Using MBSE to qualitatively define your DevSecOps Capability Maturity

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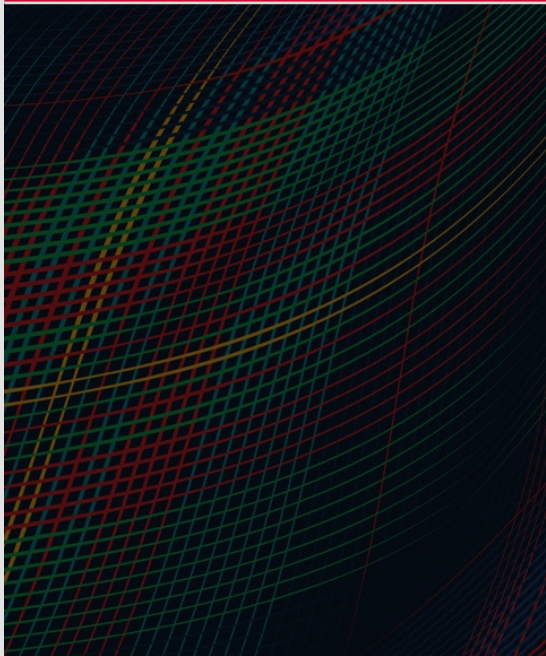

Distribution Statement

Agenda

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What is DevSecOps – It's complicated

Understanding the Complexity

Capability Maturity

DevSecOps Capability Maturity Visualization

Conclusion

What is DevSecOps – It’s complicated

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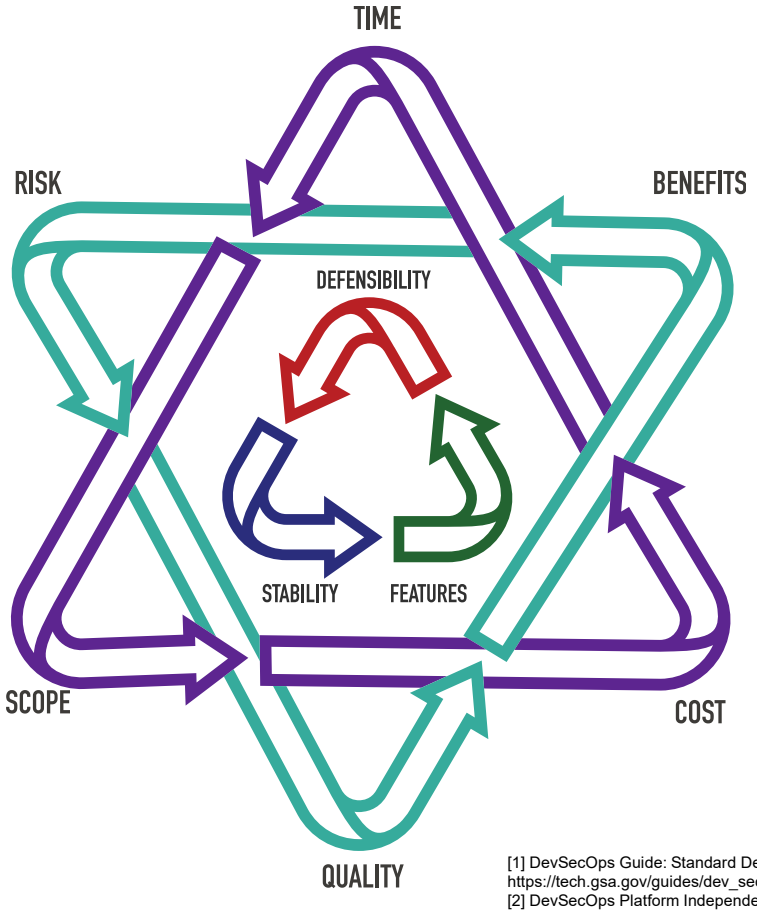
DevSecOps: Modern Software Engineering Practices and Tools that Encompass the Full Software Lifecycle



DevSecOps is a cultural and **engineering practice** that breaks down barriers and opens **collaboration between development, security, and operations** organizations **using automation** to focus on rapid, frequent delivery of secure infrastructure and software to production. It encompasses intake to release of software and manages those flows predictably, transparently, and with minimal human intervention/effort [1].

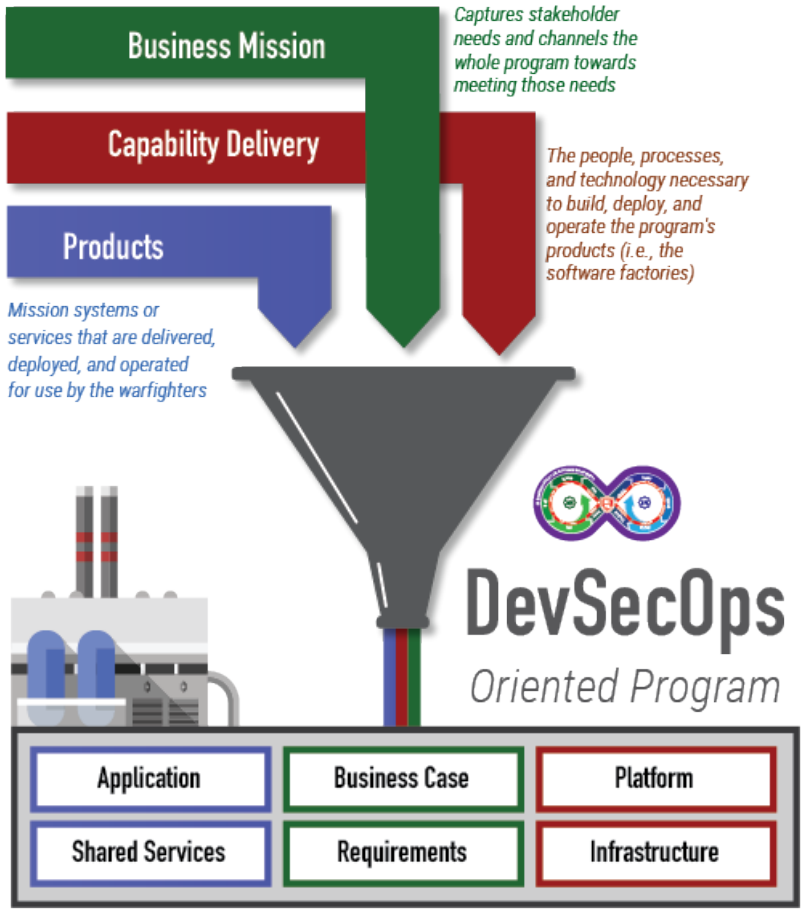
A **DevSecOps Pipeline** attempts to seamlessly integrate "three traditional factions that sometimes have opposing interests:

- **development**; which values features;
- **security**, which values defensibility; and
- **operations**, which values stability [2]."

Not only does one need to balance the factions. They must do so in a way that balances **risk**, **quality** and **benefits** within their **time**, **scope**, and **cost** constraints.

[1] DevSecOps Guide: Standard DevSecOps Platform Framework. U.S. General Services Administration. https://tech.gsa.gov/guides/dev_sec_ops_guide. Accessed 17 May 2021
[2] DevSecOps Platform Independent Model, https://cmu-sei.github.io/DevSecOps-Model/

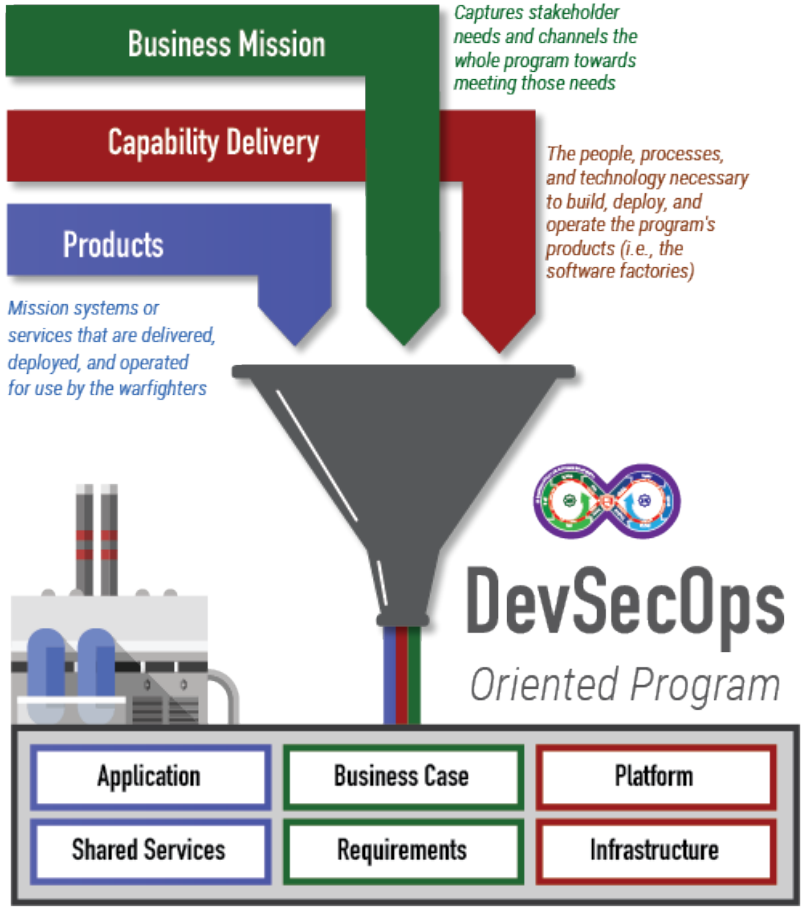
An Enterprise View



All software-oriented enterprises are driven by three concerns:

- **Business Mission** – captures stakeholder needs and channels the whole program in meeting those needs. It answer the questions *Why* and *For Whom* the enterprise exists
- **Capability to Deliver Value** – covers the people, processes, and technology necessary to build, deploy, and operate the enterprise's products
- **Products** – the units of value delivered by the program. Products utilize the capabilities delivered by the software factory and operational environments.

