SE Use Cases
SysML - SE DSIG

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2/24/2014

Sources for Use Cases

- Used the SEBoK to identify
  - Description of Knowledge Areas
  - Organized based on 15288 Life Cycle Stages
- ISO/IEC 15288
  - Definition of Life Cycle Stages
  - Content of Life Cycle Stages

Organize Use Cases by Life Cycle Phases

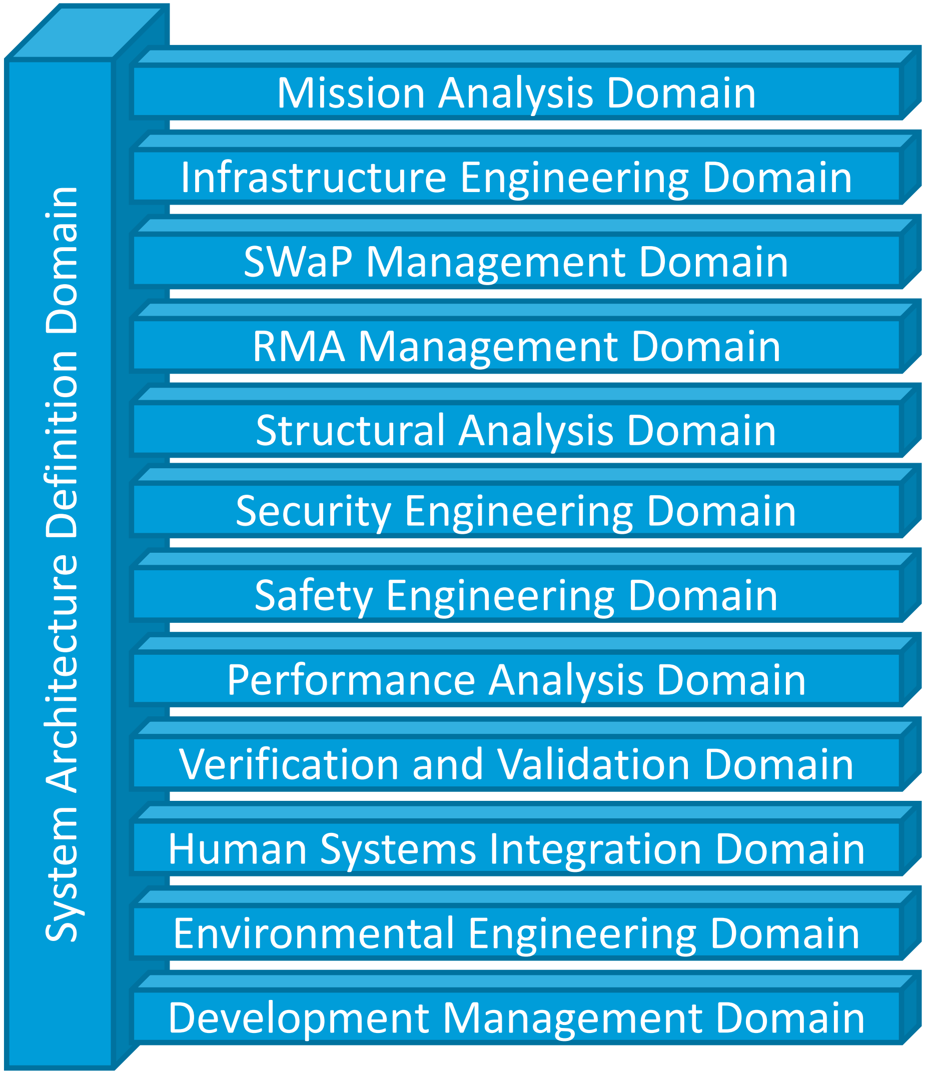
- **Exploratory/Concept Stage**
- **System Development Stage**
  - **Management Use Cases**
  - **SE Domain Use Cases**
  - **Validation and Verification Use Cases**
- **Production Stage**
- **Product and Service Life Management Stage**

