Agile for Hardware

A Briefing to Gartner, Inc.

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- Agile consultant and trainer
- Specializes in Agile development of hardware and integrated hardware / software products
- Develops Agile content, training, consulting standards
- Holds a Ph.D. in Physics from Princeton University
- Has background in classic (Project Management Institute) and Agile processes

Agile Becoming Dominant Strategy for Software Product Development

Before 2000: Waterfall was King

In 2017

- Companies migrate from Waterfall to Scrum
- No one migrates from Scrum to Waterfall

Agile vs Waterfall debate is over. Agile has won.

Agile covers Scrum and more

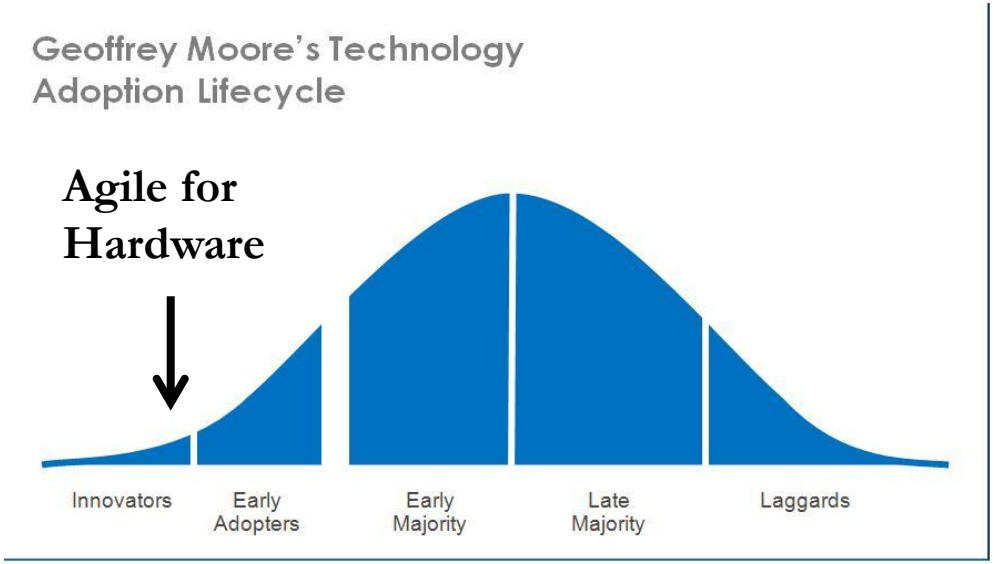
- Scrum for Product-Development Teams
- Kanban for Operations, Support, Manufacturing Teams
- Agile Program Management for large-scale, multi-team development
- Agile Portfolio Management for strategic business investments

Yet Agile is almost Unknown for Hardware Product Development

Hardware: Mass-Produced Electronic & Electro-Mechanical devices

- Telecommunications, laboratory, navigation, cameras, audio products, robots …
- Often with embedded software
- Often with associated software (admin, networking, control, analysis)

cPrime 2014 survey of 14 hardware / system vendors showed that none had a coherent end-to-end Agile process or strategy



Adaptive Spectrum Drives Process Selection

Scope Uncertainty + Effort Uncertainty:

The Agile Zone

Predictive	Adaptive	Reactive
Plan-Driven	Scrum	Kanban
Waterfall		

• Emphasize efficiency (minimum cost, duration) • Perform well when work is well understood • Perform poorly when uncertainty is high	• Emphasize adaptability to rapid change • Enable detailed short-term planning • Evolve longer-term specs, plans over time	• Emphasize continuous re-prioritization, efficient allocation of work to people • Do not require work to be planned against calendar • Handle unpredictable work well