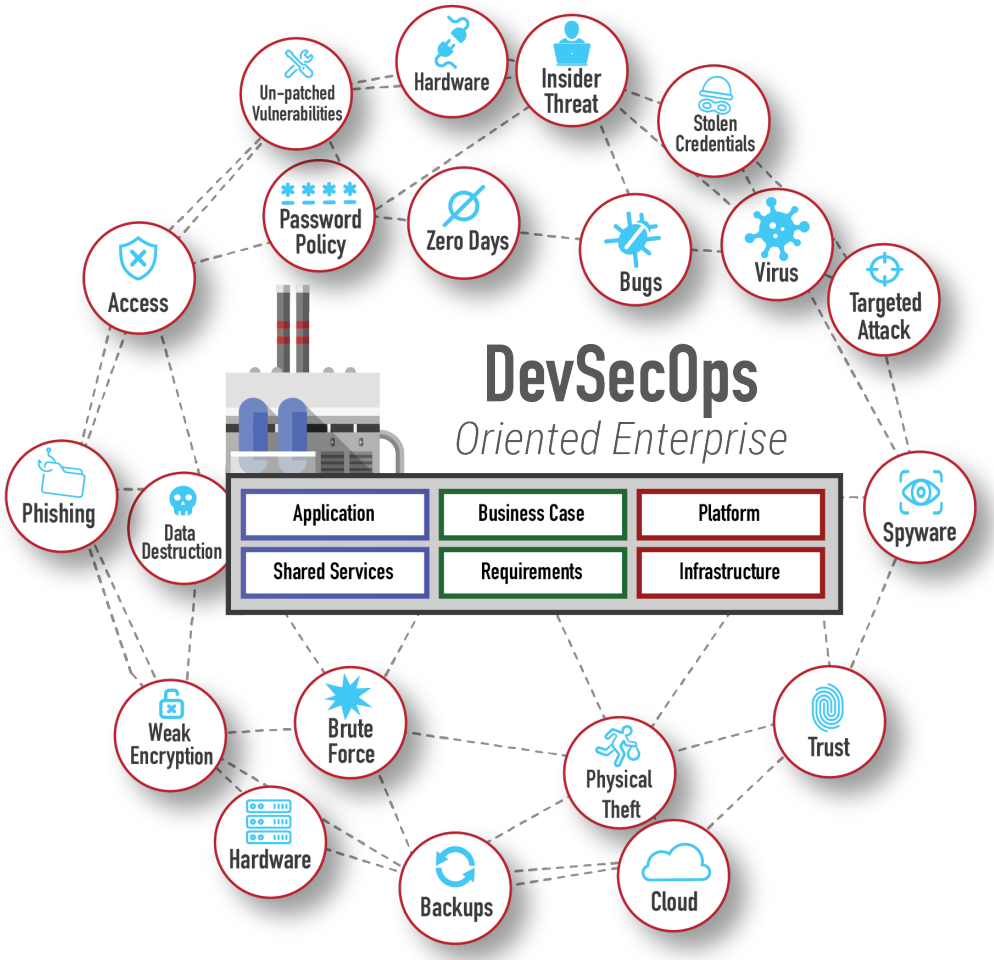
Challenge 1: connecting process, practice, and tools



Creation of the DevSecOps (DSO) pipeline for building the product is not static.

- Tools for process automation must work together and connect to the planned infrastructure
- Infrastructure and shared services are often maintained across multiple organizations (Cloud for infrastructure, third parties for tools and services, etc.)
- Processes, practices, and tools must evolve to meet the needs of the products being built and operated

Challenge 2: Cybersecurity of Pipeline and Product



The tight integration of Business Mission, Capability Delivery, and Products, using integrated processes, tools, and people, increases the attack surface of the product under development.

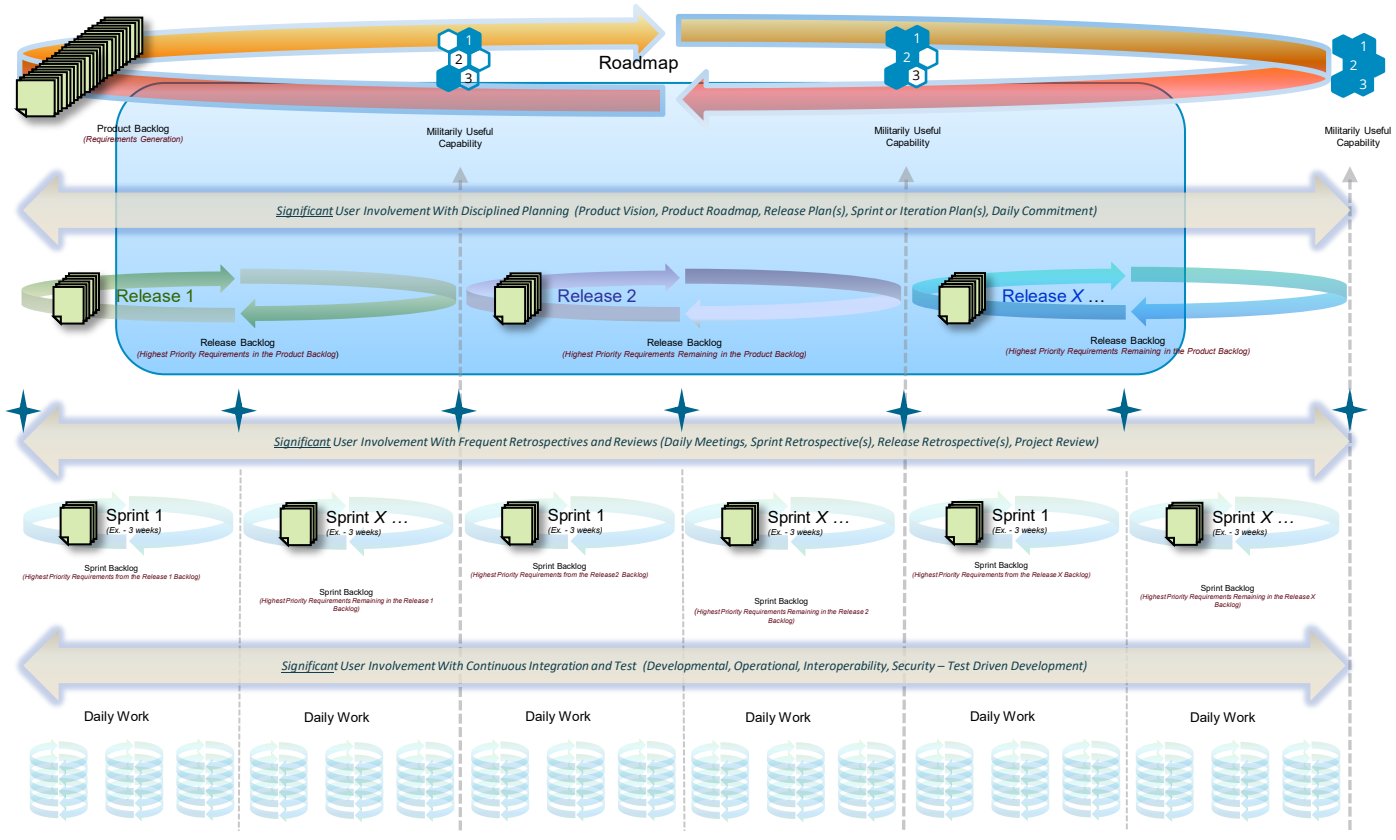
Managing and monitoring all the various parts to ensure the product is built with sufficient cybersecurity and the pipeline is maintained to operate with sufficient cybersecurity is complex.

How do you focus attention to areas of greatest concern for security risks and identify the attack opportunities that could require additional mitigations?

Not a Myth: Agile *is* likely to fail if it's "only the development team" that adopts the new practices

Frequent failure mode: Business and/or operations doesn't keep up with what the development teams can deliver.

Why?
Shift to Agile-based requirements definition and management is more of a change than practices of development alone.



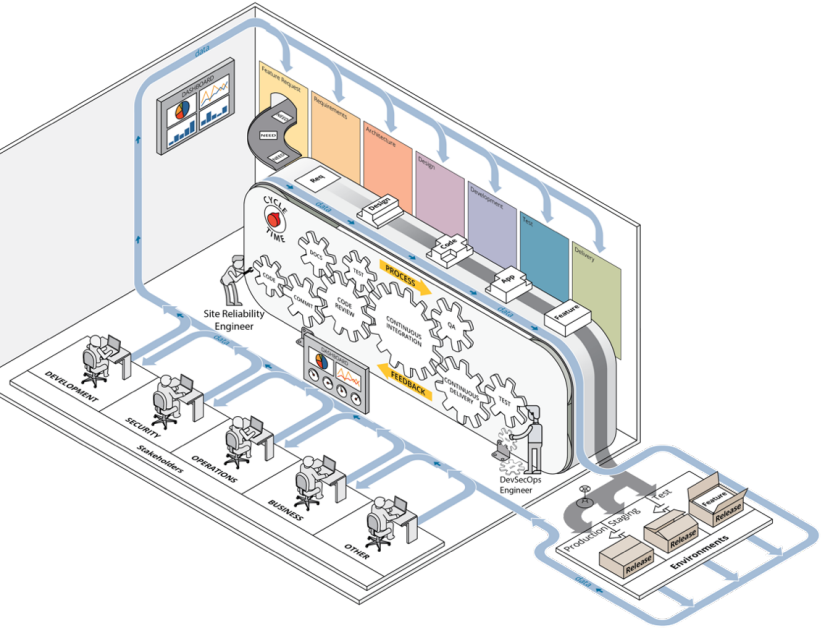
Graphic Source: Figure 4, *Parallel Worlds: Differences in Agile and Waterfall Differences & Similarities,* S. Palmquist et al, SEI-2013-TN-021, October 2013.

BUT, the Agile Principles Were Designed and Focused on Small Teams

There are lots of things beyond supporting a small team that you must focus on when scaling above a few small teams:

- managing the interfaces among the many products/system components that multiple teams are working on…
- figuring out how to synchronize releases and events across multiple teams…
- figuring out how to get the inventory (backlog) of requirements organized productively to support the development pace of multiple small teams….
- dealing with specialty disciplines (UX, security, etc.) that have significant inputs to the evolving product but aren't needed as full-time team members….
- Etc.

DevSecOps is a Complex System



- **System** is “an assemblage or combination of things or parts forming a complex or unitary whole” [1]. Thus, DSO is a system.
- DSO also possesses the **characteristics of a socio-technical system** [2] and a computer information system, since DSO is composed of **people, processes, and computer technology** that are “designed to collect, process, store, and distribute information” [3].
- If we add to this definition that **DSO pipelines are composed of independently developed, independently maintained, likely physically and logically distributed, task-dedicated, interoperable components**, then we can affirm that DSO pipelines are **complex sociotechnical** computer information systems.

