The intersection of MOSA and Agile to build better systems in DoD

NDIA Systems Engineering Division
Agile in Defense/ADAPT

Agenda

01 Introduction

02 What is MOSA

03 What is Agile

04 Where do MOSA and Agile Intersect

05 Challenges

06 Practical Implementation

07 Getting Started

08 Conclusion

Introduction

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NG Fellow, Lean Agile

NORTHROP GRUMMAN

National Defense Industrial Association

NDIA

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John Daly, Chair
Suzette Johnson & Laura Hart, Vice Chair

Agile Delivery for Agencies, Programs, & Teams Committee
Robin Yeman & Suzette Johnson, co-leads

Facilitate Industry-Government interaction
across policy, acquisition/contractual, product engineering, solutioning, and delivery
by continuously improving the implementation of Agile practices to meet business outcomes.

Context

We need to deliver cyber-physical safety-critical systems safely and rapidly

MOSA + Agile = Reliant and Adaptive Systems

Introduction

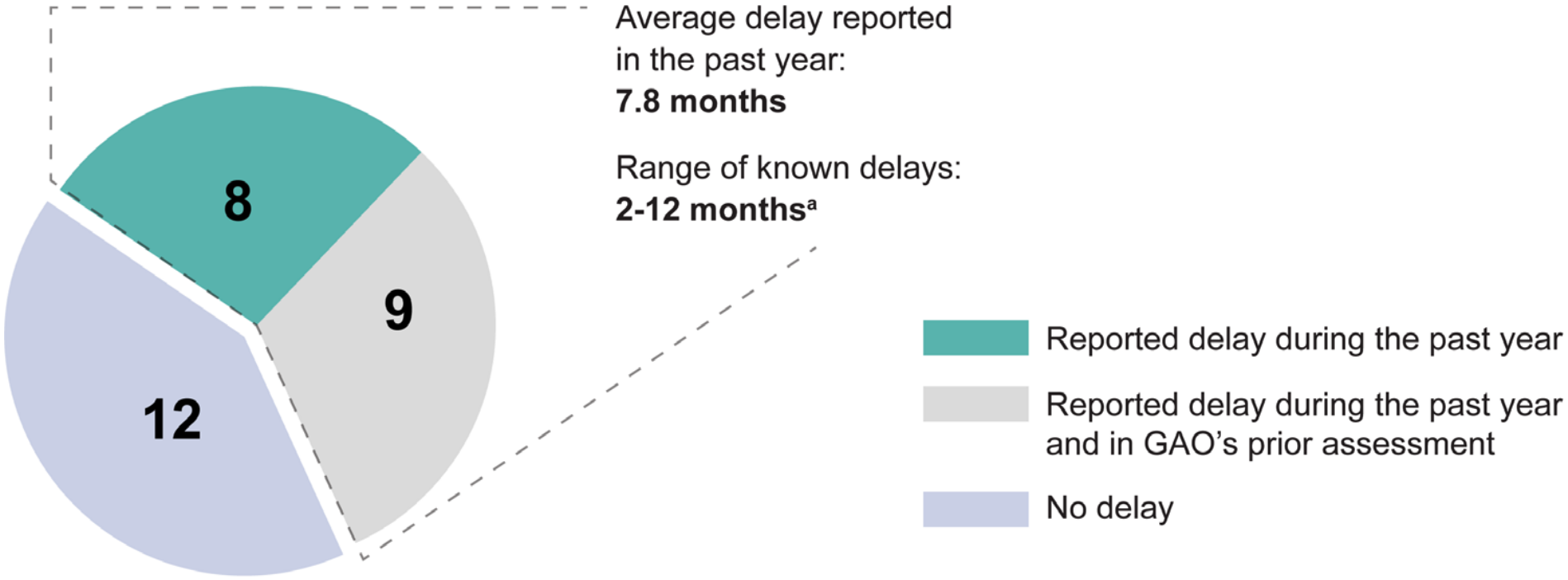
Overview

There is a need to build resilient and robust systems rapidly with the ability to adapt to changing needs

Objectives

- Value
- Safety
- Speed

What is the problem



Source: GAO analysis of Department of Defense data. | GAO-22-105230

Recommendations Made

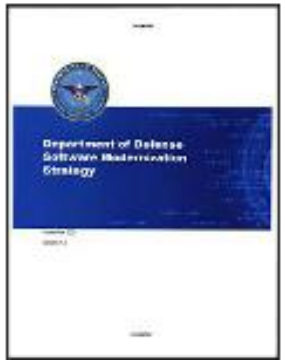
DSB 02/2018

HASC 02/2018

DIB 05/2019

DoD 07/2019

AF 10/2020



DoD 02/2022

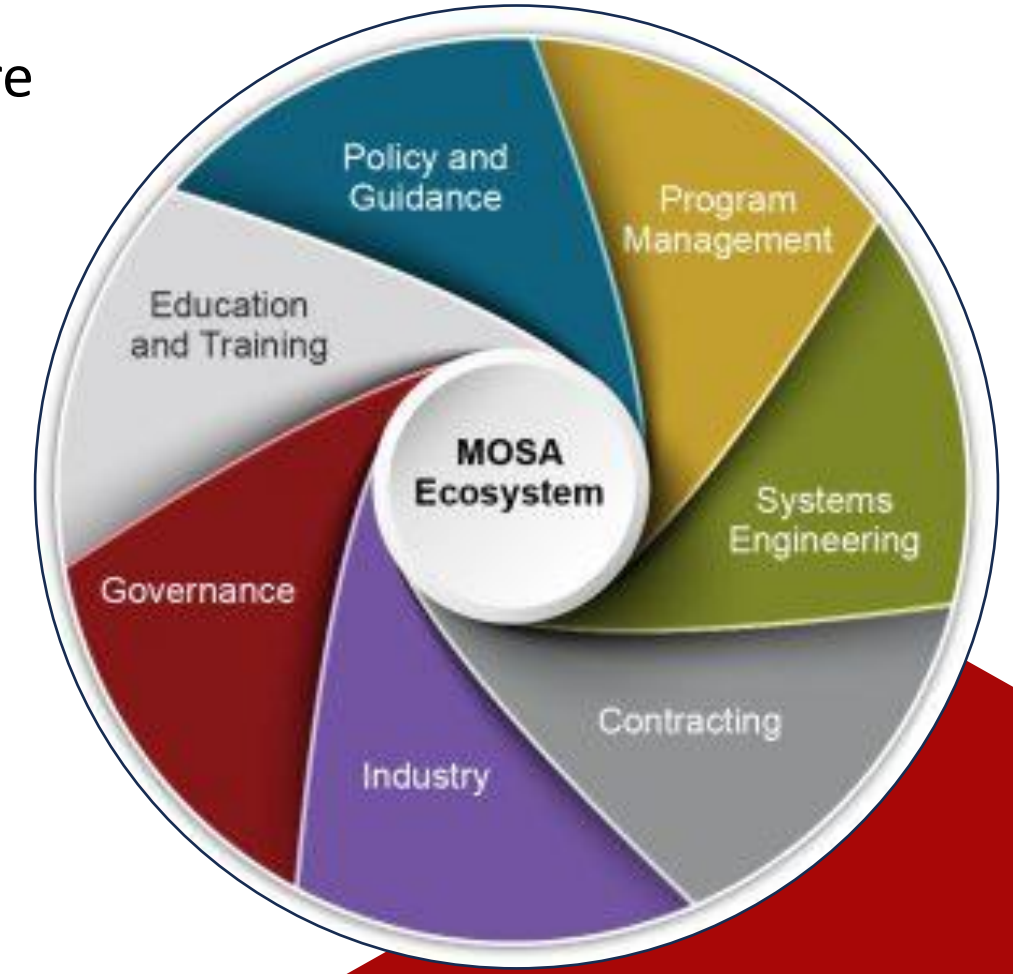
Reference: US Department of Defense

What is MOSA

A strategy for for designing and acquiring software and hardware systems. It emphasizes the use of modular components and open standards.