Product Development

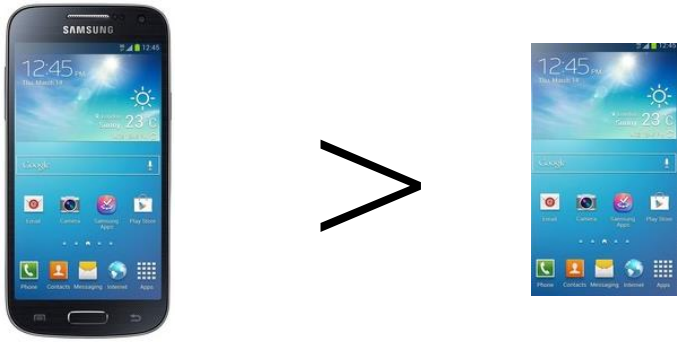
Manufacturing

Waterfall / Classic Plan-Driven Development Causes Same Problems for Hardware as for Software

- Unrealistic schedules
- Late discovery of schedule slips
- Silo-ed working groups lead to late integration problems, focus on engineering issues versus customer needs
- Poor visibility into plans, status of work

Hardware Product Development is Bigger than Software

Most devices contain embedded software



Agile owning all of product development is better than Agile owning just the software part

My Research has Shown that Agile Works for Hardware Development

Hardware

White paper, “Agile Processes for Hardware Development,” by Kevin Thompson, Ph.D., 2015.

White paper, “Eleven Lessons Learned about Agile Hardware Development,” by Kevin Thompson, Ph.D., 2015.

“Scrum for Hardware? A Groundbreaking Experiment at Thermo Fisher Scientific Shows Promise.” AgileVox magazine, 1st edition, Spring 2016.

Agile Program Management and Beyond

“Recipes for Agile Governance in the Enterprise,” by Kevin Thompson, Ph.D., 2013

Where It's Happening*

ThermoFisher SCIENTIFIC

Chromatography and Mass Spectrometry devices for laboratory and medical use

PICARRO

Isotope and Trace-Gas Analyzers for field use

Bird®

Radio-frequency telecom products and test equipment

GoPro Be a HERO.

Rugged video cameras for field and recreational use

plantronics.

Audio and communications equipment (headsets, speakerphones, etc.)

* My clients

Scrum is Different for Hardware Products, Compared to Software

	Software	Hardware
Development	Add features to product over time	Add components to design over time
Production	Copy to new environment	Manufacture based on design
Cost of Change	Low	High
Amount of initial design req'd	Low	High
Product-development lifecycle	3—6 months	6 – 18 months
Need for long-term planning	Varies	Always
Dominant type of specifications	User Experience	Technical Component
Who writes most specs	Product Owner	Team Members
Skill overlap of Team members	Large	Small
Units of work estimation	Story Points or Person-Days	Person-Days

Hardware Product Groups are Bigger than Software Groups

More people (50 – 200) than for Software (5 – 50)

More Scrum Teams than for Software

Greater need for large-scale, long-term, planning and cross-Team collaboration, synchronization of work

Agile Program Management is required for success

- Often optional for Software Product development

Change management, integration of concurrent hardware and software development is simplified when same Agile process is used to manage both

Most Benefits of Agile Approach Apply to Hardware World

Decrease

- Uncertainty and risk
- Wasted process effort
- Wasted development effort
- Opportunity costs
- Chaos in the development cycle
- Inability to adapt to changing needs / demands

Increase

- Predictability
- Reliability of estimates
- Visibility of project status
- Speed to Market
- Customer satisfaction
- Alignment with changing business priorities
- Ability to handle unexpected changes
- Quality
- Morale in Dev Teams, Organization

Quote from Thermo Fisher Scientific Regarding Scrum for Mass-Spectrometer Product Development

Dr. Michael Bedford, Senior Scientist and Product Owner had this to say at the five-month point:

"First and foremost, running this project with Scrum is an ongoing success. The team has formed nicely and we have proper buy-in from each team member. I make technical decisions with more input from the team than any other project that I have worked on. Grooming is a hassle because it takes so much time and requires us to stop doing and think, but the drawbacks I mention are also the clear benefits. We take time to plan. And we plan together….

Continued from Thermo Fisher

"…The daily standup is a life saver. As is the board. I can quickly understand where we are and what needs to be done. Release planning has been beneficial because it really focused the team onto what our big goals are as opposed to smaller engineering goals. I feel that management here in San Jose is excited about Scrum. I have had many of the bosses and decision makers stop by and ask about the process."

