Modeling DevSecOps to Reduce the Time-to-Deploy and Increase Resiliency

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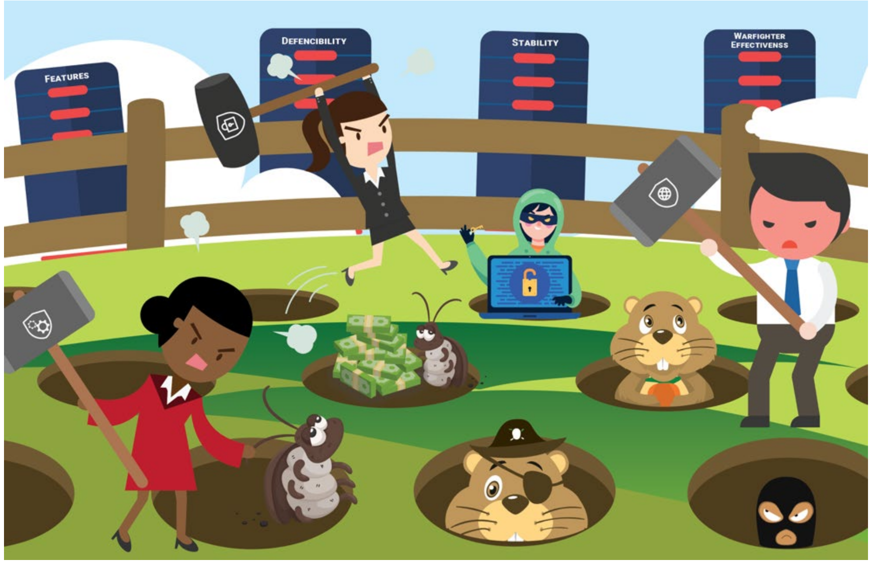
Document Markings

Today: Program Office Whac-A-Mole



Winning in Features and Warfighter Effectiveness, but Losing in Defensibility and Stability

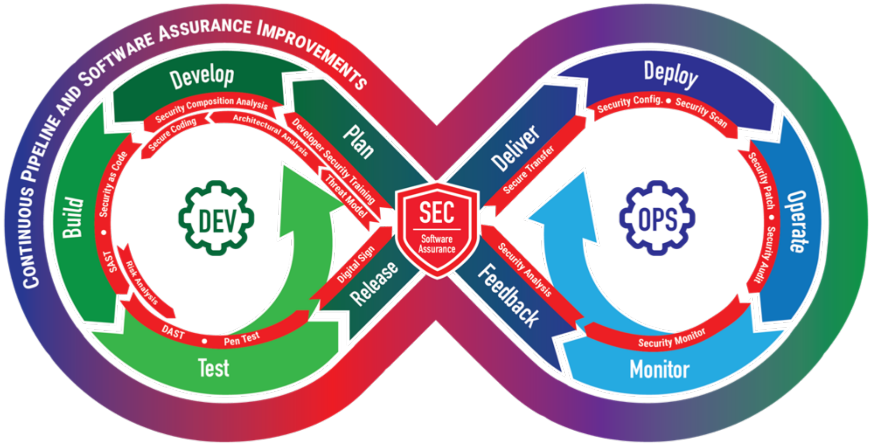
In June of 2020 a generally successful DoD program completed an **8 week "Hardening the Software Factory" effort** in order to address **accumulated technical debt** and to address **insufficient security and operations** practices **due to the narrow focus on speed of delivery**.

These things occur, even in small relatively successful programs, when technical debt and insufficient security and operational practices are in place **due to lack of knowledge, experience, and reference material to fully design and execute an integrated DSO strategy in which all stakeholder needs, including cybersecurity, are addressed.**

Without the ability to perform formal analysis of a system's numerous parameters, program offices are forced to play Whac-A-Mole and hope for the best.

