Digital Engineering Information Exchange Working Group (DEIXWG)

Digital Viewpoint Model (DVM)

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What is the DEIXWG?

- Collaboration between the International Council of Systems Engineers (INCOSE), National Defense Industrial Association (NDIA), and the Office of the Under Secretary of Defense for Research and Engineering (DoD OUSD(R&E))
- The DEIXWG supports the strategic objective of accelerating digital engineering transformation by characterizing the content and relationships involved in the exchange of digital artifacts between stakeholders of various disciplines throughout the engineering lifecycle

What is the DVM?

- The Digital Viewpoint Model (DVM) is an implementation-agnostic (platform independent), conceptual ontology developed from DEIXWG
- The DVM provides a high-level framework for describing sources of digital information in a digital engineering ecosystem (DEE)
- The DVM also conceptualizes how that information can be transferred, translated, transformed, and related for the purpose of exchanging digital information between stakeholders… who might not have the same DEE infrastructure or standards

DEIXWG Activities

Digital Viewpoint Model (DVM) WG

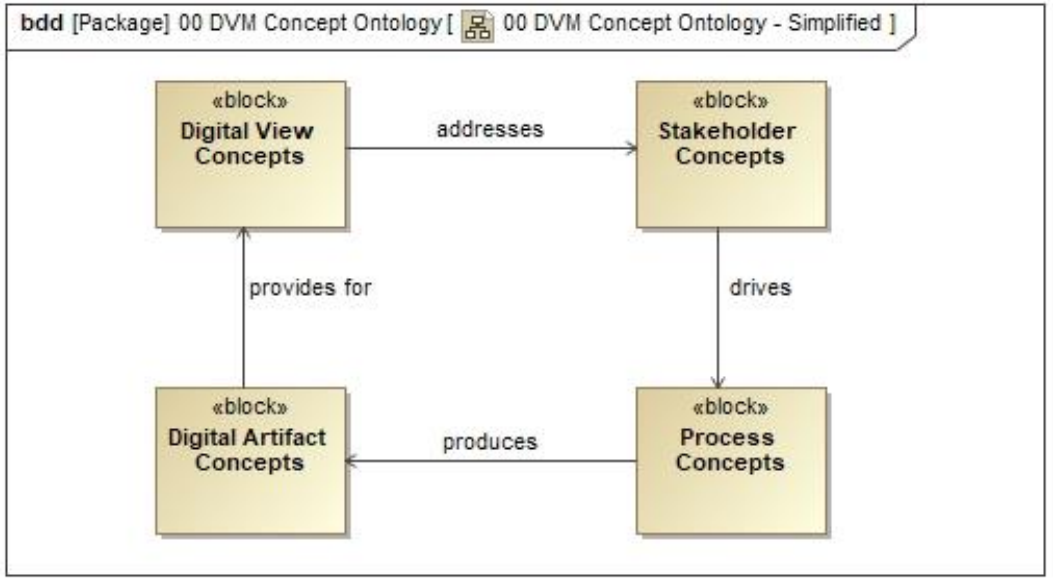
- **Manage DVM Baselines**
  - Release/Publish DVM Baselines
  - Capture proposed changes to DVM
  - Facilitate updates to DVM baseline with DEIX committee
  - Support DVM proposal to industry standards
- **Facilitate DVM Usage through Use Cases**
  - Develop supporting material for DVM usage
  - Capture use cases that involves digital exchanges
  - Host workshops on use case development and DVM usage

Standards Framework (SF) WG

- INCOSE/ISO liaison for digital engineering standards
- Manage proposals of DEIX concepts/products to ISO standards

DVM Ontology Overview

- Defined at a high-level
- Allow stakeholders to extend them with more specialized concepts
- Can be specialized to a given domain or need
- Instead of defining a set of all-purpose views, the ontology simply provide guidance in defining views for specific exchanges
- DVM is about how to better define what needs to be exchanged, not the implementation of the exchange and associated artifacts
- The DVM is divided into four interconnected ontologies

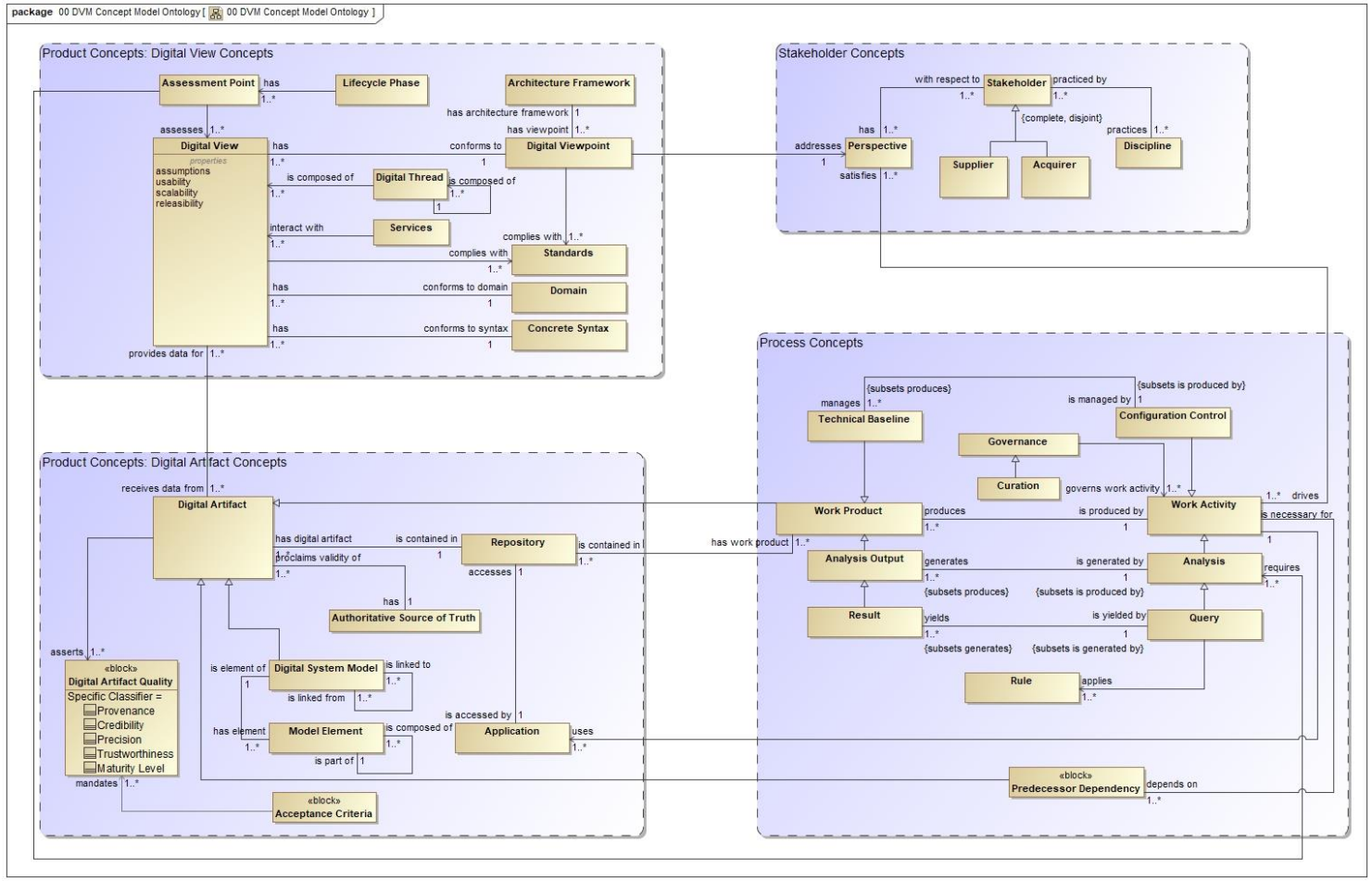


While the DVM is modeled using SysML, the concepts are agnostic of any particular language, tool, or infrastructure