Key Principles

- Modularity
- Open Standards
- Interoperability
- Scalability



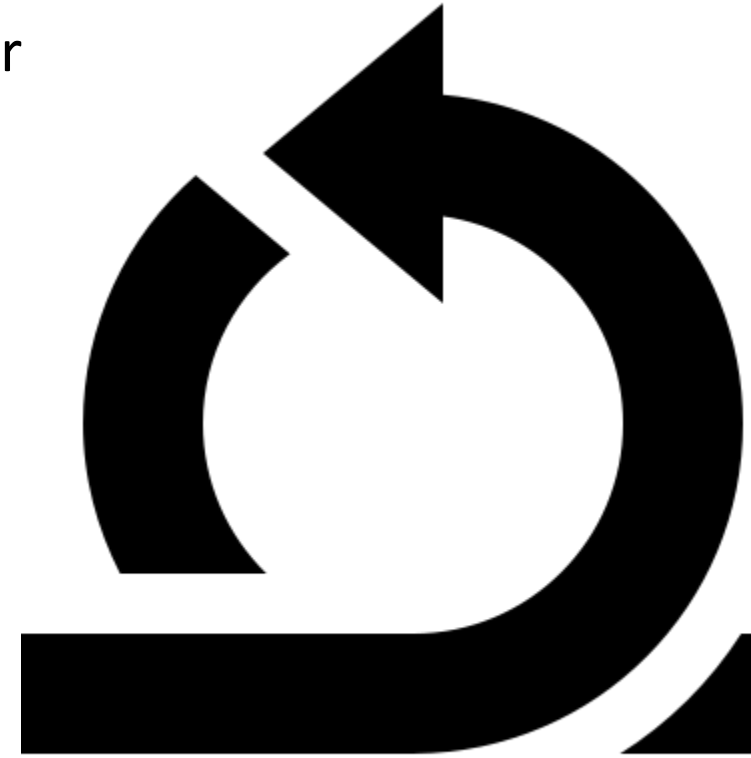
Reference: Modular Open Systems Approach – DoD Research & Engineering, OUSD(R&E) (cto.mil)
OFFICE OF THE UNDER SECRETARY OF DEFENSE FOR RESEARCH AND ENGINEERING

What is Agile

Agile is a set of principles and methodologies for managing work that prioritize flexibility, collaboration, and customer-centricity.

Key Tenets

- Empirical Lifecycle
- Value delivery
- Collaboration
- Responsive

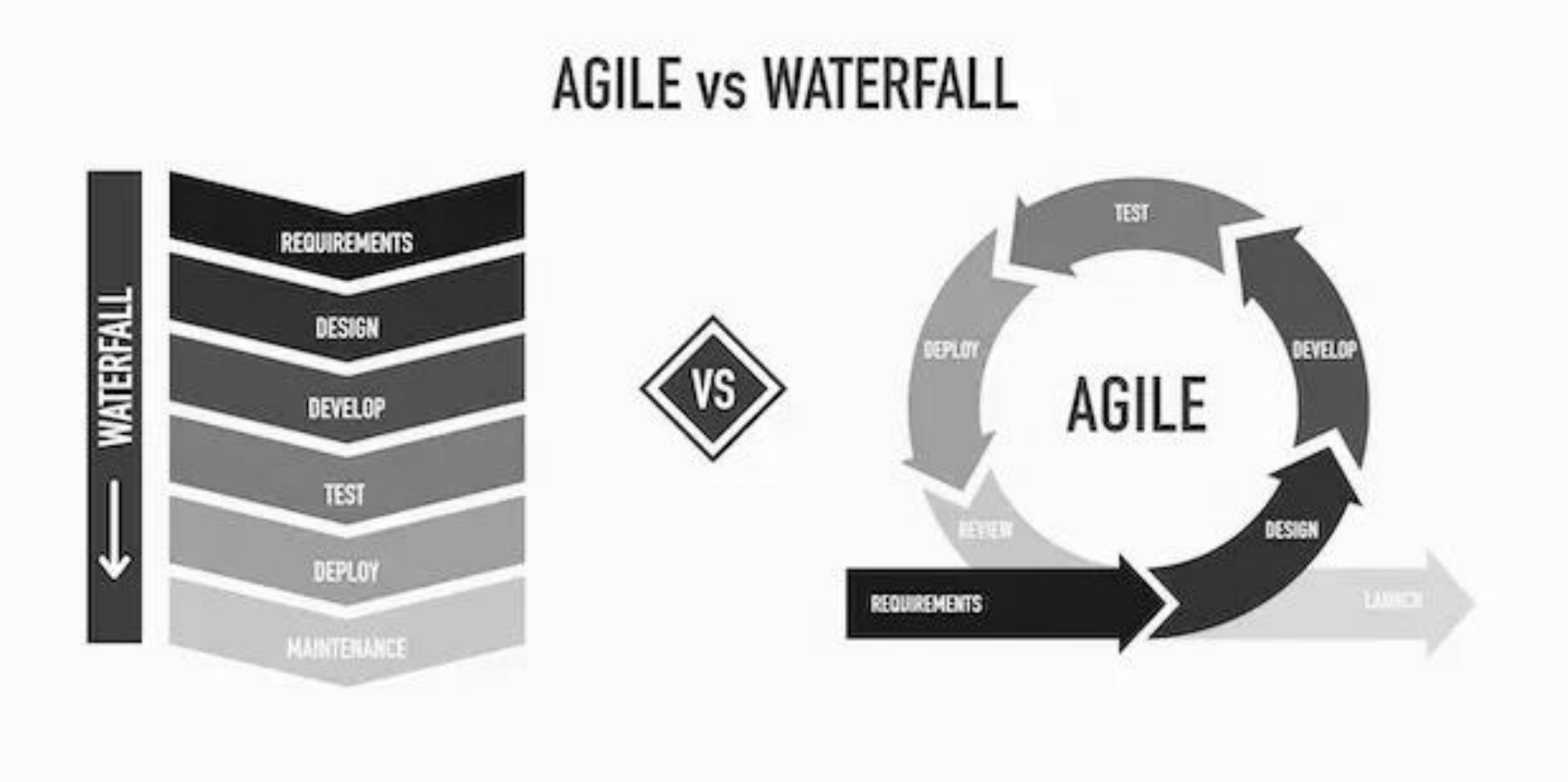


Agile is a Lifecycle

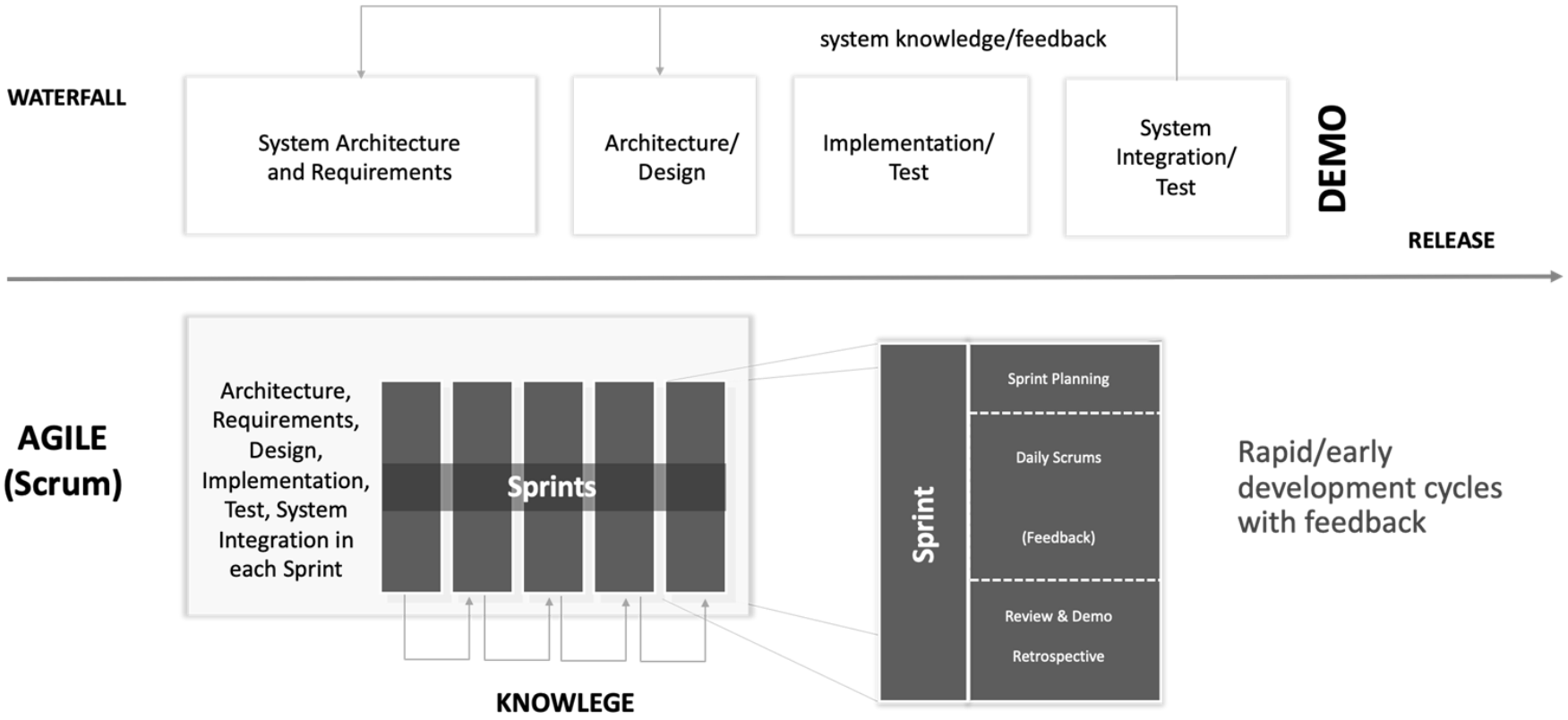
Waterfall is a predictive lifecycle based on phase gates, Agile is an empirical lifecycle based on objective data.