Some Challenges

DevSecOps: a Complex Socio-Technical Information System

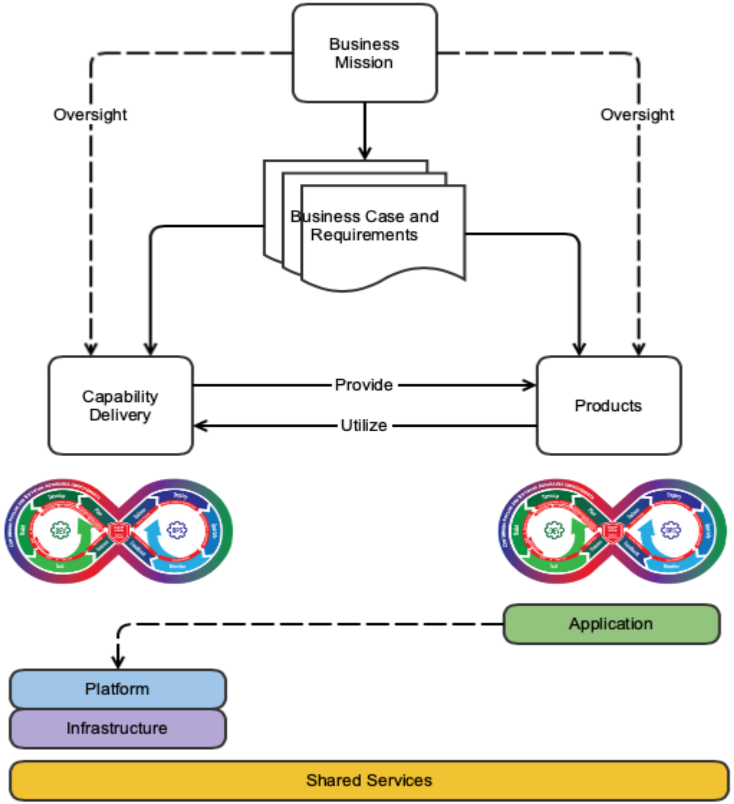


DSO is an approach that integrates development (Dev), security (Sec), and deployment/operations (Ops) of software systems to reduce the time required to move from need to capability and provide CI/CD with high software quality [13].

The DSO CI/CD pipeline is a **socio-technical system made up of both a collection of software tools and processes** [14].

It is **not a system to be built or acquired**, it is a personal and organizational **mindset** defining processes for the rapid development, fielding, and operations of software and software-based systems **utilizing automation where feasible** in order to achieve the desired throughput of new features and capabilities.

Challenge 1 for DSO: connecting process, practice, & tools

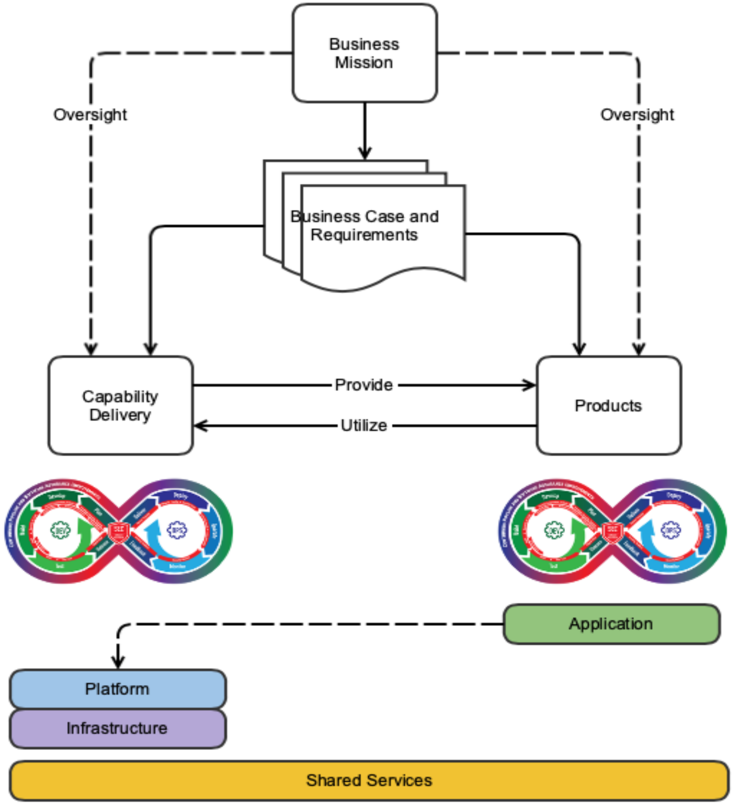


See [10] for more details

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
- Everything is software and all pieces must be maintained but responsibility will be shared across multiple organizations (Cloud for infrastructure, 3rd parties for tools and services