DVM: Exchanging Data Related Across Different Metamodels

Digital View Concepts

Digital Artifact Concepts



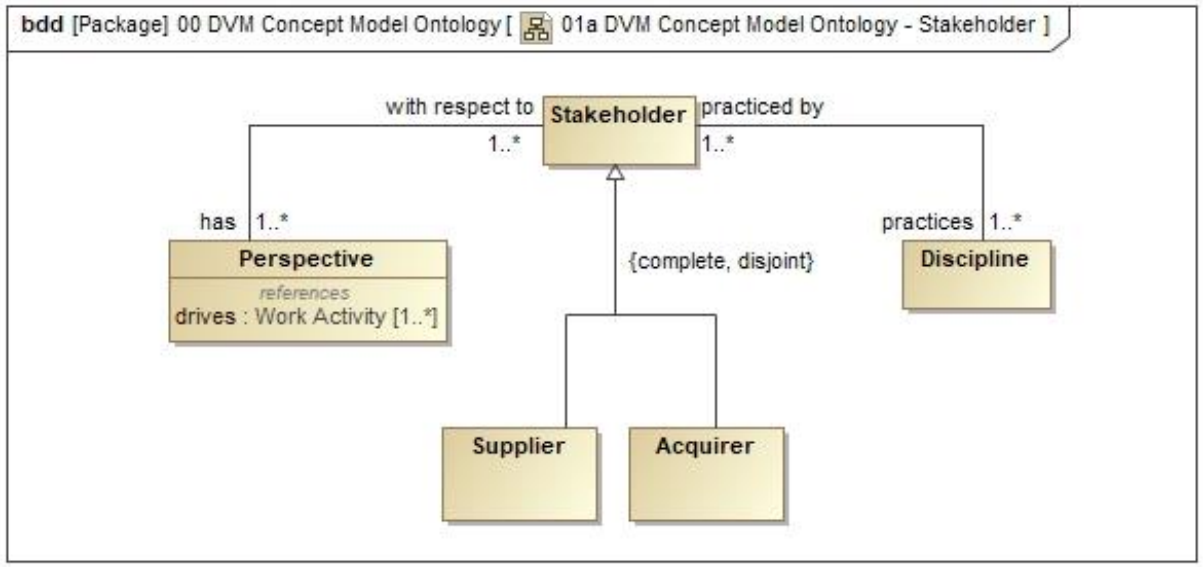
Stakeholder Concepts

Process Concepts

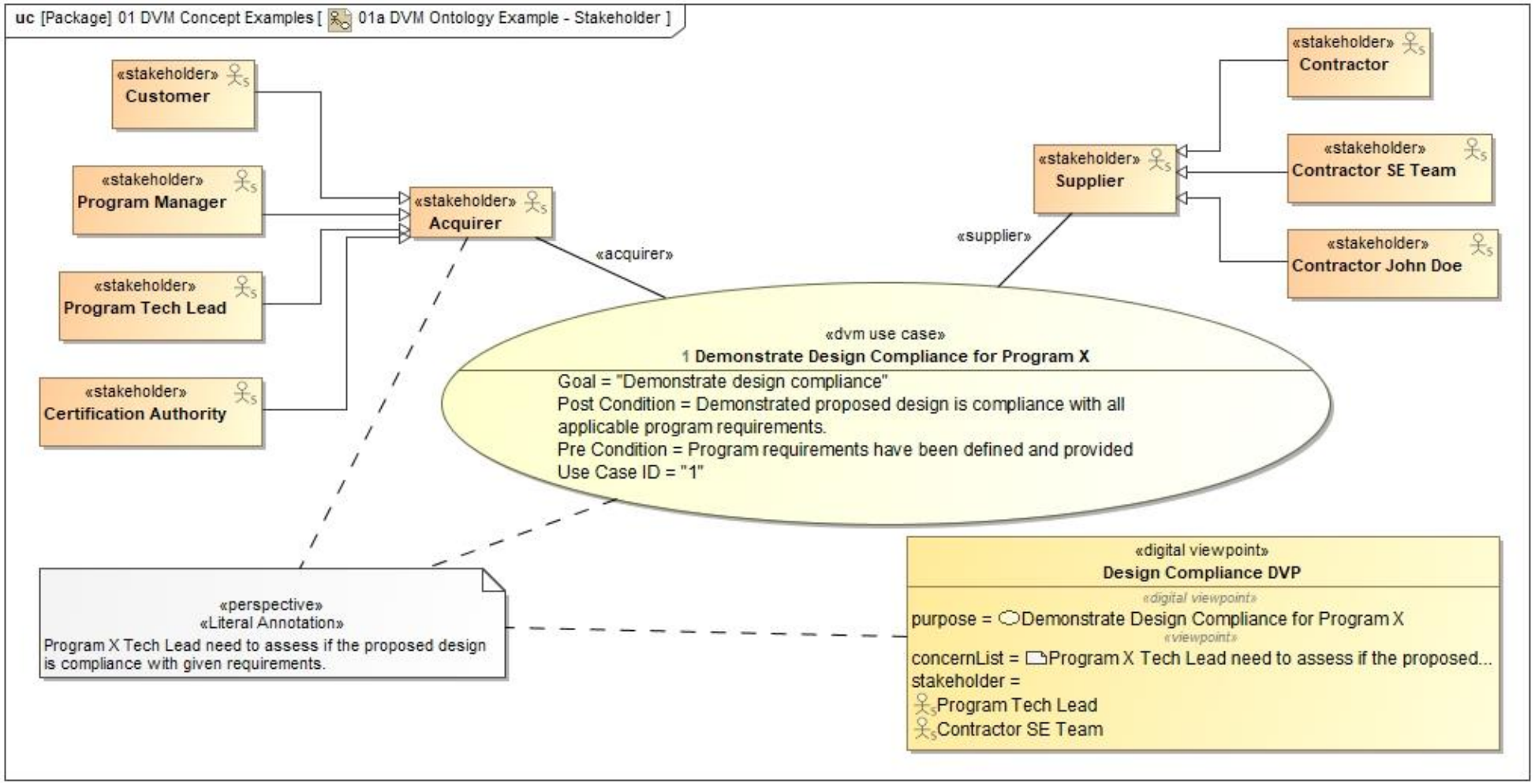
Rev A

DVM: Stakeholder Concepts Ontology

- Describe the stakeholders involved in a given exchange of digital information
- Can be applied to any stakeholders exchanging digital information, whether they are from the same or different organizations
- The perspective defines the specialized stakeholder needs that drive associated work activity and requirements for the digital view

