Testing Gripen E – Test Automation and Exploratory Testing

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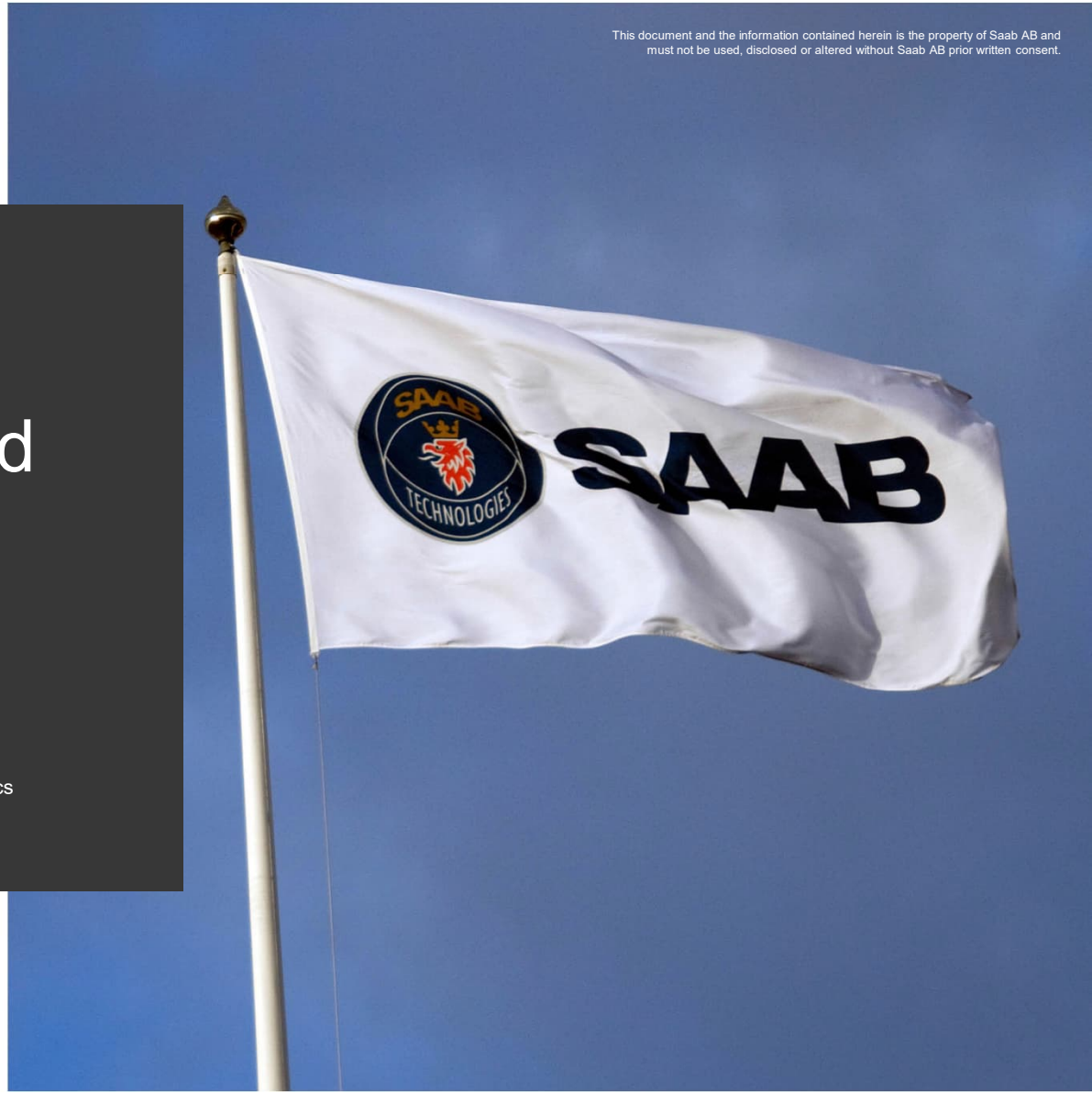

Who am I?

- **Torvald Mårtensson PhD MSc**
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- **Technical Fellow** within System Integration Testing at Saab Aeronautics
- **Associate Professor** (Senior Lecturer) at Linköping University

Takeaways from this talk

- What is Gripen E?

- Testing a large-scale and complex software system – how is it done?

- Three examples of practices implemented in the Gripen E project

Gripen A/B and C/D

- Gripen A (single seater) and B (dual seater) was developed for the Swedish Air Force

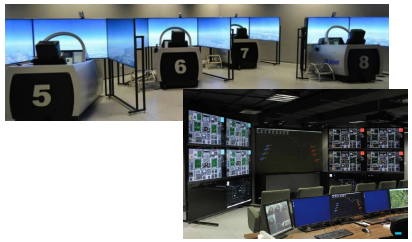
- Gripen C and Gripen D are currently operational in SE, CZ, HU, TH and SA

Gripen E – a new aircraft

First flight for the first Gripen E test aircraft (June 2017)

First flight for the first Brazilian Gripen E aircraft (August 2019)