The Big Shiny Thing

So what is the “big shiny thing” that is new and wonderful?

Big Shiny Thing – Part 1

Scrum can be employed at the Team level for development of hardware and hardware/software products

We can leverage knowledge built up in Scrum for Software

- Roles: Product Owner, Scrum Master, Team member
- Ceremonies: Backlog Grooming, Sprint Planning, Daily Stand-Up, Review, Retrospective
- Artifacts: Stories, Epics, Task Breakdowns
- Tracking: Burndown and Burn-Up charts

Big Shiny Thing – Part 2

In spite of Part 1: The hardware world is not the same as the software world

An expert in Scrum for software will fail if when trying to apply familiar techniques to the world of hardware development

Common mistakes:

- Scope decomposition by feature: **Fail**
- Incremental feature development: **Fail**
- Estimation in Story Points: **Fail**
- Write User Stories for everything: **Fail**

Training in Scrum for Hardware is required for success

Big Shiny Thing – 3

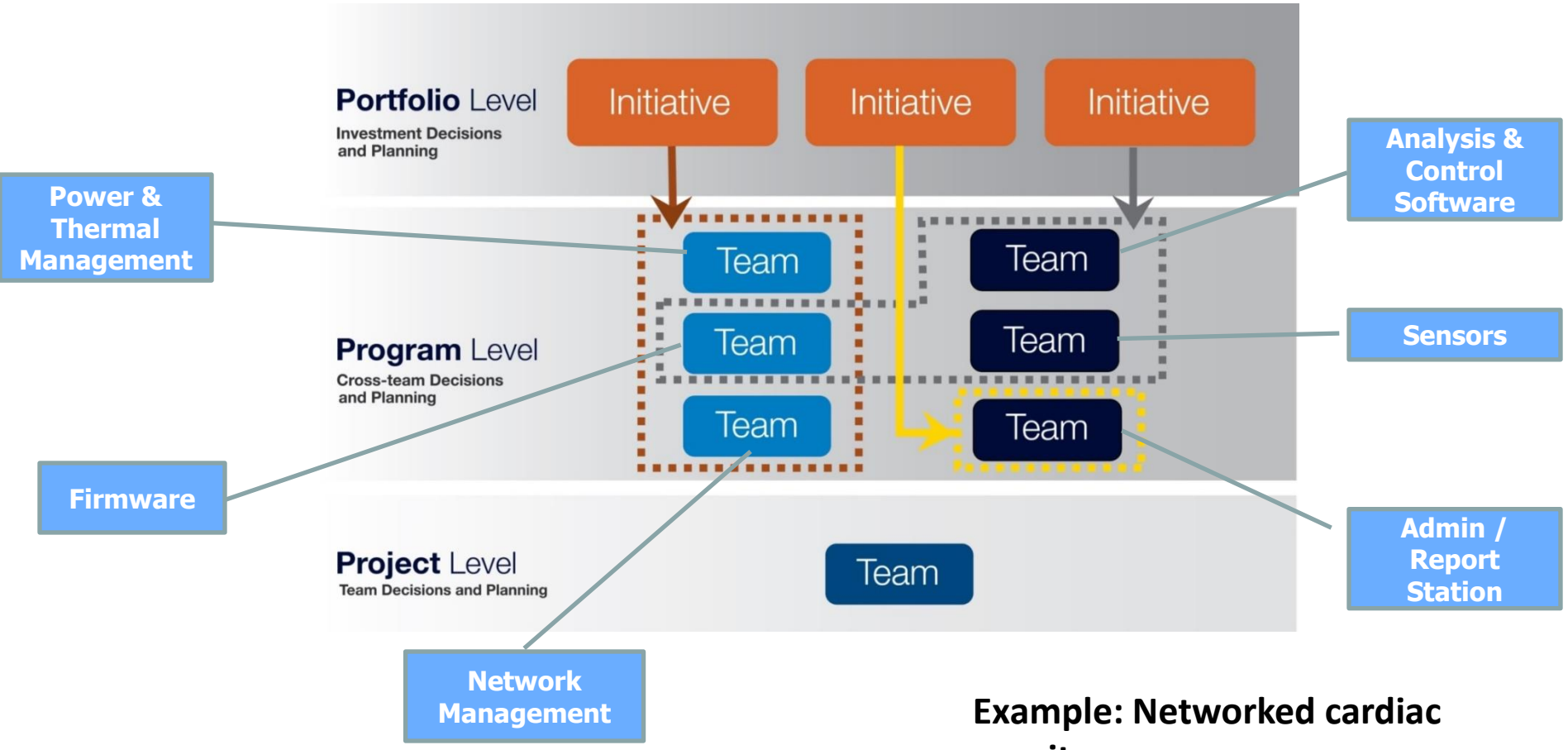
Scrum is not enough for hardware

- Larger size of hardware development organization means Scrum alone is not sufficient for product development

Hardware companies

- Need solutions that include Scrum, but are bigger than Scrum.
- Agile Program Management will normally be required

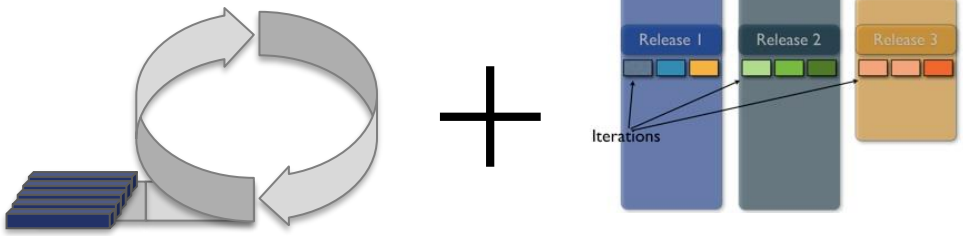
Levels of Governance: Agile Perspective



Example: Networked cardiac monitors