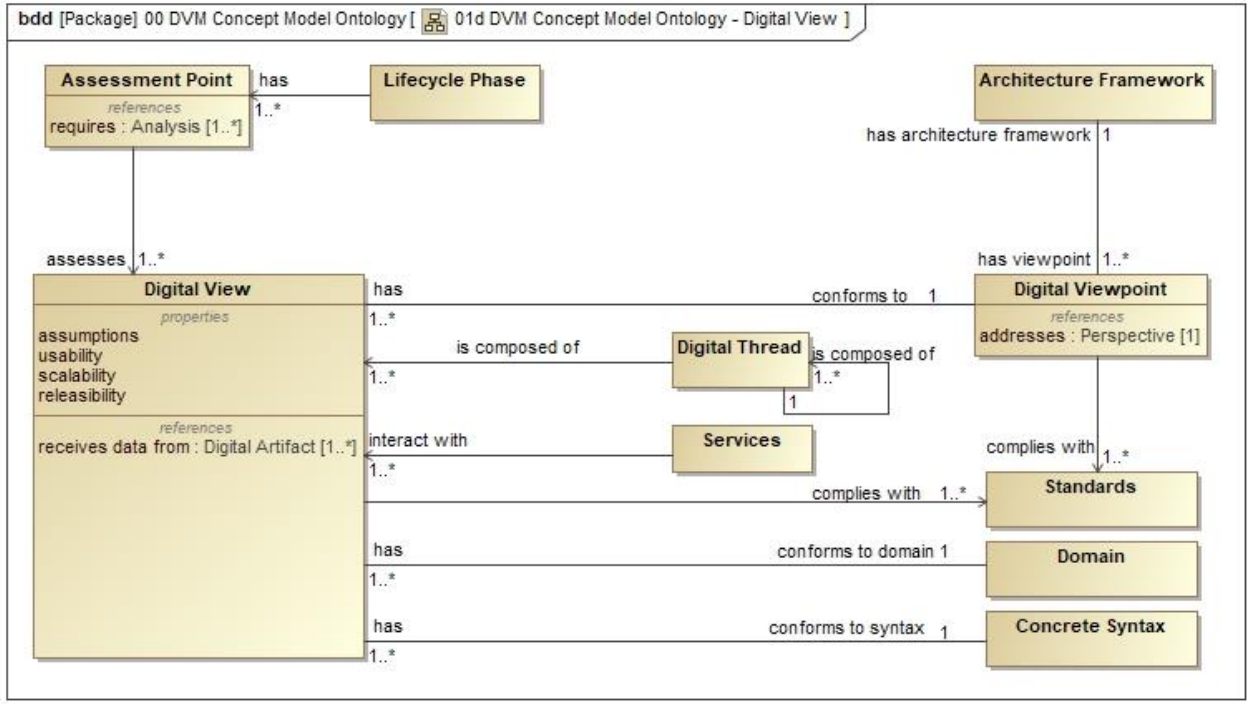


DVM: Stakeholder Concepts - Example

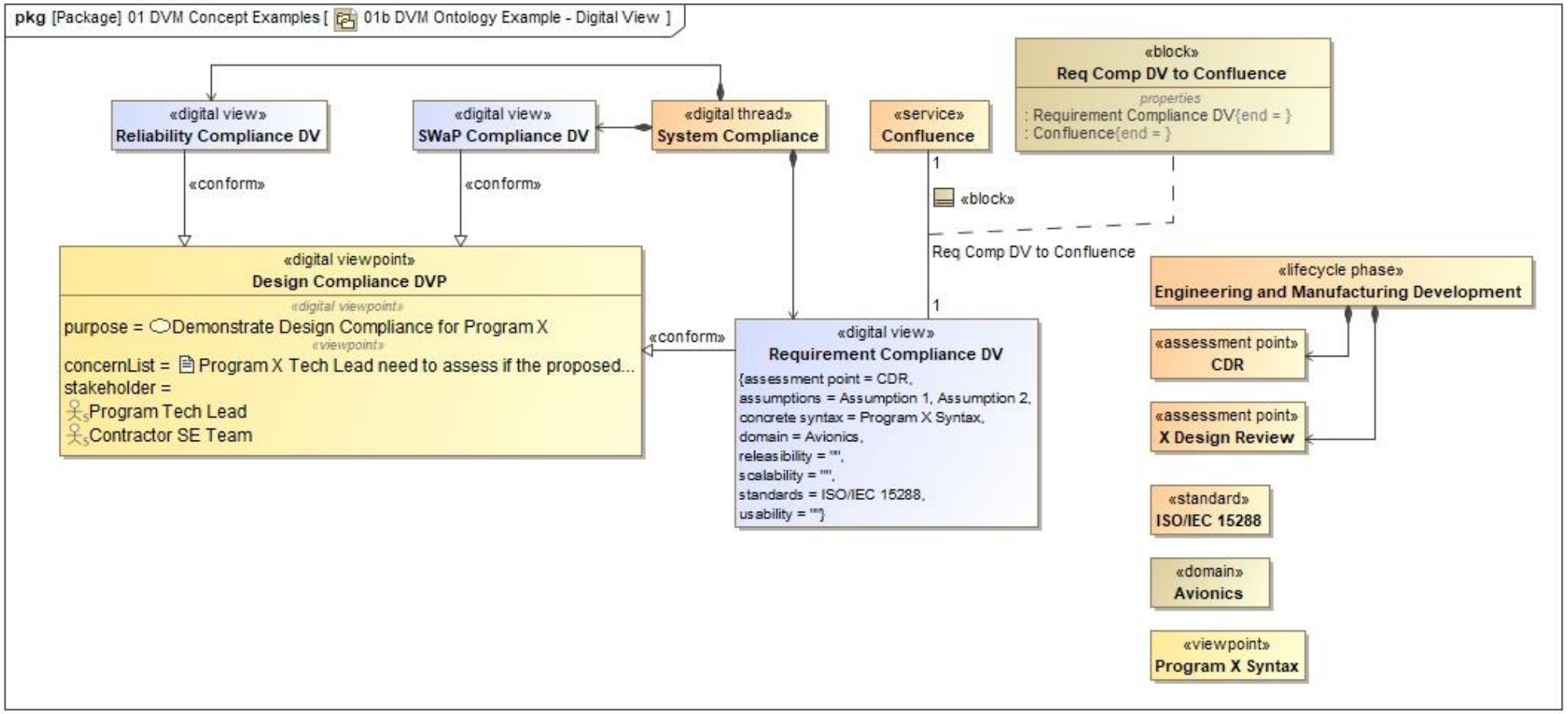


DVM: Digital View Concepts Ontology

- This ontology specifies concepts used to describe
  - Specify concepts describing digital views
  - Specify applicable standards and syntax
  - Influence of digital views in system life cycle
- The relationship between digital views and viewpoints is specified
- New digital views and viewpoints can be conceptualized as extensions of these base concepts

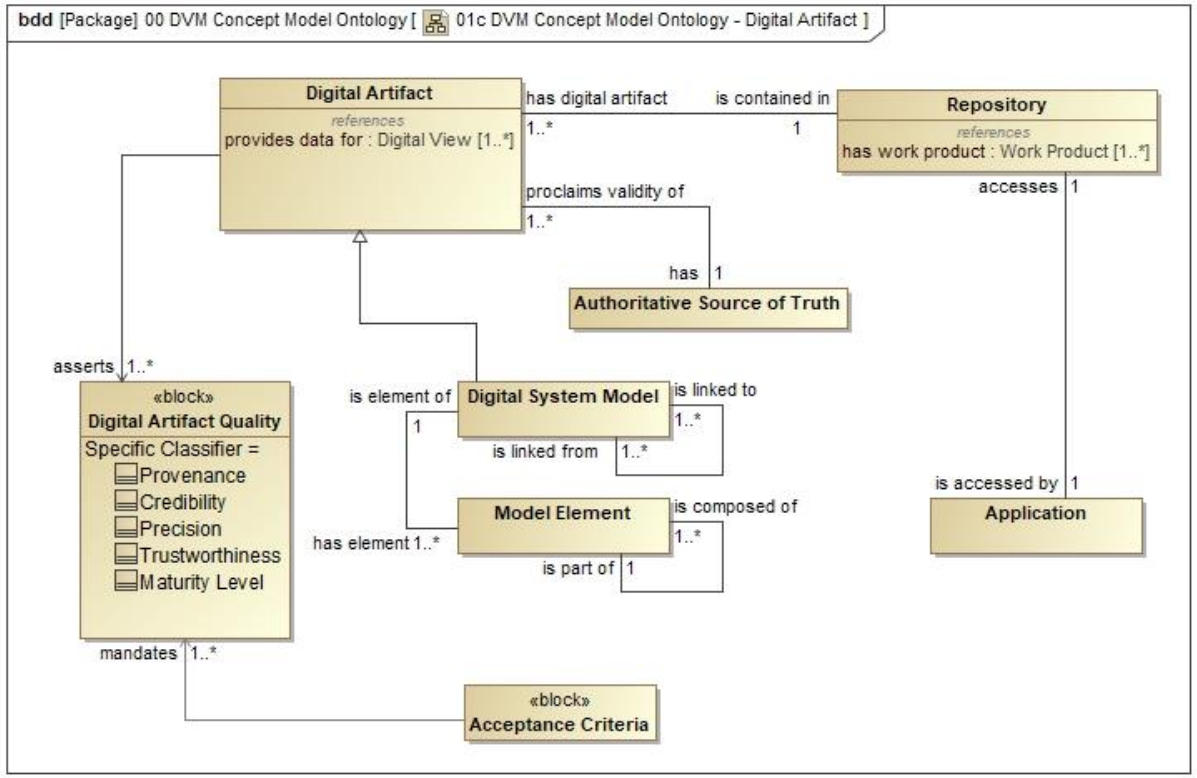


DVM: Digital View Concepts - Example

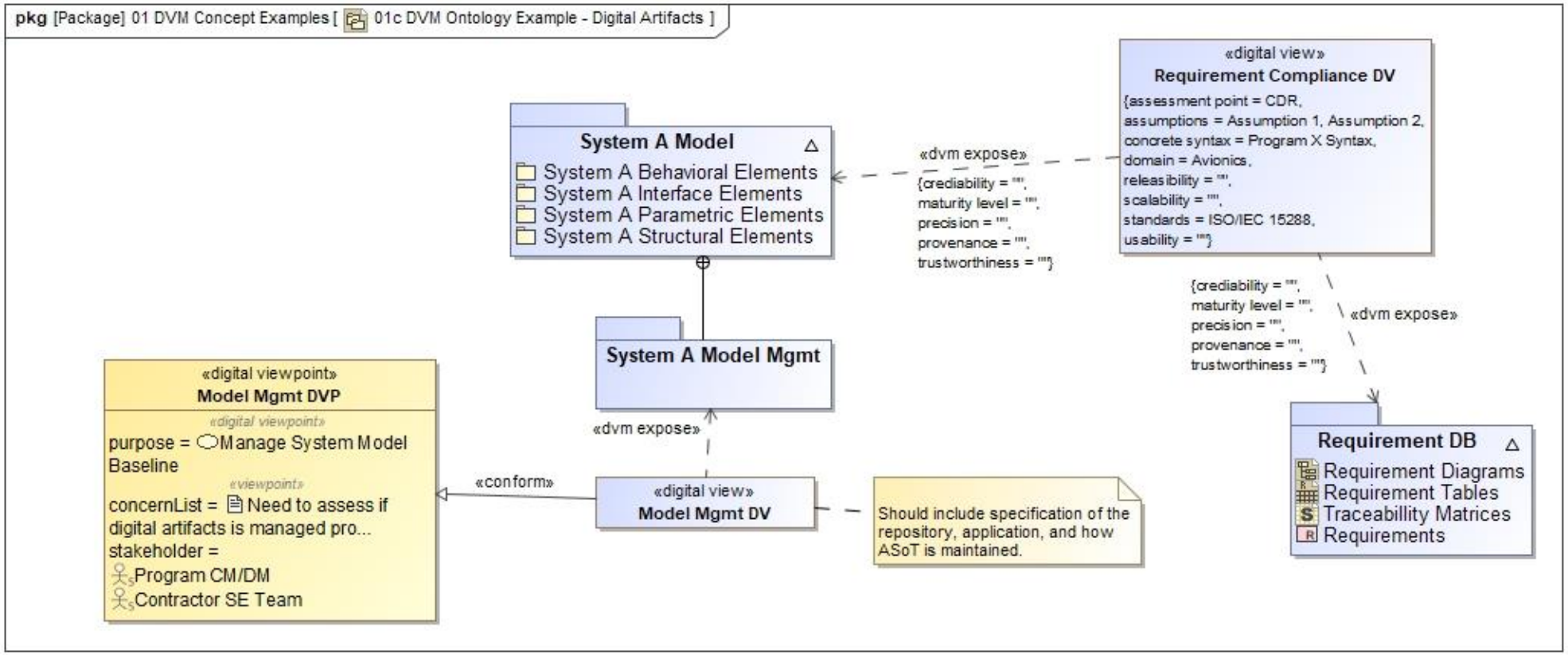


DVM: Digital Artifact Concepts Ontology

- Describe the kinds of digital information (models, databases, etc.) that comprise a digital artifact to be exchanged
- Shows how repositories and authoritative sources of truth critical in specifying pedigree of digital artifacts
- Enables specification of digital artifact quality mandate by acceptance criteria

