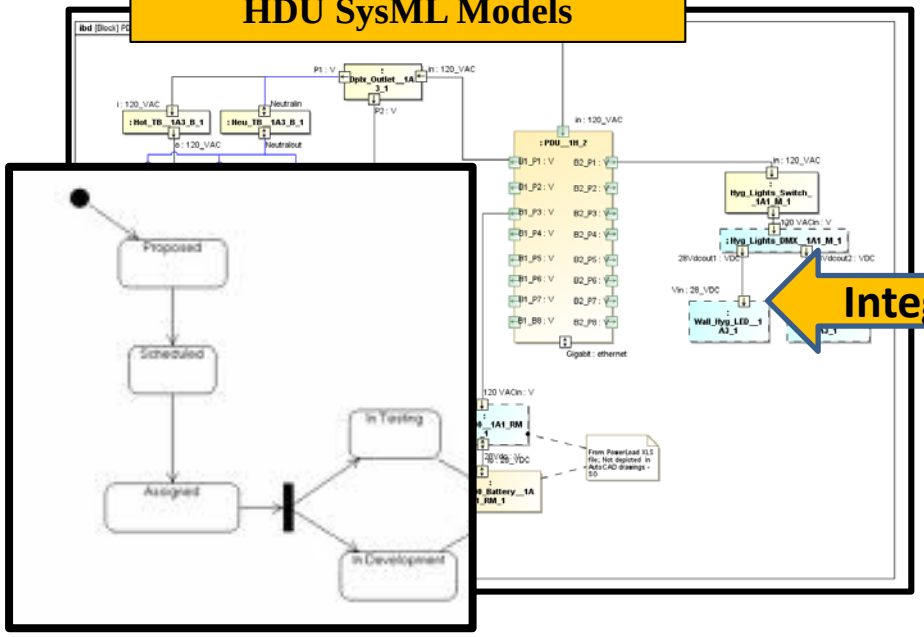


HDU SysML Models



Integrate

HDU 3D Simulation – Immersive Environment

Backup

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HESTIA SysML Models

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Reference Input

Mars Planning

DRA 5.0

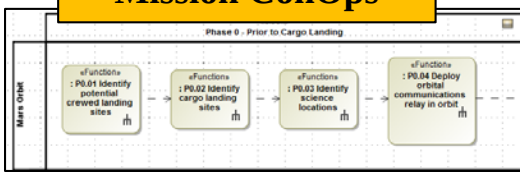
WBS

WBS used to organize the project

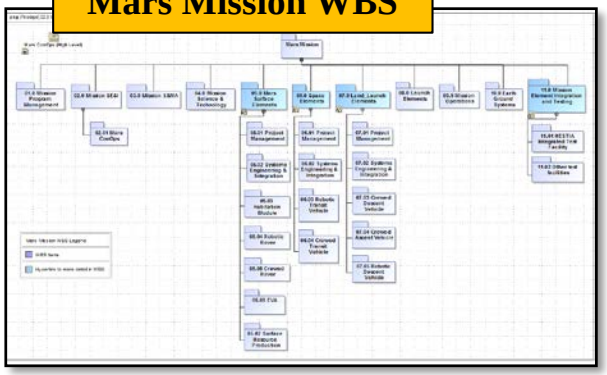
ConOps

Mars ConOps used for HESTIA scenario development

Mission ConOps



Mars Mission WBS

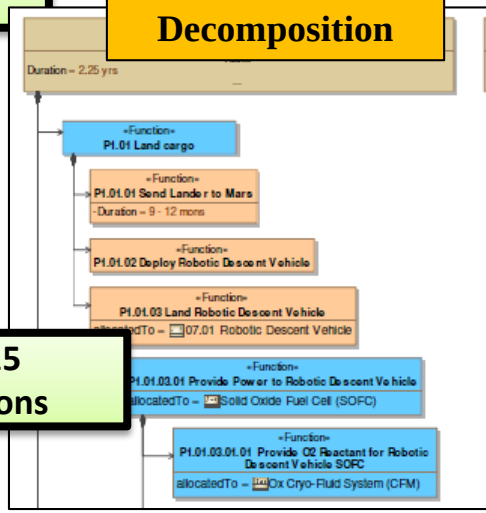


Interface Definition

Physical Models

Functional Models

Functional Decomposition



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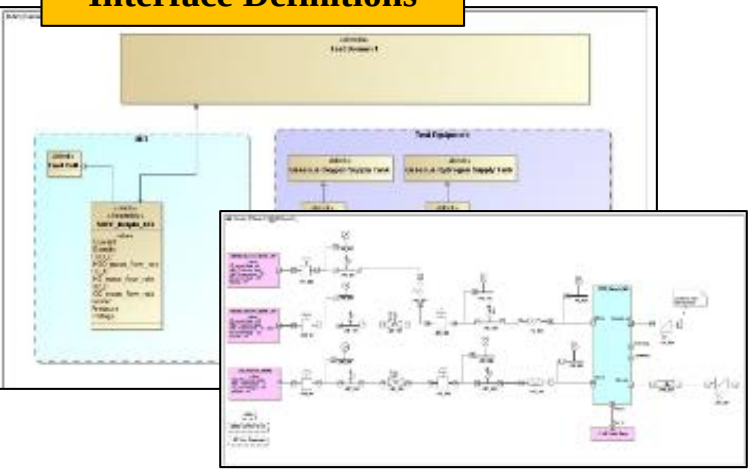
Physical Model/ Interface Definitions



HESTIA Requirements

HESTIA FY15 Demonstrations

Interface Definition

Physical Models