



34th Annual **INCOSE**
international symposium
hybrid event
Dublin, Ireland
July 2 - 6, 2024



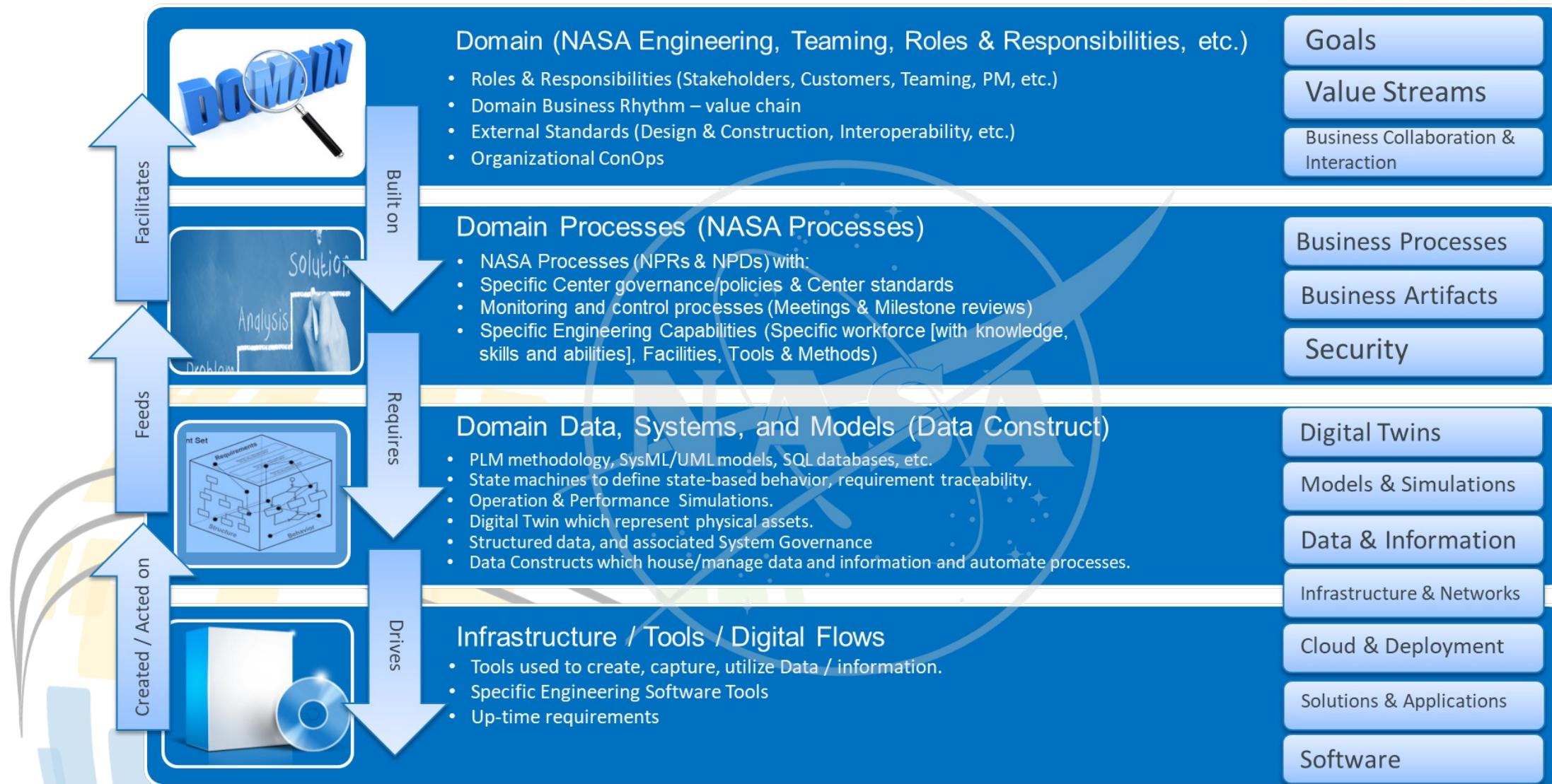
Modeling NASA's Procedural Requirement Processes – Implications for a Digital Future