Stop referring to Agile for software.

Start thinking of Agile at the system level.



Agile vs. Waterfall



"Agile Projects are 3X more likely to succeed than Waterfall projects"

2021 CHOAS report

THE STANDISH GROUP

Work remains the same

Phase gates Are dangerous

Activities as opposed to **phases** that have smaller batch sizes and are repeated.

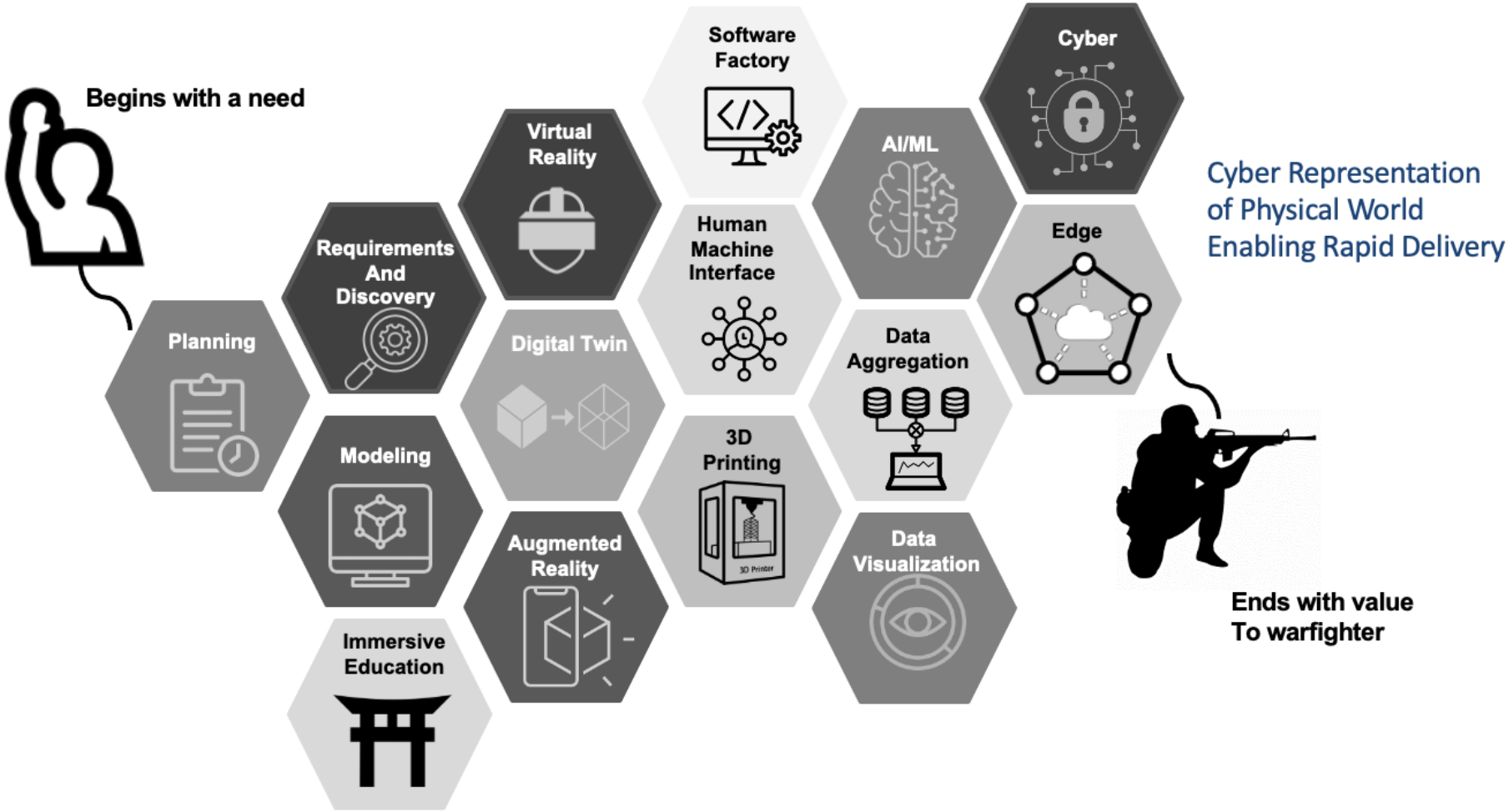
Integrated capabilities that can be demonstrated is the true measure of status

While Agile ensures the ability to **adapt efficiently** and improved responsiveness, MOSA ensures that the resulting product is **modular, sustainable, and cost-effective** in the long term.