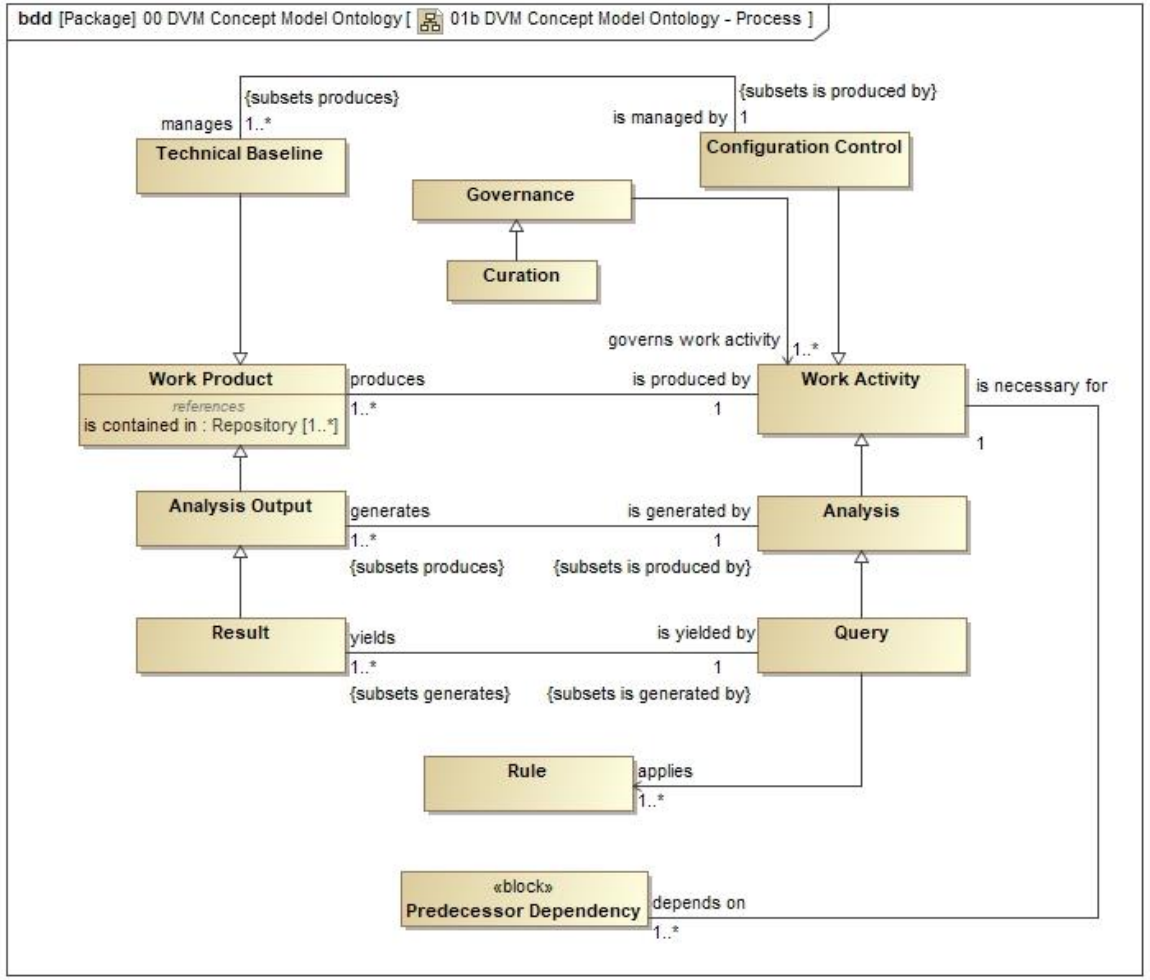


DVM: Digital Artifacts Concepts - Example



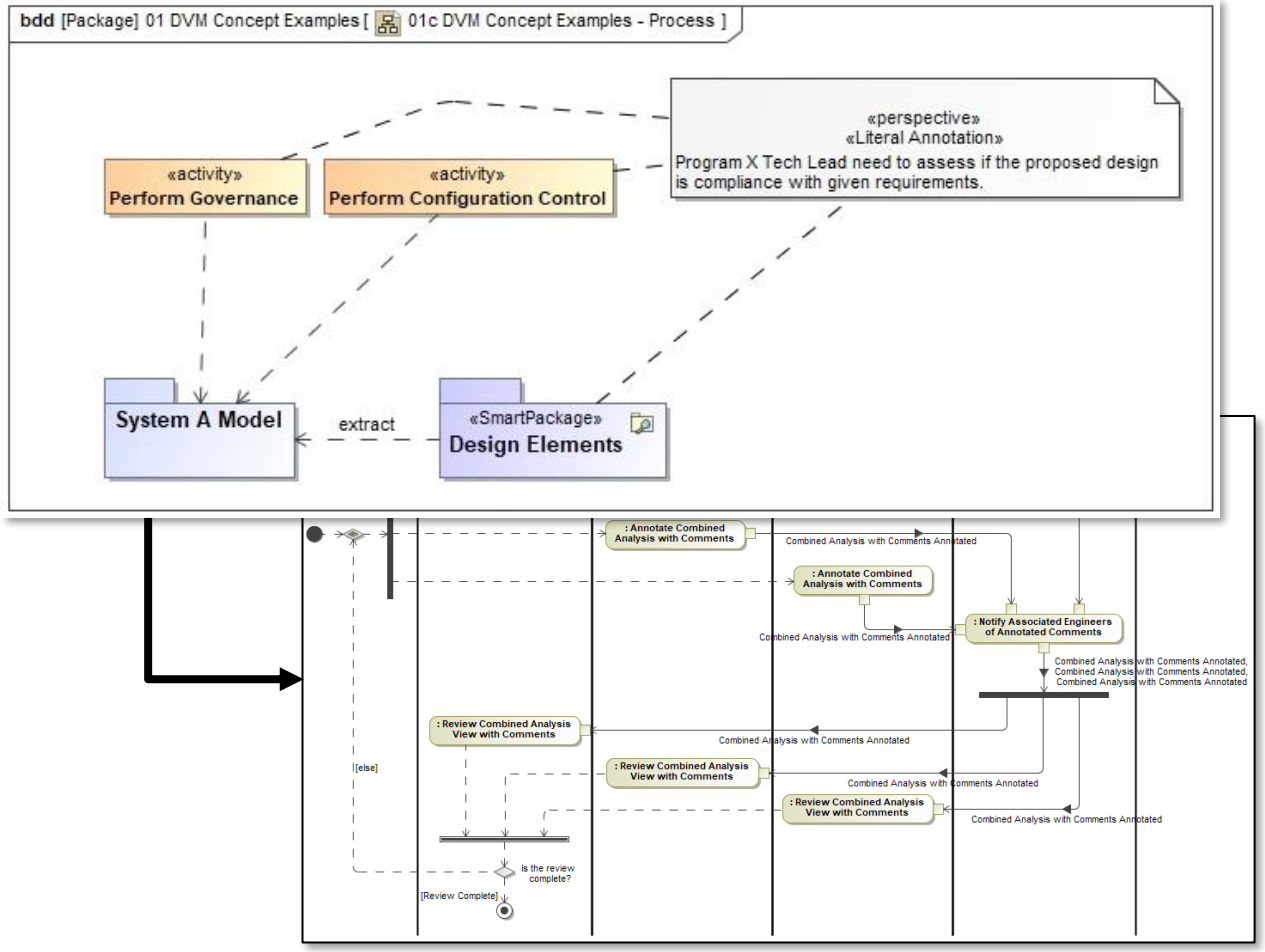
DVM: Process Concepts Ontology

- This ontology specifies concepts used to describe work products and the activities that produce them
- Some specialized kinds of work products and activities can be specified
- The concepts of governance can dictate how work activity should be performed



