Vision for Cross-Center MSBE Collaboration on the Gateway Program

IEEE Aerospace Conference, Big Sky

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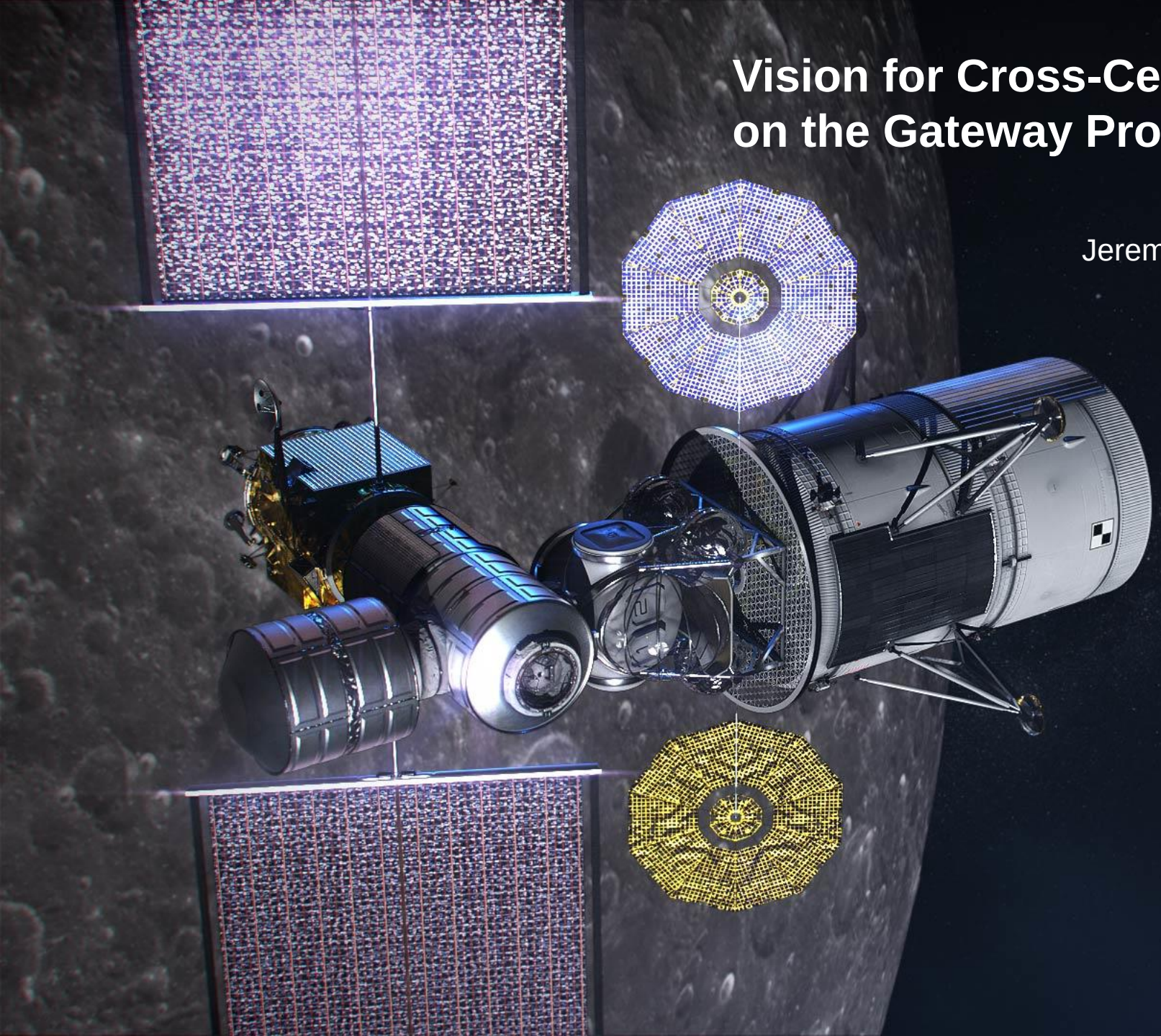
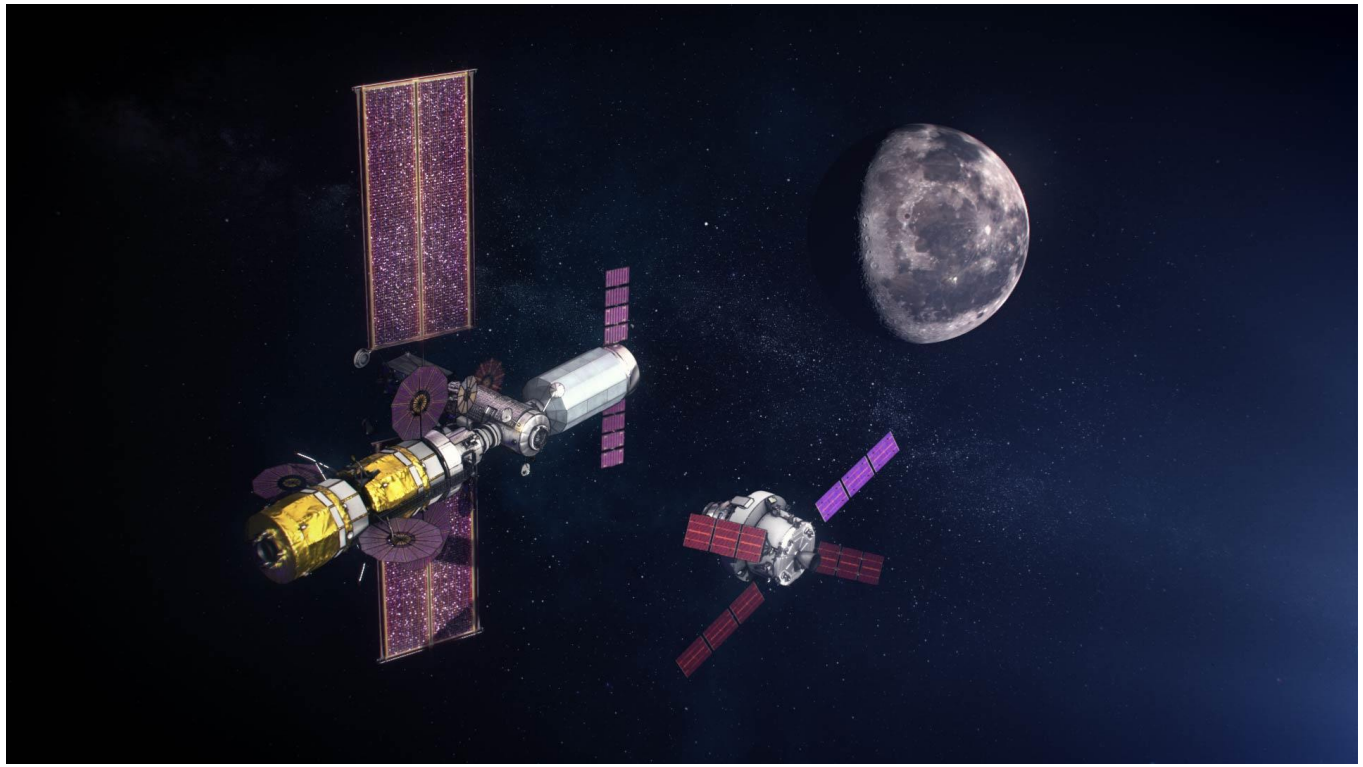
March 11th, 2020



What is Gateway?