BACKGROUND

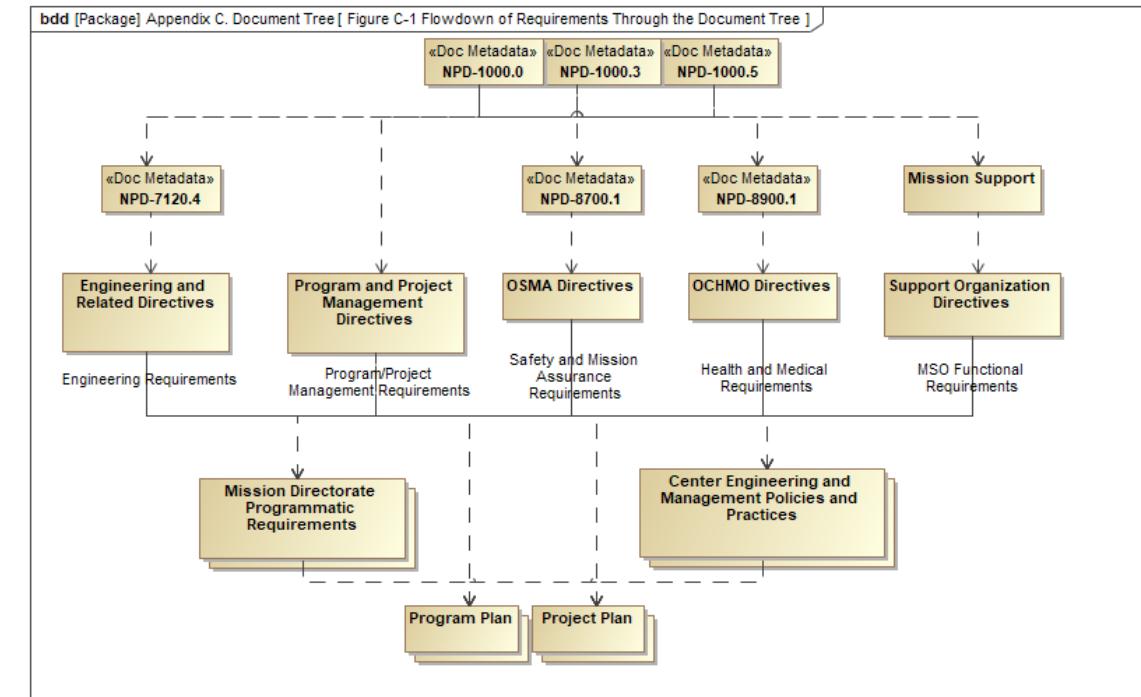
Digital Engineering Transformation

Architectural Elements



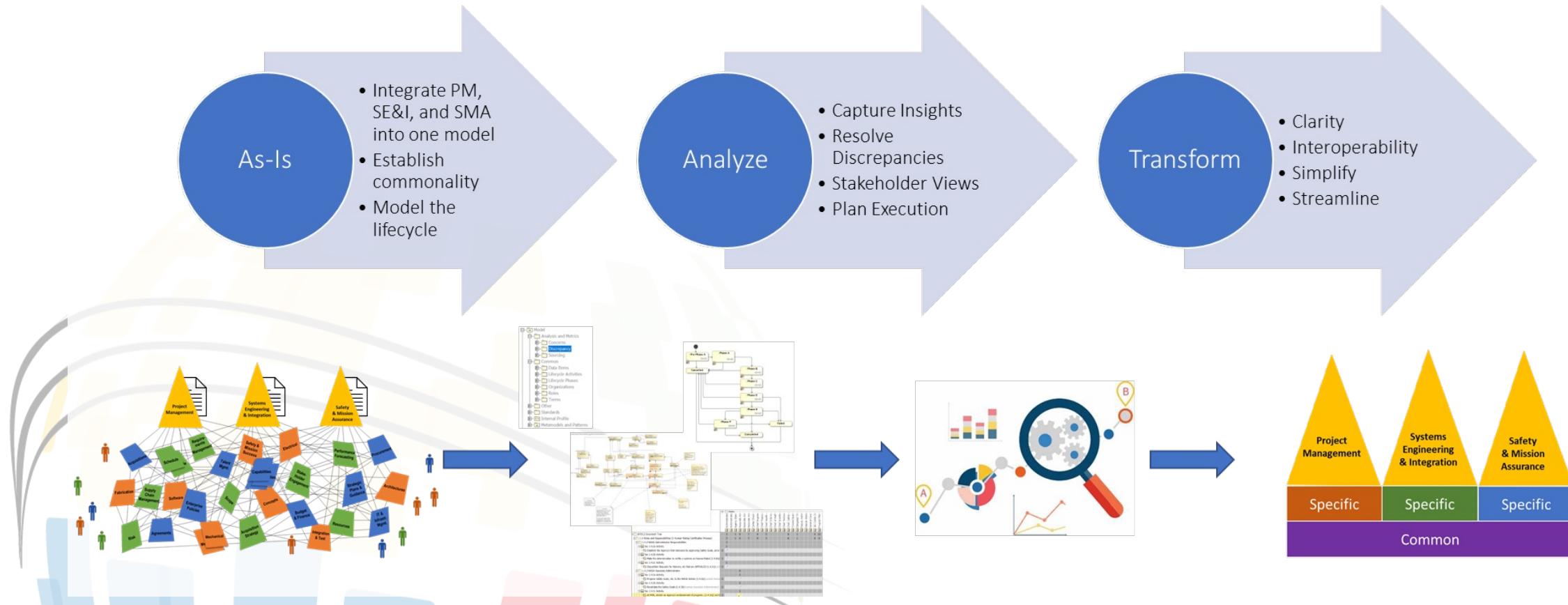
NPDs and NPRs: NASA Guidance

- NASA's success has been built upon well-established policies and procedures that evolved from best practices and lessons learned
 - NASA Policy Directive (NPD)
 - Provides broad vision and goals
 - Intended as guidance
 - NASA Procedural Requirements (NPR)
 - High-level implementation guidance for the workforce
- Provides guidelines on how work should be performed
- Aligns with the Organizational Structure
 - Programmatic Authority
 - Technical Authority
 - Institutional Authority
- Modeling effort focused on Program/Project Management, Systems Engineering, and Safety and Mission Assurance



APPROACH:

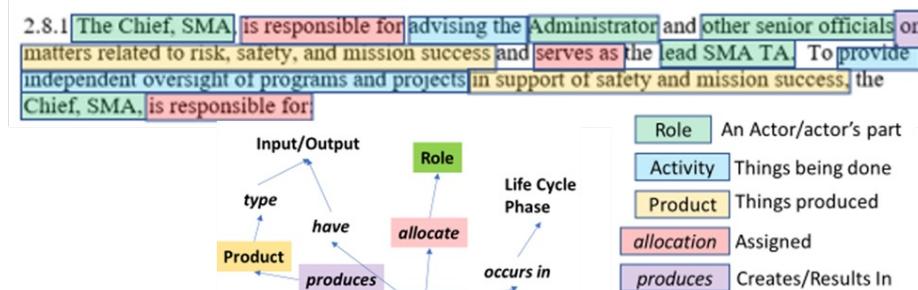
BREAK IT DOWN TO THE DATA & INFORMATION LEVEL
WHERE DECISIONS ARE MADE





AS-IS CAPTURE & ANALYSIS

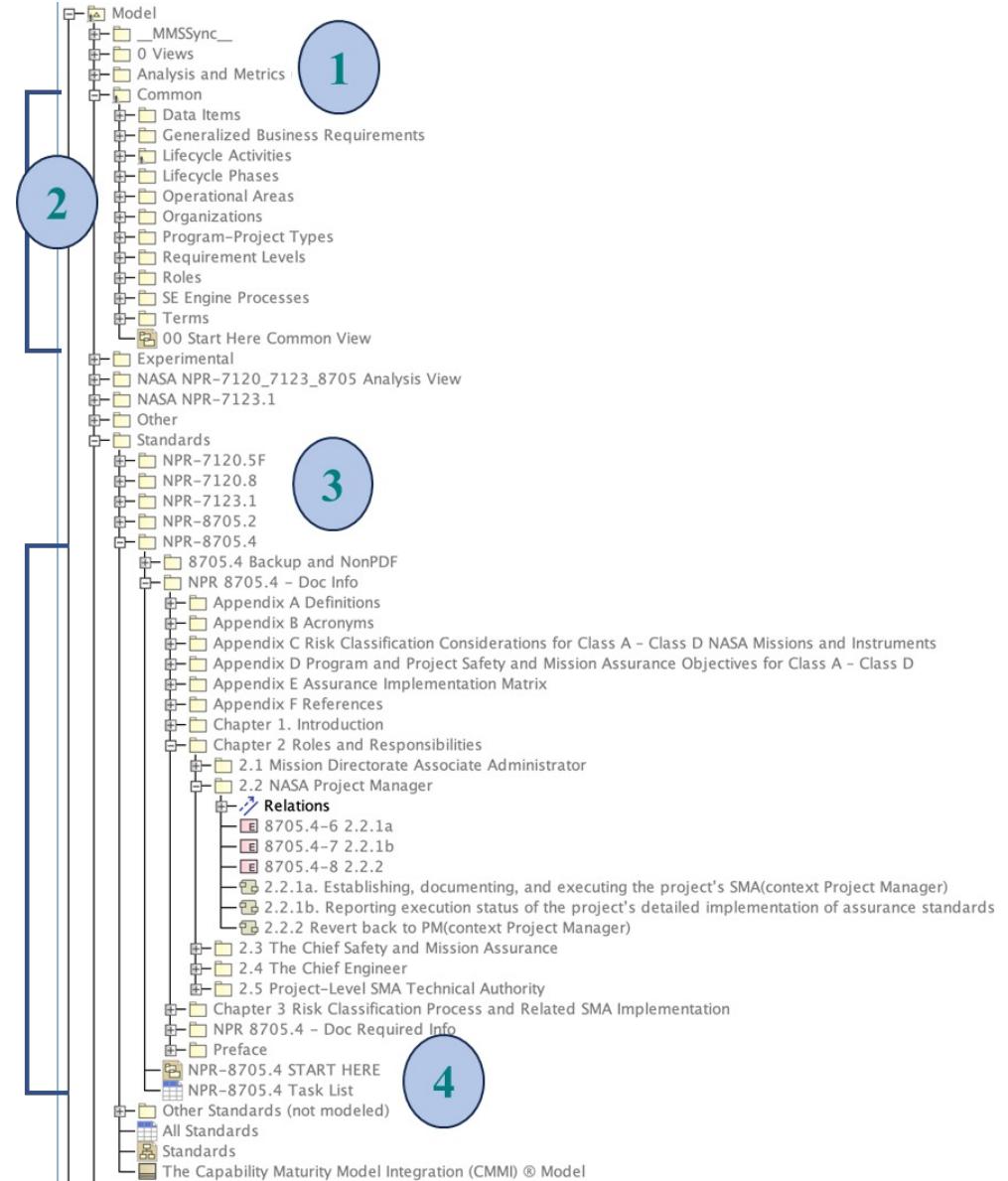
Parsing and Patterns



- Simple pattern focused on:
 - Allocating Roles to Responsibilities
 - Equating responsibilities into activities
 - Inputs/output of activities are the data/product
 - Putting them together visualizes the overall process
- Ability to produce human and machine readable from a single source
 - Machine-verification rules used to verify parsing and completeness
 - Human verification of format/layout
 - Additional views added to enable humans to verify parsing

Model Structure

- Multiple documents are integrated into one common model
 - Area 1: Views and Metrics
 - What is exposed from the model during reviews
 - Area 2: Common
 - Terms or data items that are used in multiple documents
 - Areas 3: Modeled Documents
 - Contains text, activities, requirements, etc.
 - Area 4: Documentation that hasn't been modeled
 - Reference material



Analysis Process

1

		Analysis Tags																							
		Acquisition/Contracts	Assurance	Authorities	Decision Authority	ConOps / Concept	Cost	Design	Human Rating	Implementation	Integration and Product-Logistics	Operations	Performance	Planning	Process	Quality	Requirements	Reviews	Risk	Safety	Schedule	Technology Development	V&V	Waivers Exceptions an...	
		Common	45	56	2	34	71	60	60	29	38	65	66	45	25	54	57	61	39	27	35				
		Policies, Directives and Standards	104	105	330	202	36	164	62	159	27	64	152	3	16	11	202	44	50	101	147	51	11		