Challenge 2 for DSO: cybersecurity of pipeline and product

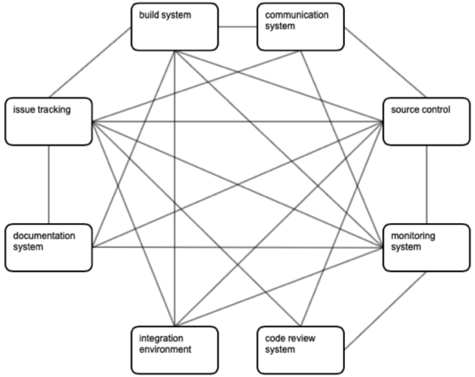


See [10] for more details

Managing and monitoring all of the various parts to ensure the product is built with sufficient cybersecurity and the pipeline is maintained to operate with sufficient cybersecurity is complex. Cybersecurity demands effective governance to address:

- What trust relations will be acceptable, and how will they be managed?
- What flow control and monitoring are in place to establish that the pipeline is working properly? Are these sufficient for the level of cybersecurity required?
- What compliance mandates are required? How are they addressed by the pipeline? Is this sufficient?

Example of Complexity: Tool Management -1



Tool groups connect roles to capabilities in a pipeline integrating Dev, Sec, and Ops capabilities with interactions that did not exist before

Administrative resources now control what each participant can see and do, way beyond the typical responsibility of authentication and authorization.

Tool Group	#Coupling	Interface
Issue Tracking System	7	create, modify, delete, read issues where an issue has some schema definition
Code Review System	2	create review, start review, add source files to review, add comments to review, create issue from review item, resolve issue from review item, close review
Monitoring System	7	write message; write metric; display metric; create, modify, delete, read alarm threshold on metric; notify on alarm; show dashboard; process message; extract metric
Integration and Test Environment	3	deploy system, tear down system, execute tests, collect test results
Documentation System	3	create, modify, delete document where a document has some schema definition
Build System	6	execute build; create, modify, delete, read build definition where a build is a collection of steps executed to create artifacts that can be executed
Source Control System	6	create, modify, delete, read repository; write source files to repository; modify source lines in repository; read repository
Communication System	4	create, modify, delete, read channel; read and write comment to channel where a channel is an interactive conversation of text between human users with machine users making contributions

See [10] for more details

Example of Complexity: Tool Management -2

Each tool type requires specific technical skills that must be drawn from the integrated capabilities (Dev, Sec & Ops) and work together in the process flow.

- Product build should move through the security activities as part of the pipeline flow.
- Security considerations can be in the control gates for the pipeline flow.

Process Type	Process	Security Activities
Dev	Plan	Threat Model
	Code	Secure Coding
	Build	SAST, Security as Code
	Test	DAST, Pen Test
	Release	Digital Sign
Ops	Deliver	Secure Transfer
	Deploy	Security Configuration and Scan
	Operate	Security Patch and Audit
	Monitor	Security Monitor
	Feedback	Security Analysis

Pipeline flow does not address security for the pipeline's capabilities

- Pipeline security must be integrated into the roles and responsibilities of those that administer and support these capabilities.
- Pipeline administrators should perform the similar processes and use similar tools, but they are applied to different content.

See [10] for more details

Example of Complexity: Tool Management -3

A range of processes can be allocated to various pipeline administrative roles.

Each process focuses on a different component of the pipeline, but all processes are needed to keep the pipeline functioning effectively.