What is MOSA with Agile

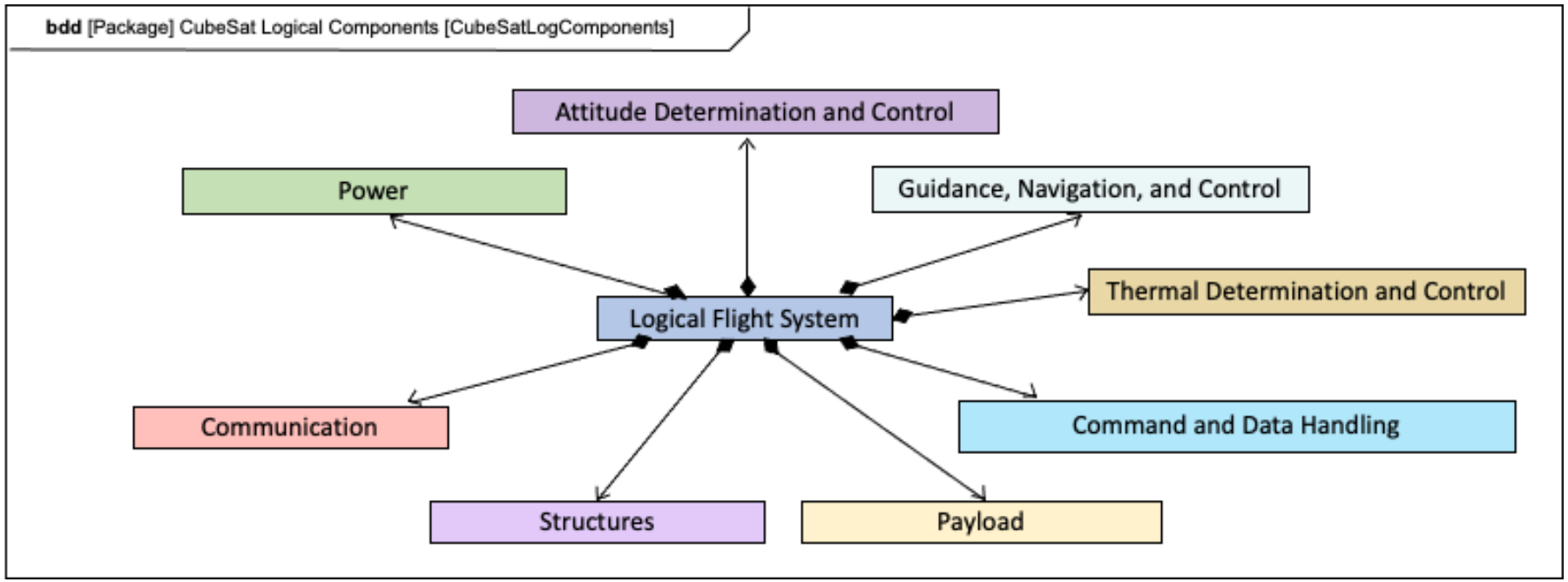
Use All the tools in your toolbox

Follow the flow of value and leverage all of the tools



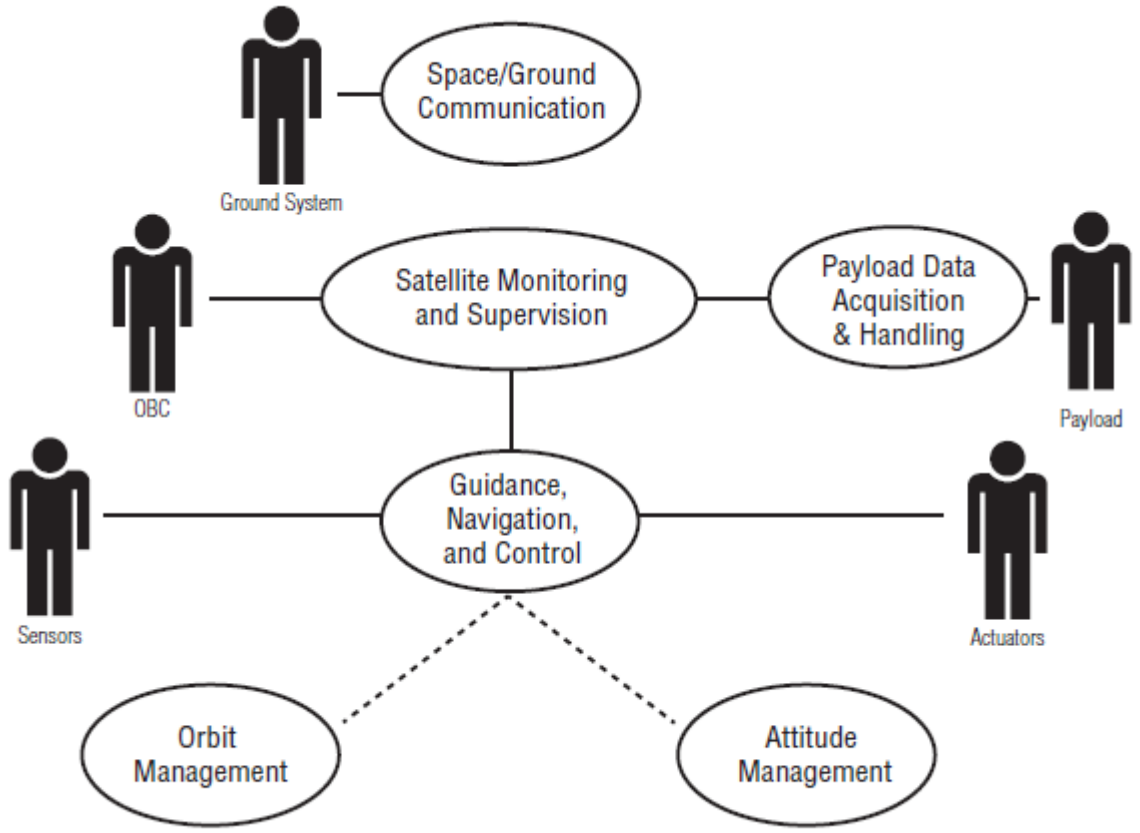
Models help visualize the system

Map your system
and provide teams
A guide to develop



Reference: Johnson and Yeman. Industrial DevOps. 2023. IT Revolution

Satellite Use Case



A use case is multiple paths through the system, a user story is one path for one user.

Link your use cases
To your product backlog
at the epic and feature level

Reference: Johnson and Yeman. Industrial DevOps. 2023. IT Revolution

Product backlog

Product Backlog
Sprint Backlog
Individual "to do list"

NDIA
AT THE HEART OF THE MISSION

Epic
(Story Points, T-shirt Size)

Title: Guidance, Navigation, and Control for Satellite

Business Outcome: Track current location, leverage navigation & target data, and control vehicle response

Months - Years

(Business Outcome)

Feature
(Story Points)

Title: Path Planner
Benefit Hypothesis: Allow satellite to find the obstacle free path

Title: Flight Control
Benefit Hypothesis: the ability to take sensor information and develop precise instructions for Propulsion

Weeks - Months

(Benefit Hypothesis)

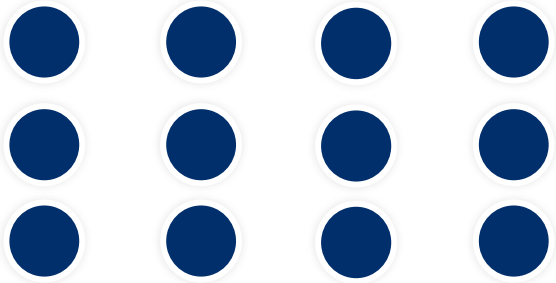
Stories
(Story Points)

"As a satellite I want to adjust my position to maintain sun synchronous orbit.

Days - Week

(Needed Functionality)

Tasks
(Hours)



- 1
- 2
- 3
- N...

- Define Tests
- Update diagrams
- Update model
- Create interface wire-frames
- Code Foo Class
- Update user documentation
- N…

Up to ~8 hours

(daily punch-list)

Intersection of MOSA and Agile

01

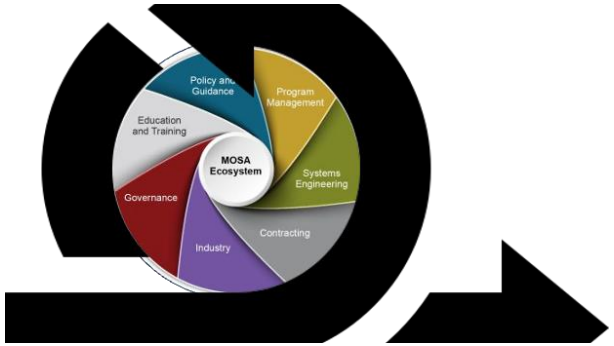
Rapid Prototyping

Agile's iterative approach complements MOSA's modularity, allowing for faster development cycles for both hardware and software components.

02

Longevity and Adaptability

MOSA's emphasis on modularity and open standards ensures that the cyber-physical system can be easily maintained and upgraded, while Agile allows for rapid adaptation to changing requirements.



03

Collaboration

Both approaches emphasize collaboration among cross-disciplinary teams, important for systems that integrate physical and digital elements.

04

Risk Mitigation

MOSA's emphasis on open standards can reduce the risk of vendor lock-in, enhancing the system’s long-term viability.

