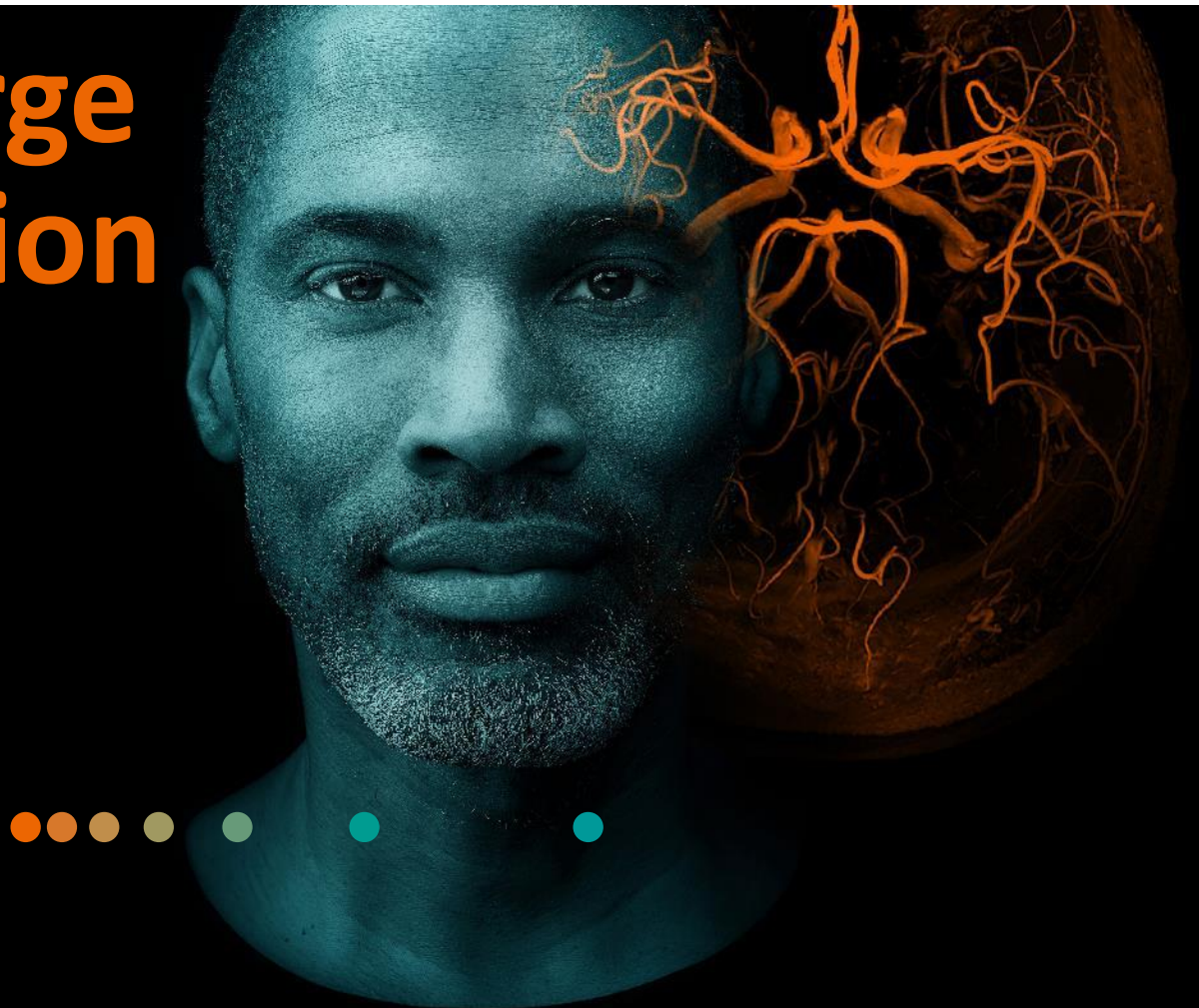


Transforming a large medical organization towards Speed and Flow

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Head of Software
Computed Tomography
Siemens Healthineers

May 2019



- **Challenges**
- **Deep Dive: DevOps**
- **What is “Flow”**
- **Applying concepts to whole organizational change program**
- **Potential future research topics**
- **Conclusion**