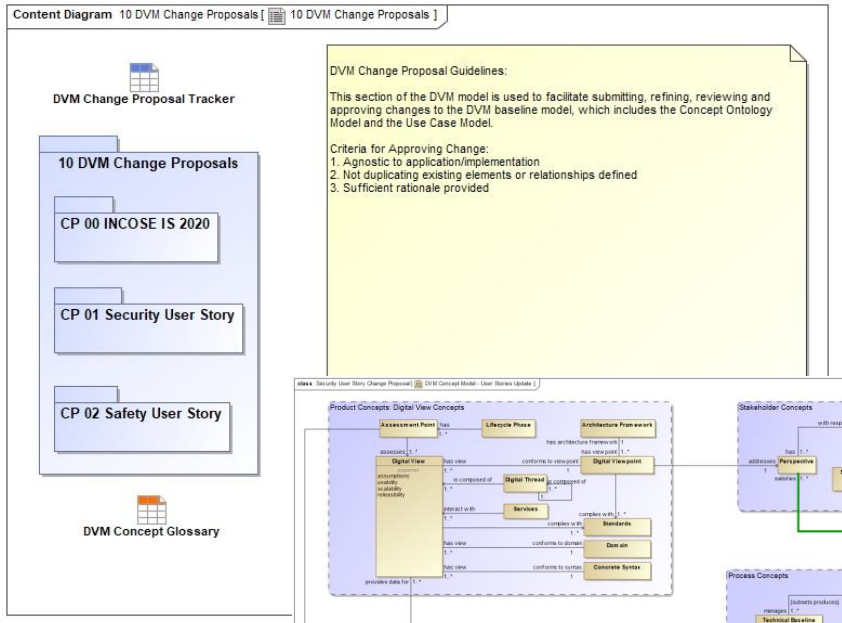
DVM: Process Concepts - Example

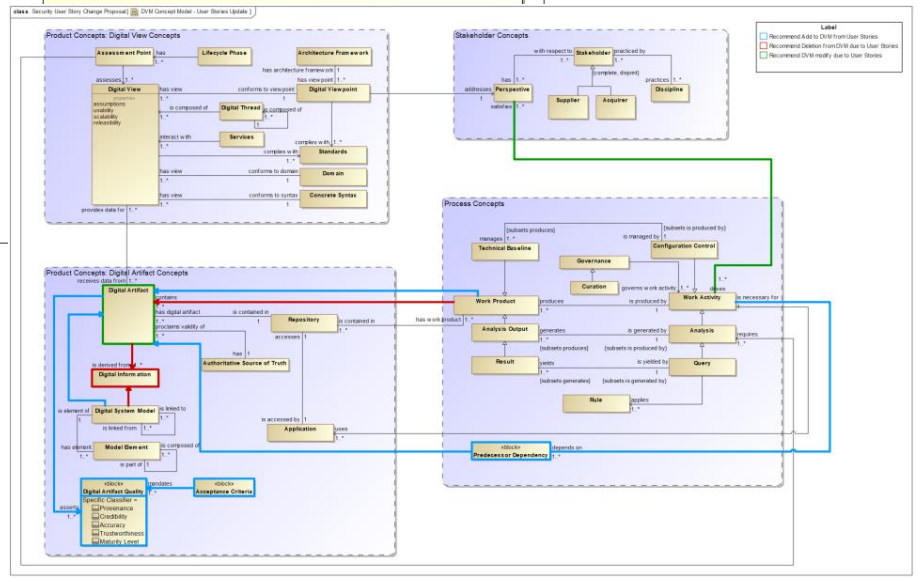
- Specified perspective influences how digital artifacts are produced
- Work process can be specified in series of activity flows
- Query is a type of work activity to define artifacts required for the perspective from a metamodel



DVM Baseline Management Process (Preliminary)

- Support update to the DVM concept, or informing the DVM
- Proposed changes are tracked from major events, and through our biweekly meetings
- Preliminary process for reviewing and approving change proposals is established, include
  - Change Proposal Submission
  - Change Proposal Tracker
  - Baseline Control Board and Approval Process
- ISO change process will supersede once this becomes an approved ISO standard project

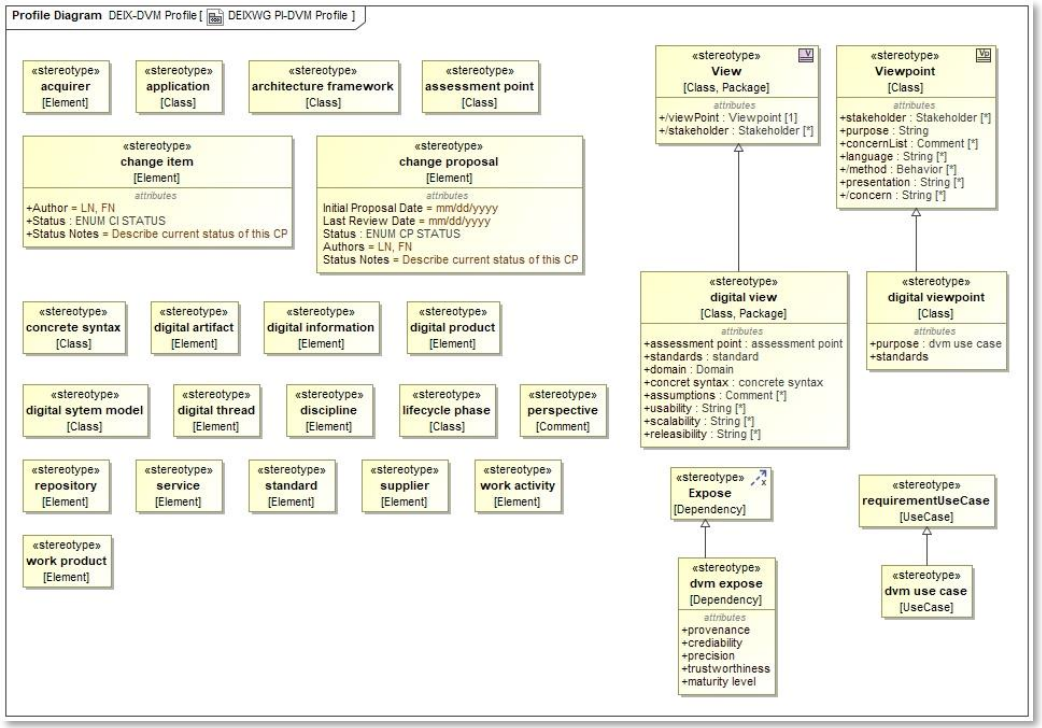


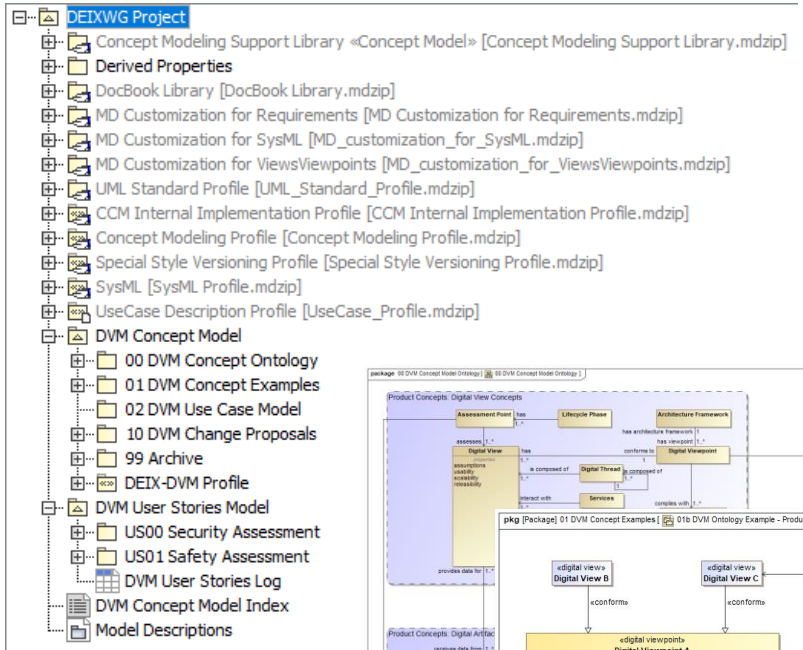


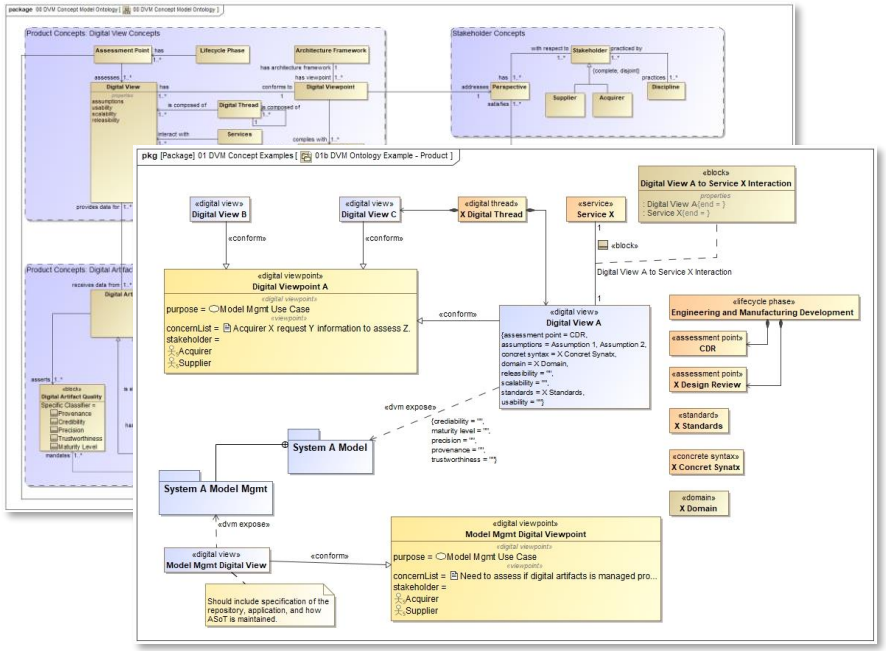
Annotated updates to the DVM

DVM Products

- DVM Baseline Model (Rev A)
  - Includes a preliminary profile
- Access via INCOSE DEIX Teams