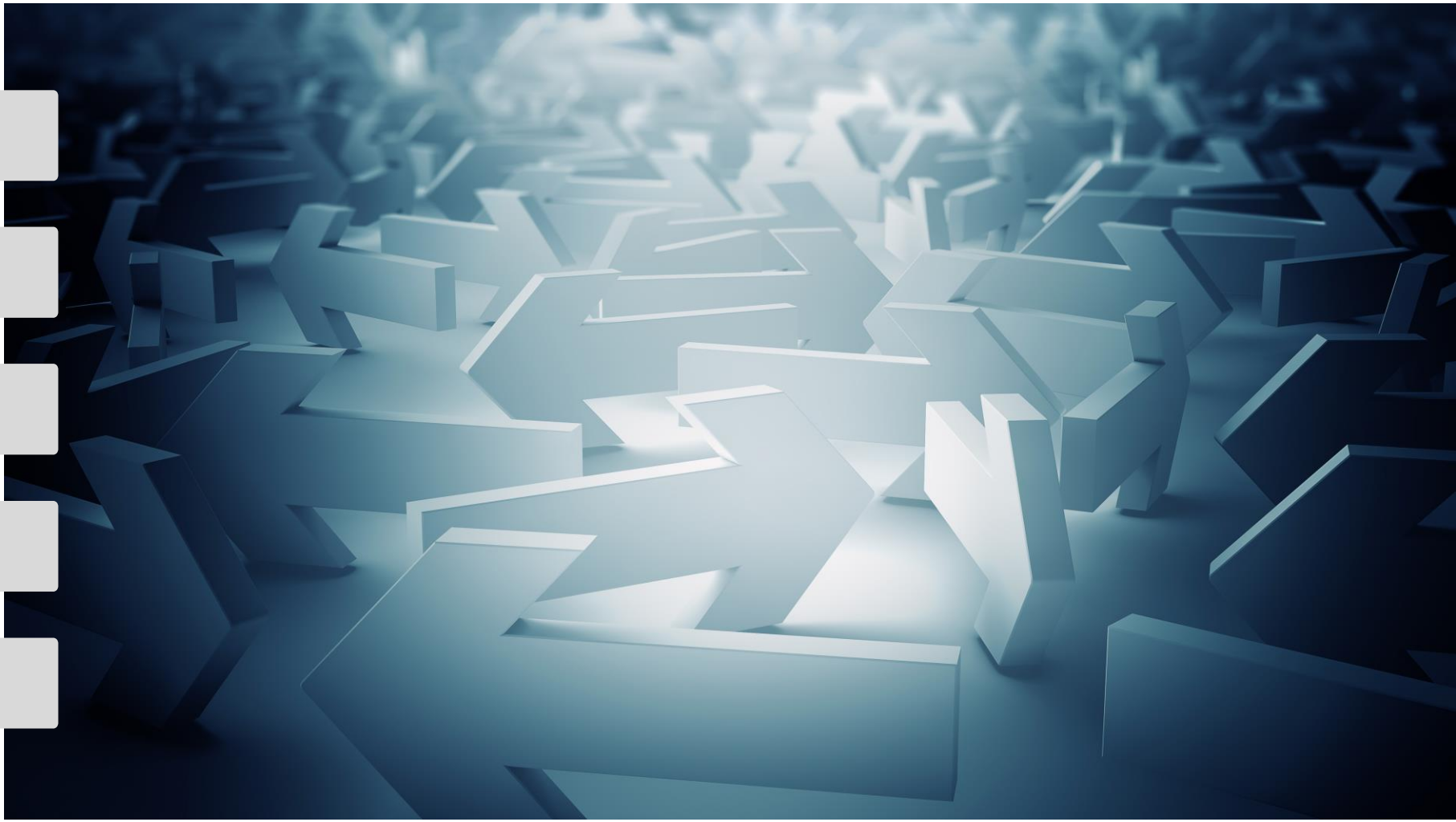
05

Speed

MOSA's emphasis on open standards and modularity enables agility and speed in response to changing priorities.

Challenges

- Cultural Barriers
- Merging Governance
- Communication
- Verification and Validation
- Legacy Systems

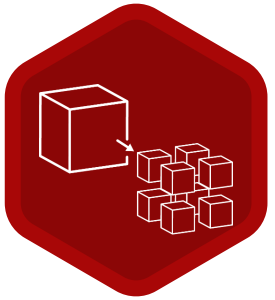


Get started with practical approaches

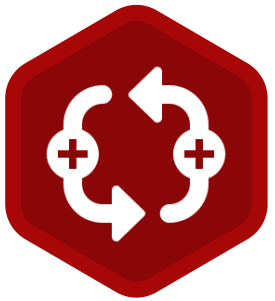
Organize

Multiple Horizons

Data driven decisions



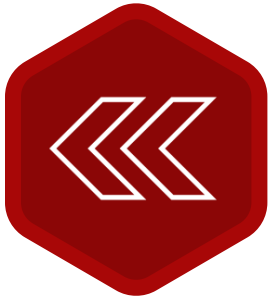
Architecture



Flow

Cadence and Synchronization

Integrate early and often

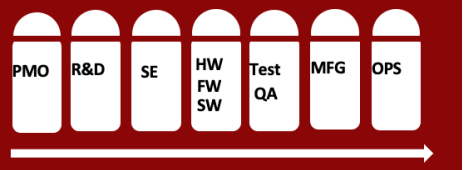


Shift Left

Growth Mindset

Reference: Johnson and Yeman. Industrial DevOps. 2023. IT Revolution.

Organizational Structure



Organize by value not function

Not This

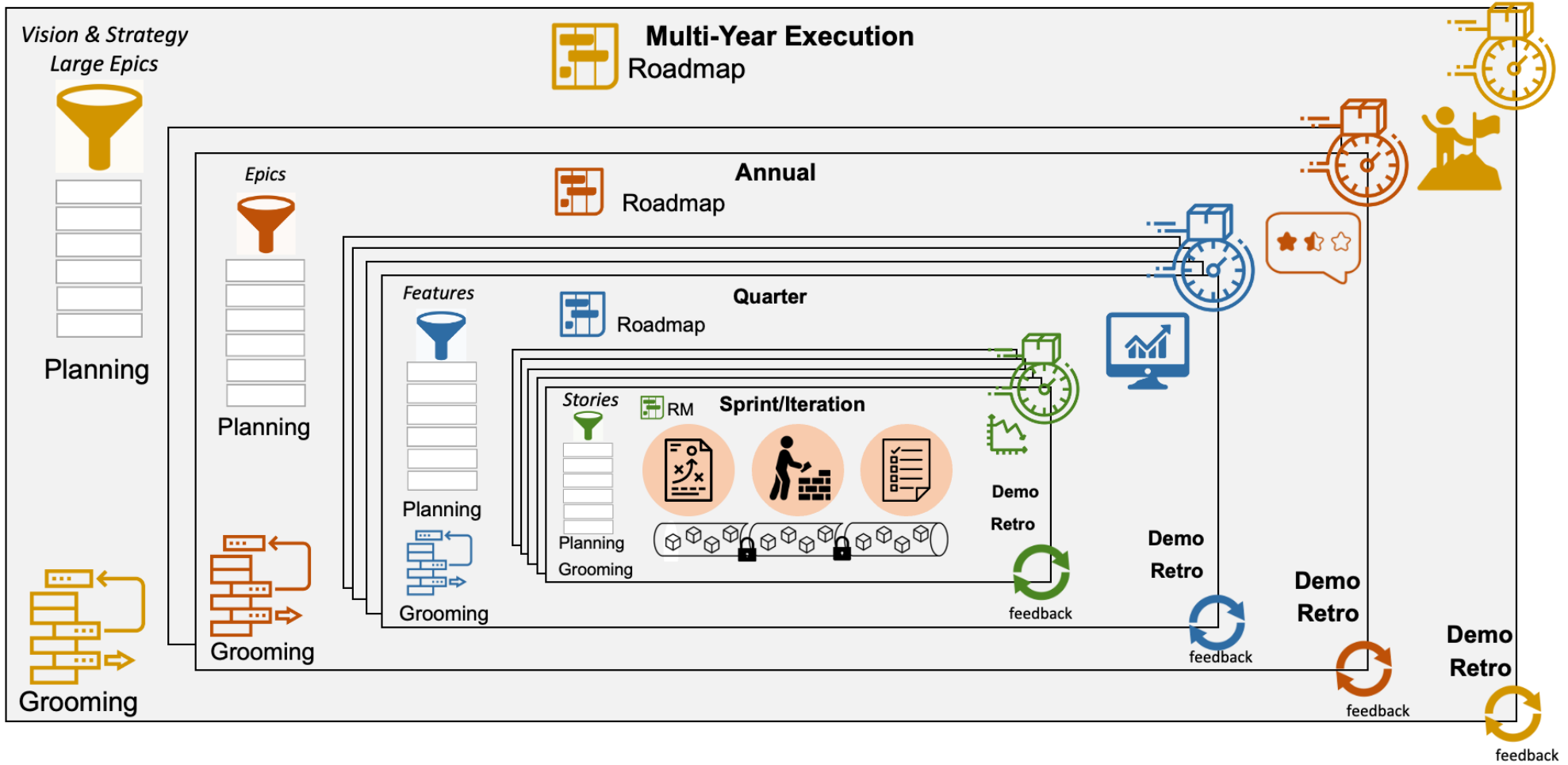
PMO	System	Design
Hardware	Firmware	software
Test	Cyber	Deploy