- **A Multinational Cis-lunar space station to enable:**
  - Sustained presence in a lunar HALO orbit
  - "Boots on the Moon" in 2024 part of the Artemis missions
  - Test bed for future Mars missions
- **Cross Program**
  - ESD (Orion, SLS), Human Landing System (HLS)
- **NASA Centers**
  - JSC, GRC, MSFC, KSC
- **International Partners:**
  - ESA, CSA, JAXA, Roscosmos



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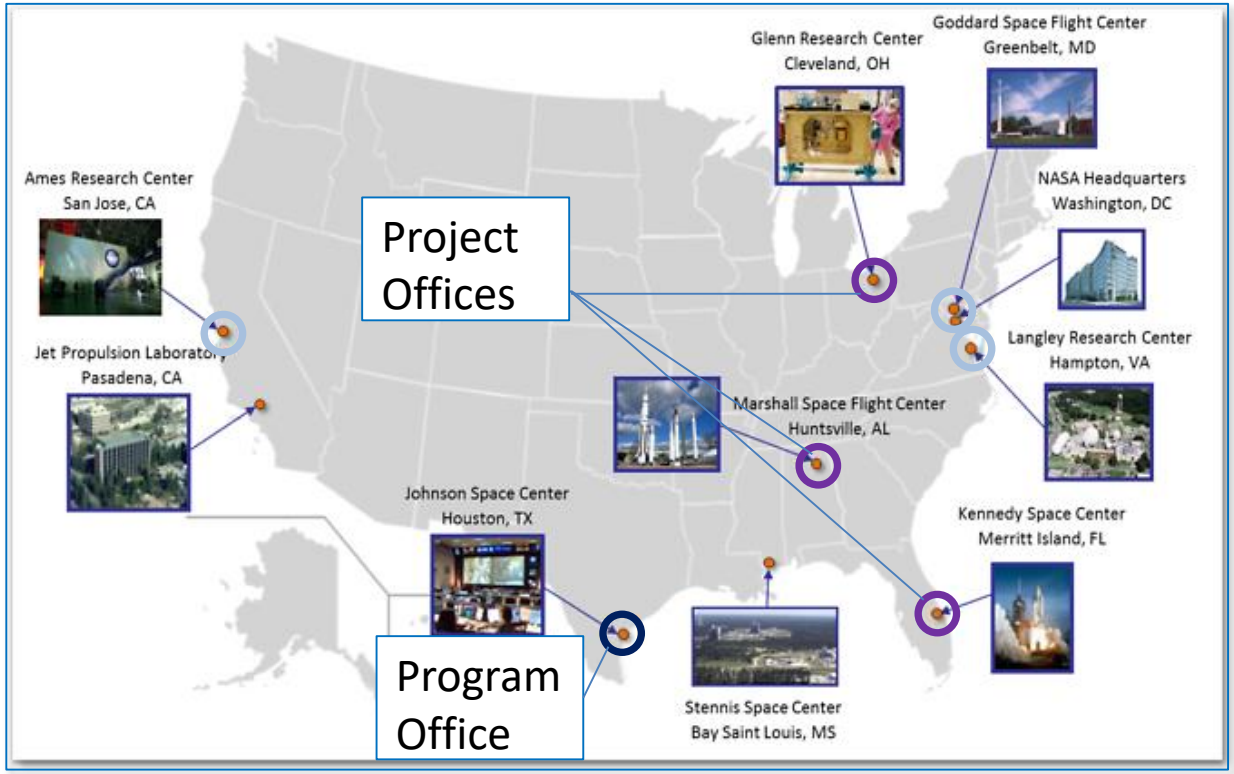
Gateway's Big Issue

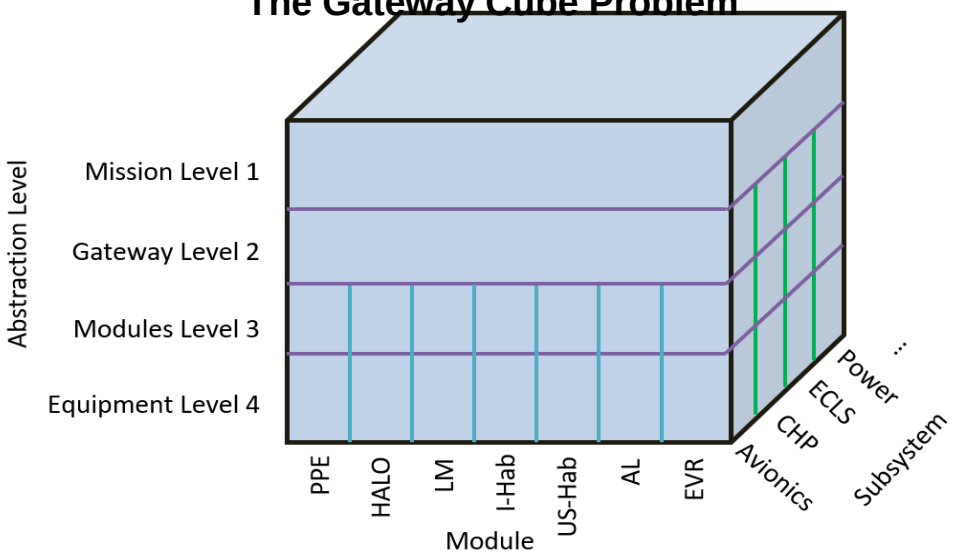
The Gateway's Geographically Desperate Acquisition



Gateway's systems must operate as a **highly interdependent stack**, but is acquired by modules from **different projects** at various centers and partners

- Lots of documents, coordinated across several different centers with domestic and international partners
- Requires a lot of coordination and manpower to approve documents
- Program office is very small, with only about ¼ the amount of resources as ISS at a similar stage