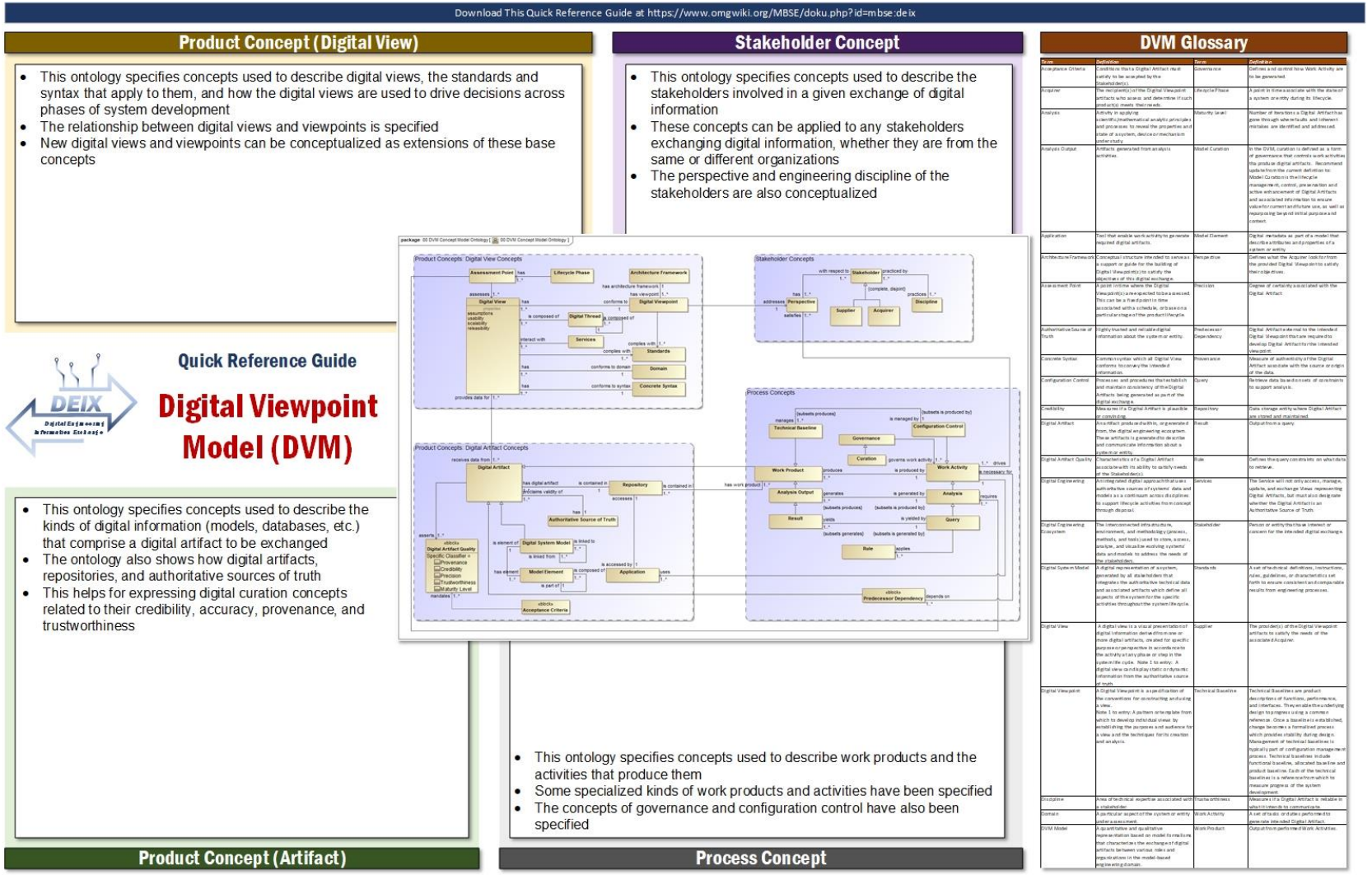






DVM Products

- DVM Quick Guide



DVM Products

- DVM Use Case Template
  - Facilitate the specification of user story that involves a digital exchange

Use Case ID:	
Use Case Name: *(Should be the use case goal as a short active verb phrase)*	
Goal In Context: *(Longer statement of the goal, if needed)*	
Precondition(s): *(Assumed state of the world at start)*	
Success End Condition: *(State of the world upon successful completion)*	
Failed End Condition: *(State of the world if goal abandoned)*	
Primary Actor(s): *(User(s) who have defined the user goal and often, but not always triggers the use case)*	
Supporting Actor(s): *(User(s) who provide an external service to the use case)*	
Trigger(s): *(Event(s) that start the use case)*	
Use Case Author(s): *(Name(s) and Organization(s))*	

Main Success Scenario:
(Steps of the scenario from trigger to goal delivery and any cleanup after)

Step #:	***Step Description:***
1.a	Systems Engineers develop the following in the Digital Engineering System (DES): • Aircraft-level Requirements • Preliminary System Architecture (Logical and Functional)
1.b	Safety Engineers provide the following to the Systems Engineers in the Digital Engineering System: • Preliminary Aircraft Safety Assessment in forms of requirement or constraints
1.c	Security Engineers provide the following to the Systems Engineers in the Digital Engineering System: • Preliminary Aircraft Security Risk Assessment in forms of requirement or constraints
2	Digital Engineering System generates a Combined Supporting Analysis for Functional Allocation View and provides the view to the System Engineers, Safety Engineers and Security Engineers
3	System Engineers, Safety Engineers and Security Engineers review the view content
4	System Engineers, Safety Engineers and Security Engineers annotate view content with comment and feedback in the Digital Engineering System
5	Digital Engineering System provides the updated view with the annotated comments to the System Engineer, Safety Engineer and Security Engineer
6	Systems Engineer updates Functional Allocation after agreement from all Associated Engineers in the Digital Engineering System

Extensions:
(Any alternative actions to a scenario step. State the affected step, condition and branching action.)

Affected Step #:	***Condition:***	***Branching Action:***
4, 5	Systems Engineer requires further feedback from the engineers before proceeding	• The use case steps 4 & 5 are revisited depending on the input views that need to be updated and re-generated
4, 5	Systems Engineer requires updated views from the Commenting Engineers before proceeding *(Not modeled for simplicity)*	• The use case steps 1-3 are revisited depending on the input views that need to be updated and re-generated

DEIX Use Case Workshop Concept

DEIX Workshop Description

- Demonstrate a methodology for defining digital view requirements for a stakeholder purpose in a selected domain
- This methodology can be used by organizations to develop their own digital engineering metamodels

DEIX Workshop – Methodology Overview

- The methodology has the following basic workflow:
  1. Identify the engineering processes of interest
  2. Define the use case descriptions and the process workflows
  3. Identify the required views from the process workflows
  4. Develop implementation plans and examples for the required views
  5. Identify updates for the digital engineering metamodel (DVM)
  6. Repeat for additional engineering processes and use cases

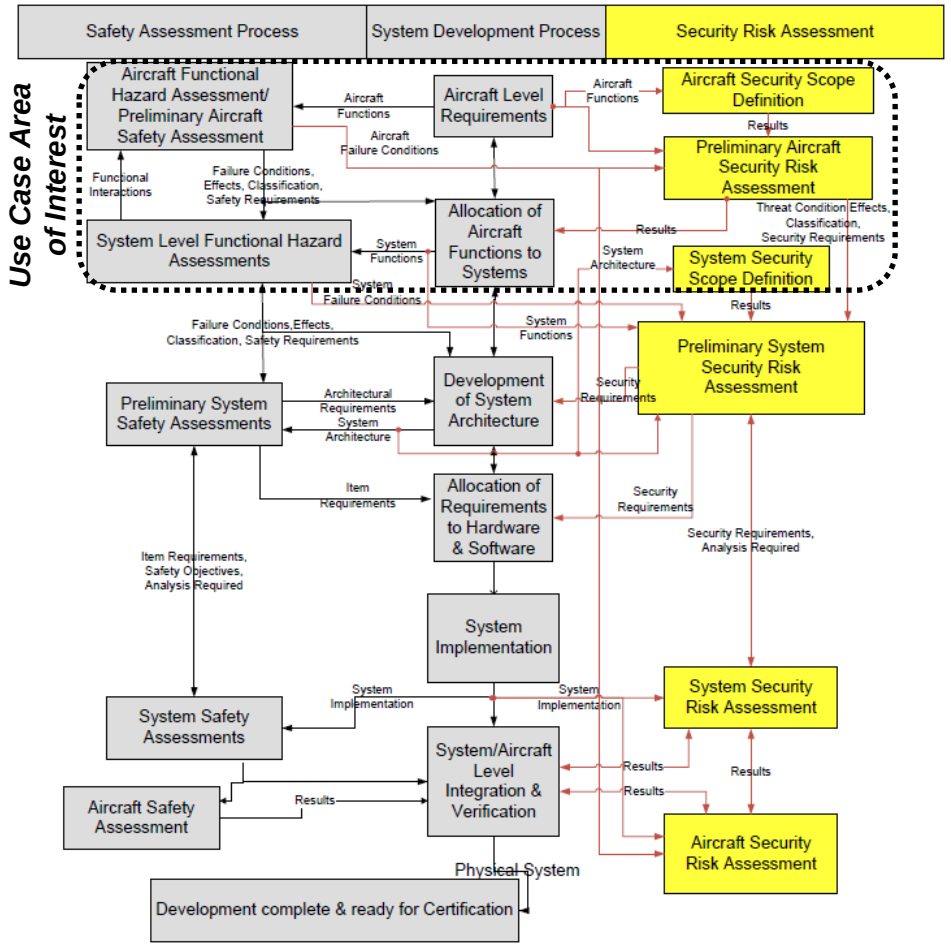
- For the workshop, we plan to demonstrate this workflow:
  - We've already developed a use case description and required views from a process in the aircraft manufacturing industry (steps 1-3)
  - We plan to demonstrate steps 4 and 5 in the workshop