Agile Hardware + Software: Minimum Viable Solution

Must have <u>at least</u> these two elements:

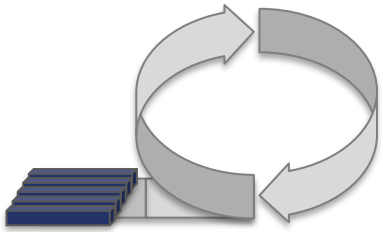


Scrum

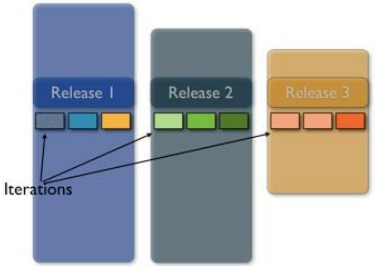
Agile Program Management

Agile Hardware + Software: Optimum Solution

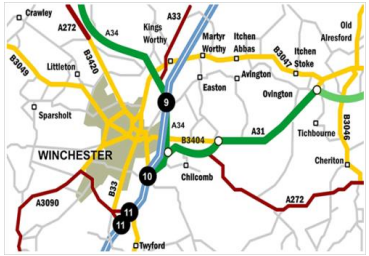
Best / largest solutions have all three elements:



Scrum



Agile Program Management



Agile Portfolio Management

Example Tools for Hardware / Software Product Development

	Software	Hardware
Project Management	Jira	
Program Management	Jira	
Portfolio Management	Jira, AgileCraft	
Information Sharing	Confluence	
Document Management (Source Code, Design files…)	BitBucket, GIT	
Requirements Management	Jama, Altium, Visure	
Test & Test Automation	Bamboo CI & Deployment	ModelSim (ASIC, FPGA)
	Selenium	LabView (HW System test)
	xUnit	

The Time is Right for an Agile Hardware Explosion

- I have conducted pioneering research into techniques for Agile Hardware Development
- I offer Consulting, Coaching, Training, and Transformation Services in Agile Project, Program, Portfolio Management for Hardware and mixed Hardware / Software Product Development

Training:

Type of Training	Software	Hardware
Project Management	Agile Software Development with Scrum	Agile Hardware Development with Scrum
Program Management	Agile Program Management	
Portfolio Management	Agile Portfolio Management	