The Gateway Cube Problem



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Challenges Seen

- **Diverse modeling community and team**
  - Interfacing all the different models into a single entity
  - Teams answer to differing management chains
- **Handling Proprietary, ITAR, SBU data within the modeling construct**
- **Transformation of Culture**
  - People are very used to their documents
  - Changing mindsets on where content is “the source of truth”
- **Environment limitations**
  - Not all tools play well together
  - Model to model usage can create long dependency chains
- **Configuration Management**
  - It has taken a few iterations to get the CM right and is still evolving
  - Agreements between modeling groups can be difficult

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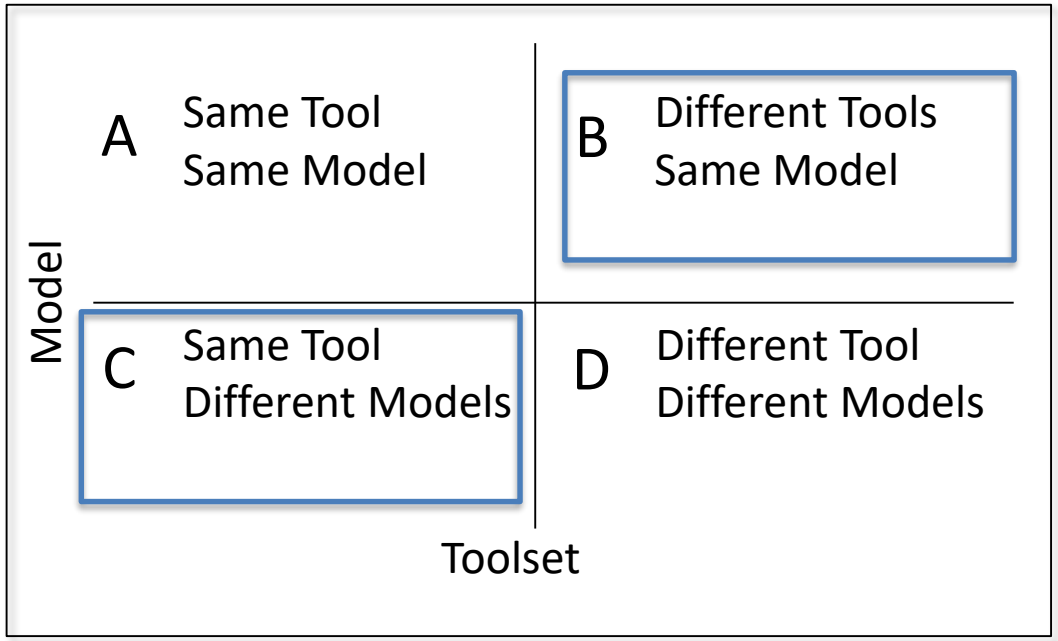
Treating The Model As a System

- **Types of Relations between models**
  - A: Links between elements, such as allocations. Done in both DOORs Next Generation (DNG) and MagicDraw (MD)
  - B: Syncing of Requirements elements between DNG and MD
  - C: Coordination of different project teams within the same shared tool on MD. Such as Program (L2) to Project (L3) integration
  - D: Most difficult, could include analytic models integrated with system models



- **Needed Coordination Effort**
  - Development of standards and model requirements
  - Treating the interface between two models the same as an interface between two systems
  - Robust processes and ground rules
  - Working groups to sort out disparities, with in person TIM's to build formal/informal relationships

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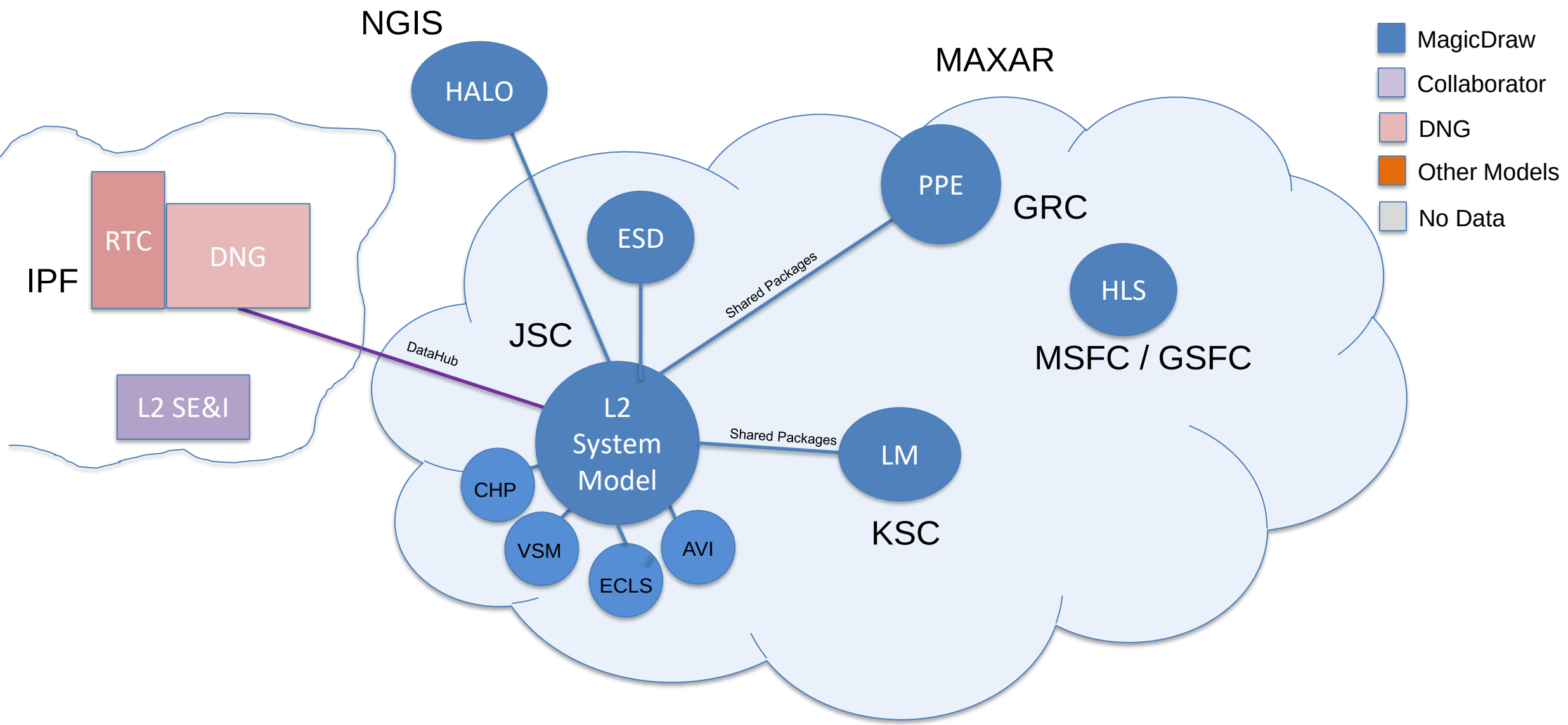
Tool Chain Environment