DEIX Workshop – Process and Use Case of Interest

- The process of interest is the aircraft system development process combined with safety assessments and security risk assessments
  - This is adapted from EUROCAE's Airworthiness Security Process Specification (ED-202A)

- The use case of interest is "Develop the Functional Allocation incorporating Aircraft Safety and Security Risk Assessment Processes"
  - This is a subset of the full ED-202A process
  - Provides a unique challenge for information exchange
    - Not a traditional "point-to-point" exchange
      - e.g. Safety Engineer to Systems Engineer
    - Rather the use case includes "combined views" across the three domains (systems engineering, safety engineering and security engineering)

EUROCAE ED-202A Process Flow



DEIX Workshop – Use Case Template

- For the workshop, we developed a use case template for the DEIXWG to use
  - Most of the attributes of the template are from Alistair Cockburn's Writing Effective Use Cases
  - Some of the attributes are custom attributes created to support better support the DEIXWG effort
  - Each attribute has a definition and instructions
- We used this template for the use case for the workshop

INCOSE DEIXWG Functional Use Case Definition

This form is to describe a functional use case in support of the INCOSE DEIXWG for the development of the Digital Viewpoint Model (DVM). This use case description describes the core functional attributes of a desired process with the intention of assisting the development of the DVM. Many of the use case attributes are taken from "Writing Effective Use Cases" by Alistair Cockburn with some alterations and additions for DVM development. This description must stay implementation-agnostic. This description DOES NOT describe what the DVM is capable of doing. This is only a mechanism to assist in the DVM's development.

Characteristic Information

Use Case ID:	1
Use Case Name: *(Should be the use case goal as a short active verb phrase)*	Develop the Functional Allocation incorporating Aircraft Safety and Security Risk Assessment Processes
Goal In Context: *(Longer statement of the goal, if needed)*	Systems engineering develops/refines the design and allocation of aircraft's system functions to the aircraft's systems guided by the information from the preliminary aircraft safety assessment and preliminary aircraft security risk assessment. This use case is an adaptation of the EUROCAE Airworthiness Security Process Specification (ED-202A). This use case focuses on a subset of the full process flow (see *DEIXWG Additional Information – Supporting Documentation*). This is a comprehensive adaptation of that process since the original EUROCAE ED-202A process is from the mindset of Security Engineering. This use case serves as a predecessor to the assignment of Development Assurance Level and Security Assurance Level.

Precondition(s): *(Assumed state of the world at start)*	• The following information has been defined:
	  ○ Aircraft-level Requirements
	  ○ Preliminary System Architecture (Logical and Functional)
	• The following assessments have been completed:
	  ○ Preliminary Aircraft Safety Assessment, which includes tailoring of applicable requirements/controls for the target system
	  ○ Preliminary Aircraft Security Risk Assessment, which includes tailoring of applicable requirements/controls for the target system
	• While system architecture is not baselined (Prior to PDR)

Success End Condition: *(State of the world upon successful completion)*	Updated functional allocation incorporating the preliminary aircraft safety and security risk assessments, with adequate substantiation information/data to

DEIX Workshop – Use Case Template Attributes

- Some Use Case Template Attributes:
  - Use Case Name
  - Goal In Context
  - Precondition
  - Success End Condition
  - Failed End Condition
  - Primary Actor(s)
  - Supporting Actor(s)
  - Trigger(s)
  - Use Case Author(s)
  - Main Success Scenario
  - Applicable Technical Processes
  - Required Views

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	  ○ Preliminary Aircraft Security Risk Assessment, which includes tailoring of applicable requirements/controls for the target system
	• While system architecture is not baselined (Prior to PDR)

Success End Condition: *(State of the world upon successful completion)*	Updated functional allocation incorporating the preliminary aircraft safety and security risk assessments, with adequate substantiation information/data to

DEIX Workshop – Use Case Main Success Scenario

- We wrote out the main success scenario for the use case in the template
- We developed a few diagrams as attachments to describe the detailed flow of the main success scenario

Scenario Information

Main Success Scenario: *(Steps of the scenario from trigger to goal delivery and any cleanup after)*	
Step #:	***Step Description:***
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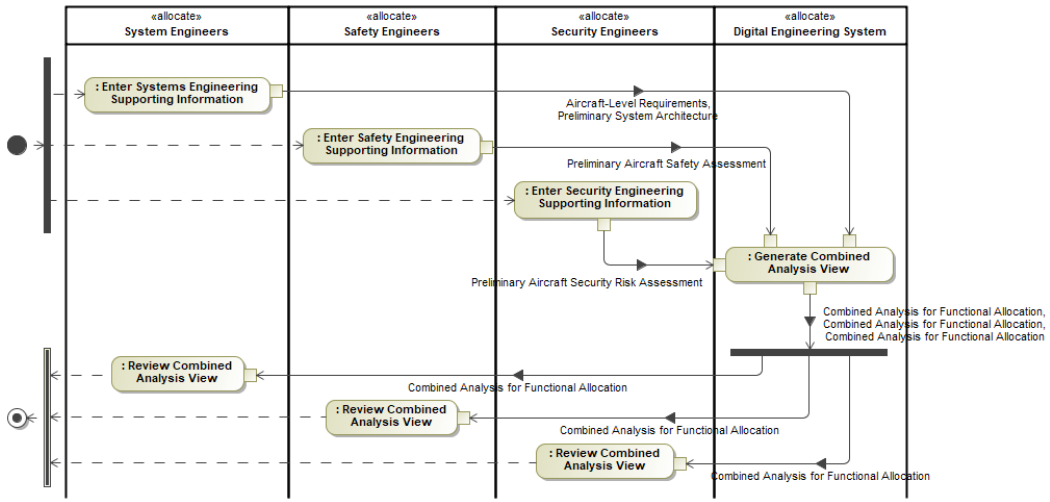
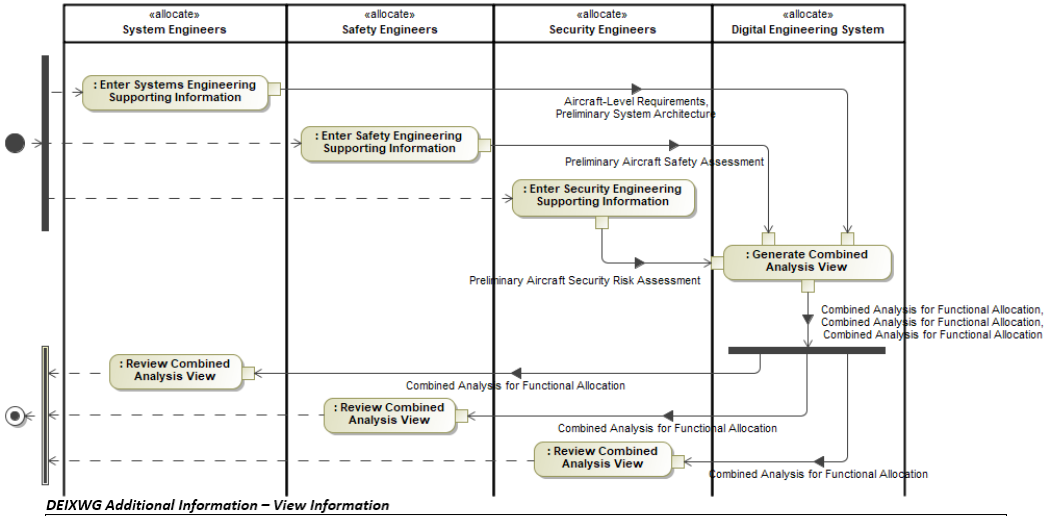


DEIX Workshop – Required Views

- After we developed the detailed scenario flow, the information flows represent the views for the use case
- We defined a list of these required views from these information flows
  - We used the ED-202A to help us define the required view content
- For the workshop, we selected the "Combined Analysis for Functional Allocation" as the view for the workshop attendees to evaluate
  - It provides the DEIXWG a complicated view to evaluate



DEIXWG Additional Information – View Information

Required Views

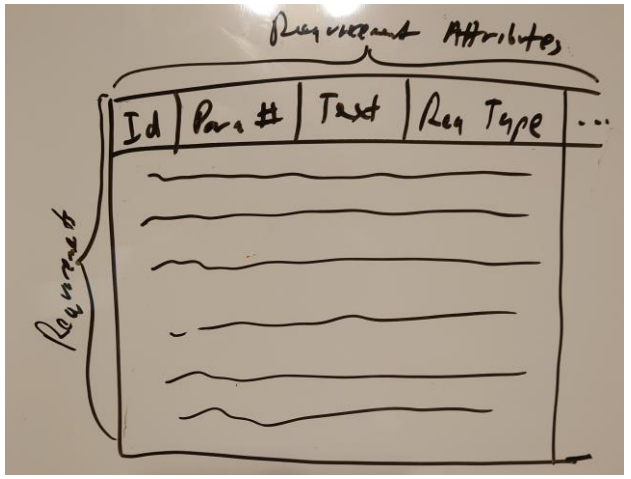
(Any required information view in order to execute the use case. State the view name, description, view content, reviewing/consuming actor and producing actor.)