The environment

Cyber-physical system of systems: CT scanners

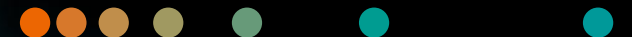
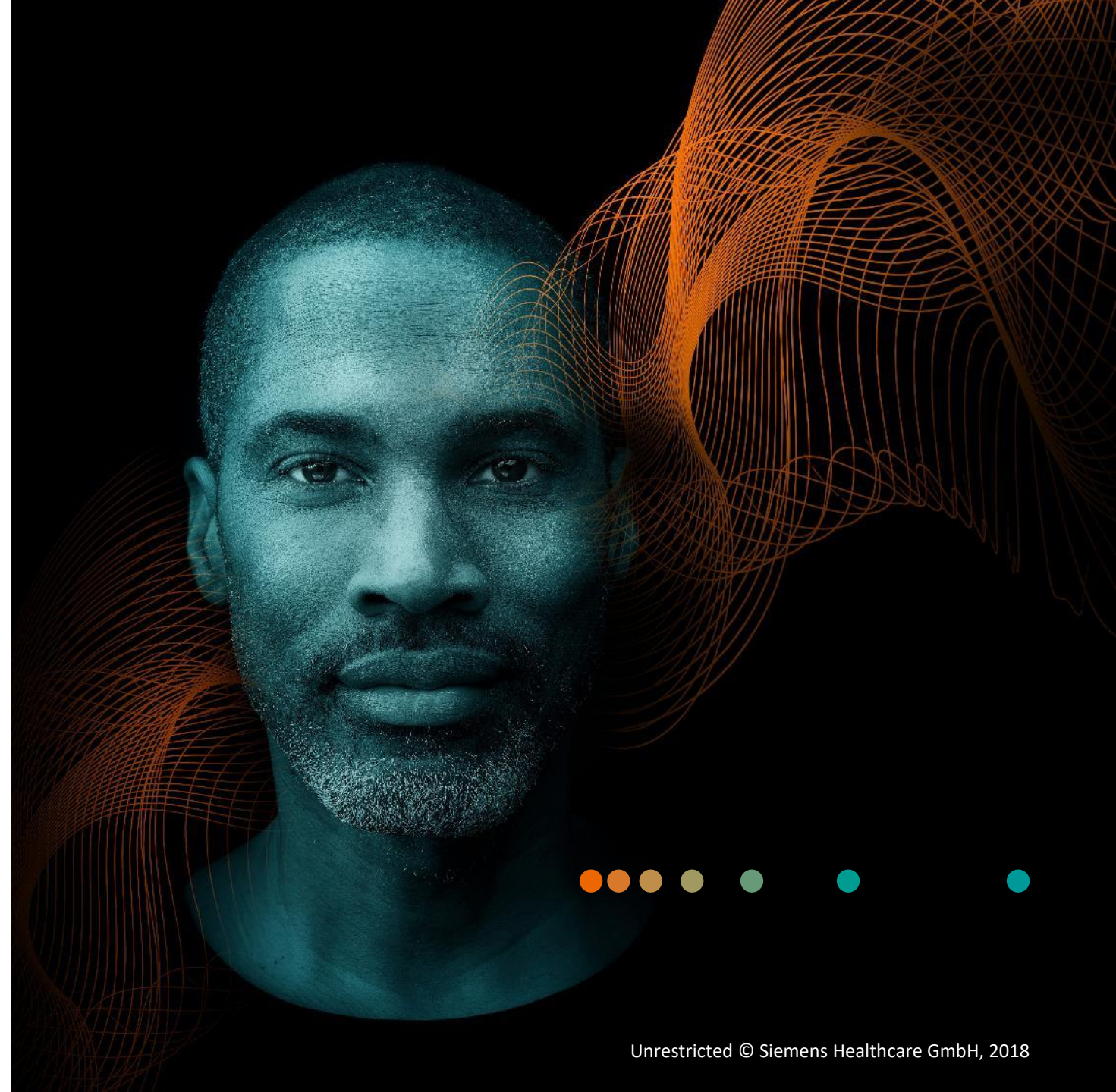
Challenges

- Growing complexity (both product and the organization)
- Transforming from a hardware driven to a software driven company causing functionality realized in software growing rapidly
- Systems become increasingly interconnected, spreading the complexity beyond the boundaries of systems
- For large, complex systems, various parts move at different “pace of change”, especially if you combine hardware and software
- Accelerating innovation cycles
- Fast pace of change of modern software technologies requires clear separation of concerns