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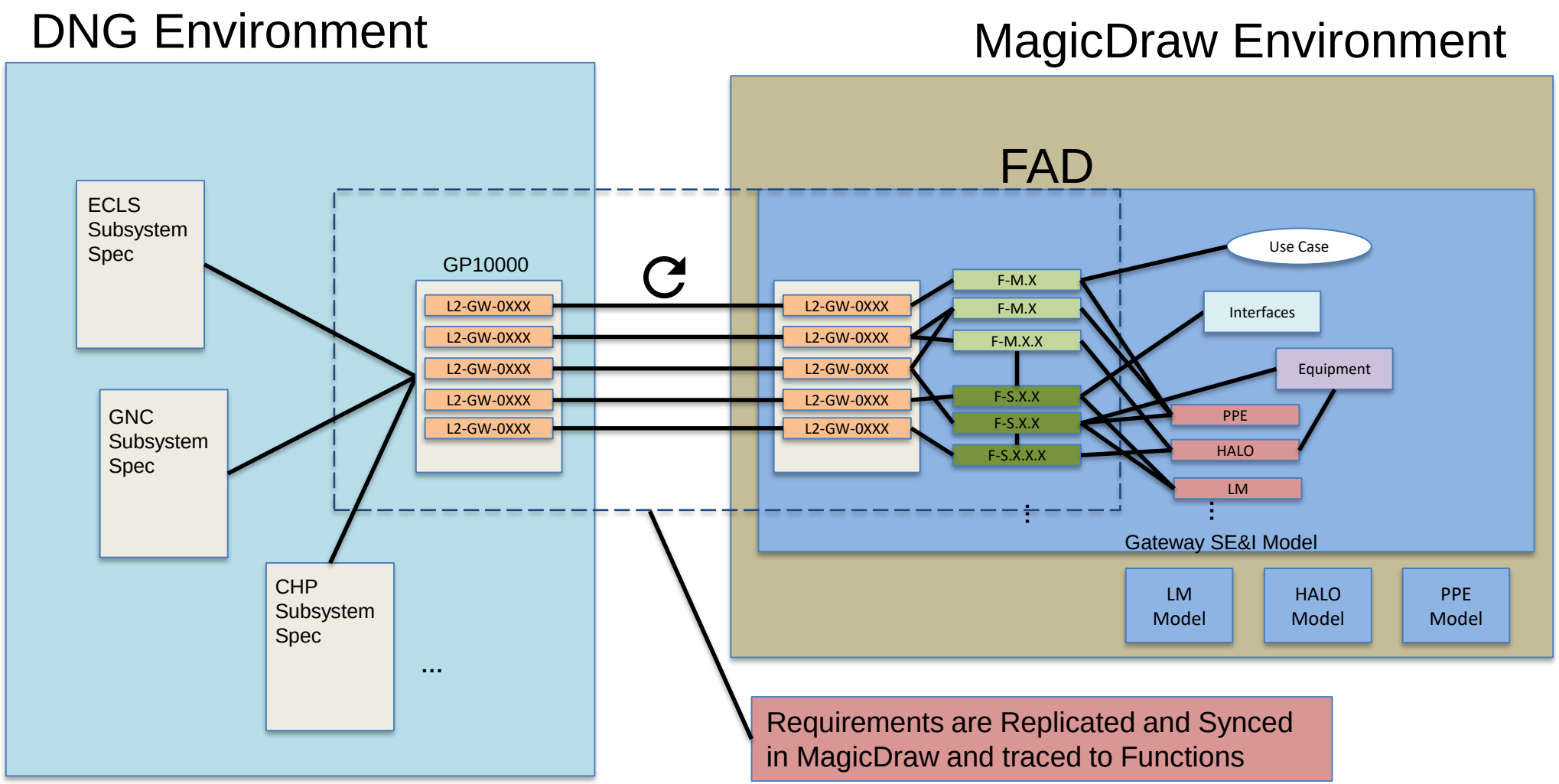
DataHub Synchronization



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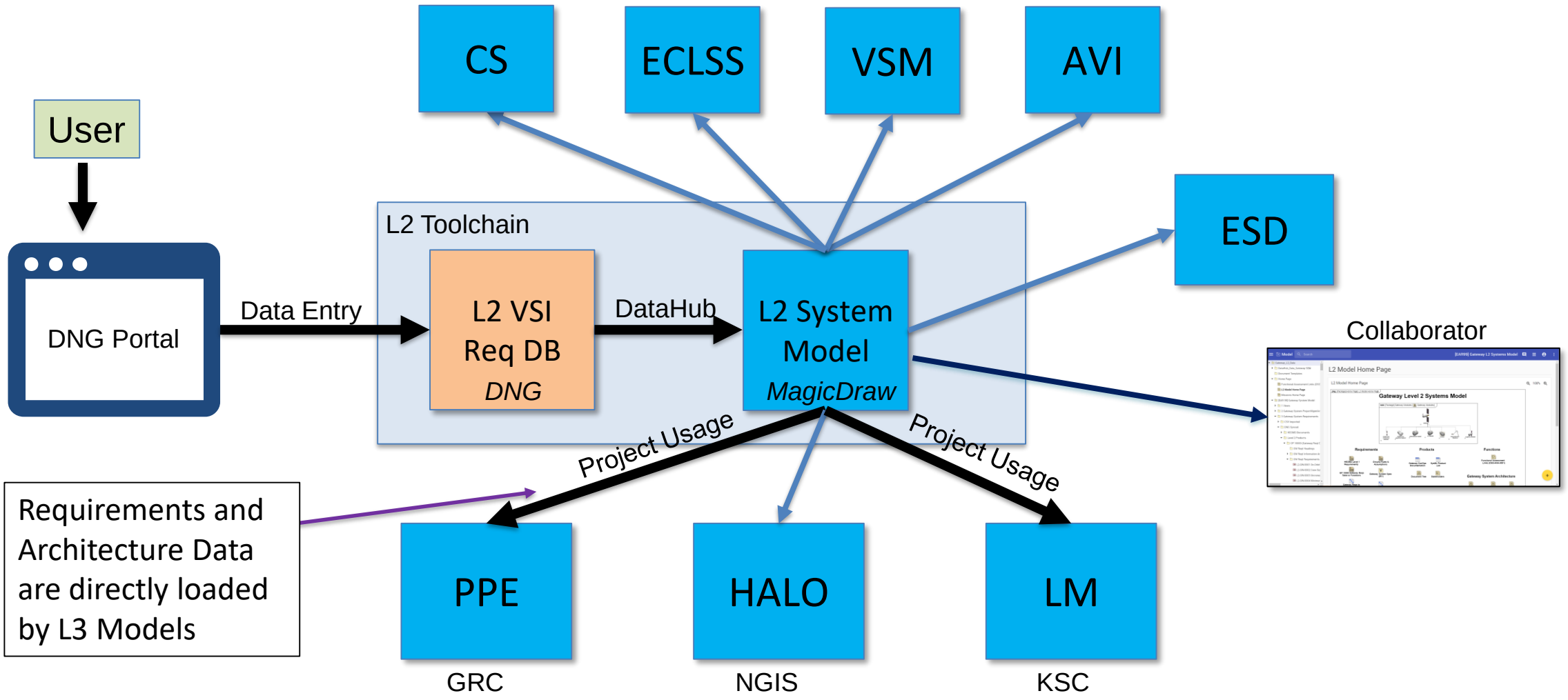
Dissemination of Requirements through the Tool Chain