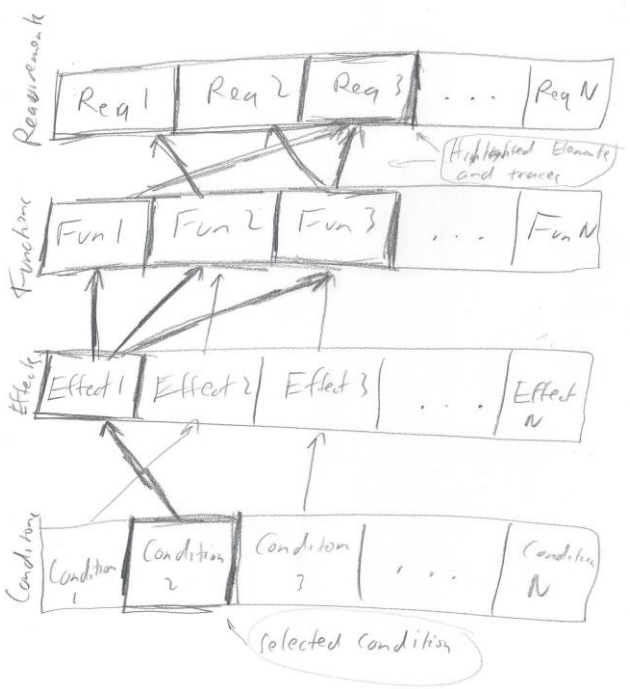
View Name:	*Description:*	*View Content*	*Reviewing / Consuming Actor:*	*Producing Actor:*
Aircraft-Level Requirements	The requirements that define the aircraft as top-level system of interest.	• Requirement Information (ID, Paragraph #, Text & Other Attributes)	**N/A for this UC* / *Captured by DES for ASOT**	System Engineers
Preliminary System Architecture (Logical and Functional)	The preliminary system architecture both logical and functional.	• Logical System Decomposition • Functional Decomposition	**N/A for this UC* / *Captured by DES for ASOT**	System Engineers
Preliminary Aircraft Safety Assessment	The preliminary assessment of aircraft's safety/functional hazards.	• Failure Conditions • Failure Effects • Affected System Functions • Safety Requirements	System Engineers	Safety Engineers
Preliminary Aircraft Security Risk Assessment	The preliminary assessment of aircraft's security risks.	• Security Scope (Environment & Perimeter) which defines this Assessment • Threat Conditions • Threat Effects • Affected System Functions • Security Requirements	System Engineers	Security Engineers
Combined Analysis for Functional Allocation	Combines the information from systems engineering, safety engineering and security engineering to assist with functional allocation.	• Affected System Functions • Related Safety & Security Requirements • Related Safety & Security Supporting Information (e.g. Failure Conditions, Failure Effects, Threat Conditions, Threat Effects, etc.)	• System Engineers • Safety Engineers • Security Engineers	• System Engineers • Safety Engineers • Security Engineers
Combined Analysis with Comments Annotated	Same as the "Combined Analysis for Functional Allocation" but with "Comment/Feedback Items" annotated.	• Combined Analysis for Functional Allocation • Attached Comment/Feedback Items	• System Engineers • Safety Engineers • Security Engineers	• System Engineers • Safety Engineers • Security Engineers
System Functional Allocation	The allocation of system functions to system components.	• System Function Mapping (Mapping of functions to system components)	**N/A for this UC* / *Captured by DES for ASOT**	System Engineers

DEIX Workshop – Sample Example Views

- Workshop attendees will come up with example implementations of the required view
  - Workshop attendees will have the completed use case template, required view information and any other attachments as reference
  - Workshop attendees will have materials (whiteboard, paper, pencils, etc.) to prototype sketch examples of the view
  - Workshop attendees will be broken up into groups and will collaborate with their fellow group members on their view examples

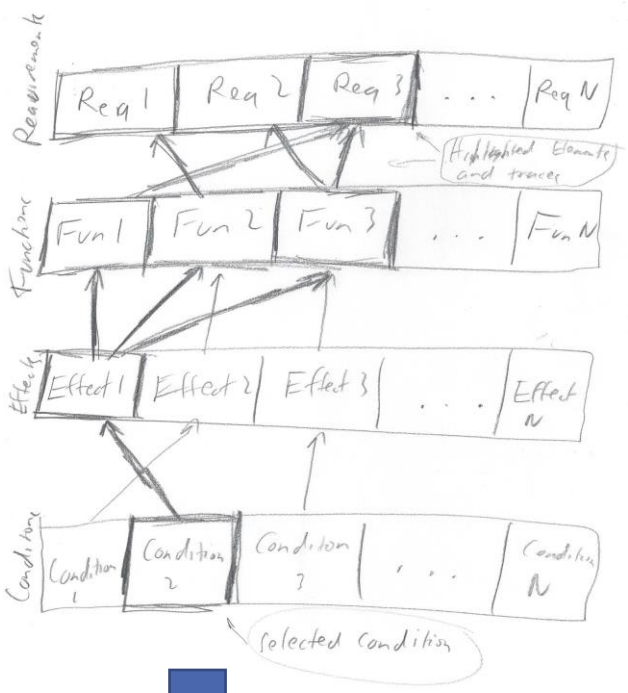
- Here are some potential examples using other required views from the use case

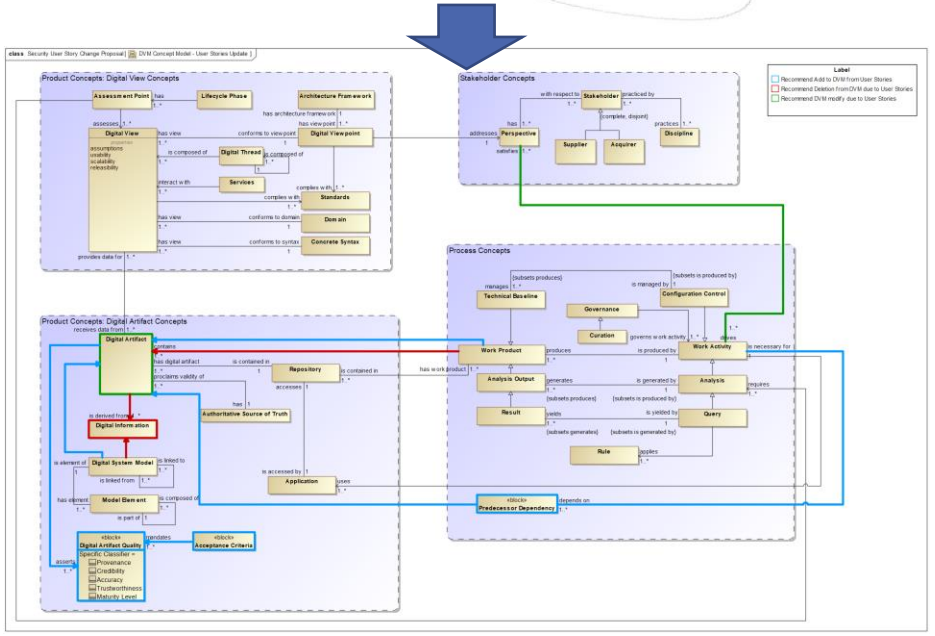




DEIX Workshop – Informing the DVM

- After developing their implementation examples, workshop attendees will use their example to inform the DVM
  - Workshop attendees will make recommendations to the DVM which align with their implementation
  - Since workshop attendees will be broken up into groups, the groups will get to compare their use case implementation and DVM recommendations with the other groups





DVM – Next Steps

- Industry
  - Participate in future DVM meetings
  - Contribute to the DVM definition
  - Develop products to enable usage of the DVM
- DVM Use Case Workshop at INCOSE IW2023
- Support incorporation of DVM method to ISO 15288 standards; guidance document
- Forming a standard for the DVM concept itself; similar to ISO 42010

References

Reference	Description
DEIX INCOSE Teams	https://incose2.sharepoint.com/:f:/r/sites/DEIXWG/Shared%20Documents/Standards%20Framework?csf=1&web=1&e=j3rb3C
Glossary of Key DEIX Terms	DEIX Topical Encyclopedia Entries (DEIXPedia)
Digital Engineering	Digital Engineering References on the OMG MBSE Wiki Page
DEIXWG on OMG MBSE Wiki	OMG Wiki Page for DEIXWG
INCOSE DEIXWG Page	INCOSE WG Page for DEIXWG