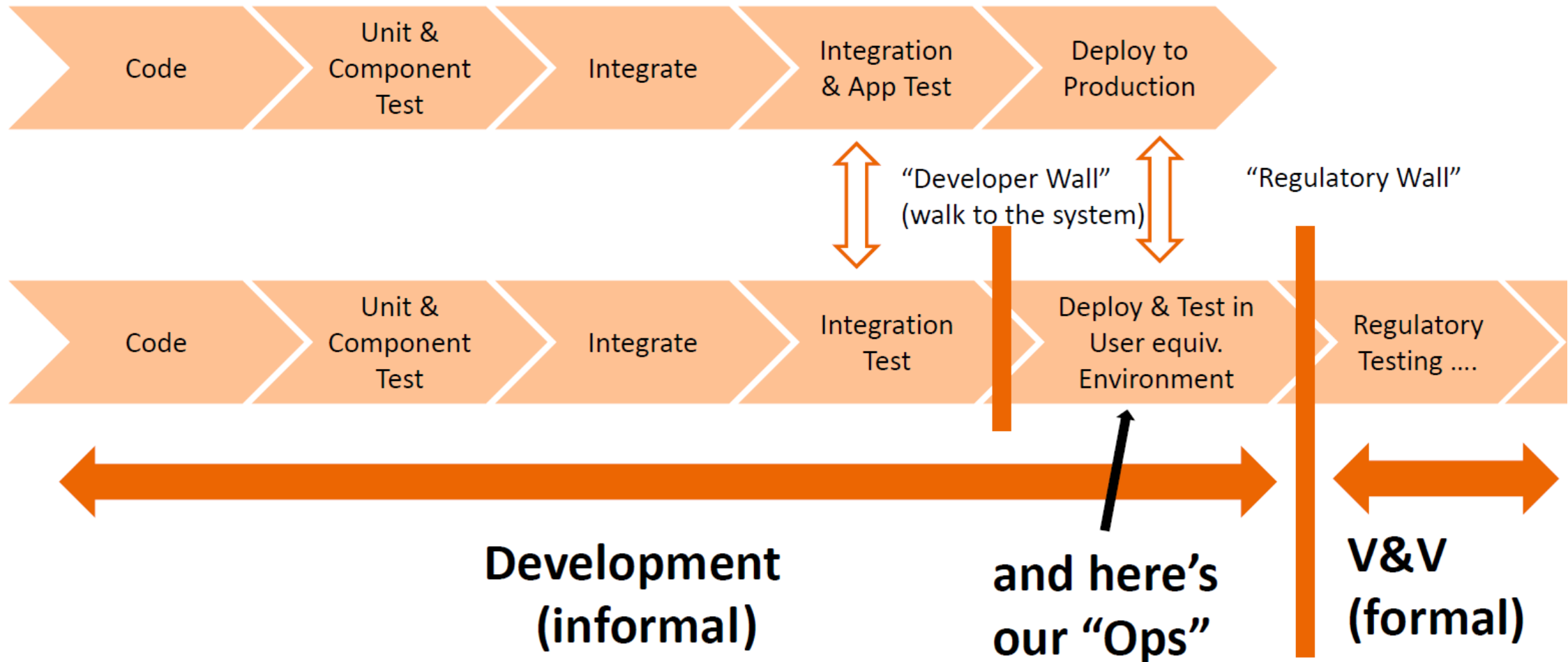


Let's start with a **Deep Dive**

Leveraging the power of DevOps
concepts internally



DevOps typically ends in medical environments at the “Regulatory Wall”



Do not change anything before you can measure it

INT Gated CI

The integration gate for AWP SW

- Selected tests by TestFinder for each check in
- In RSFL environment
- Mainly on VMs

Number of test errors decides about check in

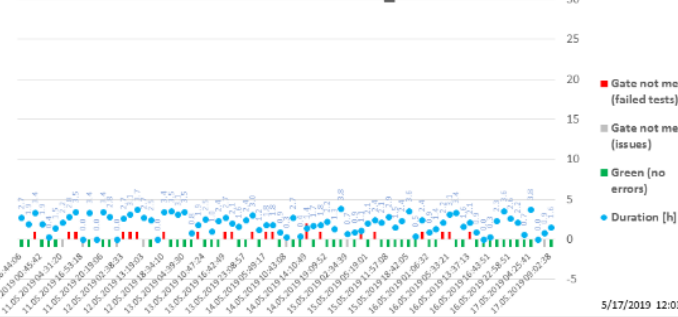
- 0 errors: check in ok
 - above: reject check in
 - goal: > 60% successful check ins
- IntMgr decides in case of issues.

Percentage of Green Builds

85%

Green

Failed tests on INT_GCI

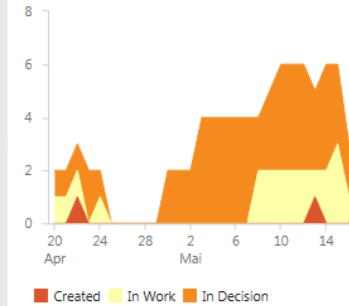


Defects blocking Continuous Integration

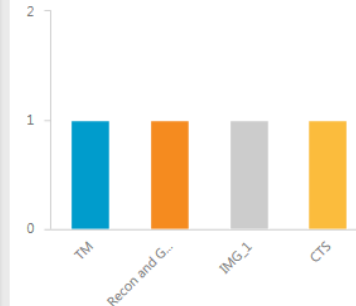
The most important defects during development

- Analyze immediately
 - Fix as fast as possible
 - Fix directly on INT if possible
- Limit: tbd
Click chart for list of current defects.

Defects blocking CI - last 4 weeks



Defects blocking CI - by Team today



Syngo Integration Blocker

Number of defects that currently block integration of the candidate to INT

Current

4

Limit: 0

INT RollingBuild

Build and test at least once a day:

- All tests
- In RSFL environment
- Mainly on VMs

Number of test errors decides about state

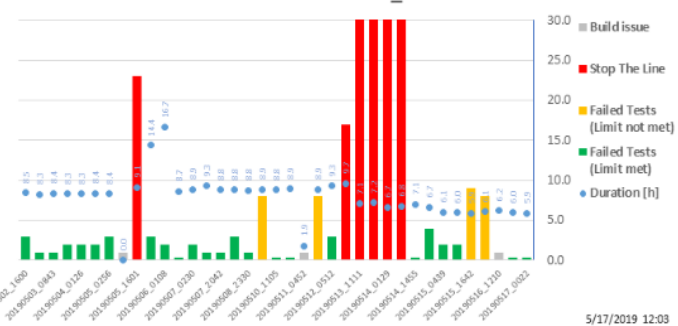
- 0-5 errors: green
- 6-15 errors: yellow, analyze!
- above: Stop the Line