System Architecture Domain Activities

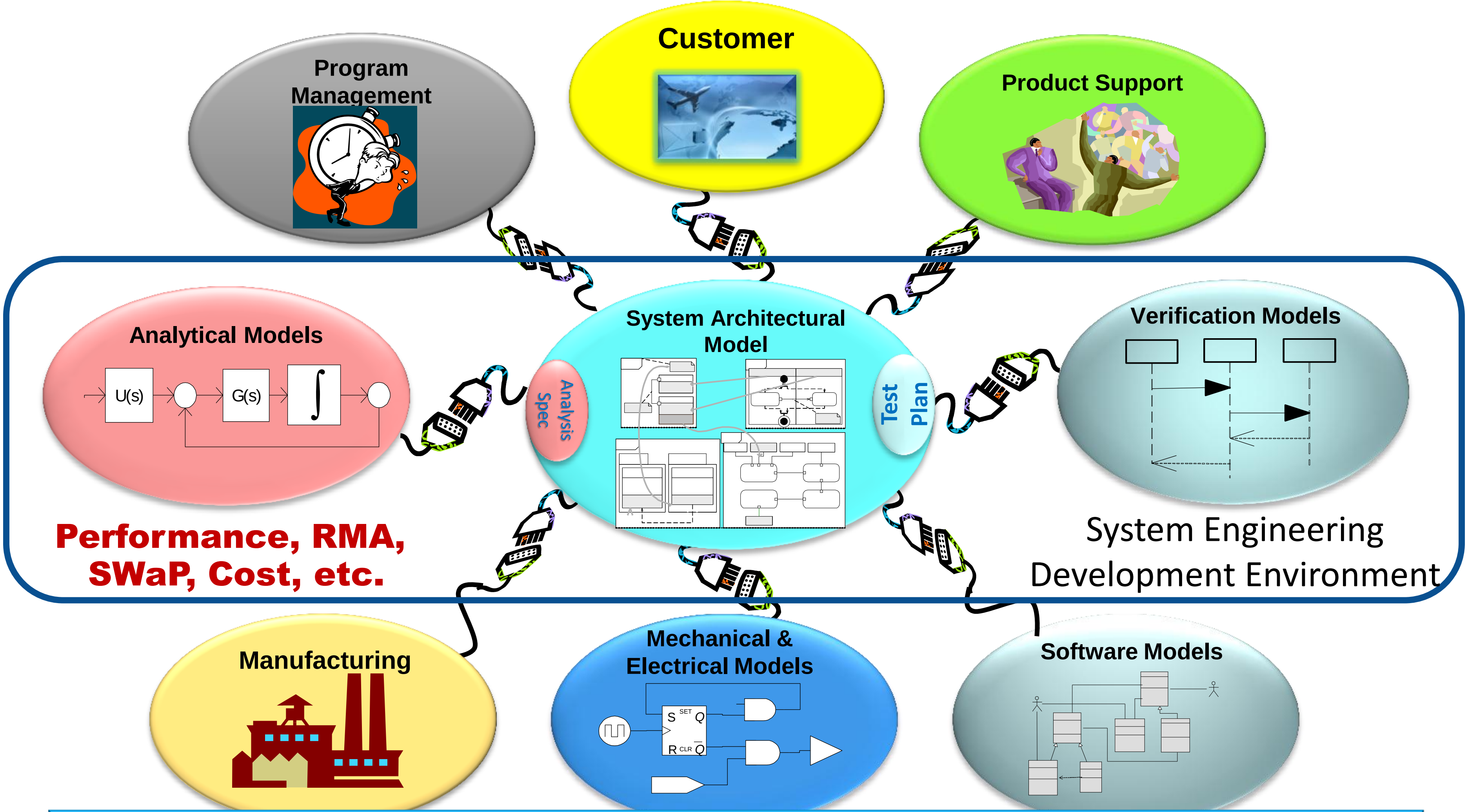
- Analyze Stakeholder Needs
- Analyze Missions
- Analyze System Behavior
- Derive system requirements
- Derive logical and physical structure
- Derive System Components Specifications
- Manage System Life Cycle Costs

SE Domain Integration and Information Layers

- Each SE Domain;
  - Contributes domain specific information
  - Has Responsibility for their information content
  - Information content can reference content from other domains
  - Iterates solution with other Domains
  - Has one or more views to information content
  - Defines and manages Requirements
  - Measures impact of their changes in their domain and across other domains
  - Conducts Reviews
  - Produces Deliverables


System Architecture Definition Domain
Mission Analysis Domain
Infrastructure Engineering Domain
SWaP Management Domain
RMA Management Domain
Structural Analysis Domain
Security Engineering Domain
Safety Engineering Domain
Performance Analysis Domain
Verification and Validation Domain
Human Systems Integration Domain
Environmental Engineering Domain
Development Management Domain

Expanded SysML Context



Program Management

Customer

Product Support

Analytical Models

System Architectural Model

Analysis Spec

Test Plan

Verification Models

Performance, RMA, SWaP, Cost, etc.

