WHITEPAPER

Scaling Scrum & Agile in Hardware Organizations:

A Comparative Analysis of MAHD, SAFe, Nexus, and LeSS

INTRODUCTION

Hardware-based systems typically include physical components, software and firmware. While organizations have widely adopted Agile methods for software, scaling Agile and Scrum methodologies in hardware organizations poses unique challenges due to longer development cycles, intricate dependencies, and regulatory compliance requirements and other factors.

This paper provides a comparative analysis of four prominent frameworks— the MAHD (Modified Agile for Hardware Development) Framework™, SAFe (Scaled Agile Framework)™, Nexus, and LeSS (Large-Scale Scrum)—with a focus on their applicability and effectiveness in the context of hardware development. This article posits why the MAHD Framework optimizes Agile principles and best practices to best fit the needs of physical product and hardware-based systems development.

By Vishal Sheth and Dorian Simpson

Four Approaches to Scaling Agile for Hardware

Let's start with a high-level overview of four prominent Agile frameworks, including their origins, before delving into more detailed discussions.

MAHD: Modified Agile for Hardware Development Framework

MAHD is a hardware-first framework born out of the challenges in applying other Agile frameworks to a development ecosystem that involves physical, firmware and software components. While it is based on Agile principles, the strategies and tactics have been modified to accommodate varied component lead times, the inclusion of multiple functional areas, shared resources, compliance needs and end customer use cases that cannot be expressed simply by User Stories or features. The MAHD Framework also incorporates the ability to freeze hardware designs and can work seamlessly with phased development systems when necessary.

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MAHD takes the unique needs of hardware development into account to deliver predictable results in an iterative (Agile) way. The framework was officially launched in 2017 and has been successfully implemented and proven by 100s of teams, in organizations large and small, over its 8 year journey.

SAFe: Scaled Agile Framework

SAFe is a widely deployed framework for scaling Agile and Scrum across large software enterprises first launched in 2011 built on the founder's roots from Rational Software. For hardware development, it offers 'Extended SAFe Guidance'. This provides general guidance but does not include formal adaptations to the framework to meet hardware development's unique needs and challenges. A typical challenge that teams face is attempting to identify discrete features and related User Stories to develop in 3-month "Program Increments." While SW teams have little problem doing this, the holistic nature of physical products makes this a structural deficiency in the SAFe Framework for hardware teams.

As a software-first framework, the structure and methods, based primarily on Scrum, do

not fit well with hardware organizations. The organizations that have tried, often find it to be like fitting a square peg into a round hole, with many reverting back to familiar waterfall methods.

Nexus

Nexus was created by Ken Schwaber, co-creator of the Scrum framework, and was released by his organization, Scrum.org in 2015. It offers a lightweight framework for scaling Scrum using primarily a team-of-teams approach and an additional planning team that coordinates activities across the teams. Nexus attempts to solve the problem of dependencies and multiple team integration often faced by larger software as well as hardware projects.

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While Nexus provides tactical guidance for integrated project execution, it is still a SW-first methodology relying on Scrum (software) tactics at its core. This means it assumes any project will have a never-ending series of releases with the ability to add additional features in a linear, incremental fashion. Nexus also does not offer guidance on initiating large, complex projects, nor does it provide insights into Portfolio or Program level governance, which are crucial for managing multiple hardware projects simultaneously within organizations.

LeSS: Large-Scale Scrum

The LeSS Framework was the result of Bas Vodde and Craig Larman's work "to apply Agile and Scrum to very large and multisite product development" efforts in 2005. LeSS focuses on principles such as a whole-product focus, team empowerment and continuous improvement. The general approach is largely based on coordinated feature teams. LeSS also relies on Scrum at its core (as denoted in the name), but allows a lot of flexibility to let teams figure out the details of how they want to scale. While this stays true to the Agile principle of "self-organizing teams", it also makes it unwieldy to apply at an organizational level or with projects requiring cross-discipline collaboration or other hardware development needs.

FRAMEWORK FOCUS

The Details: A Deeper Comparison

The key attributes of each approach to scaling agile for hardware development are summarized in the following tables. Although all four frameworks are rooted in Agile principles, they differ significantly in their application of these principles to project tactics. The comparison is divided into three sections based on their overall focus on hardware development, approach to project planning and approach to execution. The cell text in bold are noted as important distinctions.