Number of Errors currently on INT

000

Limit met - Green

Failed Tests on INT_RB



RUBBLE RB

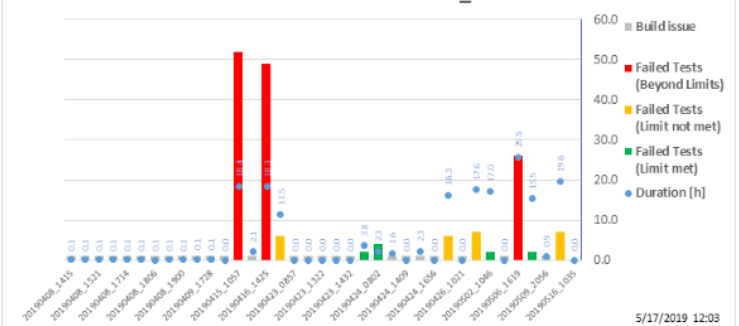
Build and test with latest n/s and apps candidate:

- All tests
- In RSFL environment
- On syngo.via server HW

Number of test errors decides about state

- 0-5 errors: green
- 6-15 errors: yellow (takeover not recommended)
- above: Takeover not possible

Failed Tests on RUBBLE_RB



INT System NightBuild

The truth about SW

- Smoketests and ~50 main workflow tests
- Product environment
- On real Container

Number of test errors decides about state

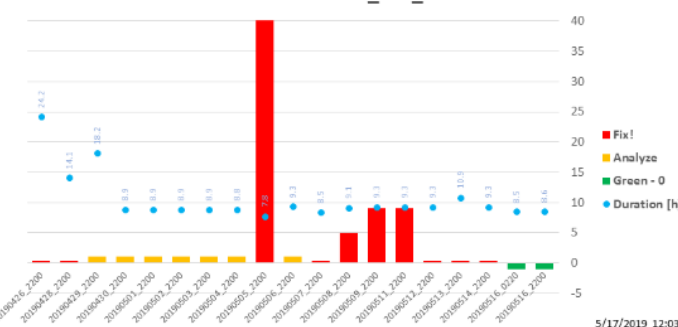
- 0 errors: green
- 1 error: yellow, analyze!
- above: red, fix immediately!

Number of Errors on INT Container

000

Limit met - Green

Failed Tests on INT_SYS_NB



Quarantine Build

Tests taken out of the gate

State of Tests in QT

QT Defects

Each test that is

Quarantine Defects

Non Blocking

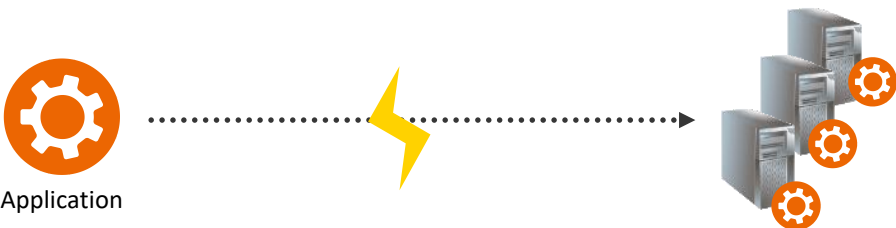
Defects found in

Non Blocking Defects in CI (incl. QT)