System Engineering Development Environment

Manufacturing

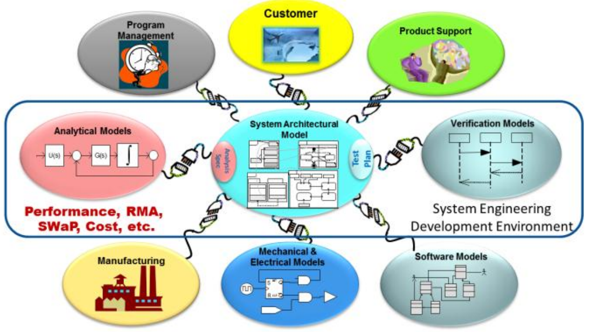
Mechanical & Electrical Models

Software Models

To measure SysML effectiveness we need to understand the context of how it is used

Suggested Approach

- Define the System Engineering Development **System Context**
  - – Not as set of independent tools



- Identify the **SE Use Cases** this System must support
  - – First Pass - Identifying Use Case Goal, Primary Actor and Textual Description
  - – Select the few that will provide the most SysML benefit
    - Derive Functional entities, via Activity Diagrams
    - Derive SysML Requirements
    - Determine to what extent is SysML supporting System Engineering

Future Use

- Architect a Development System
  - Decompose System into a set of Components with Interfaces
  - Example Components – Modeling Tools, Analysis Tools, CM tools. Etc.
  - Components and Interfaces are standards based, e.g. OSLC
- Provide input, clarity and vision to:
  - Standards Groups –
    - Identifying enhancements to existing standards
    - Demonstrate the need of **integration threads across standards**
    - Identify new standards
  - Tool Vendors –
    - A full view of the need
    - A specification of what needs to be built Tool Vendors

Life Cycle System Engineering Use Cases

- **Exploratory/Concept Stage**
  - Evaluate Customer Proposal
  - Define Stakeholders Needs
  - Analyze System Missions
  - Define the System Requirements
  - Analyze System Life-cycle Costs
- **System Development Stage**
  - **Management Use Cases**
    - Plan a Development Cycle
    - Manage Development Progress
    - Manage Development Environment

Life Cycle System Engineering Use Cases

- **System Development Stage (Continued)**
  - **SE Domain Use Cases**
    - Derive Product Architecture
    - Evaluate System Safety
    - Perform System Reliability, Availability and Maintainability Engineering
    - Perform System Security Engineering
    - Analyze System Performance
    - Allocate and Manage SWaP
    - Perform Trade Study
    - Analyze Behavior Correctness
    - Manage Product Lines
    - Integrate Human Domain Constraints
    - Perform Environmental Engineering
    - Integrate with Implementation Domains
    - Perform EMI Engineering

Life Cycle System Engineering Use Cases

- **System Development Stage (Continued)**
  - **Validation and Verification Use Cases**
    - Develop Verification Plan and Procedures
    - Develop a System Integration Plan
    - Execute a Verification Test Procedure
    - Provide V&V Status
- **Production Stage Use Cases**
  - Support Produce-ability Engineering
- **Product and Service Life Management**
  - Support Initial Installation
  - Evaluate Change Request
  - Support System Modernization Plan
  - Support System Disposal and Retirement