PMO	Power	Attitude
Structures	Thermal	Payload
Communic ation	Command Handle	GNC

This

Multiple horizons of planning

Empirical Planning



Agile requires a lot of planning and adapting

Make data driven decisions

Use the Data

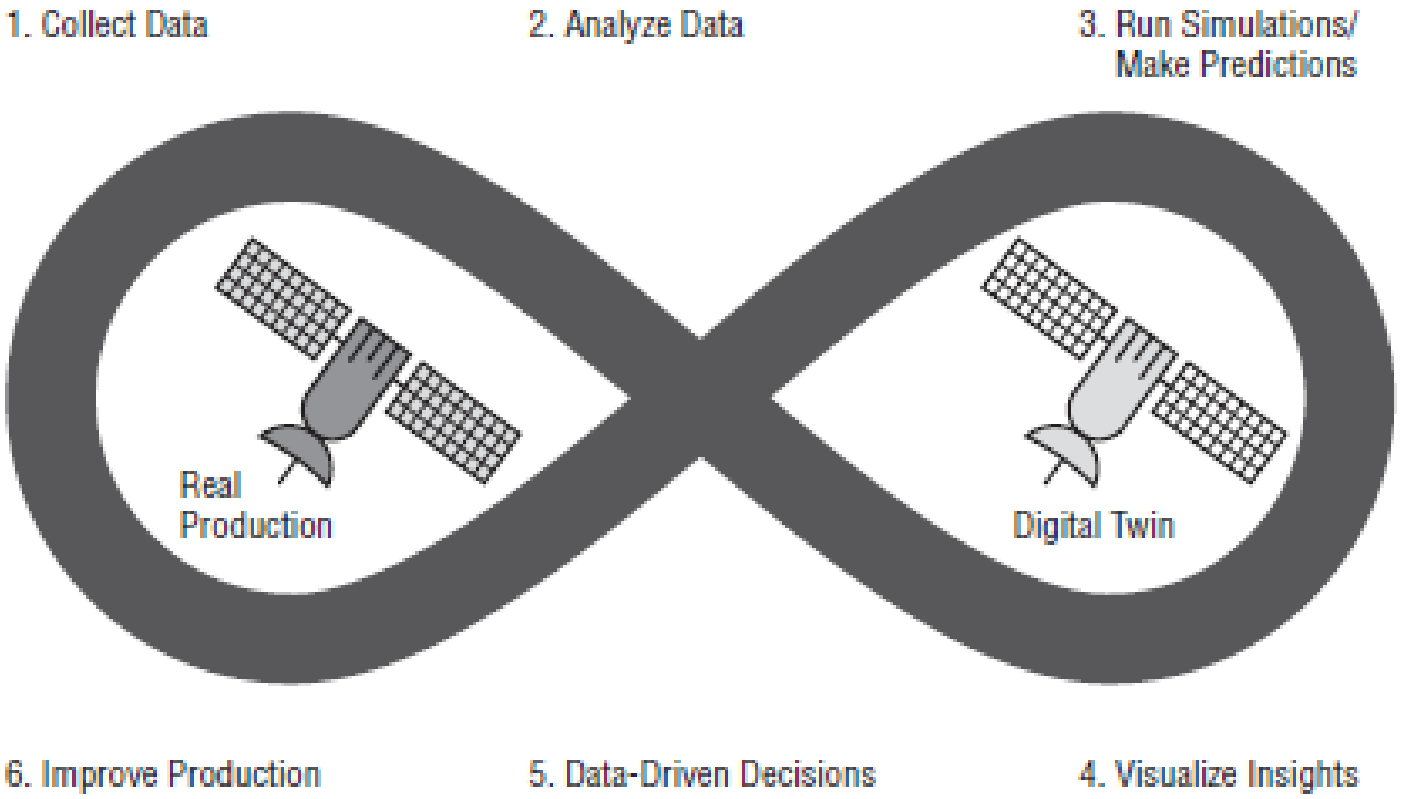
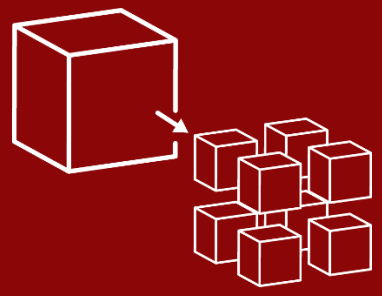