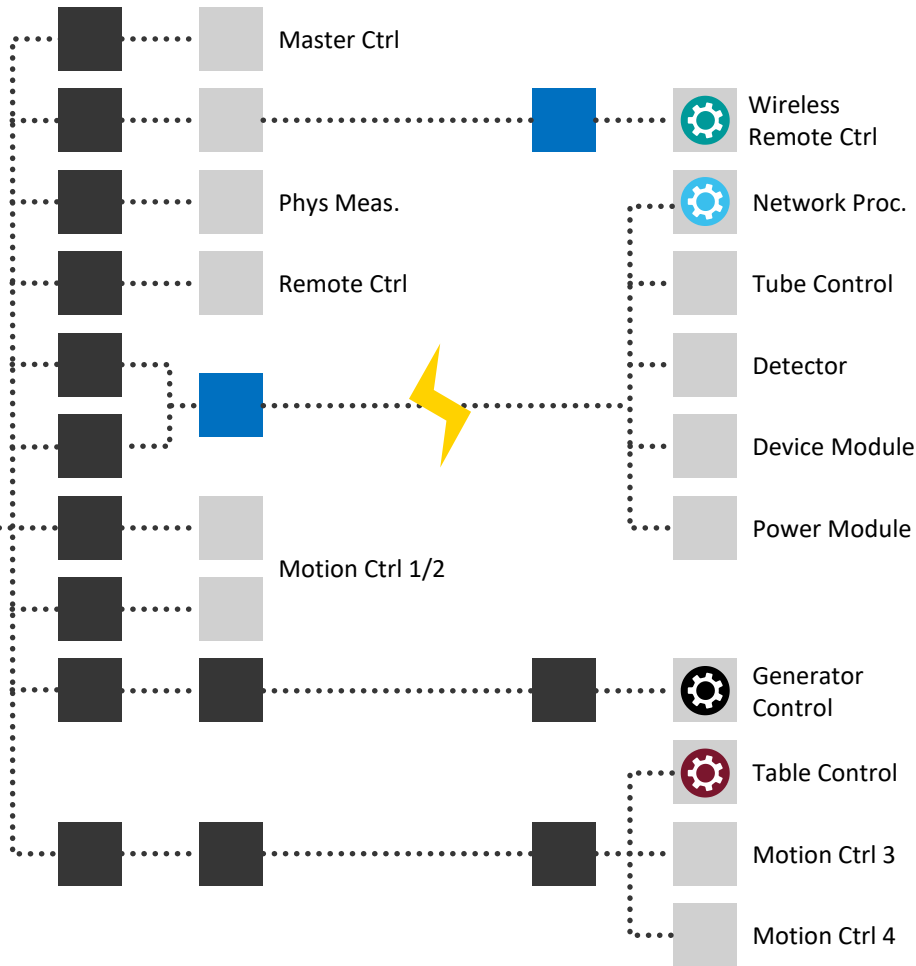
75

How to deploy regularly on the target system

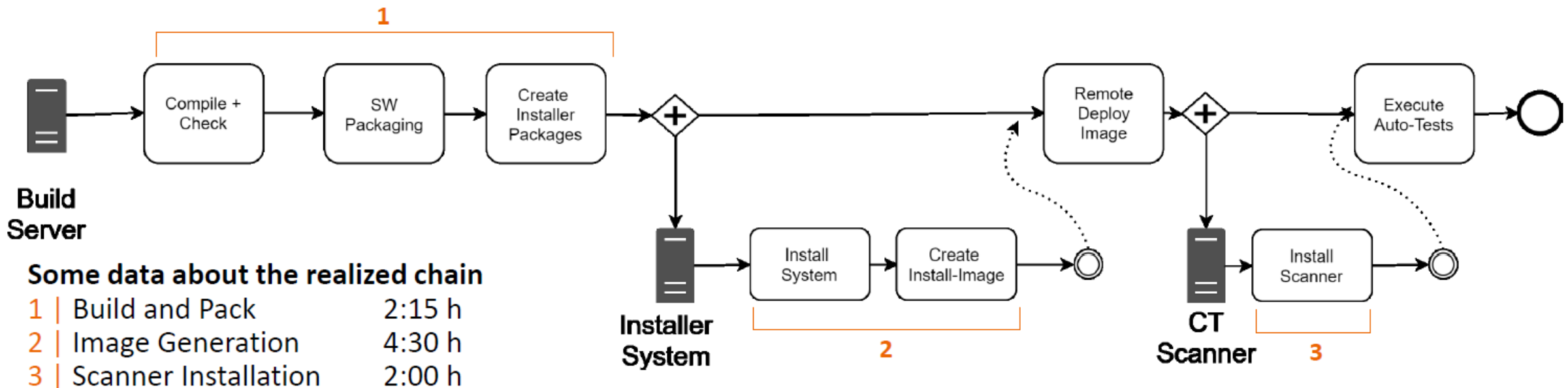
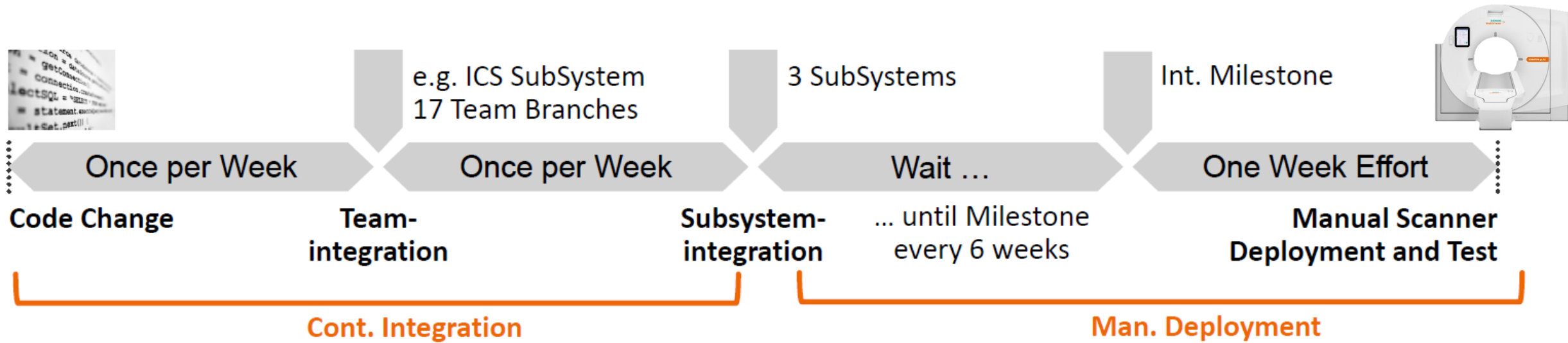
Cloud Application → One production system
Homogenous System/SW Deployment