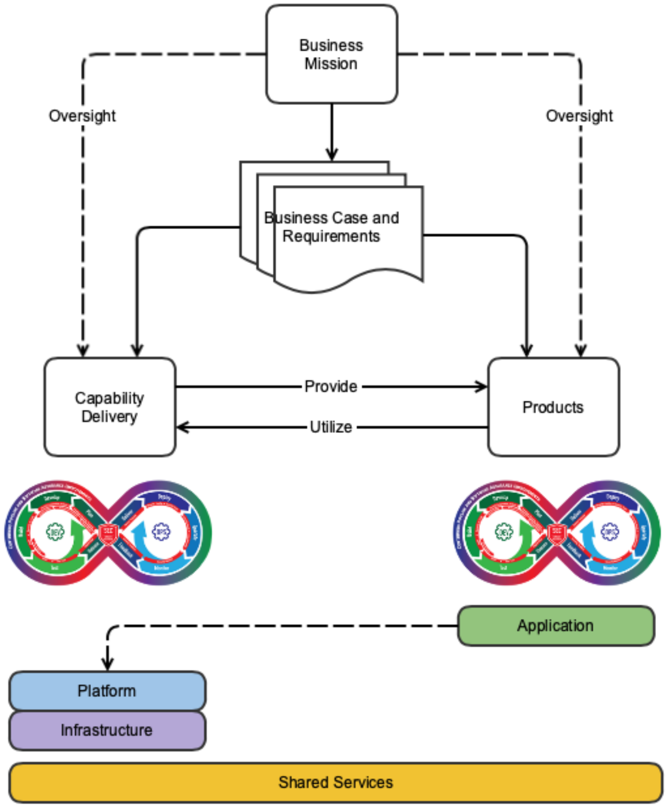
Due to this complexity and repurposing of existing administrative resources without integrated oversight, infrastructure services and development tool types are increasingly the target of attacks.

Operational Process	Component	Role
Add Hardware	Host System	infra
Code Software	Source Control System Issue Tracking System IdAM Communication System Code Review System	dev
Configure Infrastructure	Host System	infra
Decommission Hardware	Host System	infra
Deploy Application	Any	ops
Disaster Recovery	Any	all
Install Software	Any	admin
Manage Incidents	Monitoring System	admin
Manage Users	IdAM System	admin
Monitor Infrastructure	Monitoring System	infra
Operate Solutions	Any	ops
Patch Infrastructure	Host System	infra
Patch Software	Any	admin
Perform Backup	Any	admin
Review Logs	Monitoring System	ops
Test Applications	Any	dev

See [10] for more details

Addressing the Challenges

What Are We Trying to Do…?



Create a Platform Independent Model (PIM) of a DevSecOps (DSO) System in order to be able to:

- Specify the DSO requirements to the lead system integrators who need to develop a platform-specific weapon solution that includes the weapon system and CI/CD pipeline
- Assess and analyze alternative pipeline functionality and feature changes as the weapon system evolves
- Apply DSO methods to complex weapon systems that do not follow well-established software architectural patterns commonly used in industry
- Provide a basis for threat and attack surface analysis to build a cyber assurance case

How Is It Done Today, and What Are the Limits of Current Practice?

- Currently, guidance and policies focus on functionality and leave the major decision making to the programs:
  - "DoD organizations should define their own processes, choose proper activities, and then select tools suitable for their systems to build software factories and DevSecOps ecosystems" [8]
  - "The PM shall ensure that software teams use iterative and incremental software development methodologies (such as Agile or Lean), and use modern technologies (e.g. DevSecOps pipelines) … "[9]
- Program offices lack sufficient capability to design, build, and implement a DSO continuous integration/continuous delivery (CI/CD) pipeline.
- Current guidance
  - fails to prepare the program office to address the full socio-technical aspects of DSO
  - is not definitive and require a considerable amount of interpretation, resulting in:
    - DSO perspectives not being fully integrated in DoD guidance and policy documents
    - Program offices being unable to perform an analysis of alternative (AoA) in regards to the DSO pipeline tools and processes
    - Multiple programs using similar infrastructure and pipelines in different and incompatible ways, even within the same program
    - Suboptimal tools and security controls
- Large and complex DoD weapon system acquisition programs have already embraced model-based engineering, but have not applied the same techniques to their DSO CI/CD pipelines. This limits a program office's ability to build a cyber-physical software factory that is fit for purpose.

Enterprise Architecture (EA) Approach

Why EA?: To provide the knowledge and tools that will enable program offices to adopt DSO in support of the new software acquisition pathway [9].