Activity - Perform System Security Engineering

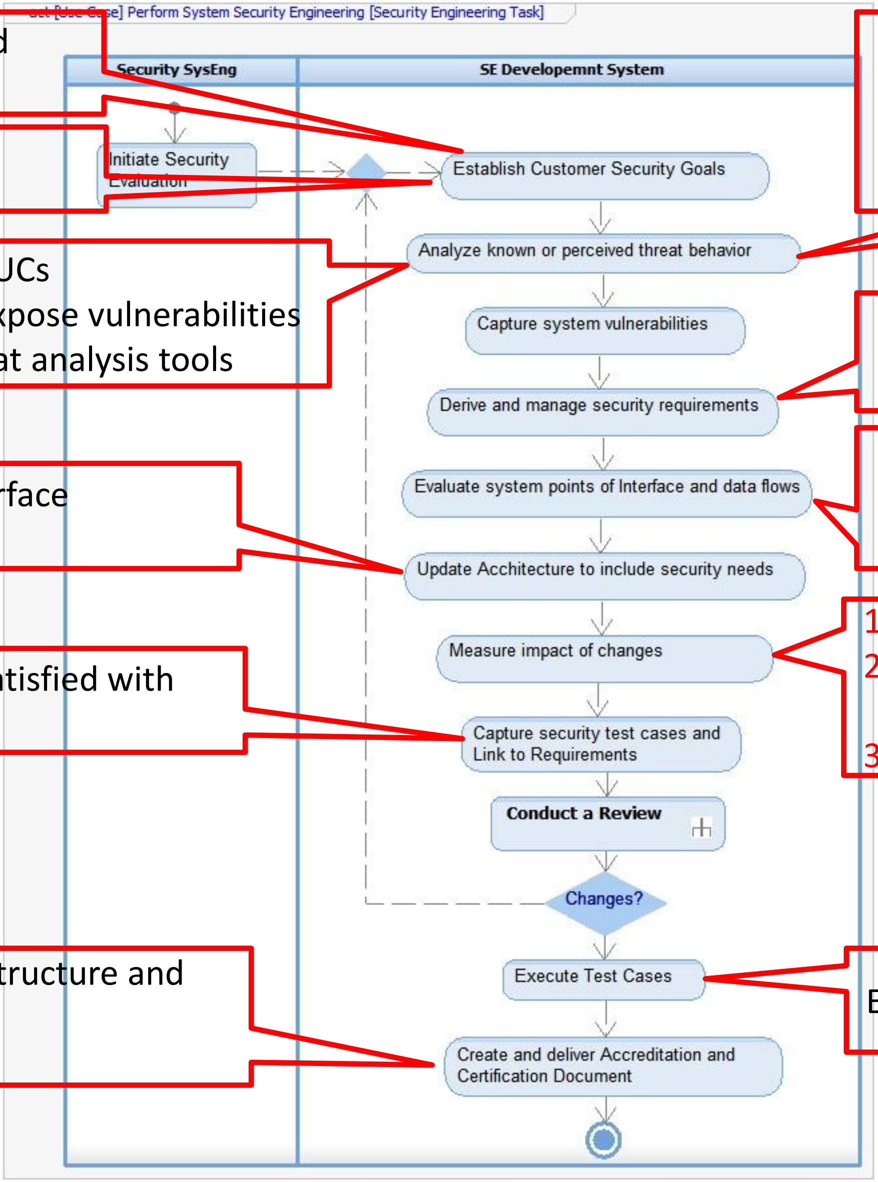
- **Goal** – The goal of this use case is to incorporate in the system of interest the necessary security design features to meet the needs of the customer.
- **Primary Actor** – SE Security Specialist
- **Secondary Actors** –
- **Preconditions** –
  1. A list of known potential threats are available
  2. A list of applicable policy documentation is available
- **Activity** – This use case begins early in the development cycle and continues to iterate through the remaining development cycles as the product matures.
  1. Obtain and/or define the customer's security protection goals for the following security domains including:
     1. Information security governance and risk management
     2. Access control
     3. Cryptography
     4. Physical (environmental) security
     5. Security architecture and design
     6. Business continuity and disaster recovery planning
     7. Telecommunications and network security
     8. Application development security
     9. Operations security
     10. Legal, regulations, investigations, and compliance
  2. Capture the system vulnerabilities by analyzing the known or perceived threats and their behavior.

Activity - Perform System Security Engineering

3. Derive a set of security requirements that address the vulnerabilities and other applicable security policy documents.
4. Evaluate points of Interface;
   1. Identify all external interface points
   2. Identify internal interface points of major subsystems such as server farms, sensors, security management, business network, etc.
   3. Identifying the points of interface may have been completed earlier in a use case such as “Derive Product Architecture”.
   4. Determine and capture the level of security required for the information exchanged at the points of interface.
5. Capture the security architecture design that satisfy these requirements and minimize or contain the vulnerabilities.
6. Measure the change impact to other domains and mitigate issues
7. Conduct appropriate reviews within engineering and with the customer
8. Capture test cases that validate the security requirements have been reached.
9. If the proposed design does not meet the System goals, refine the design.
10. Prepare the necessary documentation for system accreditation and certification.