Scanner Application → more than 25000 systems
Heterogenous System/SW Deployment



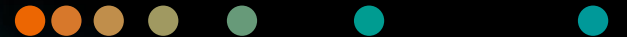
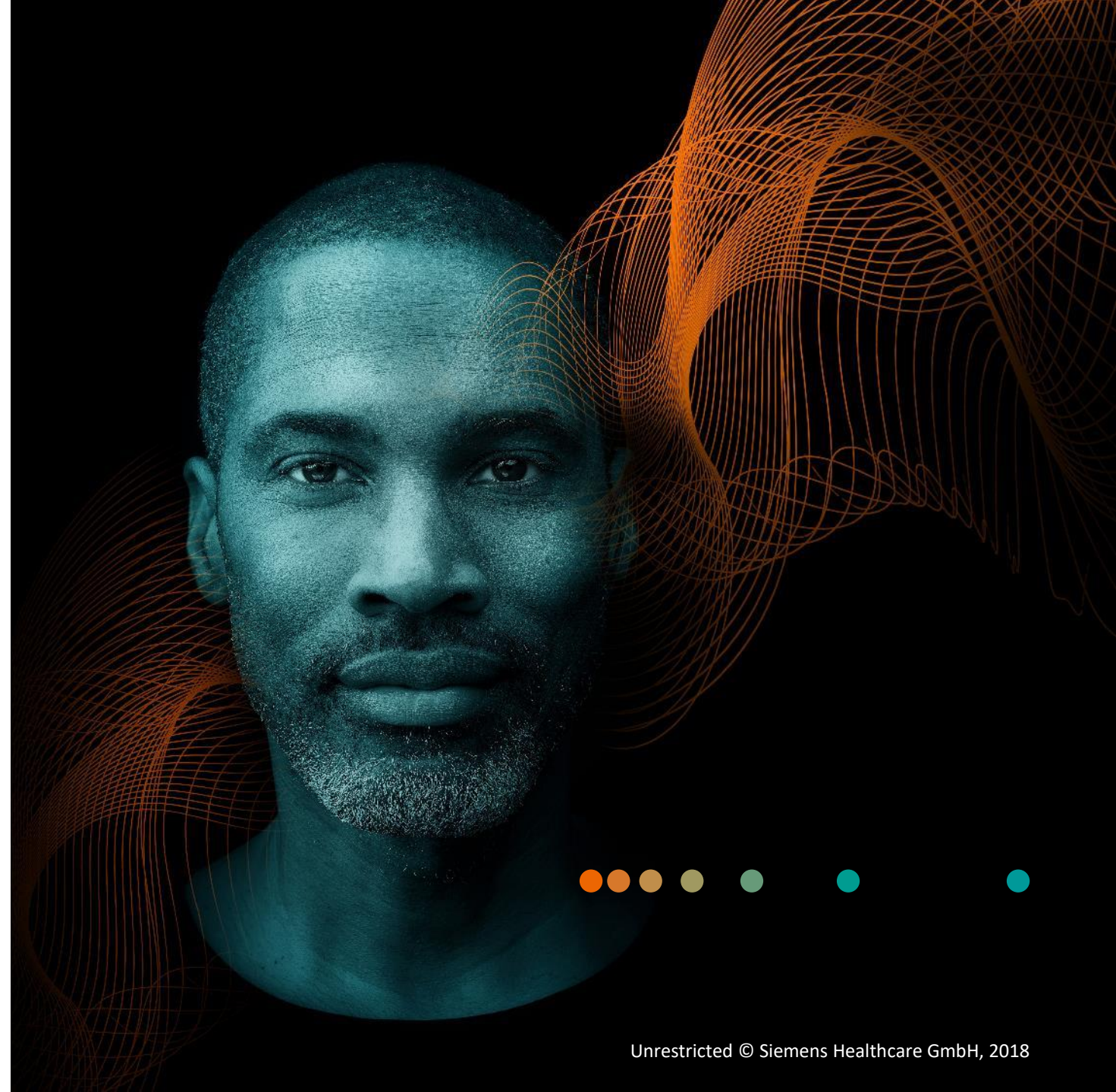
Changing towards a fully automated Continuous Deployment



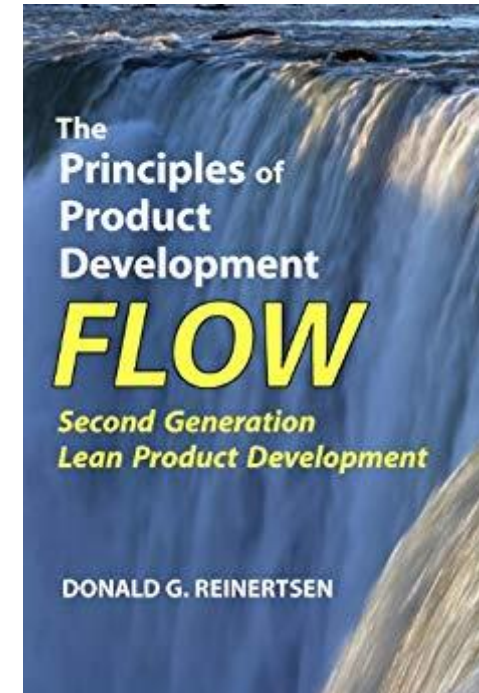
Some data about the realized chain

1 Build and Pack	2:15 h
2 Image Generation	4:30 h
3 Scanner Installation	2:00 h

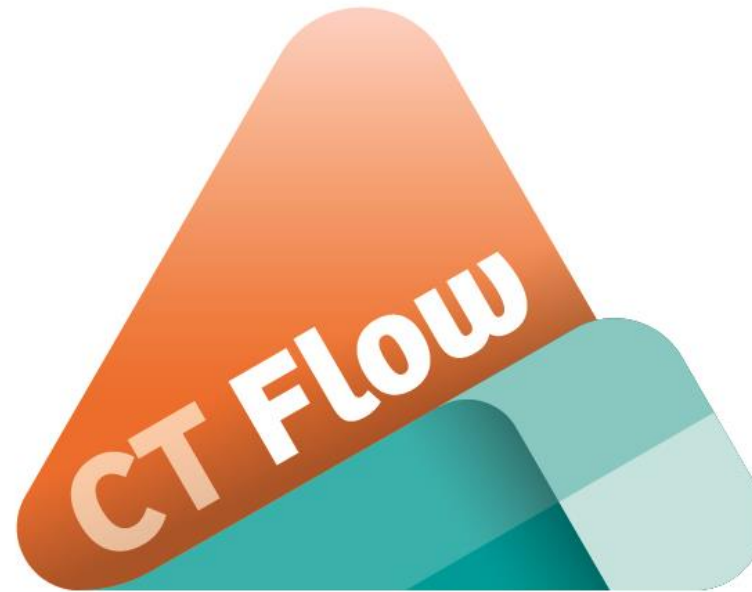
Apply the DevOps
learnings to
**organizational
change**