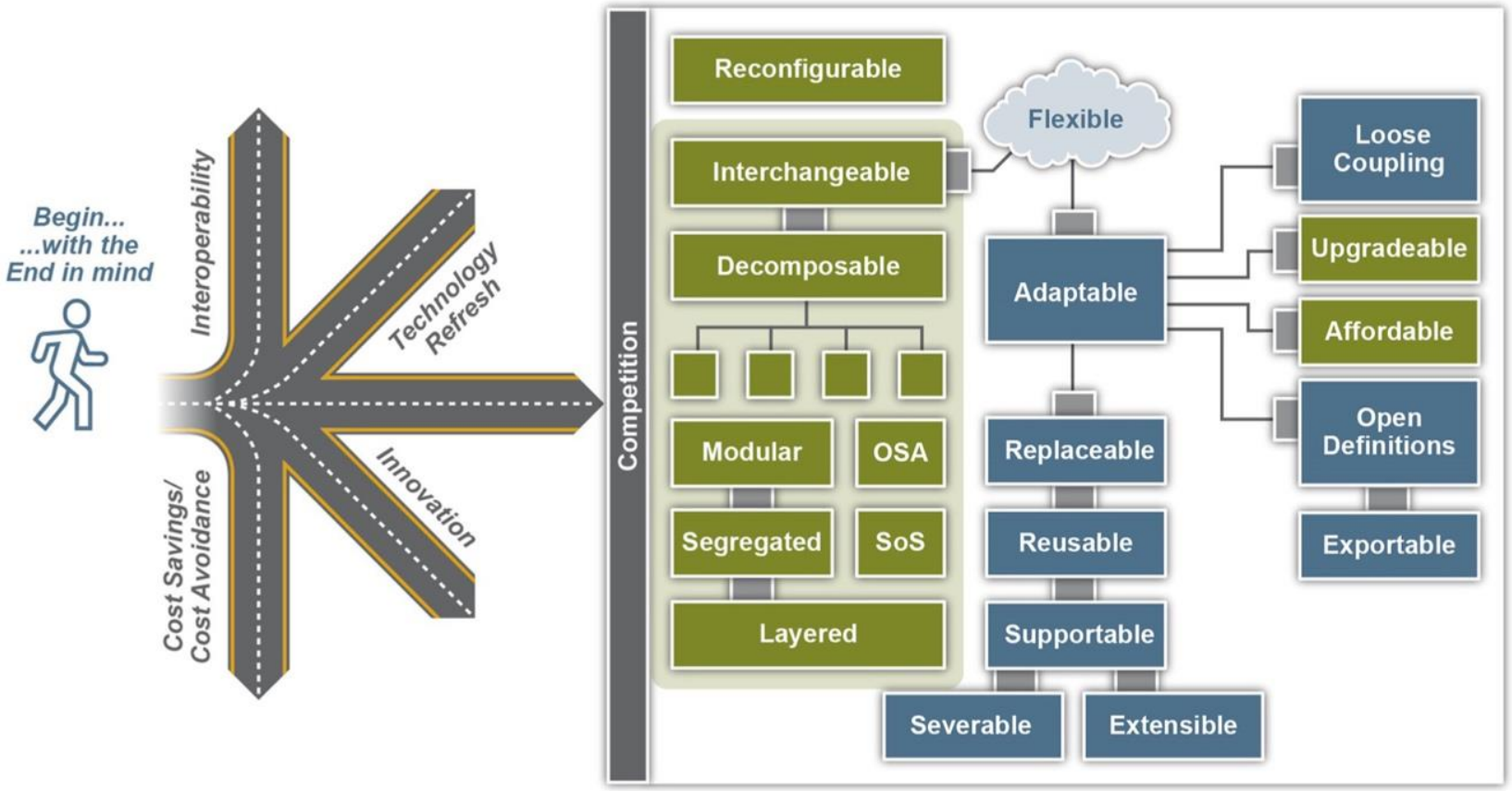
Figure 7.10: Digital Thread

Reference: Johnson and Yeman. Industrial DevOps. 2023. IT Revolution

Architect for change and speed



Modular Open Standard

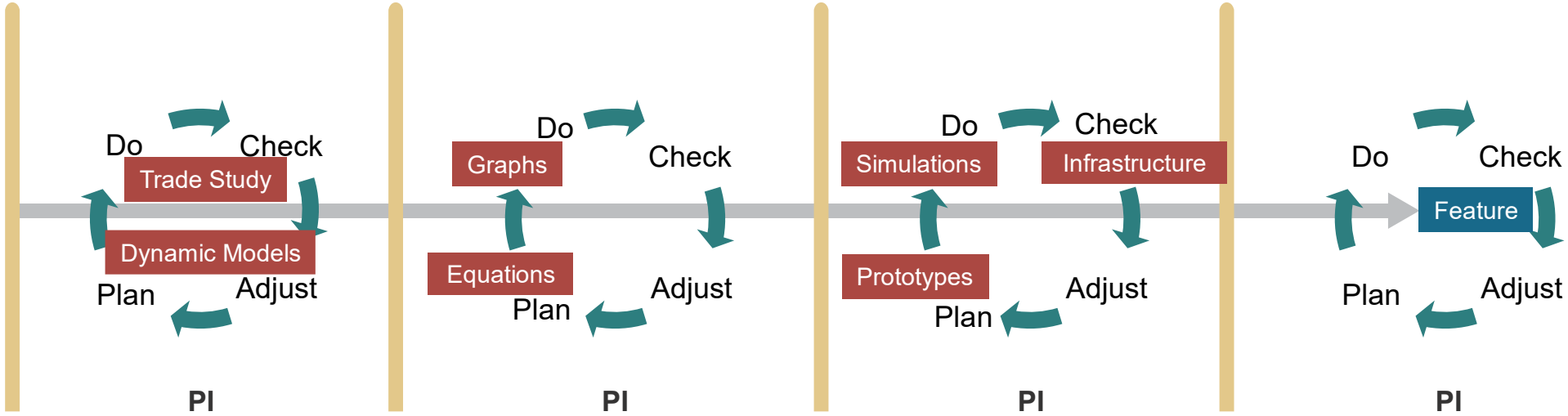


All things MOSA

Zimmerman P, Ofori M, Barrett D, Soler J, Harriman A. Considerations and examples of a modular open systems approach in defense systems. The Journal of Defense Modeling and Simulation. 2019;16(4):373-388. doi:10.1177/1548512917751281

Iterate, manage queues

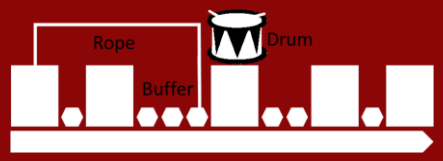
Manage flow



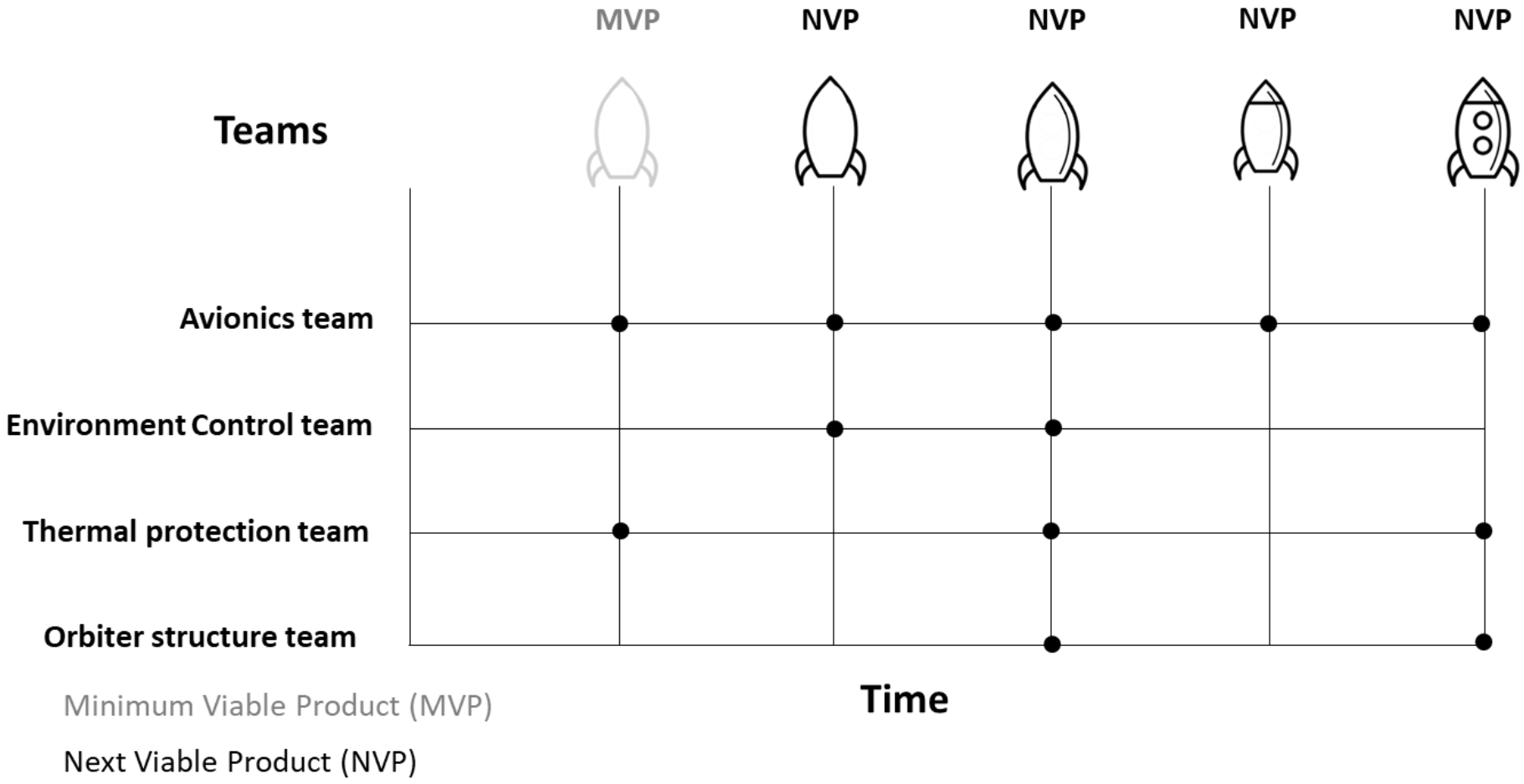
Iterate with all work products

Reference: [Model-Based Systems Engineering - Scaled Agile Framework]

Apply Cadence and Synchronization



Drum, Rope, and Buffer



Minimum Viable Product (MVP)

Next Viable Product (NVP)