Scalability & Compatibility with Hardware Systems Development

Each framework is designed to scale for large projects. While both MAHD and SAFe address the complexities of managing multiple projects or portfolios. SAFe primarily targets enterprise software organizations and offers limited support for discrete hardware development and manufacturing. Notably, MAHD is the only framework that offers seamless compatibility with other SDLC processes enabling Enterprise scalability.

Key Attributes	MAHD	SAFe	LeSS	NEXUS
Fit for Hardware	100%: **HW-based** system approach.	Challenging - A **SW first** process.	Very **difficult**.	Possible but **impractical**.
Company Size	**Indivual project to large enterprises.**	**Large monolithic organizations**	**Individual projects** with multiple teams.	**Individual projects** with multiple teams.
Team Configuration Support	• Small Projects • Large Projects (dependencies) • Enterprise (Multiple programs)	• Essential (ART w/5-12 teams) • Large (Several ARTs) • Portfolio (whole organization)	• LeSS (2-to-8 teams) • LeSS Huge (~ 8 teams)	Base Nexus Framework
Fits w/other SDLC Processes	Yes	No	Limited focus on integration outside Scrum teams	Limited focus on integration outside Scrum teams
Solution Focus	**Discrete Product or Value Stream delivery.**	Program Increment (**Value Stream**) delivery.	**Continuous** delivery.	**Sprint level** dependency and integration.
Key Roles	Product Owner/ Manager, Agile Project Leader, Tech Leads	ART, Product Owner, Scrum Master	Product Owner (LeSS Huge), Area Product Owner, Scrum Master	Product Owner, Scrum Master, Integration Team (NIT)
Certification	Available.	Required	No	No

Project Planning & Iterative Approach

Each framework leverages iterative execution cycles as expected for Agile-based processes. However, they vary for how Iterations are planned and the expected outcome from each cycle. Software-centric frameworks typically focus on adding incremental value in the form of new features to a core solution that are developed and tested each cycle. This practice often overlooks the challenges of physical products, which require more system-oriented Agile techniques since incremental changes or additions can be problematic, costly or not possible. Regarding project initiation, while SAFe employs time-boxed PI Planning, only the MAHD Framework provides explicit steps for initiating hardware projects, ensuring they are thoroughly prepared for agile execution.

To scale, both the MAHD and SAFe frameworks employ a two-tier iteration process, combining longer iterations (IPAC and PI respectively) for planning and integration with shorter, Scrum-like sprints for execution. However, the MAHD Framework is optimized for hardware projects and allows for adjustable iteration durations to meet specific project needs. In contrast, the LeSS and Nexus frameworks depend on standard Scrum iterations for integration and dependency-management needs.

Key Attributes	MAHD	SAFe	LeSS	NEXUS
Portfolio Management	**Complete MAHD Framework. Project priority focus.**	**Enterprise SAFe. System resource focus.**	**No consideration.**	**No consideration.**
Project Kickoff	Once during project initiation (the On-ramp). **Strategic direction focus.**	Big Room sessions every 8-12 weeks. **Feature selection** (PI) focus.	Limited or not needed. **Not defined.**	Limited or not needed. **Not defined.**
Increment Focus	IPAC Milestones. **Vertical system slice.**	**Features**	**User Stories (=features)**	**User Stories (=features)**
Release Approach	**Manufacturing** & Sustaining Engineering.	**Dev Ops**	**Dev Ops**	**Dev Ops**
Time/Scope Trade Off Focus	Constraints identified during **project** initiation.	Scope and Time are both **fixed** each Increment.	Time is fixed, **scope is flexible** each iteration.	Time is fixed, **scope is flexible** each iteration.
Framework Flexibility	Some core prescriptive elements.	Very Prescriptive. Various scaling per size of Initiative.	Some. Minimalist and empirical.	Some.

Comparing Project Execution Approaches

The final comparison area examines project execution details and alignment with other project governance requirements. All frameworks use a backlog to manage project tasks. SAFe, LeSS, and Nexus employ a typical Agile software approach, using the backlog to prioritize features and user stories. In contrast, the MAHD Framework organizes its backlog into swimlanes based on the project's subsystems or disciplines, tracking and prioritizing development work items accordingly.