[1] system, https://www.dictionary.com/browse/system
[2] SEBoK, https://www.sebokwiki.org/wiki/Sociotechnical_System_(glossary)
[3] Information system, https://en.wikipedia.org/wiki/Information_system

Understanding the Complexity

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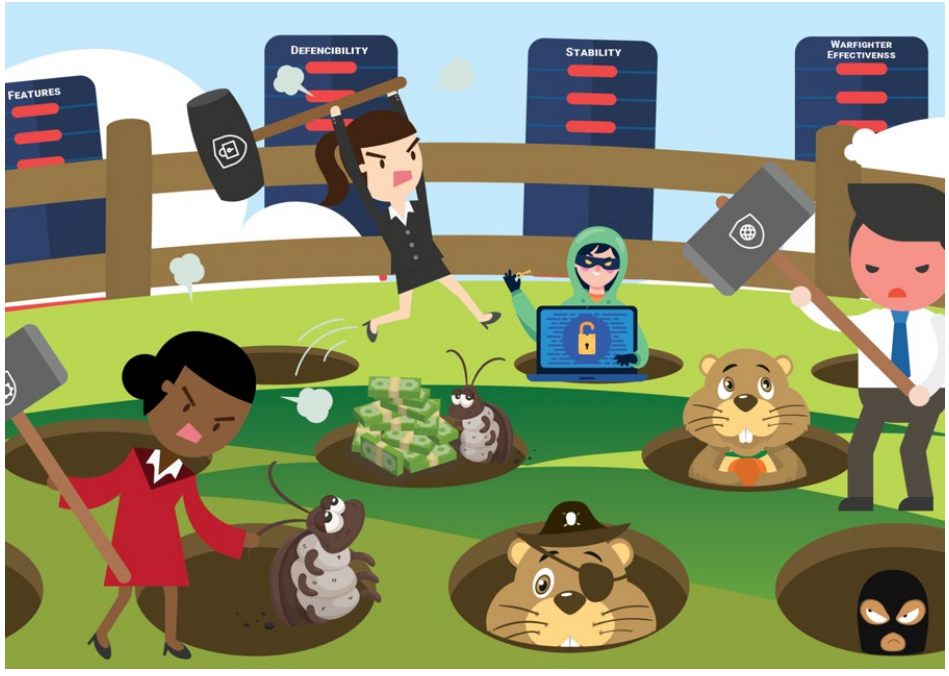
Avoiding Pipeline Whac-A-Mole



The usage of a pipeline is the cornerstone of a mature and robust DevSecOps environment.

A CI/CD pipeline provides for the vetting, building, testing, packaging, and delivery of a change to the desired destination.

No standard implementation of DevSecOps or a pipeline exists that works for everyone.

Each organization must analyze its

- Existing and desired culture
- Budget constraints
- Defined business cases
- Solution space

So how do you:

- go about building it?
- decide what to implement first, second, …?

It is extremely important to have a well-defined end state in mind before implementation begins to avoid costly mistakes.

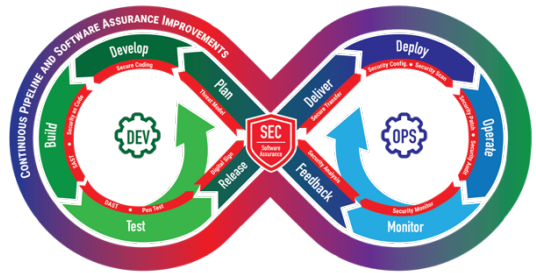
The end state must consider the perspective of all stakeholders, including software architects, developers, system administrators, test and quality-assurance engineers, security officials, management, end users, etc.

Insufficient details for a complicated socio-technical system

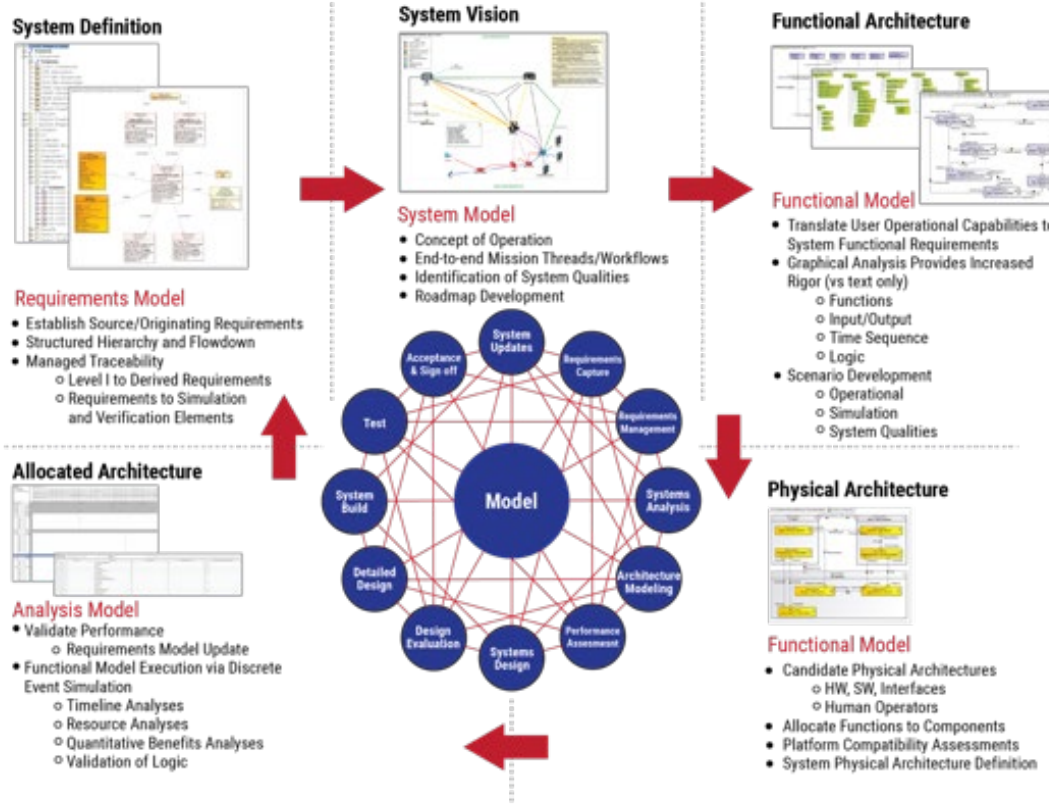
While one can search “DevSecOps” or “DevOps” and find a lot of literature that paints a picture of what it could be or should be, they are not definitive and require a considerable amount of interpretation

Resulting in:

- perspectives not being fully integrated in organizational guidance and policy
- projects being unable to perform an analysis of alternatives (AoA) in regard to the pipeline tools and processes
- multiple projects using similar infrastructure and pipelines in different and incompatible ways, even within the same organization
- suboptimal tools and security controls
- Etc.



Socio-technical Systems Require Model Based Systems Engineering

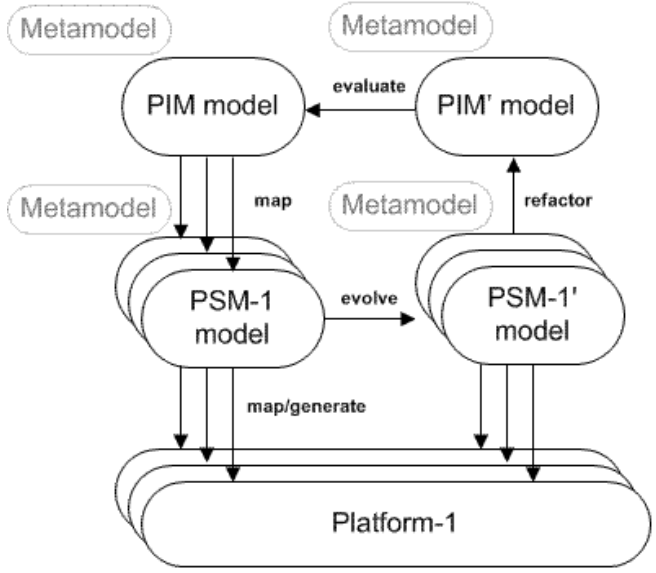


*The Digital System Model contains the most current requirements, key mission/business operations, architecture, design details, implementation details, test and evaluation details, and supporting documentation.

- ***Not* yesterday's Document-Centric Systems Engineering!**
- MBSE uses a Digital System Model* to facilitate common system understanding and decision-making.
- The Digital System Model* is the single authoritative source of truth
- System and Components can be integrated at various levels of abstraction and fidelity
- Model Views are chosen to best communicate information to a variety of stakeholders via the dynamic creation of multiple, consistent, accurate views
- Impacts of changes are more easily analyzed and evaluated

Bridging the gap between theory and implementation

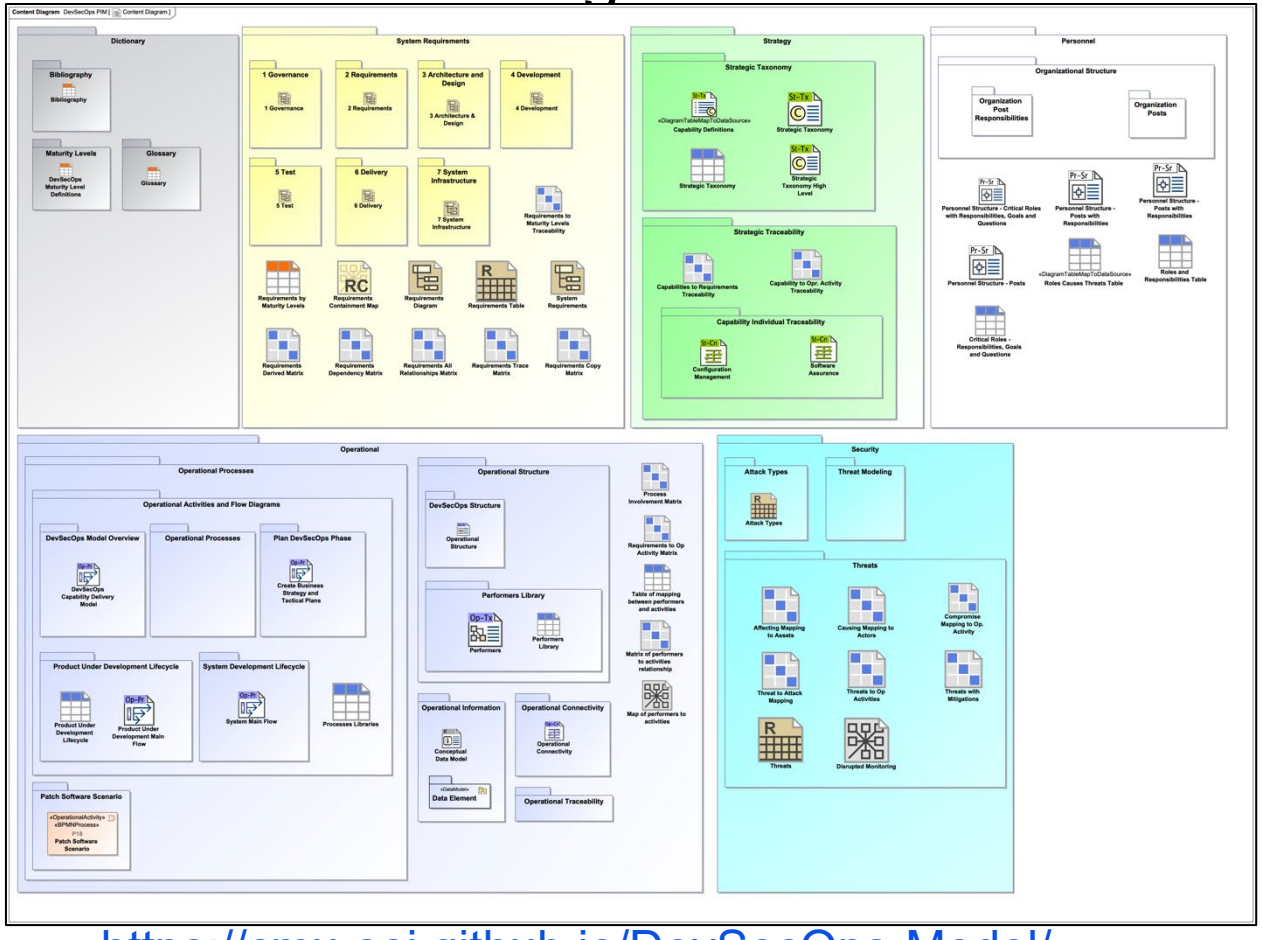
A PIM is a general and reusable model of a solution to a commonly occurring problem in software engineering within a given context and is independent of the specific technological platform used to implement it.