The system need to sprint together

Integrate early and often

Frequent Integration Don't wait

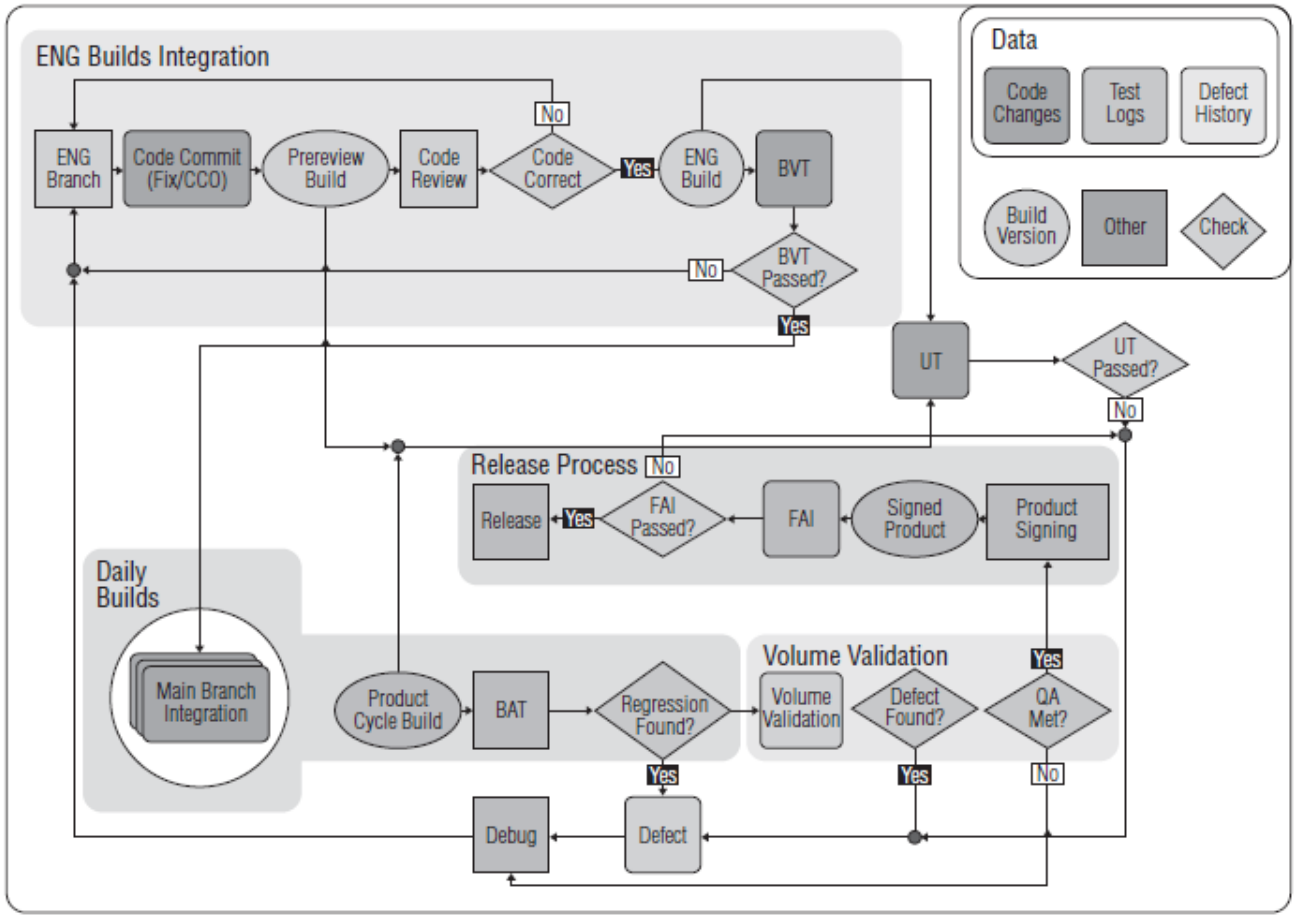


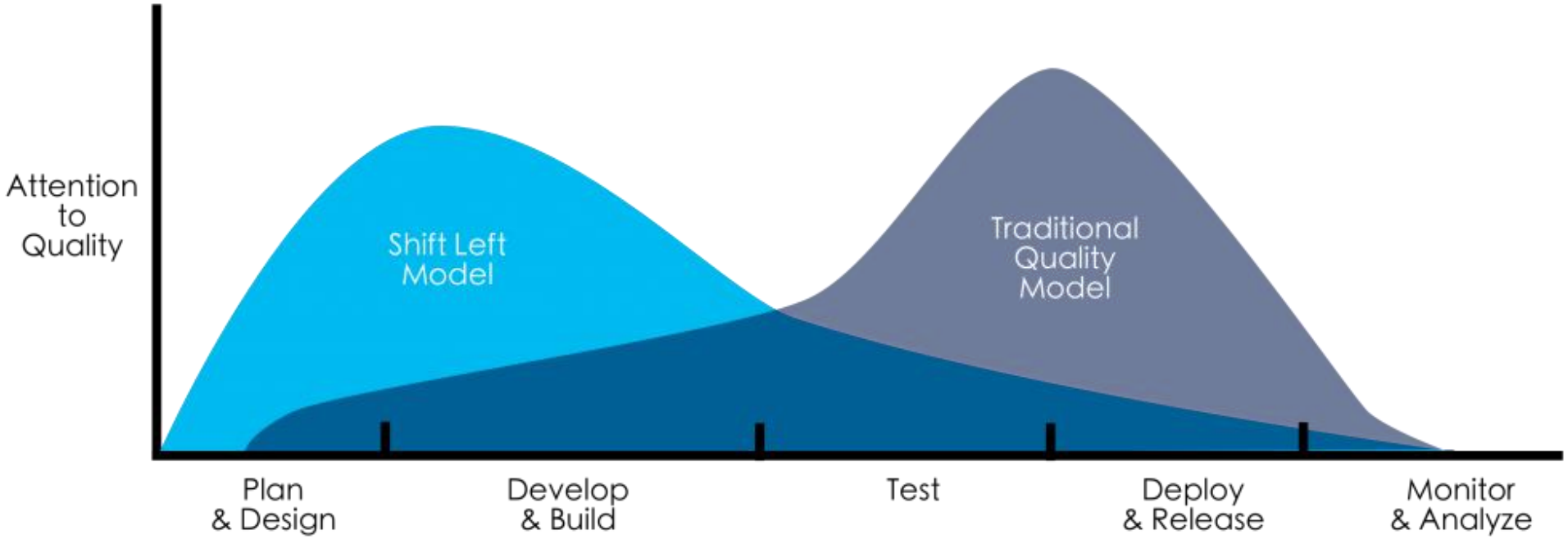
Figure 10.2: CI/CD for Firmware Development for Embedded Systems

Source: Mateusz Kowzan and Patrycja Pietrzak, "Continuous Integration in Validation of Modern, Complex, Embedded Systems," 2019 IEEE/ACM International Conference on Software and System Processes (2019): 160–164.

Reference: Johnson and Yeman. Industrial DevOps. 2023. IT Revolution

Shift-left everything

Begin with the end in mind



Apply a growth mind-set

Are we fixed?

Are we open to new ideas?

"It's kind of fun to do the impossible."
- *Walt Disney*

"A growth mindset is best described by Carol Dweck as "the belief that your basic qualities are things you can cultivate through your efforts."

Through applied learning and resilience, we have seen those who may have felt defeated rise to unimagined success.

They explore, innovate, and recreate. They are resilient!

A learning organization applies the same growth mindset."

Johnson and Yeman. Industrial DevOps. 2023. IT Revolution

Practical Implementation

Joby Aviation

American aerospace company developing an electric vertical takeoff and landing aircraft for urban air mobility with plans to launch an air-taxi service.
Joby uses a modular architecture with standardized interfaces and a delivery pipeline that enables them to rapidly iterate on changes to the vehicle. They use agile practices and test-driven development of the entire vehicle to ensure quality is built in.

Planet Labs

American Private company with a mission to image all the Earth daily to identify temporal global changes. The imaging data allows them the ability to analyze agricultural, energy, forestry, maritime, and sustainability events and impacts.
Optimizing spacecraft design using success patterns of modularity, standardized interfaces, and open architecture along with Agile and DevOps practices.
Results: Faster time to delivery; ability to continuously optimize designs.

Reference: Johnson and Yeman. Industrial DevOps. release October 2023

Getting Started

- Create a checklist of nonfunctional considerations to complete a trade-off analysis against the vision
- Build an easy-to-follow blueprint to design, communicate, and maintain
- Utilize MOSA architecture in design
- Invest in standardized interfaces
- Design for change and flow

Reference: Johnson and Yeman. Industrial DevOps. release October 2023

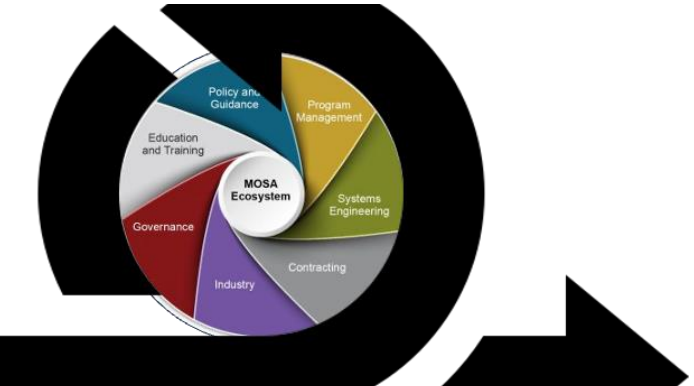
Coaching Tips

- Begin by understanding constraints such as compliance, security, safety; architecting these into the system early to avoid extensive rework which negatively impacts your time to market
- Use right-sized models and artifacts. If they are too difficult to be maintained, read, or understood, they are shelfware.
- Bidirectional traceability is necessary to continuously verify and validate the system.

Reference: Johnson and Yeman. Industrial DevOps. release October 2023

Conclusion

1. Agile's iterative approach complements MOSA's modularity, allowing for faster development cycles for both hardware and software components.
2. MOSA's emphasis on modularity and open standards ensures that the cyber-physical system can be easily maintained and upgraded, while Agile allows for rapid adaptation to changing requirements.
3. Both approaches emphasize collaboration among cross-disciplinary teams, important for systems that integrate physical and digital elements.
4. MOSA's emphasis on open standards can reduce the risk of vendor lock-in, enhancing the system’s long-term viability.
5. MOSA's emphasis on open standards and modularity enables agility and speed in response to changing priorities.



Questions

Thank You