When evaluating compatibility with existing processes, such as a staged development system or managing new "Green Field" initiatives with uncertain outcomes, only the MAHD Framework is designed for easy integration. Rooted in the flexible needs of cross-functional teams, it effectively supports various organizational requirements not typically considered by software-based frameworks."

Key Attributes	MAHD	SAFe	LeSS	NEXUS
Backlog Items	Project Epics and **Tasks organized by sub-system** or discipline (swimlanes).	Epics. **Features**. User Stories.	Focus is on small, **incremental features**.	Focus is on cross-team **incremental features**.
Integration Cadence	Project optimized, **flexible IPAC Iteration** durations.	**Inflexible** 8-12 weeks.	Every **Sprint**.	Every **Sprint**.
Fits w/ Phased NPD	**Yes. Seamless.**	Only if gates are on the **same cadence** as Program Increments.	**No** consideration.	No consideration.
"Green Field" project fit	**Yes**	Sub-optimal.	Yes, (for SW) smaller scale. Other R&D projects, no.	Yes, (for SW) smaller scale. Other R&D projects,, no.

CONCLUSION

Conclusion

Each of the four frameworks discussed can be applied to hardware development organizations with varying levels of success and fitness-for-purpose.

- MAHD provides a proven, comprehensive and integrated end-to-end approach from Portfolio to Deployment. As it is tailored for hardware-based systems that also include software, it is designed to manage integration, dependencies, manufacturing and other hardware development needs.
- SAFe is the most widely deployed system for scaling software solutions and manages integration and dependencies through detailed Program Increment planning. However, the framework lacks specific adaptations to meet the needs of physical solutions.
- Nexus offers a good approach to managing integration and dependencies across teams but leaves out true scaling to the organizational level. It also lacks needed adaptations for hardware development to build and manage a finished product.
- LeSS prioritizes simplicity and self-organization, promoting agility through whole-product focus and empirical process control but provides limited structure beyond scaling Scrum from one team to many.

In summary, the MAHD Framework stands out as the most suitable solution for hardware organizations. Its origins in hardware development and comprehensive approach — from portfolio management to deployment — make it well-aligned with the complex integration requirements of hardware-based systems and enterprises.

Ultimately, hardware organizations must evaluate the best approach for them based on their unique context and objectives, including factors such as regulatory requirements, dependencies on partners and suppliers as well as their organizational culture to determine the most suitable framework for scaling Agile effectively. However, it is essential not to revert to traditional waterfall models and forego the advantages of Agile, such as increased speed, efficiency, and customer value. By integrating the principles and best practices of Agile and adapting the tactics to meet the needs of physical development found in the MAHD Framework, hardware organizations can significantly boost collaboration, innovation, and value delivery in their product development processes.

ABOUT US

How Can We Help?

The MAHD Framework is built on Agile principles with input from dozens of companies ranging from electronics to medical equipment to address the needs of hardware development. The MAHD Team has been involved with product development for decades and has experience with development processes ranging from adhoc to Six Sigma, we have seen the challenges posed by many NPD processes and how Agile can help. When working with teams trying to implement Agile processes designed for SW development, we were determined to find a better way to get the benefits of Agile while solving the needs of physical development. Below are three recommendations to get started. To learn more, visit: www.MAHDFramework.com

1

GET AN OVERVIEW

Visit www.mahdframework.com to set up a 45-minute consultation

- Review your situation and goals
- Overview of the MAHD Framework
- Determine if MAHD is right for you
- How to best get started

2

TRAIN AND PILOT

The fastest way to start is to train a focused team and pilot a project

- Identify a pilot team and project
- Get hands-on MAHD training
- Execute MAHD w/facilitation
- Learn, improve and repeat

3

ASSESS AND PLAN

This is a great option if you know MAHD is right for your whole organization

- Establish clear NPD goals
- Identify areas for improvement
- Develop a roadmap w/milestones
- Pilot, learn, expand

About MAHD Framework LLC

MAHD Framework LLC was established to help product development teams take their NPD capabilities to a new level of performance with Agile principles and methods. We provide a wide range of materials, training and certifications to ensure your team has the skills and tools necessary to succeed.

Challenges we address include:

- Slow or inefficient NPD processes
- The need to adapt quickly to market needs
- Improving ROI for new projects
- Achieving predictable NPD results
- Aligning hardware & software processes

Contact Us

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