- strive for a synchronization of our PLM processes that enable a continuous flow through our PLM processes and beyond
- understand your queues (wait times) and their length
- reduce the batch sizes by breaking down the work into small incremental improvements
- striving to avoid a start-stop mentality as found in waterfall projects



Donald Reinertsen, The Principles of Product Development Flow: Second Generation Lean Product Development, Celeritas Publishing, 2009



Business

Product

Technology

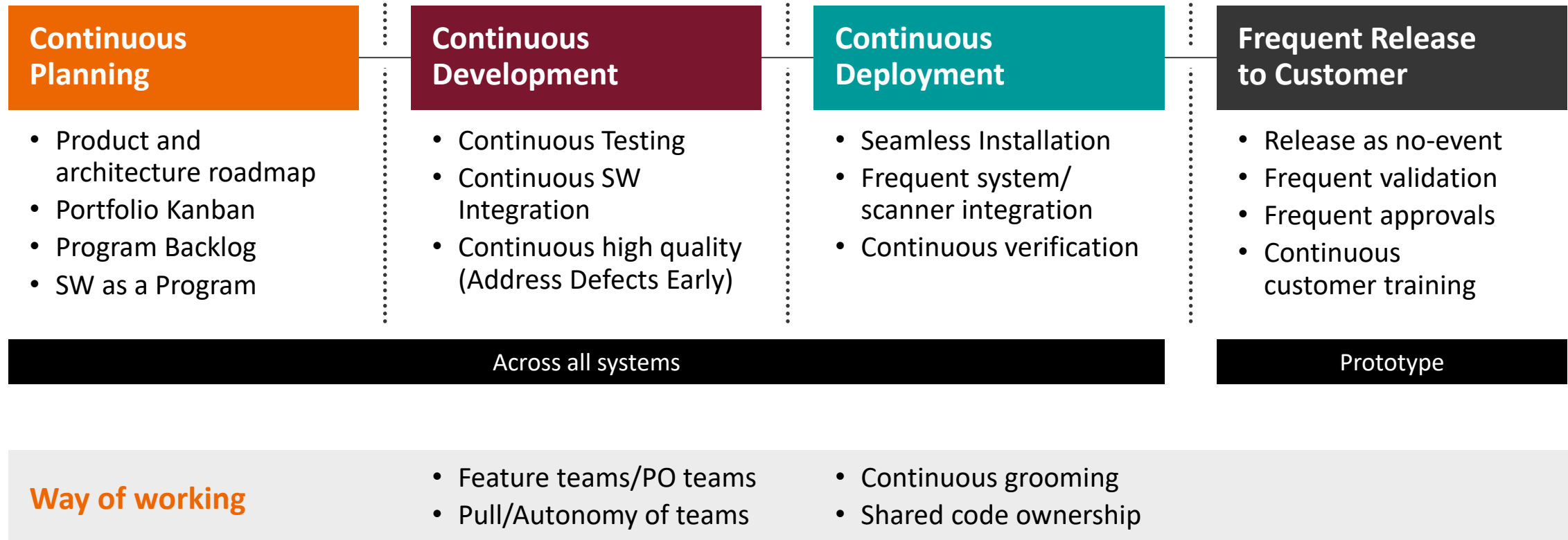
FLOW as an “Umbrella”

Coherent PLM improvement initiatives

«Deliver often,
release on demand»