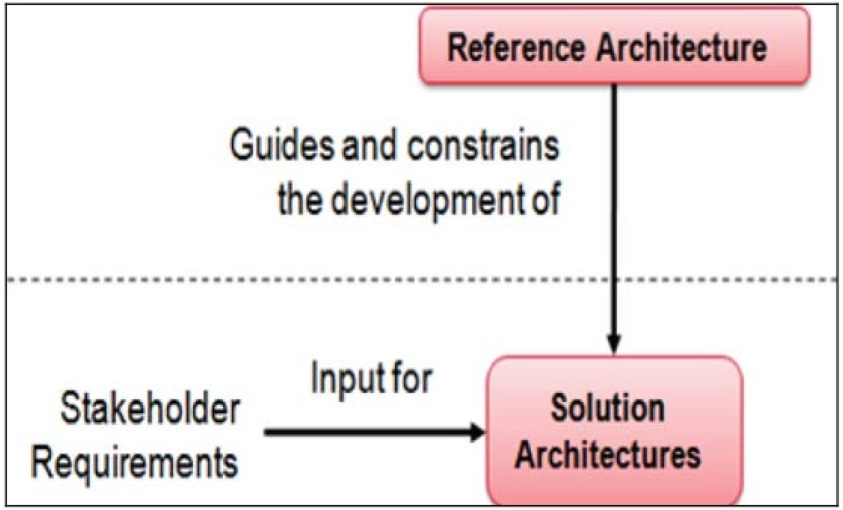
An EA approach will expand the focus of DSO to the whole enterprise.

- What capabilities does the enterprise need to be successful?
- How must existing functional roles (e.g., program managers, finance, contracting, logistics, security, engineers) adapt to succeed in DSO?
- What new roles (e.g., product development, software engineering, information security, IT operations) are required?
- What critical processes must be implemented for DSO and what information do they need?
- What existing policies, guidelines, and best practices provide requirements and constraints for the enterprise to achieve its DSO goals?

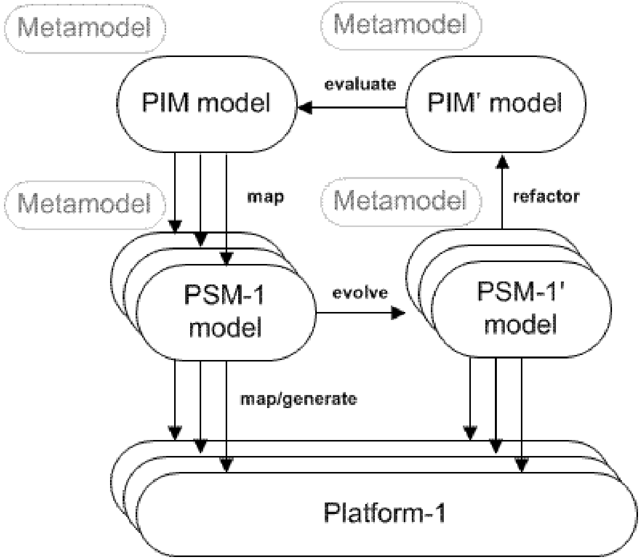
Goal: What is the *Minimum Viable Enterprise* that is capable of defining, developing, and operating a *Minimum Viable Product?*

Reference Architecture/Platform Independent Model (PIM)

A **Reference Architecture** is an authoritative source of information about a specific subject area that guides and constrains the instantiations of multiple architectures and solutions [18].