Post Conditions – Accreditation Certificate is submitted

Perform System Security Engineering UC


act [Use Case] Perform System Security Engineering [Security Engineering Task]
Security SysEng
SE Developemnt System
Initiate Security Evaluation
Establish Customer Security Goals
Analyze known or perceived threat behavior
Capture system vulnerabilities
Derive and manage security requirements
Evaluate system points of Interface and data flows
Update Acchitecture to include security needs
Measure impact of changes
Capture security test cases and Link to Requirements
Conduct a Review
Changes?
Execute Test Cases
Create and deliver Accreditation and Certification Document

Create and share validated reference libraries

View external reference documents

Create a domain specific profile that includes concepts and iconic representations compatible with SysML

1. Define and Organize UCs
2. Create Activities to expose vulnerabilities
3. Integration with threat analysis tools

1. Define and Organize Requirements
2. Create Activities

Update Structure and interface definitions

1. Define and Organize Requirements
2. Add domain attributes to Interfaces

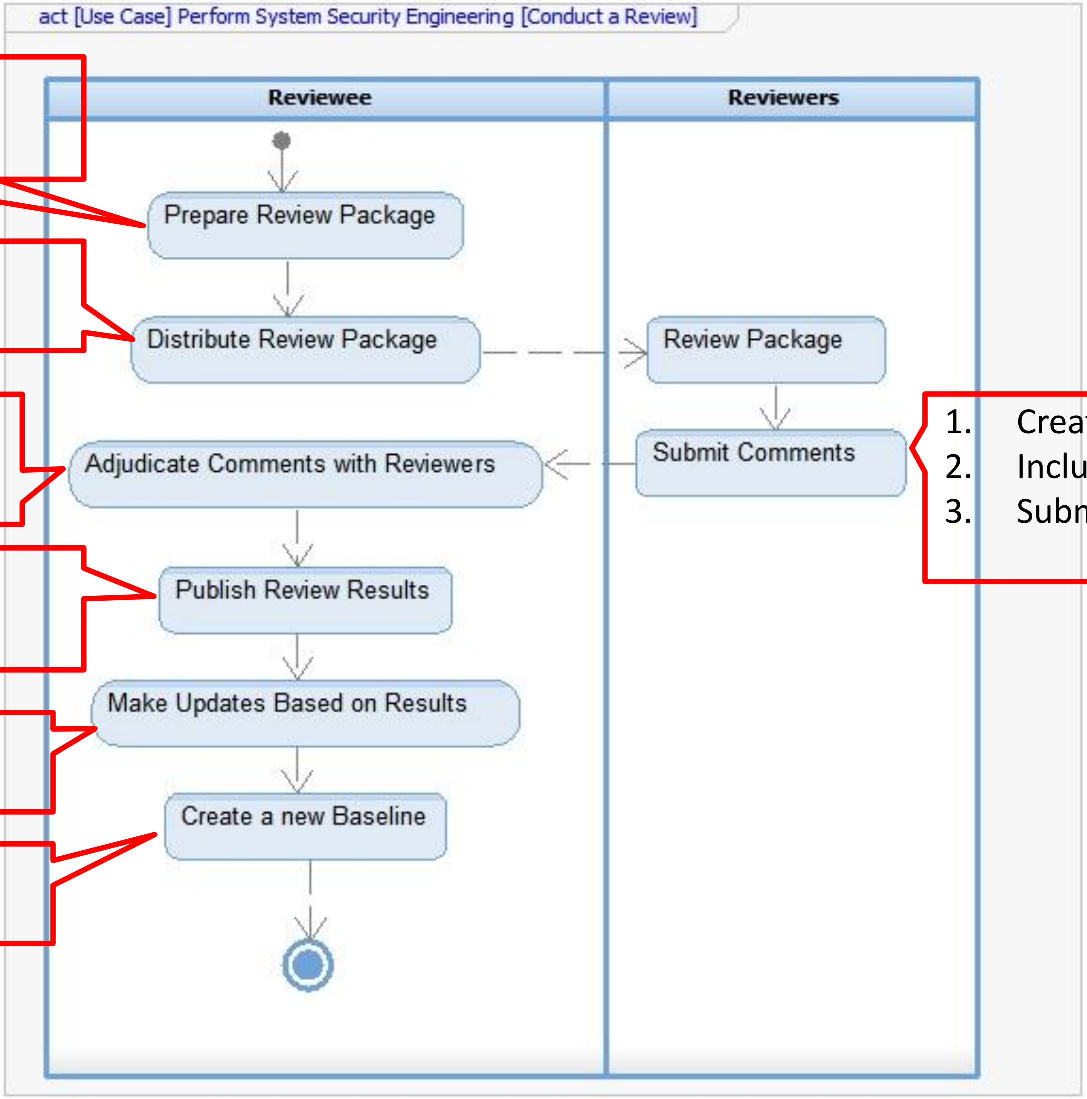
1. Assessing change impacts
2. Include and overlay impacted domain views
3. Remove un-impacted domain views