SEI DevSecOps Platform Independent Model (PIM)

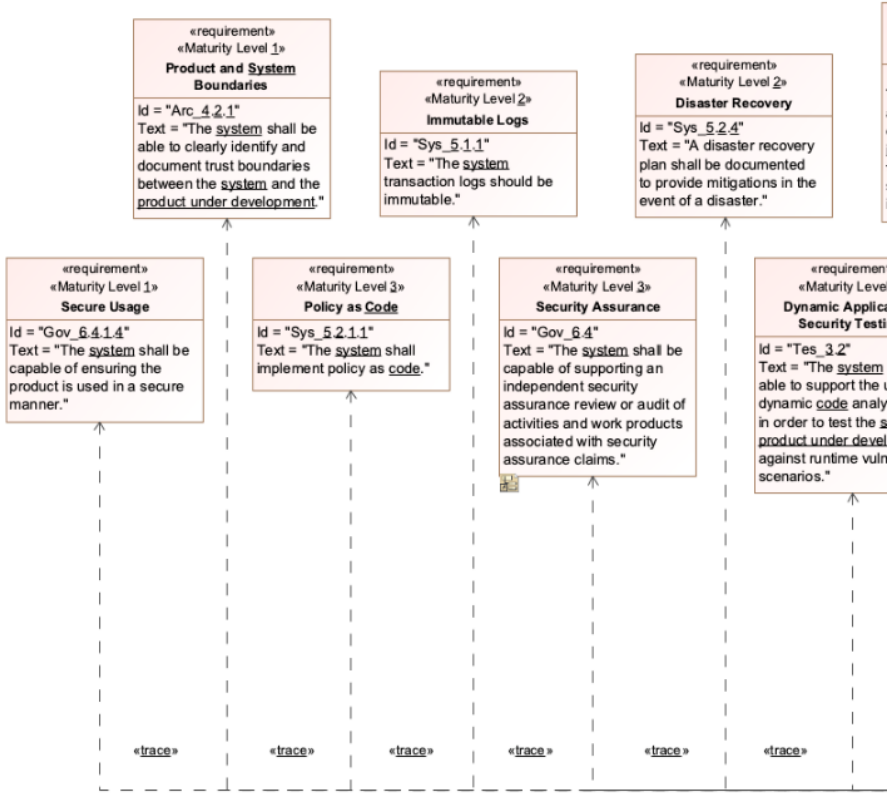
- is an authoritative reference to fully design and execute an integrated Agile and DevSecOps strategy in which all stakeholder needs are addressed
- enables organizations to implement DevSecOps in a secure, safe, and sustainable way to fully reap the benefits of flexibility and speed available from implementing DevSecOps principles, practices, and tools
- was developed to outline the activities necessary to consciously and predictably evolve the pipeline, while providing a formal approach and methodology to building a secure pipeline tailored to an organization's specific requirements

DevSecOps PIM - Content Diagram



https://cmu-sei.github.io/DevSecOps-Model/

DevSecOps Requirements



Example of Requirements Representation in Diagrams from PIM

All requirements are organized into categories based on logical and functional groupings:

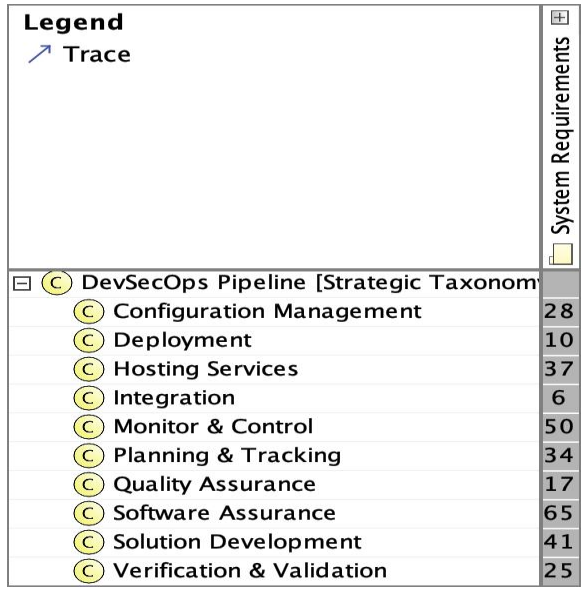
- Governance
- Requirements
- Architecture and Design
- Development
- Test
- Delivery
- System Infrastructure

Requirements Table Link

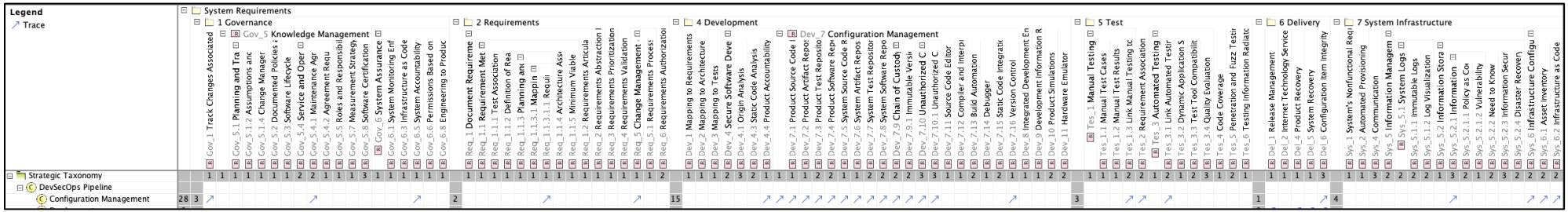
DevSecOps Capability/Strategic Viewpoint

A capability is a high-level concept that describes the ability of a system to achieve or perform a task or a mission.

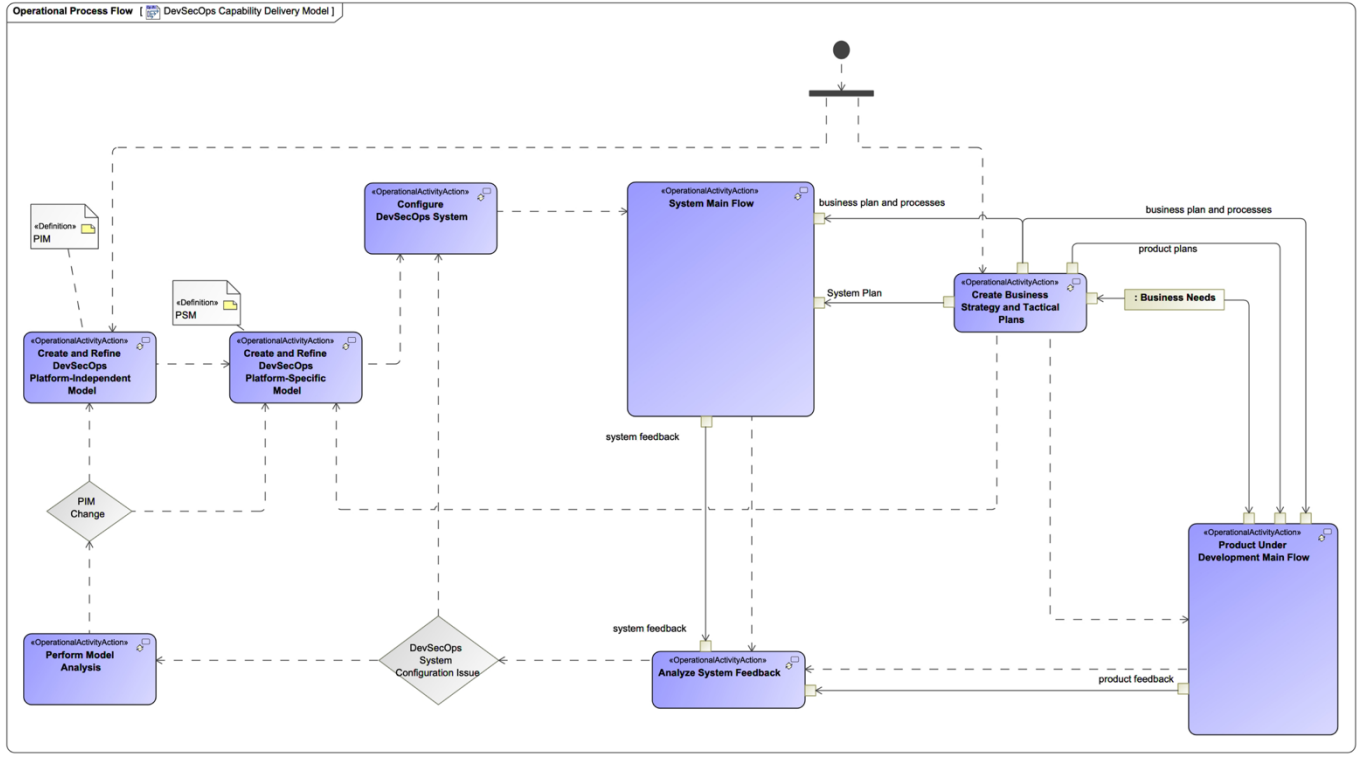
All requirements in the DevSecOps PIM were allocated to corresponding capabilities.



- Capability to Requirements Traceability Link
- Capability to Operational Activity Traceability Link
- Capability Definitions Link
- Strategic Taxonomy High Level



DevSecOps Operational Viewpoints



- DevSecOps Capability Delivery Model Link

An operational model for a system describes behavior of the system to conduct enterprise operations.

The main operational processes for DevSecOps includes development process for the product, as well as the DevSecOps process itself.