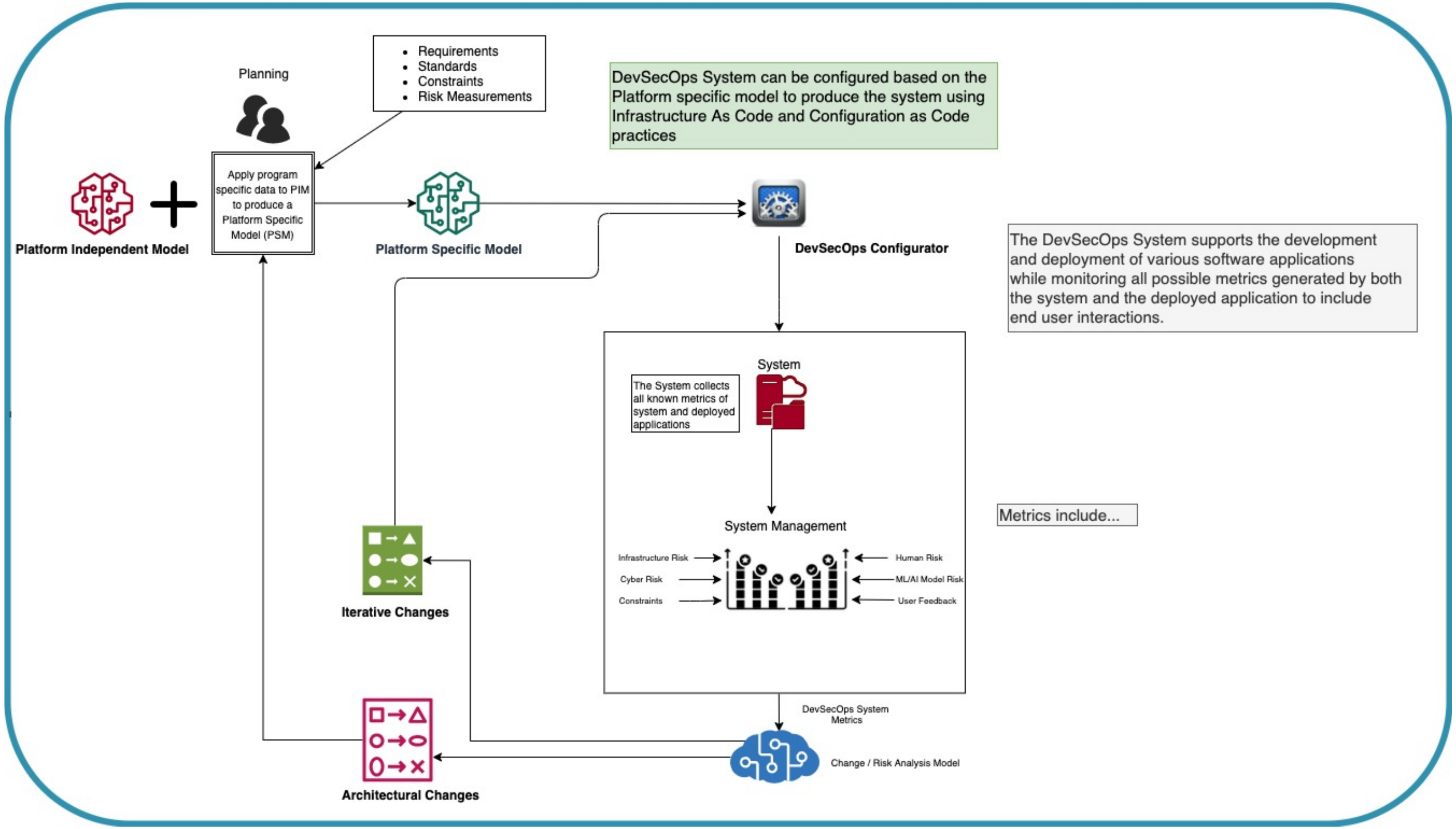


A PIM is a general and reusable model of a solution to a commonly occurring problem in software engineering within a given context, and is independent of the specific technological platform used to implement it.



NOTE: PSM = Platform Specific Model

PIM Usage Overview



Who Cares? If We Are Successful, What Difference Will It Make?

Program offices use the DSO PIM to improve their ability to root out errors and costly mistakes earlier in the lifecycle. The PIM provides:

- Consistent guidance and modeling capability that ensure all proper layers and development concerns are captured.
- The model-based engineering of the DSO is included in the system model. This allows proper modeling of DSO design trades within the program AoA processes, resulting in less costly DoD weapon systems.
- Metrics and documentation of trades is captured and analyzed through the model-based engineering platform—PIM will explicitly identify points that should be addressed or mitigated as well as mechanisms to manage coverage of the points. The model will provide dynamical matrices of whether those points were addressed, how they were addressed, and how well the corresponding (to the points) module is covered.
- Risk modeling against decisions and DSO model-based engineering to ensure security controls and processes are properly selected and deployed.

Future: Program Office Topple

PIM will explicitly identify points (e.g. requirements, constraints, and conditions) that should be addressed or mitigated as well as mechanisms to manage coverage of the points. PSMs will present solutions for that. Using provided mechanisms will allow for the comparison of PSMs, analyzing of trade-offs and balancing the system dynamically.

Combining the DSO PSM with the system's architecture to build the single architecture, enables program offices to become organizations driven by smart automation, where delivery of a secure and resilient application quickly is the objective.

Through proper balance, programs will be able "to maintain a constant pace (i.e., play Topple) indefinitely." [11]

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