Inputting data gets a fast track dissimilation to those integrated into the environment

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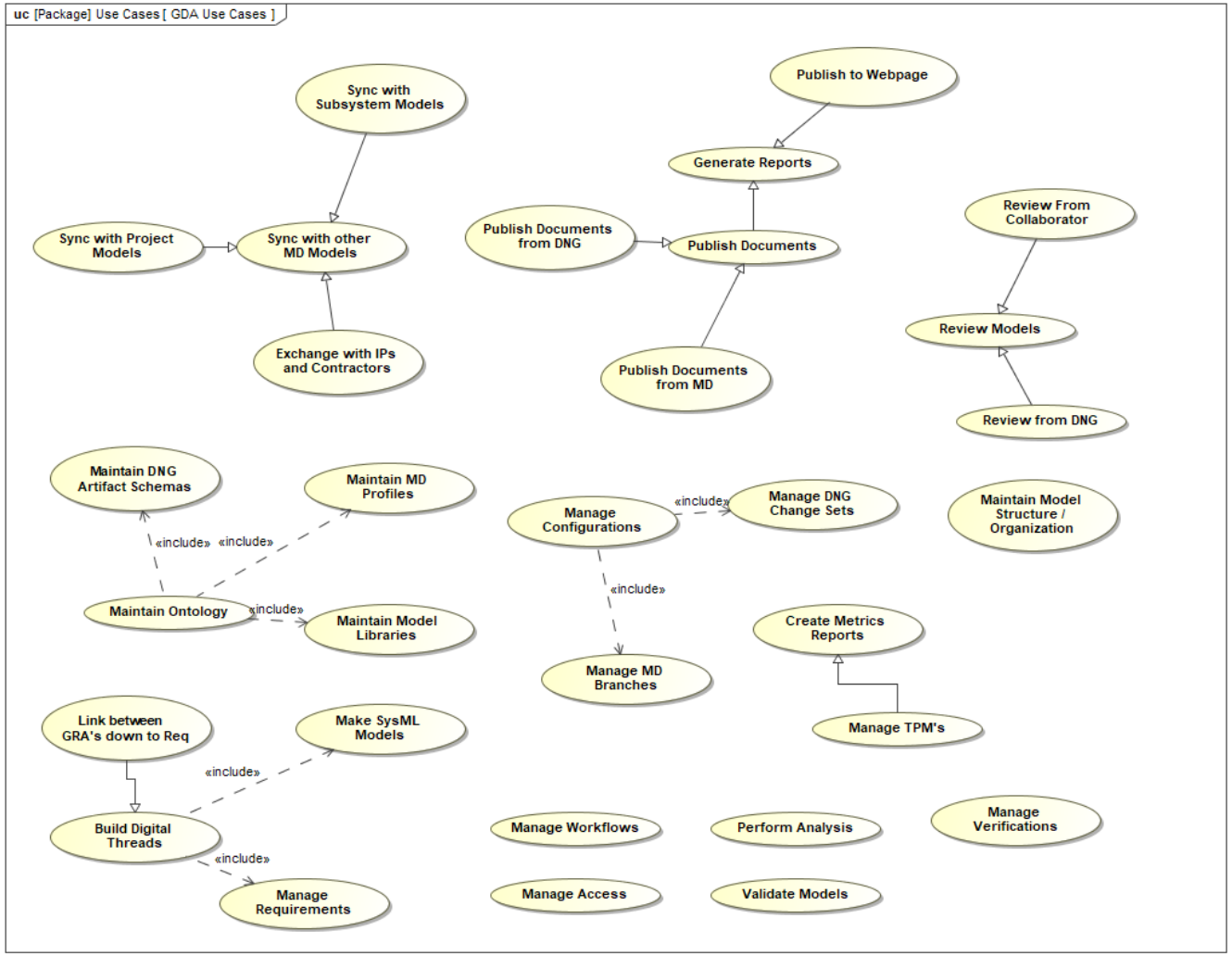
Use Cases for the GDA and MBSE Management Plan



- **Capturing the user needs of the Gateway Digital Architecture (GDA)**
  - Identifying tool chain needs
  - Typical actions needed to be performed
    - Sync, publish, model, etc
  - Assign roles to specific use cases
  - Develop use cases into requirements on the system