DevSecOps Personnel Viewpoints

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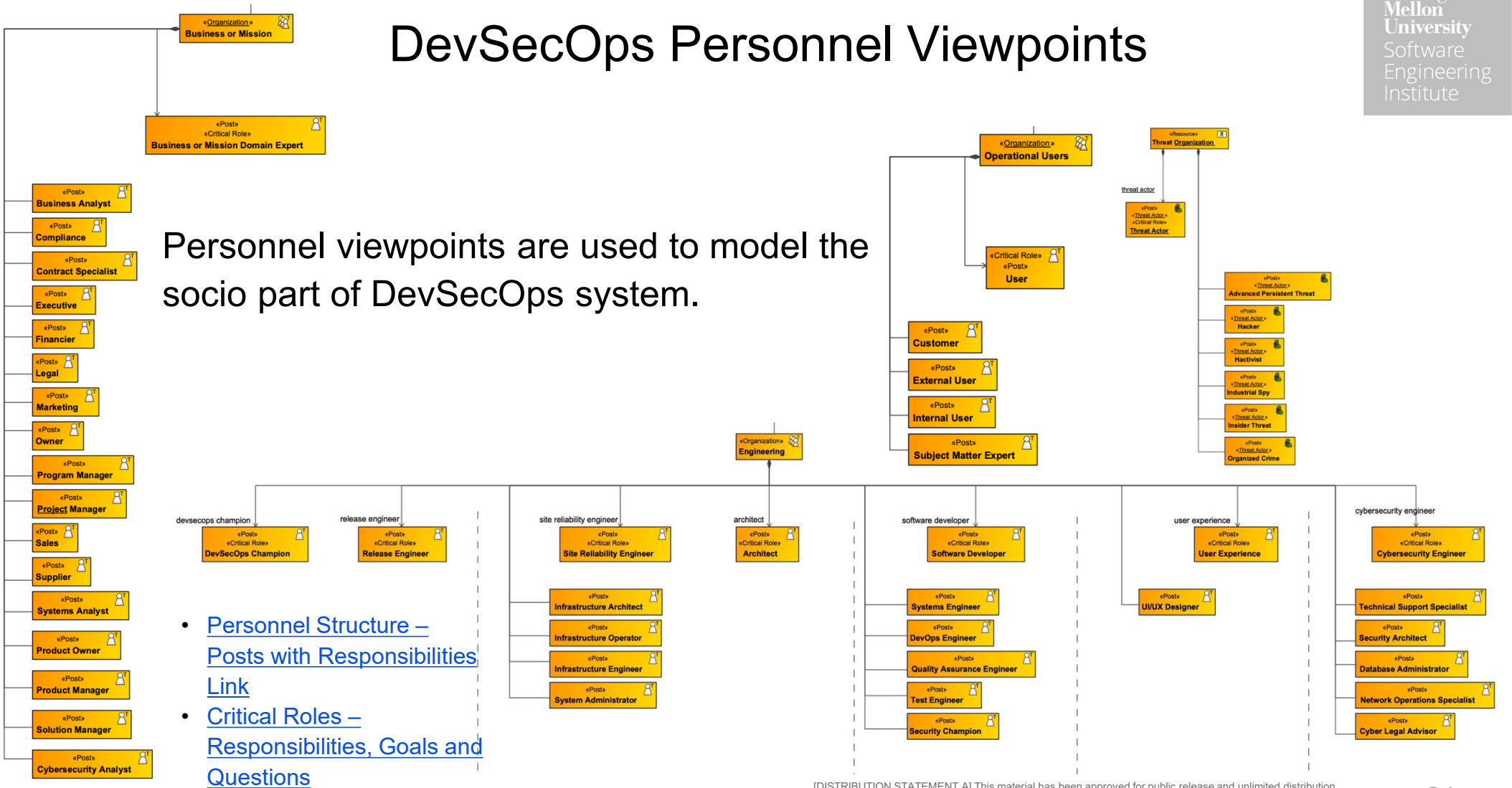
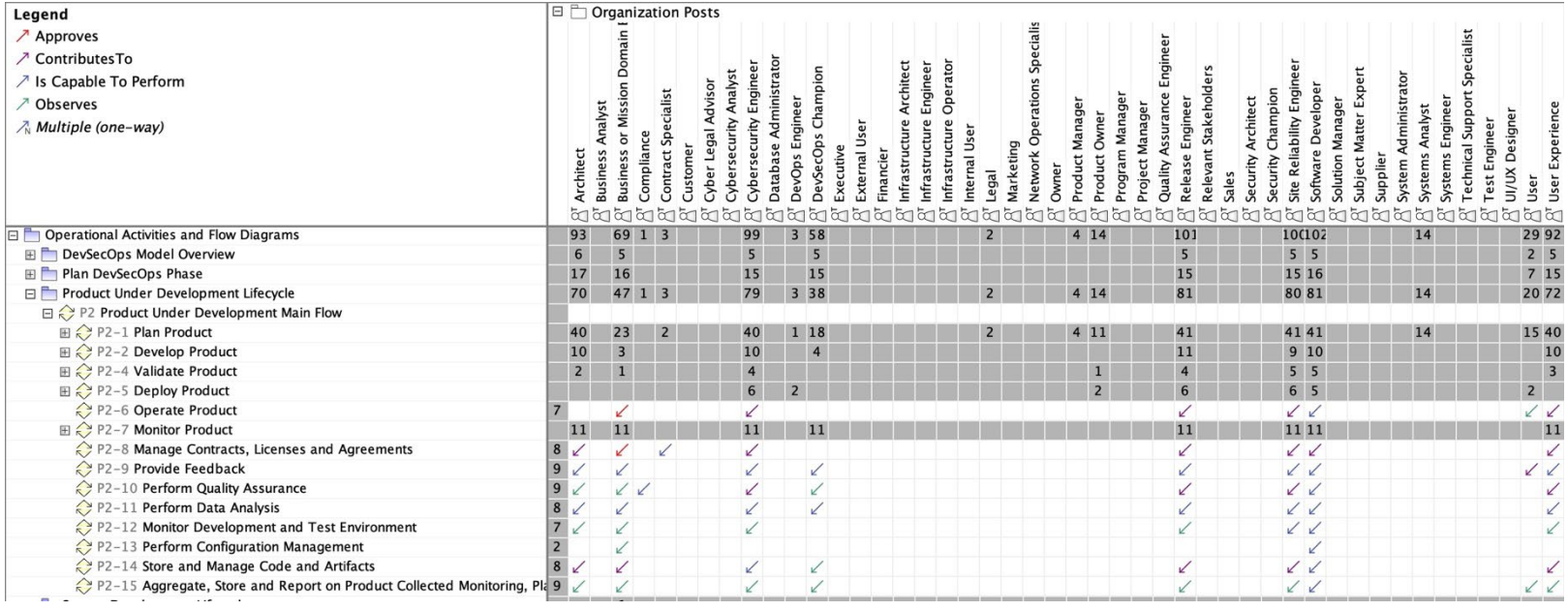
Personnel viewpoints are used to model the socio part of DevSecOps system.



- Personnel Structure – Posts with Responsibilities Link
- Critical Roles – Responsibilities, Goals and Questions

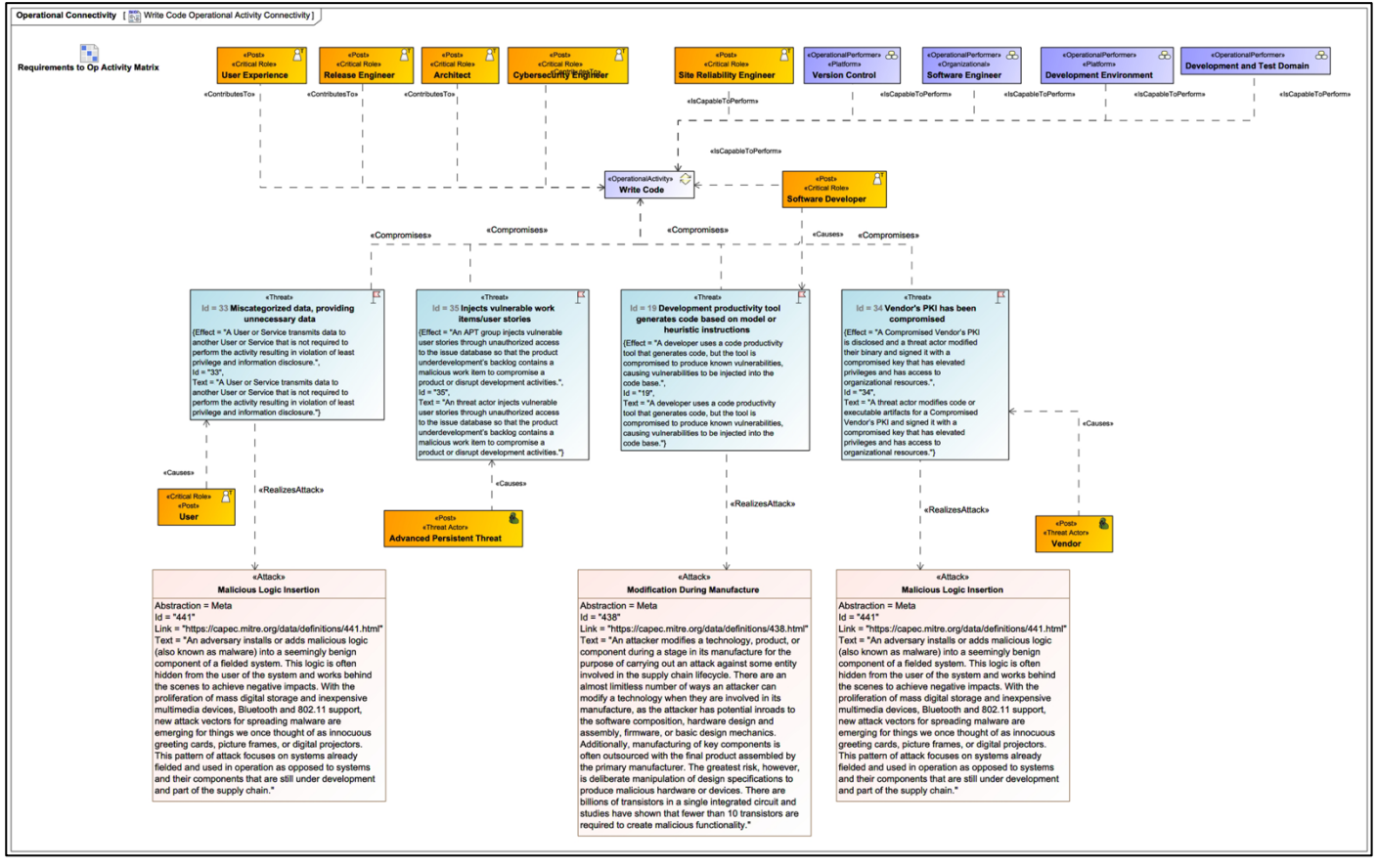
Everyone Plays a Role in DevSecOps



- [Process Involvement Matrix Link]