Verify requirements are satisfied with test cases

1. Define a document structure and content
2. Publish document

Execute defined behavior

Artifact Review Pattern


act [Use Case] Perform System Security Engineering [Conduct a Review]
Reviewee
Reviewers
Prepare Review Package
Distribute Review Package
Review Package
Submit Comments
Adjudicate Comments with Reviewers
Publish Review Results
Make Updates Based on Results
Create a new Baseline

Create a view to isolate information to be reviewed

Share information to be reviewed

Manage and track change requests

Update and share reviewed information view

Manage and merge multiple branches

Baseline model artifacts

1. Create a change request
2. Include Reviewer and Date
3. Submit changes to Reviewee

Summary

- Examine the complete System Engineering Context to examine:
  - How well is SysML supporting System Engineering activities?
  - Are there other areas where SysML could be expanded?
- Use SysML to:
  - Define that Context
  - Define System Engineering Use Cases
  - Drive the language requirements
- One Use Case Example was shown but;
  - We expect to see re-occurring patterns and requirements throughout many of the use cases

References

- Pyster, A. and D.H. Olwell (eds). 2013. *The Guide to the Systems Engineering Body of Knowledge (SEBoK)*, v. 1.2. Hoboken, NJ: The Trustees of the Stevens Institute of Technology. Accessed DATE. www.sebokwiki.org/
- International Standard – ISO/IEC 15288 and IEEE 15288 – 2008, Second Edition 2008-02-01, Systems and software engineering - System life cycle processes
- Pramanik, Sarah. “Security Architecture Approaches.” 2013. Crosstalk November/December