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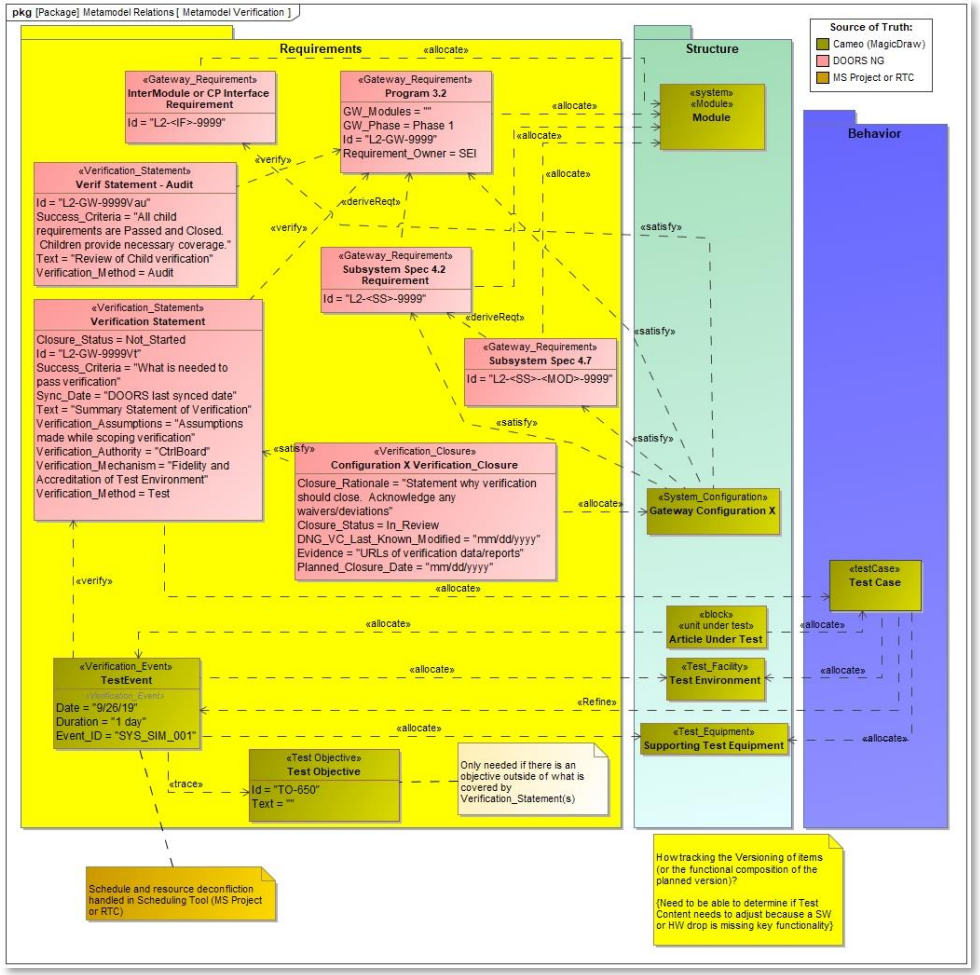
MBSE Management Plan

- **Document** the MBSE processes, including project interactions, configuration management and workflow tracking.
- **Embed** the plan information in the model to support generation of the document from the model to keep current
- **Utilize** the profile diagrams in the model to document the stereotype customizations used to support the modeling.
  - Embed documentation into the diagrams to support plan generation
- Use **metamodel** diagrams to illustrate desired relations between elements to assist modeler in traversing the model
- **Document** supporting tools and plug-ins



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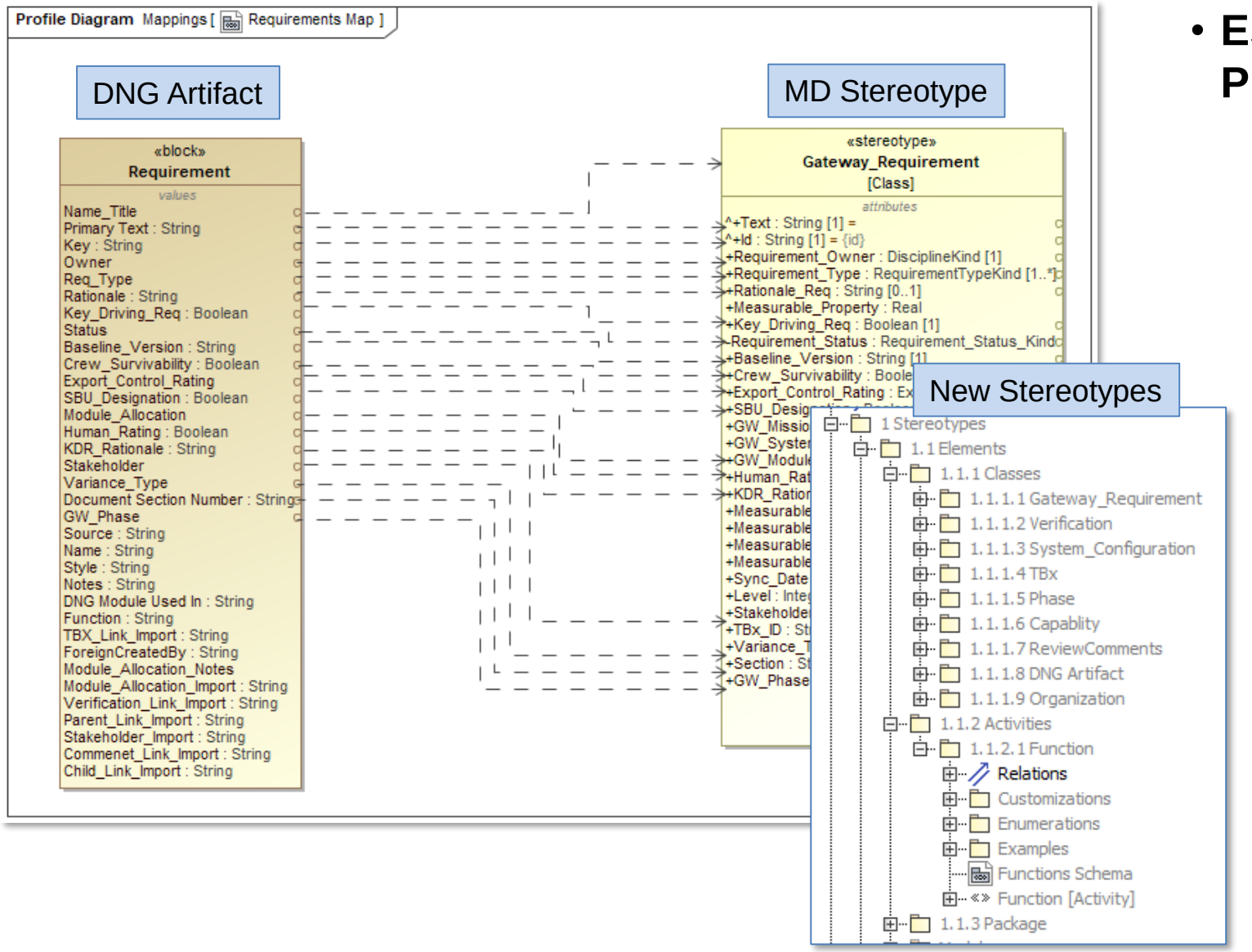
Schema Between Tools



- **Establishment of a Gateway Profile**
  - Expanded SysML to include
    - Requirements, Verifications statements, Review comments, etc.
  - Coordination of attribute changes occurred at working group levels.
  - Created central project file that was accessible for multiple projects