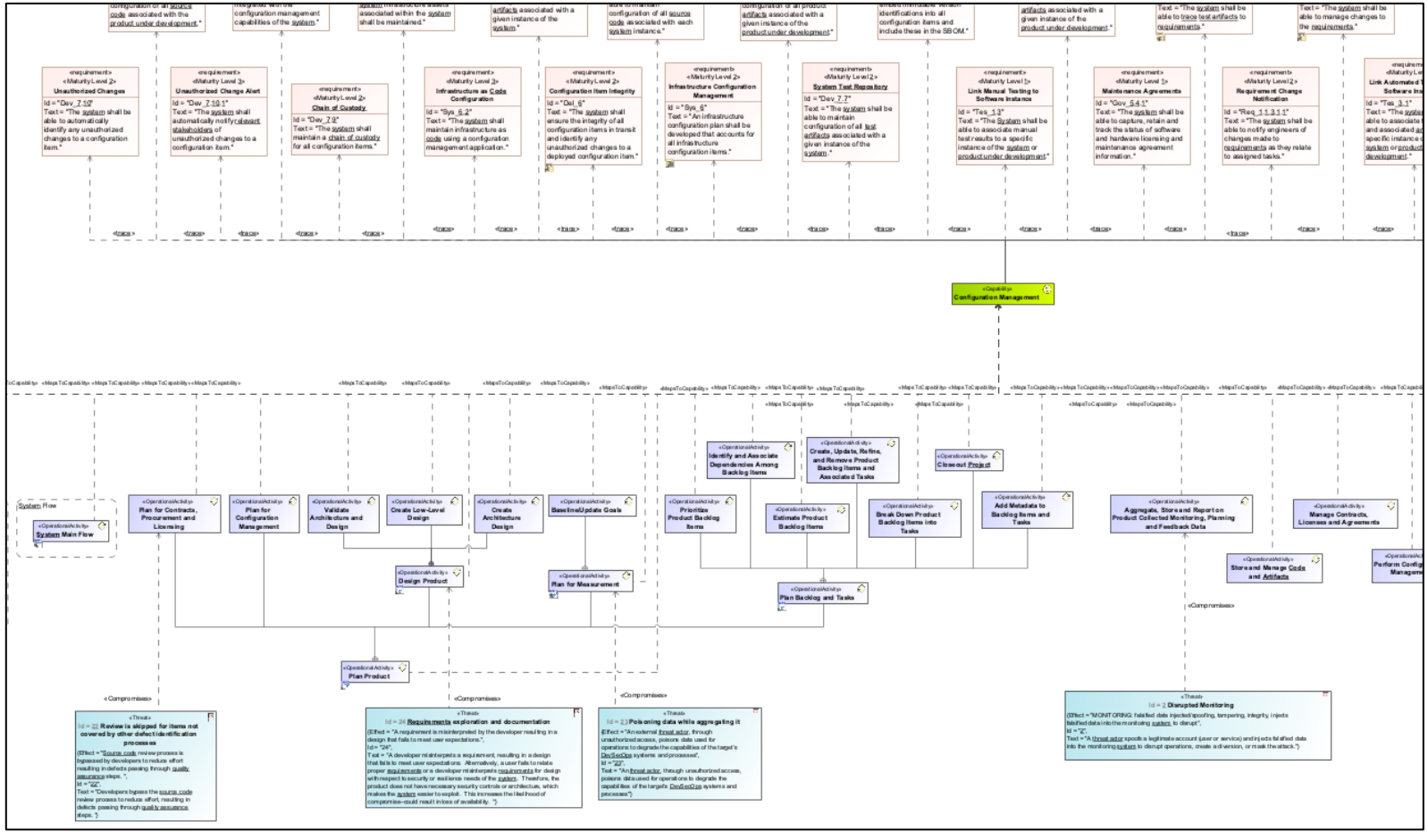
Critical Roles are mapped to Operational Activities.

Example Threat Modeling Diagram for Write Code Operational Activity



[Write Code Operational Activity Connectivity Link]

Capturing the Theats of the DevSecOps System



Example of Threats Traced to Capabilities via Operational Activities

[Configuration Management Complexity Link]

The DevSecOps PIM enables Organizations, Projects, Teams, and Acquirers to

- specify the DevSecOps requirements to the lead system integrators tasked with developing a platform-specific solution that includes the designed system and continuous integration/continuous deployment (CI/CD) pipeline
- assess and analyze alternative pipeline functionality and feature changes as the system evolves
- apply DevSecOps methods to complex products that do not follow well-established software architectural patterns used in industry
- provide a basis for threat and attack surface analysis to build a cyber assurance case to demonstrate that the product and DevSecOps pipeline are sufficiently free from vulnerabilities and that they function only as intended
- evaluate the capabilities of software factories

Capability Maturity

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Capability Maturity

- A maturity model is a set of characteristics, attributes, indicators, and patters that represent progression and achievement in a particular domain or discipline
- A maturity model allows an organization, or software factory, to have its practices, processes, and methods evaluated against a clear set of artifacts that establish a benchmark
- Capability maturity levels are arranged in an evolutionary scale that defines measurable transitions from one level of capability to another.
- Maturity models can be used to
  - Determine an organization's current level of capability and then apply these methods over time to drive improvements
  - Determine how well a program is performing by examining the capabilities of its sister programs.
- The SEI has been defining such models and associated appraisal methods for over 30 years.

DevSecOps Capability Maturity

As a DevSecOps system matures, so will its capabilities

DevSecOps can be broken down into 10 capabilities

- These capabilities are groupings of requirements that, when combined, define a collective competency in performing a set of functional activities across the product lifecycle

The capability levels represent the measure of consistency and completeness

- This is usually achieved through increased automation, in which functional activities are performed.

DevSecOps Requirements

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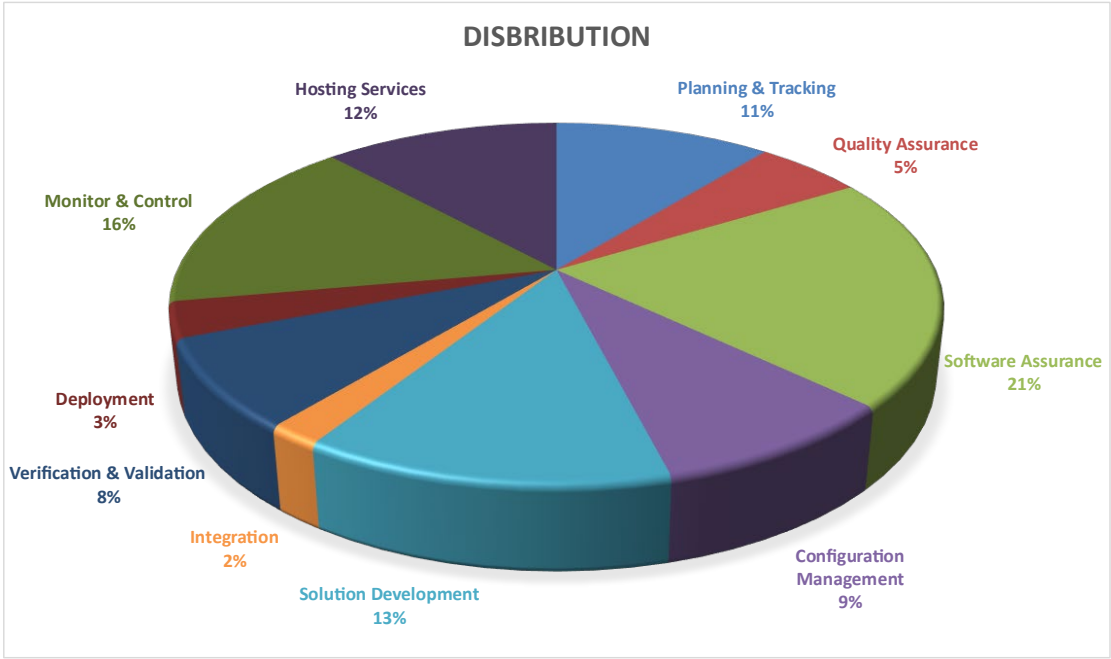
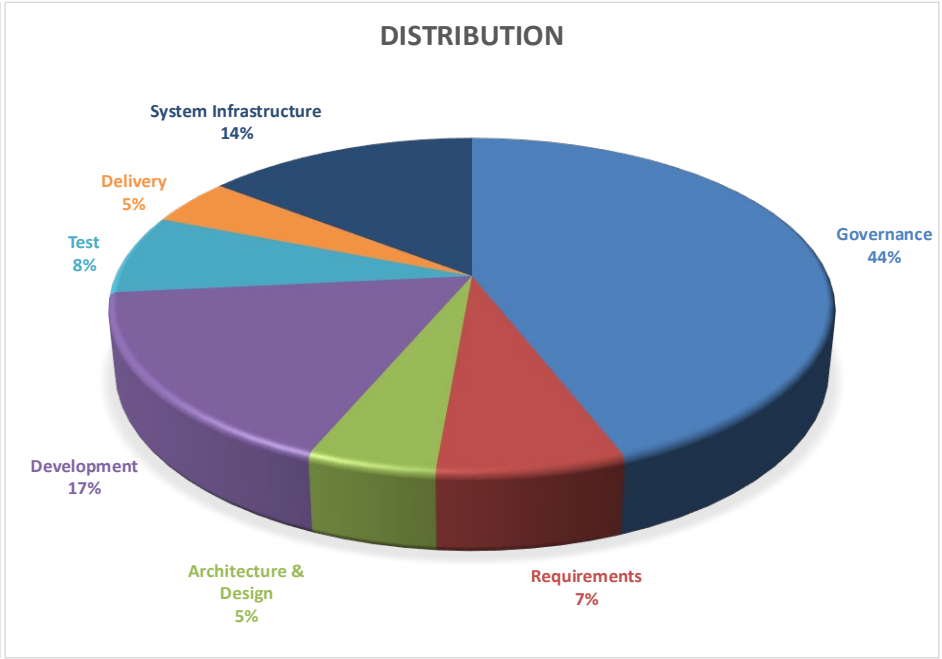
10 Capabilities



Lifecycle View

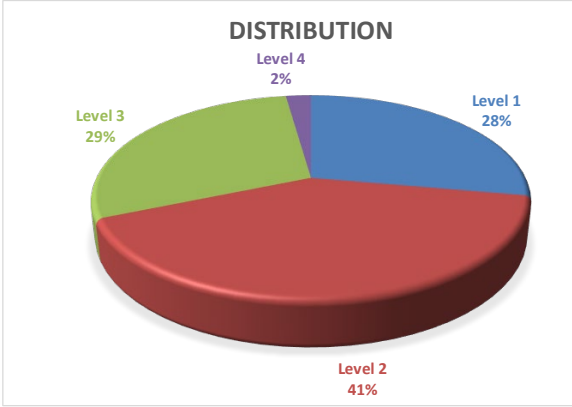


https://cmu-sei.github.io/DevSecOps-Model/

Distribution of over 200 defined DevSecOps Requirements

DevSecOps Capabilities Evolve

Term	Documentation
Maturity Level 1	**Performed Basic Practices:** This represents the minimum set of engineering, security, and operational practices that is required to begin supporting a product under development, even if only performed in an ad-hoc manner with minimal automation, documentation, or process maturity. This level is focused on minimal development, security, and operational hygiene.
Maturity Level 2	**Documented/Automated Intermediate Practices:** Practices are completed in addition to meeting the level 1 practices. This level represents the transition from manual, ad-hoc practices to the automated and consistent execution of defined processes. This set of practices represents the next evolution of the maturity of the product under development's pipeline by providing the capability needed to automate the practices that are most often executed or produce the most unpredictable results. These practices include defining processes that enable individuals to perform activities in a repeatable manner.
Maturity Level 3	**Managed Pipeline Execution**: Practices are completed in addition to meeting the level 1 and 2 practices. This level focuses on consistently meeting the information needs of all relevant stakeholders associated with the product under development so that they can make informed decisions as work items progress through a defined process.
Maturity Level 4	**Proactive Reviewing and Optimizing DevSecOps**: Practices are completed in addition to meeting the level 1-3 practices. This level is focused on reviewing the effectiveness of the system so that corrective actions are taken when necessary, as well as quantitively improving the system's performance as it relates to the consistent development and operation of the product under development.