2

2.1.3.1 As with programs, projects vary in scope and complexity and thus require varying levels of management requirements and Agency attention and oversight. Consequently, project categorization defines Agency expectations of project managers by determining both the oversight council and the specific approval requirements. Projects are Category 1, 2, or 3 and shall be assigned to a category based initially on: (1) the project life-cycle cost (LCC) estimate, the inclusion of significant radioactive material 3, and whether or not the system being developed is for human space flight; and (2) the priority level, which is related to the importance of the activity to NASA, the extent of international participation or joint effort with other government agencies, the degree of uncertainty surrounding the application of new or untested technologies, and spacecraft/payload development risk classification. (See NPR 8705.4, Risk Classification for NASA Payloads.) Guidelines for determining project categorization are shown in Table 2-1, but categorization may be changed based on recommendations by the Mission Directorate Associate Administrator (MDAA), who considers additional risk factors facing the project. Projects that plan continuing operations and production, including integration of capability upgrades, with an unspecified end point are assigned to Category 1 unless otherwise agreed to by the Decision Authority (DA) (See 2.4.1.3, b and Section 2.4.1.6.) The NASA Associate Administrator (AA) approves the final project categorization. The project category is identified in the Formulation Authorization Document (FAD) and documented in the KDP B Decision Memorandum. The Office of the Chief Financial Officer is responsible for the official listing of NASA programs and projects. 4 For purposes of program categorization, the project LCC estimate includes phases A through F and all Work Breakdown Structure (WBS) Level 2 elements and is measured in real-year (nominal) dollars.

Summary Example – NPR 7120.5 2.1.3.1

- As-Is
 - Activities (Blue)
 - One shall requirement applicable to a project
 - One is responsible for statement
 - Data/Deliverables Items
 - 10+ inputs (yellow)
 - 1+ output – project categorization
 - Documentation in 4 Deliverables (orange)
 - Allocated to 5 Roles (green)
 - Assume project
 - Requirement owned by OCE
 - References 2 different NPRs and 2 items within this NPR
- Analysis planning (Discrepancies & Concerns)
 - Inconsistent use of terms (LCC estimate, WBS L2 elements)
 - Data inputs
 - Priority level only impacts projects that are less than \$365M
 - NPR call outs add additional requirements (~30)
 - Data outputs/consistency/traceability
 - Project plan and categorization needed in Project Plan
 - Role/requirements/activities that are buried in the text or matrices in the appendices
 - Requirement compliance to Easy Approach to Requirement Syntax (EARS)
 - Score of 1 out of 5

2.1.3.1 As with programs, projects vary in scope and complexity and thus require varying levels of management requirements and Agency attention and oversight. Consequently, project categorization defines Agency expectations of project managers by determining both the oversight council and the specific approval requirements. Projects are Category 1, 2, or 3 and shall be assigned to a category based initially on: (1) the project life-cycle cost (LCC) estimate, the inclusion of significant radioactive material 3, and whether or not the system being developed is for human space flight; and (2) the priority level, which is related to the importance of the activity to NASA, the extent of international participation or joint effort with other government agencies, the degree of uncertainty surrounding the application of new or untested technologies, and spacecraft/payload development risk classification. (See NPR 8705.4, Risk Classification for NASA Payloads.) Guidelines for determining project categorization are shown in Table 2-1, but categorization may be changed based on recommendations by the Mission Directorate Associate Administrator (MDAA), who considers additional risk factors facing the project. Projects that plan continuing operations and production, including integration of capability upgrades, with an unspecified end point are assigned to Category 1 unless otherwise agreed to by the Decision Authority (DA) (See 2.4.1.3, b and Section 2.4.1.6.) The NASA Associate Administrator (AA) approves the final project categorization. The project category is identified in the Formulation Authorization Document (FAD) and documented in the KDP B Decision Memorandum. The Office of the Chief Financial Officer is responsible for the official listing of NASA programs and projects. 4 For purposes of program categorization, the project LCC estimate includes phases A through F and all Work Breakdown Structure (WBS) Level 2 elements and is measured in real-year (nominal) dollars.

3. Significant radioactive material is defined as levels of radioactive material emitted by a reactor and/or launch vehicle that are regulated by the Nuclear Regulatory Commission (NRC) and/or the U.S. Environmental Protection Agency (EPA). Nuclear flight safety is regulated by the NASA Administrator or Executive Office of the President as described in NPR 8712.26, Nuclear Flight Safety.

4 This data is measured by NASA as the number of projects and programs in the spending areas of Human Operations and Mission Support offices.