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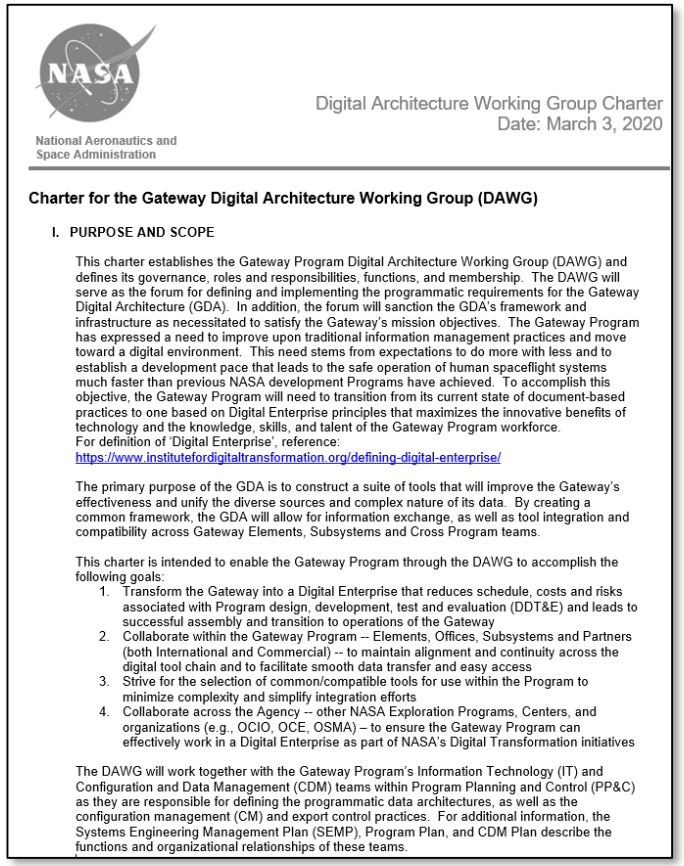
Working groups and Face to Face Meetings

- **Started 2 working Groups that meets weekly**
  - **Gateway Digital Architecture WG (DAWG):** Establish and maintain the tool chain, processes and governance
  - **MBSE WG:** A sub-WG of DAWG that lays the ground work to enable the L2 Gateway, L3 Modules and subsystem Model to interact with each other by using common terminology and format.
- **Conduct bi-annual face to face meetings**
  - Re-sync and re-energize the modeling effort
  - Discuss different cross-cutting schema ideas and implementation to select a schema that works across the program
  - Share models and expertise
- **Set to have a modeling summit as pre-work for System Design Review informed sync point**



National Aeronautics and Space Administration

Digital Architecture Working Group Charter
Date: March 3, 2020

Charter for the Gateway Digital Architecture Working Group (DAWG)

I. PURPOSE AND SCOPE

This charter establishes the Gateway Program Digital Architecture Working Group (DAWG) and defines its governance, roles and responsibilities, functions, and membership. The DAWG will serve as the forum for defining and implementing the programmatic requirements for the Gateway Digital Architecture (GDA). In addition, the forum will sanction the GDA's framework and infrastructure as necessitated to satisfy the Gateway's mission objectives. The Gateway Program has expressed a need to improve upon traditional information management practices and move toward a digital environment. This need stems from expectations to do more with less and to establish a development pace that leads to the safe operation of human spaceflight systems much faster than previous NASA development Programs have achieved. To accomplish this objective, the Gateway Program will need to transition from its current state of document-based practices to one based on Digital Enterprise principles that maximizes the innovative benefits of technology and the knowledge, skills, and talent of the Gateway Program workforce.
For definition of 'Digital Enterprise', reference:
https://www.institutefordigitaltransformation.org/defining-digital-enterprise/

The primary purpose of the GDA is to construct a suite of tools that will improve the Gateway's effectiveness and unify the diverse sources and complex nature of its data. By creating a common framework, the GDA will allow for information exchange, as well as tool integration and compatibility across Gateway Elements, Subsystems and Cross Program teams.

This charter is intended to enable the Gateway Program through the DAWG to accomplish the following goals:

1. Transform the Gateway into a Digital Enterprise that reduces schedule, costs and risks associated with Program design, development, test and evaluation (DDT&E) and leads to successful assembly and transition to operations of the Gateway
2. Collaborate within the Gateway Program -- Elements, Offices, Subsystems and Partners (both International and Commercial) -- to maintain alignment and continuity across the digital tool chain and to facilitate smooth data transfer and easy access
3. Strive for the selection of common/compatible tools for use within the Program to minimize complexity and simplify integration efforts
4. Collaborate across the Agency -- other NASA Exploration Programs, Centers, and organizations (e.g., OCIO, OCE, OSMA) – to ensure the Gateway Program can effectively work in a Digital Enterprise as part of NASA's Digital Transformation initiatives

The DAWG will work together with the Gateway Program's Information Technology (IT) and Configuration and Data Management (CDM) teams within Program Planning and Control (PP&C) as they are responsible for defining the programmatic data architectures, as well as the configuration management (CM) and export control practices. For additional information, the Systems Engineering Management Plan (SEMP), Program Plan, and CDM Plan describe the functions and organizational relationships of these teams.

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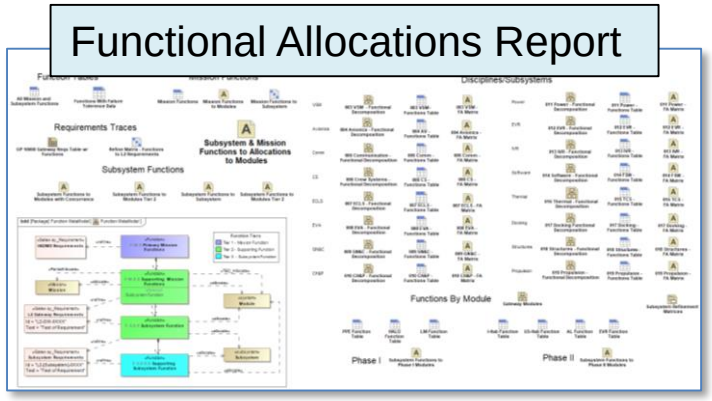
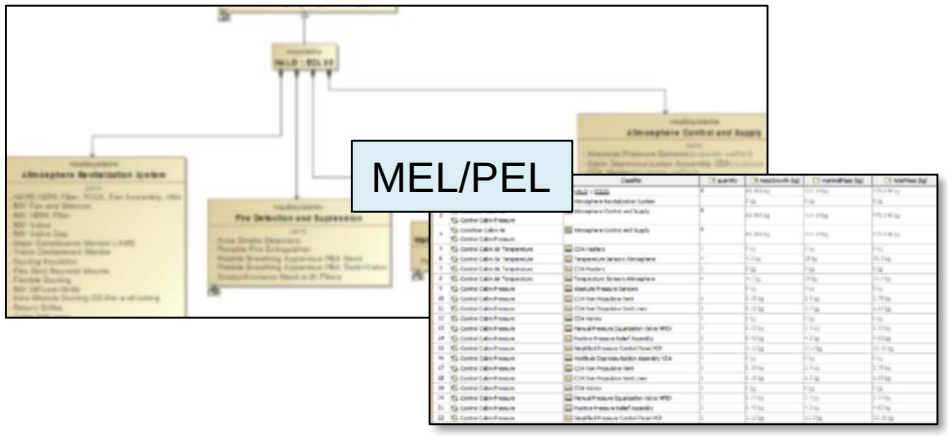
Products in models or databases