Distribution of over 200 defined DevSecOps Requirements

https://cmu-sei.github.io/DevSecOps-Model/

DevSecOps Core Capabilities (1 of 3)

Link to Capabilty Level Definitions

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Capability	Definition
Configuration Management	Configuration management is the set of activities used to establish and maintain the integrity of the system and product under development, and associated supporting artifacts throughout their useful lives. Different levels of control are appropriate for different supporting artifacts and implementation elements and for different points in time. For some supporting artifacts and implementation elements, it may be sufficient to maintain version control of the artifact or element that is traced to a specific instance of the system or product under development in use at a given time, past or present, so that all information related to a given instance, or version, is known. In that case, all other variations of the artifacts and elements can be discarded as subsequent iterations are generated or updated. Other supporting artifacts and implementation elements may require formal configuration, in which case baselines are defined and established at predetermined points in the lifecycle. Baselines, and subsequent changes, are formally reviewed and approved which will serve as the basis for future efforts. The configuration management capability of a system matures as the consistency and completeness of the integrity controls are put in place to capture all supporting artifacts and implementation elements associated with the system and product under development while keeping pace with the DevSecOps pipeline through automation and integration with all aspects of the lifecycle. This includes (1) monitoring the relationship between artifacts and elements for a given instance, or version, of the system or product under development, (2) capturing sufficient information to identify and maintain configuration items, even if those who created them are no longer available, (3) defining the level of control each artifact and element requires based on technical and business needs, (4) systematically controlling and monitoring changes to configuration items, and (5) enforcing and logging of all required relevant stakeholder reviews and approvals, based on the organization, project, and team policies and procedures.
Deployment	Deployment is the set of processes related to the delivery or release of the product under development into the environment in which users of the product interact with it. The deployment capabilities of the system mature with increased levels of automation and advanced rollback and release functionality.
Hosting Services	Hosting services are made up of the underlying infrastructure and platforms that both the system and product under development operate upon. This includes the various cloud providers, on premises bare-metal and virtualization, networks, and other software as a service (SaaS) that is utilized along with the management, configuration, access control, ownership, and personnel involved.

DevSecOps Core Capabilities (2 of 3)

Link to Capabilty Level Definitions

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Capability	Definition
Integration	Integration is the process of merging changes from multiple developers made to a single code base. Integration can be made manually on a periodic basis, typically by a senior or lead engineer, or it can be made continuously by automated processes as individual changes are made to the code base. In either case, the purpose of integration is to assemble a series of changes, merge and deconflict them, build the product, and ensure that it functions as intended and that no change broke the whole product, even if those changes worked in isolation.
Monitor & Control	Monitor and control involves continuously monitoring activities, communicating status, and taking corrective action to proactively address issues and consistently improve performance. More mature projects automate as much of this as possible. Appropriate visibility enables timely corrective action to be taken when performance deviates significantly from what was expected. A deviation is significant if it precludes the project from meeting its objectives when left unresolved. Items that should be monitored include cost, schedule, effort, commitments, risks, data, stakeholder involvement, corrective action progress, and task and work product attributes like size, complexity, weight, form, fit, or function.
Planning & Tracking	Planning and tracking is the set of practices one uses to define tasks and activities. It also includes the resources one needs to perform those tasks and activities, achieve an objective or commitment, and track progress (or lack thereof) towards achieving the given objective. It provides the mechanisms required to inform relevant stakeholders where an effort currently is within the process and whether it is on track to provide the expected outcomes. These mechanisms allow relevant stakeholders to determine what has been accomplished and what adjustments or corrective actions need to occur to account for impediments and other unforeseen issues. Ideally, impediments and issues are proactively identified and addressed. Practices include documenting activities and breaking them down into actionable work to which one can assign resources, capturing dependence, forecasting, mapping work to requirements, collecting data, tracking progress to commitments, and reporting status. The planning and tracking capability of a system matures as the automation and integration of associated practices increases.
Quality Assurance	Quality assurance is a set of independent activities (i.e., free from technical, managerial, and financial influences, intentional or unintentional) designed to provide confidence to relevant stakeholders that the DevSecOps processes and tools are appropriate for and produce products and services of suitable quality for their intended purposes. It assumes that the organization's, team's, and project's policies and procedures have been defined based on all relevant stakeholder needs, which will result in a value stream that consistently produces products and services that meet all relevant stakeholder expectations. The quality assurance capability of a system matures as its ability to assess adherence to and the adequacy of the defined policies and procedures improves.

DevSecOps Core Capabilities (3 of 3)

Link to Capabilty Level Definitions

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Capability	Definition
Software Assurance	Software assurance is the level of confidence that software functions only as intended and is free from vulnerabilities either intentionally or unintentionally designed or inserted as part of the software throughout the full software lifecycle. It consists of two independent but interrelated assertions: 1. The software functions only as intended. It exhibits only functionality intended by its design and does not exhibit functionality not intended. 2. The software is free from vulnerabilities, whether intentionally or unintentionally present in the software, including software incorporated into the final system. It is the responsibility of the DevSecOps system to ensure that software that meets the organization's threshold for software assurance is allowed to be deployed and operated.
Solution Development	Solutions development determines the best way of satisfying the requirements to achieve an outcome. Its goals are to evaluate baseline requirements and alternative solutions to achieve them, select the optimum solution, and create a specification for the solution. Each development value stream develops one or more solutions, which are products, services, or systems delivered to the customer, whether internal or external to the enterprise.
Verification & Validation	Verification and validation is the set of activities that provides evidence that the system or application under development has met the requirements and criteria that are expected. The scope includes the general realm of testing, verifying, and validating activities and matures as automation, feedback, and integration with other elements increase.

DevSecOps Capability Maturity Visualization

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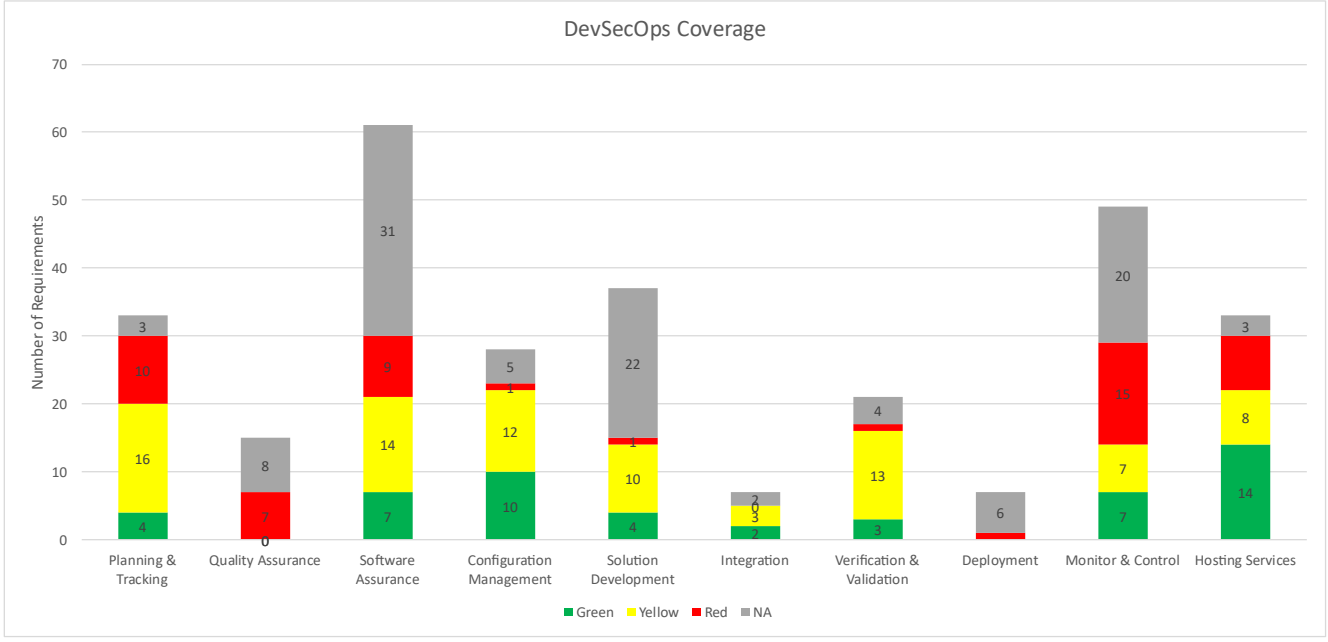
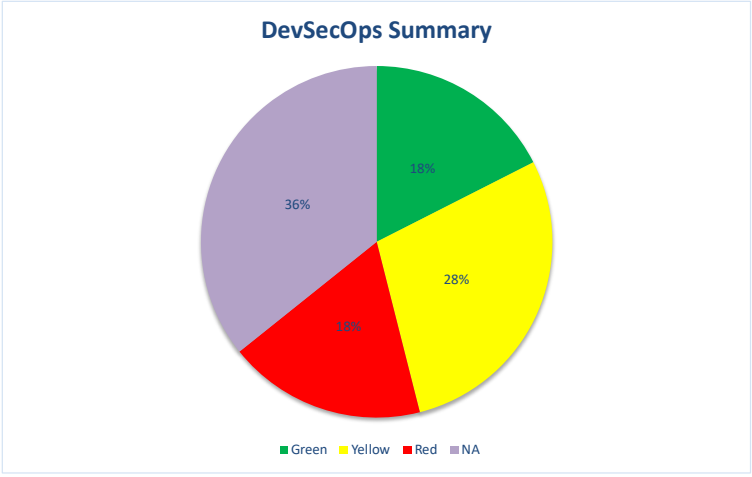
Capability Summary