Table 2-1 Project Categorization Guidelines			
Priority Level	LCC < \$265M	\$365M ≤ LCC ≤ \$2B	LCC > \$2B; significant radioactive material, or human space flight
High	Category 2	Category 2	Category 1
Medium	Category 3	Category 2	Category 1
Low	Category 3	Category 2	Category 1

Data Product Characterization

Requirement Quality Exploration

Integrate Processes and Explore Utilization

Ability to tag data items and create alternate views of the textual data.

Parsing allowed for use of COTS requirement quality tool that highlighted issues quickly

Explored overlapping processes, terminology inconsistencies, and stakeholder interpretations



FINDINGS & RECOMMENDATIONS

Data-Centric Views of Common Items

Terminology

Easy to find discrepancies between terms.
Method created for extending definitions.

Roles & Responsibilities

Role expectations are documented in multiple NPD/NPRs. View created based on roles.

Milestone Reviews

Integrated data-centric views makes it easier to tailor and make decisions.



References

Defined metadata necessary for reference data. Easier to find references and ensure that they are current.

Data/Deliverable Hierarchy

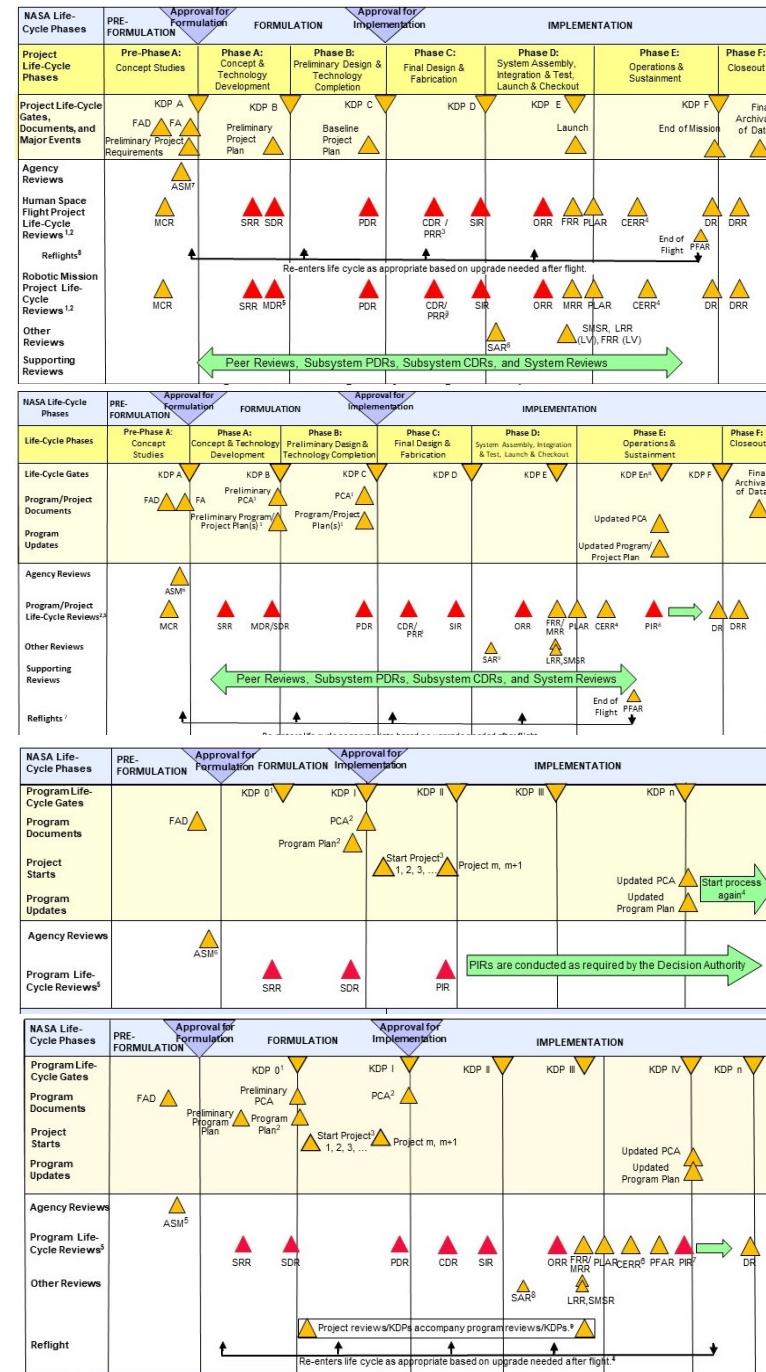
Document-centric deliverables were broken into the required data elements which allows for re-use and traceability.