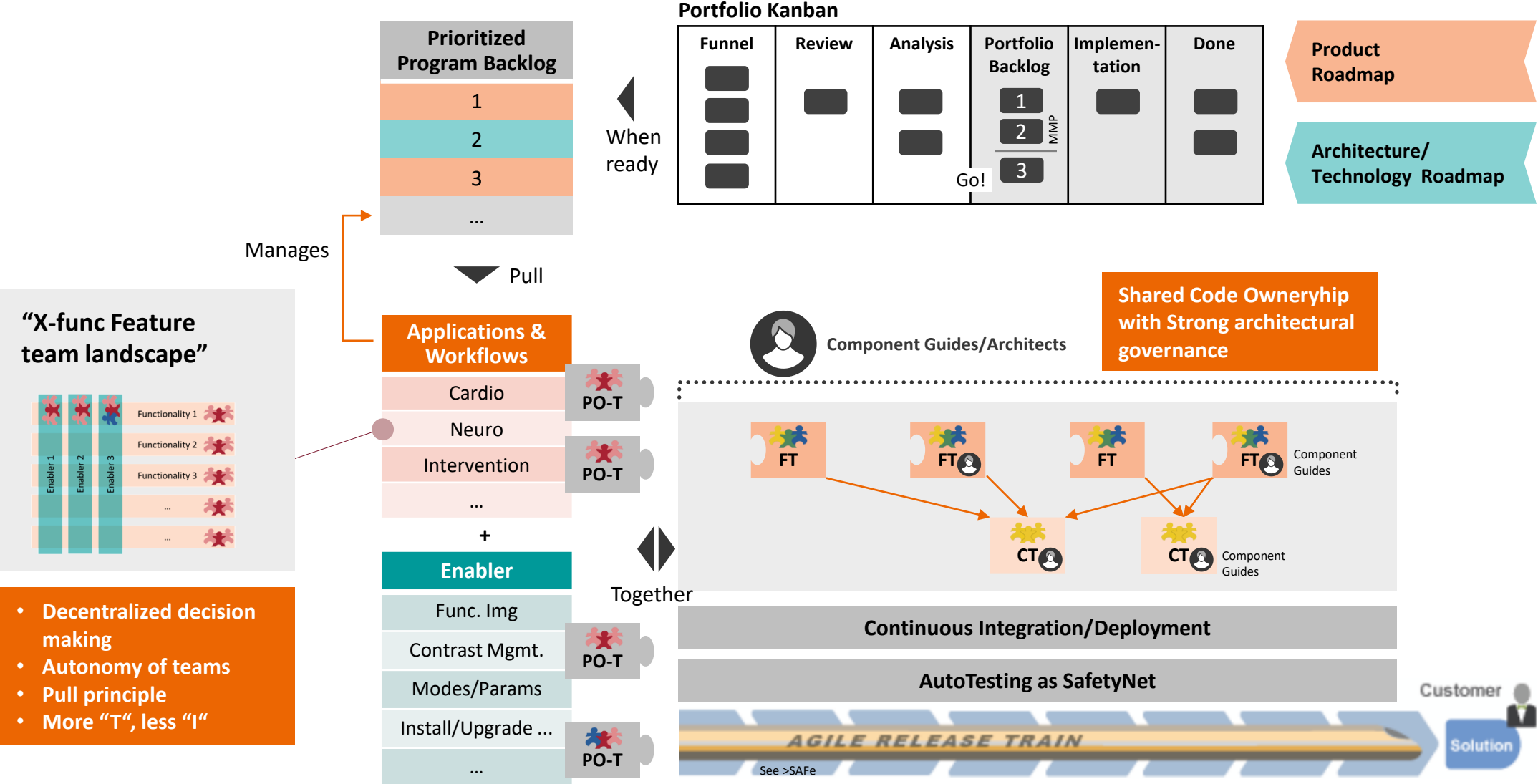


SIEMENS
Healthineers



FLOW

High level view



The ability to embrace Flow starts with the **roadmap and roadmap process**.
If there is already an overload situation there, everything else is an uphill battle.
This needs to be a persistent management priority.

.....

Complexity is the evil that needs to be fought. You need a balance of discipline and agility,
high degree of automation, structure product and organization to **avoids dependencies**.
This goes beyond PLM level, but requires **whole organization** to prevent complexity.

.....

Shortening the feedback cycles is a key priority for enabling a learning organization.
Measure before you change (this implies more automation) and go incrementally from there.

.....

Working on a **fully automated continuous integration pipeline** from software to system
reveals weaknesses and if you have enough perseverance removes quite some slack

.....

Common understanding and vision throughout the organization is necessary pre-requisite.
Invest in continuous and transparent information flow

.....

Changing behavior takes time until it becomes a **culture**

There is much work to be done to bring lean and agile principles to the core of medical development. A subset of relevant research areas include:

Dealing with complexity of cyber-physical system of systems: Solutions that work today for software only (e.g. fully automated cloud deployments) fall short in context of complex systems with many pieces of software and hardware interacting (not only technically but also along its development cycle). More intelligent impact/delta analysis and test mechanisms for complex cyber physical systems need to be stressed without having to start the analysis from scratch. How can digital twins, Artificial intelligence and other technologies help to cope with the inherent complexity

.....

Regulatory requirements: Are there some aspects of dealing with regulatory requirements e.g. from avionics, automotive, financial sector areas that could apply in healthcare domain or vice versa? In many of these domains (including healthcare) also we need to assess the whole “system” (including hardware) – what are the best ways to do that in a compliant, but continuous way? What approaches allow “Flow” to the customer?

.....

Continuous documentation: (of product, of documents required for approvals). There is some work in this area “DevDocOps” – esp. for us producing documents in x languages, training videos etc. but still a lot of work to do in order to speed up approval processes.

- Changing a large organization towards Flow is not only an improvement program, it is a **journey** where at each step of the journey you will benefit from what you have learned.
- **Invest in the organizational** and upstream improvements;
- We believe that in the medical domain the approaches we took (or at least parts of them) could be adopted by many others who are facing the same combination of complex systems in regulated environments that include a large amount of software.
- **Be courageous and take the first step**, otherwise you will spend your time lamenting that the desired state would be so much nicer, but you will never reach it.

And don't forget that

“if it hurts, do it more often, and bring the pain forward”.

David Farley and Jez Humble

Thank you very much!

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Thomas Jachmann
Computed Tomography
Siemens Healthineers

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