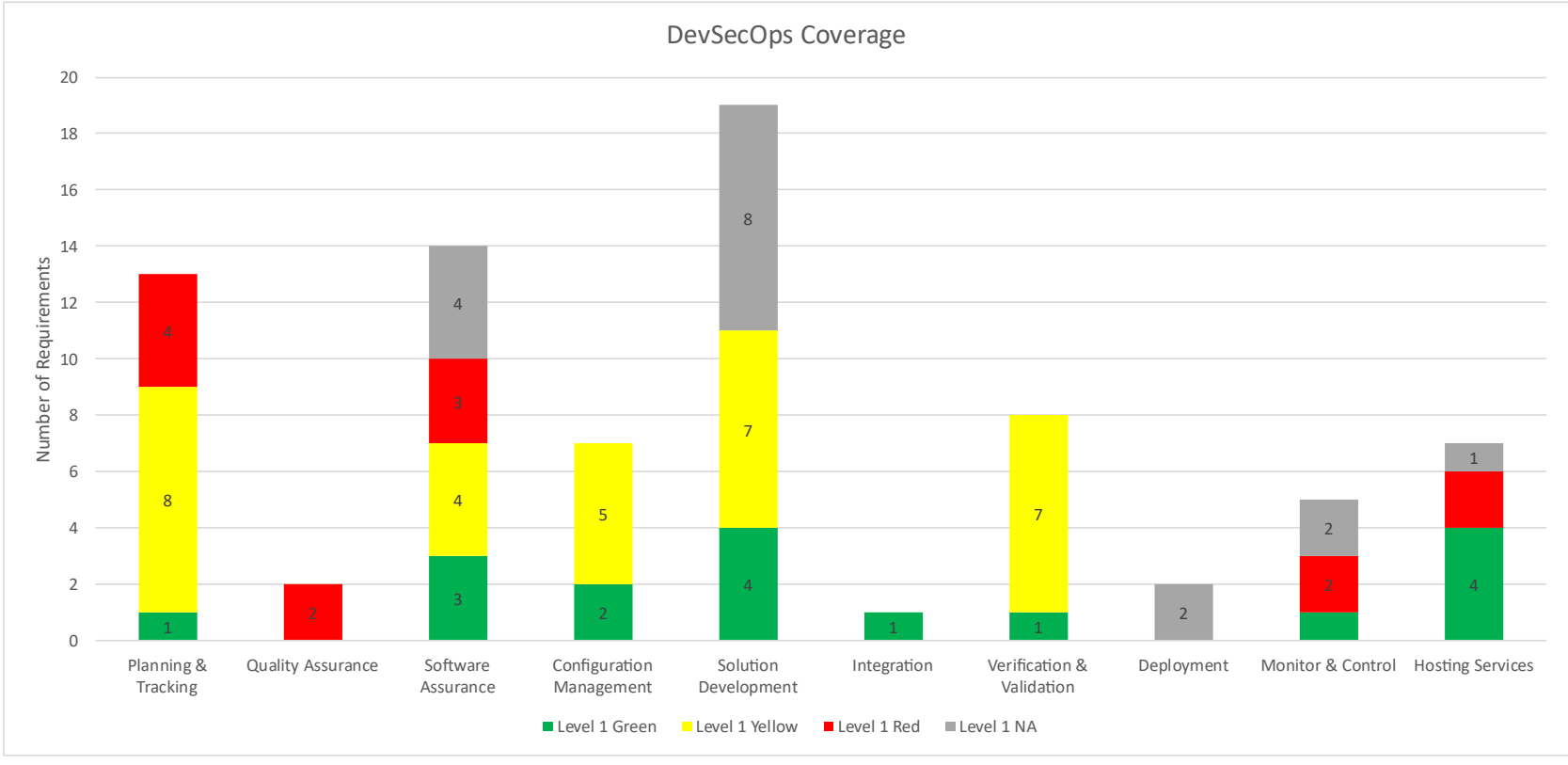


Over 200 Agile/DevSecOps requirements broken into 10 Capabilities and 4 Maturity Levels

Key	Description
Green	Consistently Demonstrated
Yellow	Occasionally Demonstrated
Red	Insufficient Evidence Found
NA	Not Applicable to Program

Level 1

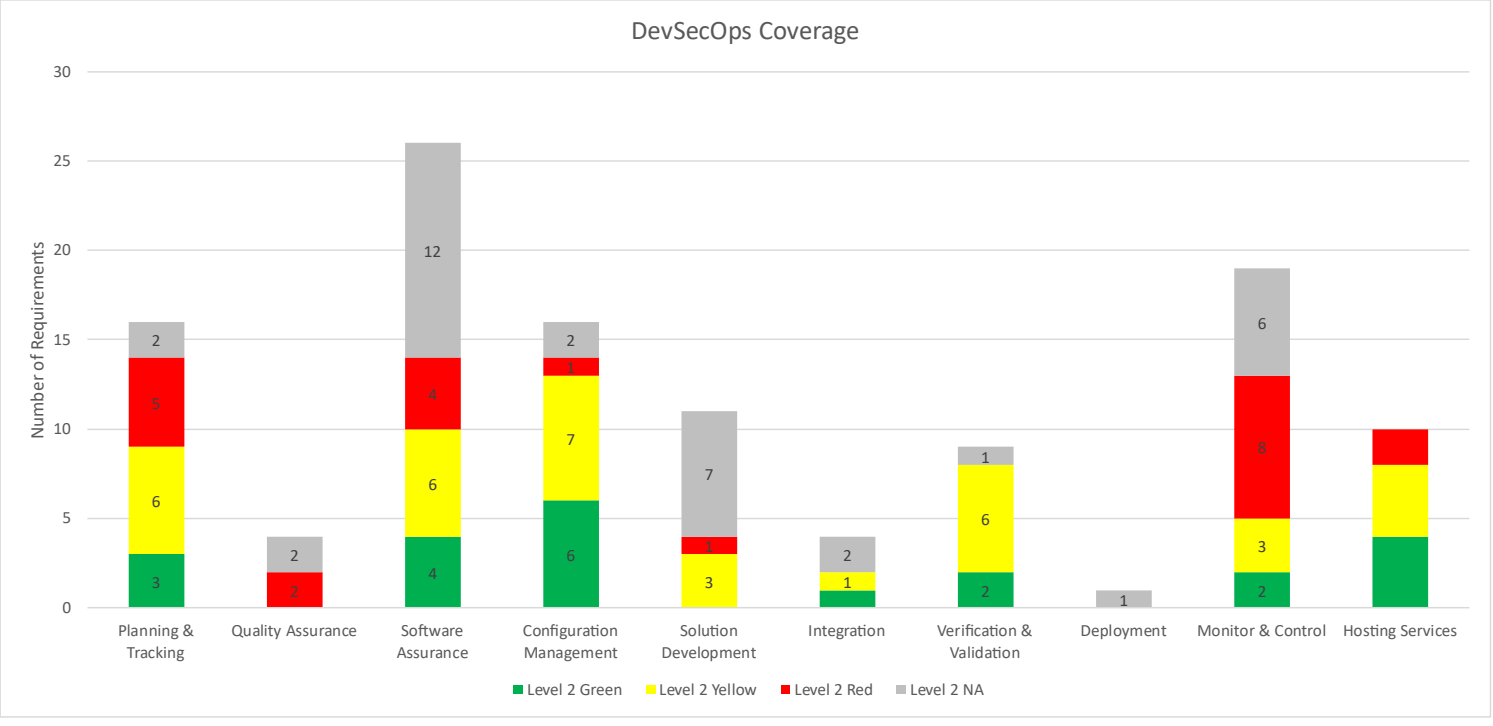
Performed Basic Practices: This represents the minimum set of engineering, security, and operational practices that is required to begin supporting a product under development, even if only performed in an ad-hoc manner with minimal automation, documentation, or process maturity. This level is focused on minimal development, security, and operational hygiene.



Over 60 Maturity Level 1 Agile/DevSecOps requirements broken into 10 Capabilities

Level 2

Documented/Automated Intermediate Practices: Practices are completed in addition to meeting the level 1 practices. This level represents the transition from manual, ad-hoc practices to the automated and consistent execution of defined processes. This set of practices represents the next evolution of the maturity of the product under development's pipeline by providing the capability needed to automate the practices that are most often executed or produce the most unpredictable results. These practices include defining processes that enable individuals to perform activities in a repeatable manner.



Over 80 Maturity Level 2 Agile/DevSecOps requirements broken into 10 Capabilities

Summary

Enterprises need to be able to evaluate and articulate their capability to deliver value and the value of the Product/Service being provided. These are 2 distinct, but integrated areas of concern.

The SEI DevSecOps PIM

- Bridges the gap between high-level DevSecOps concepts and actual instantiations
- Provide a single source of truth in which multiple perspectives and views can be analyzed using MBSE
- Provides a basis for driving alignment across distinct pipelines within an enterprise
- Provides a roadmap to implementing DevSecOps
- Provides a repeatable approach to quantifying a pipeline's current capabilities

Through proper balance you should be able to play Topple indefinitely.

Stop playing Whac-A-Mole!

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Why Apply Model-based Engineering to DevSecOps?

The idea of **applying model-based engineering methods to socio-technical systems is not new**. Examples include; social systems [1] [2], complex command and control system [3], border security [4], sociotechnical systems [5]

The overall **adoption of model-based engineering and virtual modeling tools in everyday practices has grown**.

Using a model-based approach such as BPM (Business Process Modeling) **to design or describe patterns of human activities as a context of the functioning of a computer information system**, aka business process, is a **standard practice in industry** now [6].

[1] Haskins, C. 2008a. “Using patterns to transition systems engineering from a technological to social context,” Systems Engineering, 11: 147–155.
[2] Palmer, E. 2016. “Investigating structural gender inequality in the Norwegian pension system: An example of using MBSE in the evaluation of social systems,” 26th Annual INCOSE International Symposium (IS 2016), Edinburgh, Scotland, UK, July 18-21, 2016
[3] Oosthuizen, R., Venter, J.P., Serfontian, C. 2018 “Model Based Systems Engineering Process for Complex Command and Control Systems,” 23rd International Command and Control Research and Technology Symposium (ICCRTS 2018), Pensacola, USA, 6-9 November 2018
[4] Asan, E., Albrecht, O., Bilgen, S. 2013 “Handling Complexity in System of Systems Projects – Lessons Learned from MBSE Efforts in Border Security Projects,” 4th International Conference on Complex System Design & Management, pp. 281-299.
[5] Miller, Lori Ann, "Modeling forward base camps as complex adaptive sociotechnical systems" (2012). Masters Theses. 6943.
[6] OMG Standards for BPM, https://www.omg.org/technology/readingroom/BPM.htm