Requirements

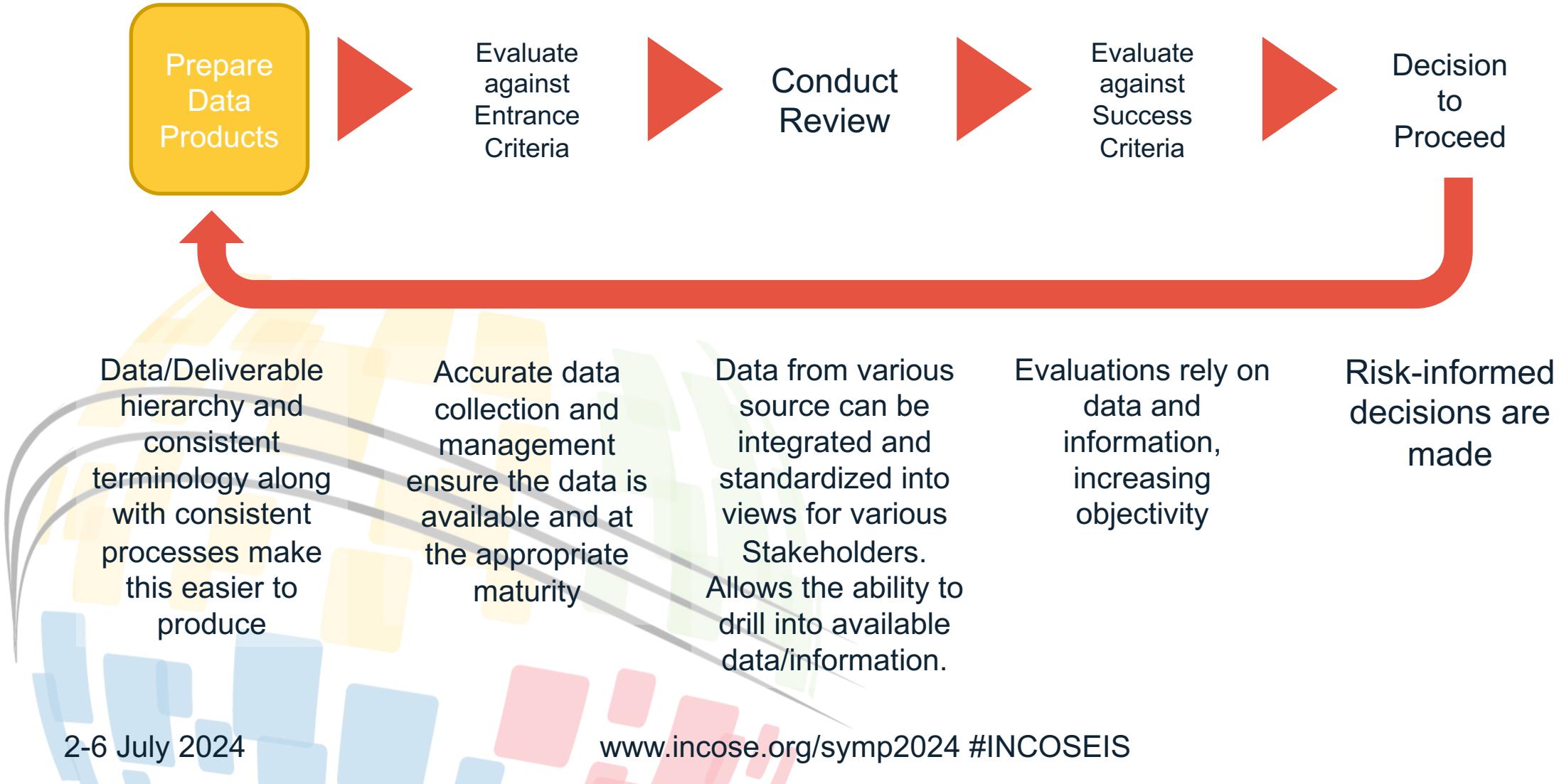
Defined metamodel that breaks text into data elements and process flows allows orchestration of large/complex processes.