Backup Slides

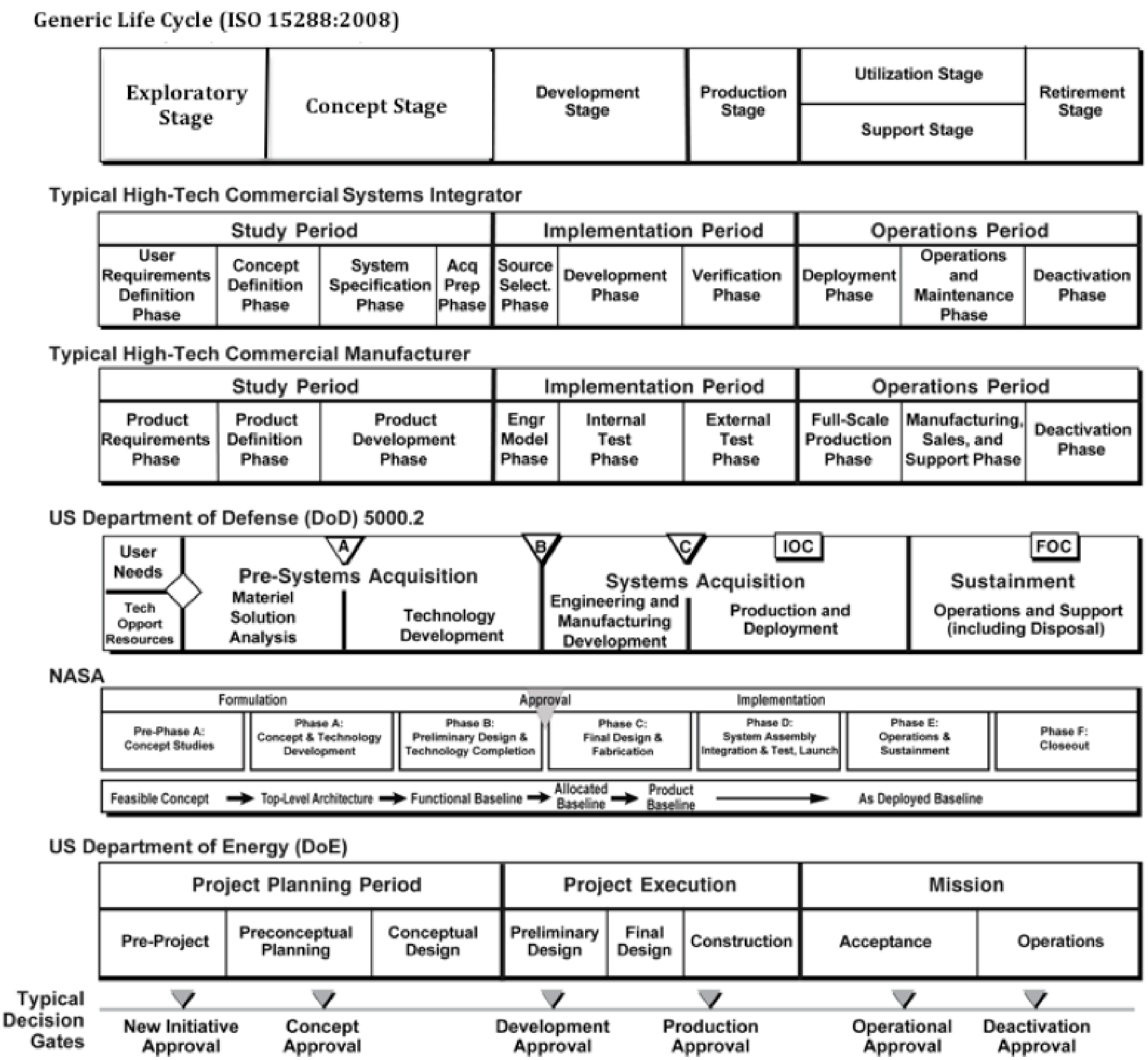
What to Harvest from Use Cases

- Functional entities
  - Represents the **Development System functionality** required by **Systems Engineers** to do their work
  - Examine how **SysML** is used to support each functional entity
  - Many will appear in multiple Use Cases
  - Use these functional entities to derive SysML Requirements
- Functional Entity Examples;
  - Conduct a Review, Capture System behavior/structure/requirements, measure change impact, share information across domains, produce a deliverable, analyze performance, select a domain view, select a multi-domain view, create a baseline, assess change impact, manage domain information, etc.

Infrastructure Engineering Domain Activities

- Define Hardware platforms and performance
- Define Physical Network
- Define System Management
  - Define Status and Error Messages
  - Status and error collection and reporting
  - Error management
- Define common system services
- Time management
- Redundancy Architecture

Industry Available Product Phases



Generic Life Cycle (ISO 15288:2008)

Exploratory Stage	Concept Stage	Development Stage	Production Stage	Utilization Stage Support Stage	Retirement Stage

Typical High-Tech Commercial Systems Integrator

Study Period				Implementation Period			Operations Period		
User Requirements Definition Phase	Concept Definition Phase	System Specification Phase	Acq Prep Phase	Source Select. Phase	Development Phase	Verification Phase	Deployment Phase	Operations and Maintenance Phase	Deactivation Phase

Typical High-Tech Commercial Manufacturer

Study Period			Implementation Period			Operations Period		
Product Requirements Phase	Product Definition Phase	Product Development Phase	Engr Model Phase	Internal Test Phase	External Test Phase	Full-Scale Production Phase	Manufacturing, Sales, and Support Phase	Deactivation Phase

US Department of Defense (DoD) 5000.2

User Needs Tech Opport Resources	Pre-Systems Acquisition		Systems Acquisition		Sustainment
	Materiel Solution Analysis	Technology Development	Engineering and Manufacturing Development	Production and Deployment	Operations and Support (including Disposal)

NASA

Formulation			Approval	Implementation		
Pre-Phase A: Concept Studies	Phase A: Concept & Technology Development	Phase B: Preliminary Design & Technology Completion	Phase C: Final Design & Fabrication	Phase D: System Assembly Integration & Test, Launch	Phase E: Operations & Sustainment	Phase F: Closeout

Feasible Concept → Top-Level Architecture → Functional Baseline → Allocated Baseline → Product Baseline → As Deployed Baseline

US Department of Energy (DoE)

Project Planning Period			Project Execution			Mission	
Pre-Project	Preconceptual Planning	Conceptual Design	Preliminary Design	Final Design	Construction	Acceptance	Operations

Typical Decision Gates: New Initiative Approval; Concept Approval; Development Approval; Production Approval; Operational Approval; Deactivation Approval

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