- **Nearly all Level 2 requirements specification for program office**
  - Gateway System spec
  - 17 Subsystem specs
  - 5 Interface Definition specs
  - 2 Module SRD
- **SE&I productions**
  - CONOP
  - Architecture Definition Document
  - Functional allocations (this one notable because it will no longer be a document)
  - Mass & Power Equipment Lists (MEL/PEL)
  - Intra-module interface definition
- **Assessments**
  - Gap analysis, completeness, meta-data metrics





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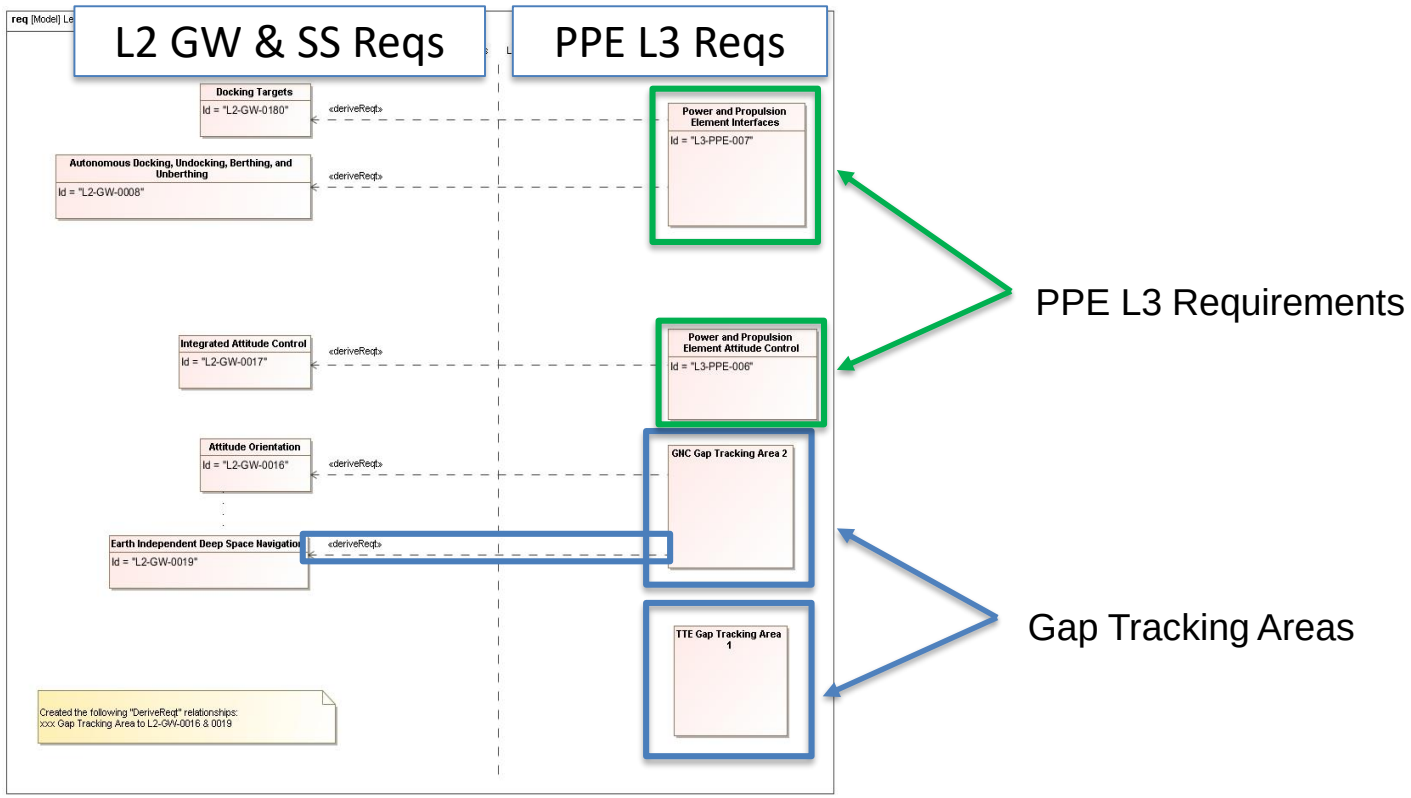
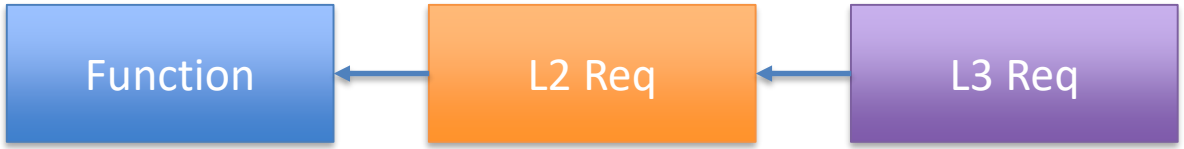
Level 2 to Level 3 Coordination on Finding Requirements Gaps

- **Goal**
  - Ensure functionality established in L2 requirements was captured in L3 specifications.
- **Method**
  - Pull mappings provided by L3 models (PPE & LM in MD, HALO in DNG)
  - Use Function to L2 Req to categorize the gaps
  - Give tailored reports to SSM's
  - Closure of this analysis acts as a validation of requirements





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Benefits & Summary

- **Benefits seen**
  - Data rich distribution of requirements. Meta-data plus relationships imported directly into lower models or via exports of DNG
  - Collaboration on profile extensions and reuse of elements types occurring in disparate module
  - Ability to quickly assess requirements impacts on architecture or function changes
  - Greater general collaboration of projects outside of face to face meetings
- **Expected benefits in work**
  - Robust MEL/PEL lists that allow us to hold multiple
    - Roll up of equipment list from lower models
  - Coordination on interface development to reduce risk
- **Development of the models and environment to support them is still evolving**
  - Have developed a framework for adding new tools or adjusting processes and schemas
- **A growing community and demand for Model-Based methods**
  - More subsystem managers and users are demanding content from models or desire to contribute to the modelling effort itself.

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