Assess Lifecycles

- NASA currently has numerous lifecycles
- Data-centric views allow for assessment of:
 - Complexity vs. Flexibility
 - Codified vs. Guidance
 - Traceability to Centers vs. Program/Project
 - Missing details/allocations
- Recommendations for changes based on:
 - Accuracy and consistency
 - Efficiency
 - Risk management
 - Data patterns and trends
- Enable attribute-based customizations



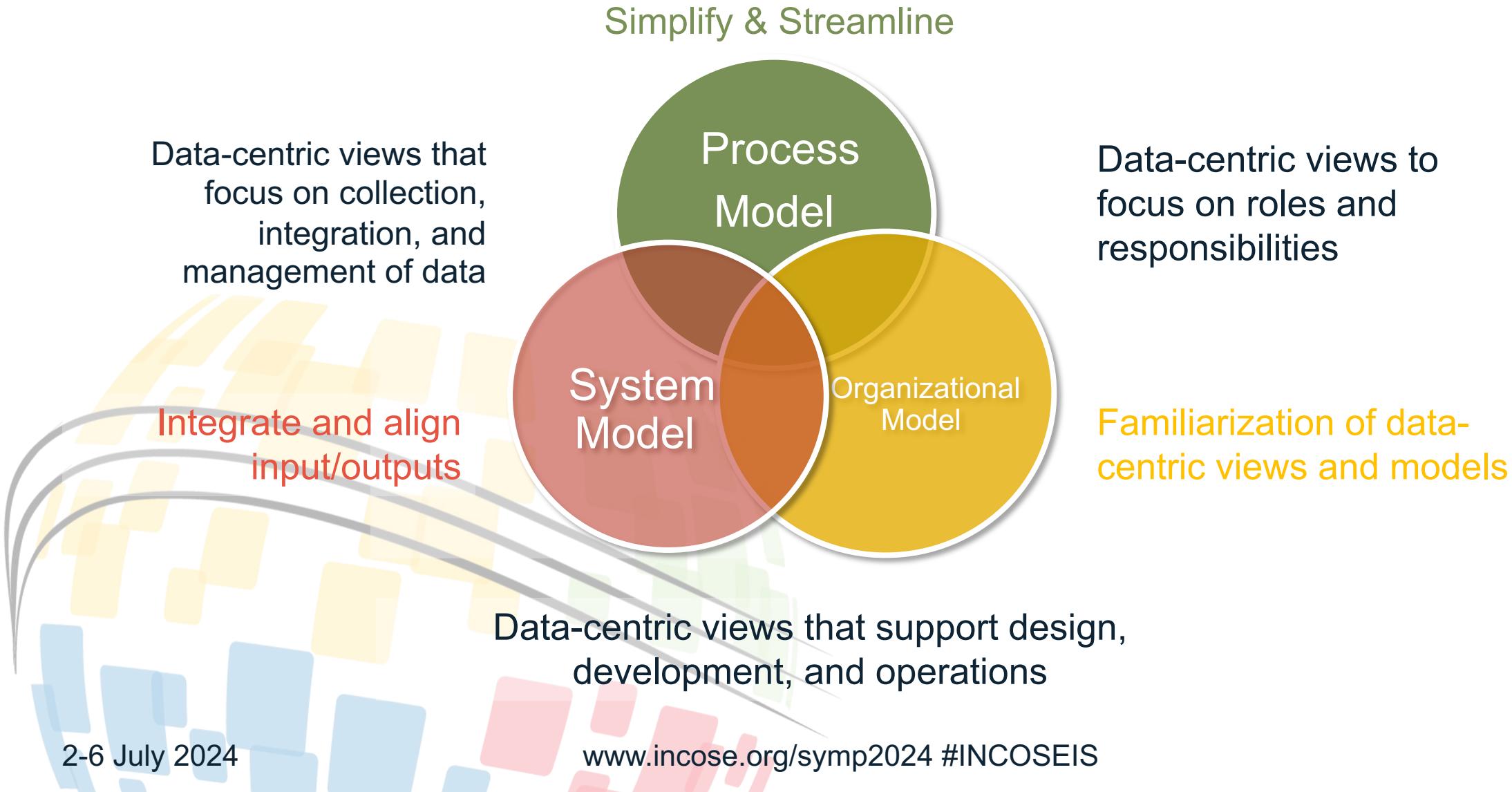
Data-Centric Review Process Pattern





Summary

Digital Engineering – Next Steps





Questions?



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www.incos.org/symp2024
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