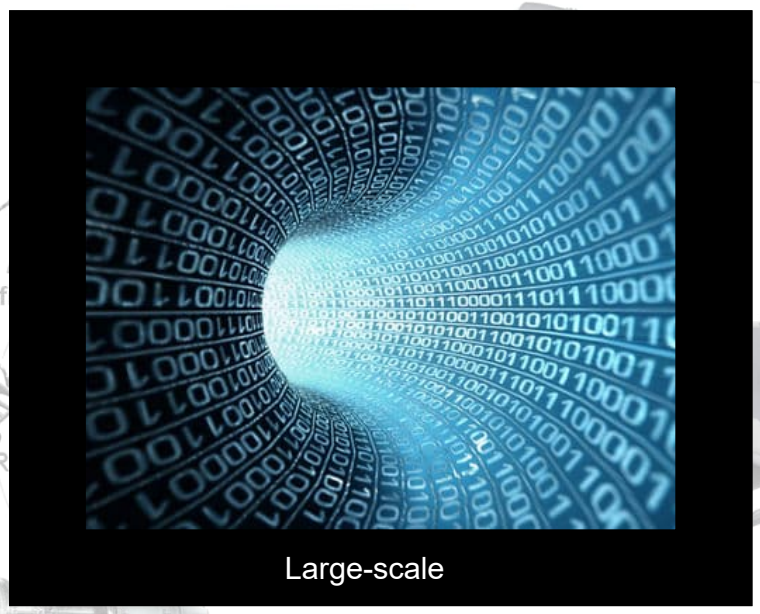
Developing Gripen E



Training Systems

Support Systems

Developing Gripen E



Large-scale

Complexity

Testing a large-scale and complex software system

Testing on different levels

Testing a software component

- Algorithms
- Precision
- Range

Testing a subsystem

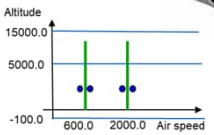
- Integration of software and hardware
- System functions for a subsystem

Testing the complete system

- Integration of subsystems
- System functions in the complete product
- Operational capabilities

Combining different test techniques

- **The Agile Testing Quadrants**



Automated & Manual

Business-Facing

Manual

Functional Tests
Examples
Story Tests
Prototypes
Simulations

Exploratory Testing
Scenarios
Usability Testing
UAT (User Acceptance Testing)
Alpha/Beta

Supporting the Team

Critique the Product

Q2 **Q3**

Q1 **Q4**

Unit Tests
Component Tests

Performance & Load Testing
Security Testing
“ility” Testing

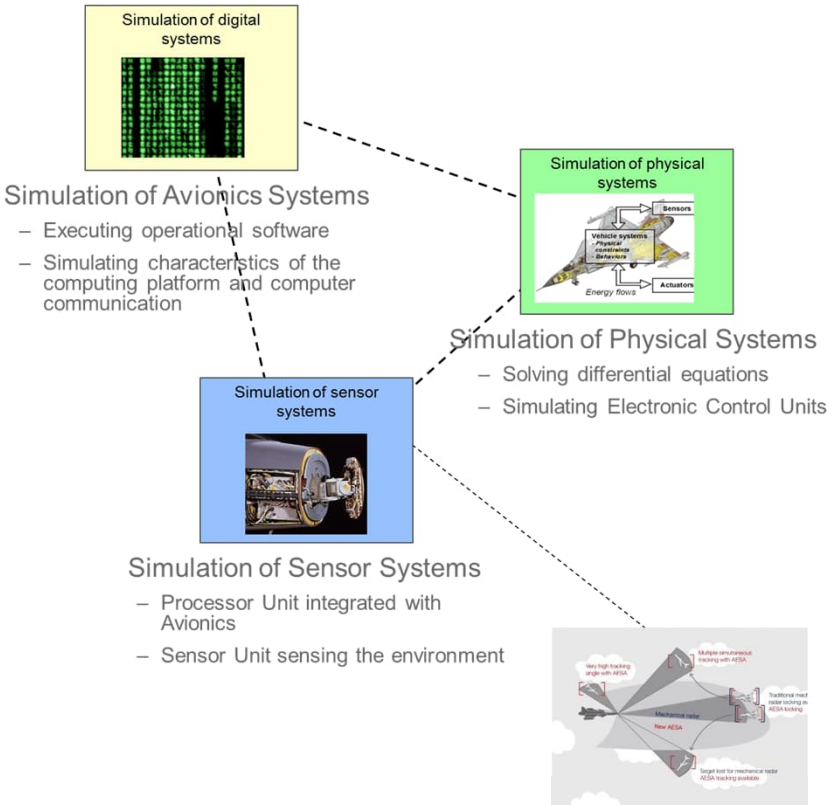
Automated

Technology-Facing

Tools

SAAB

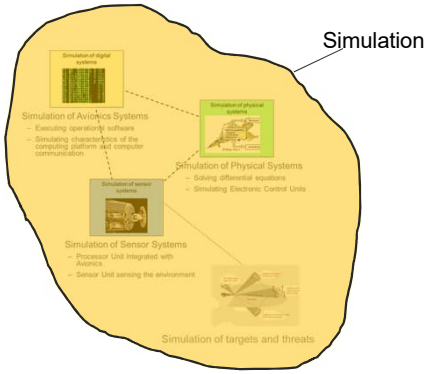
Testing in different types of test environments



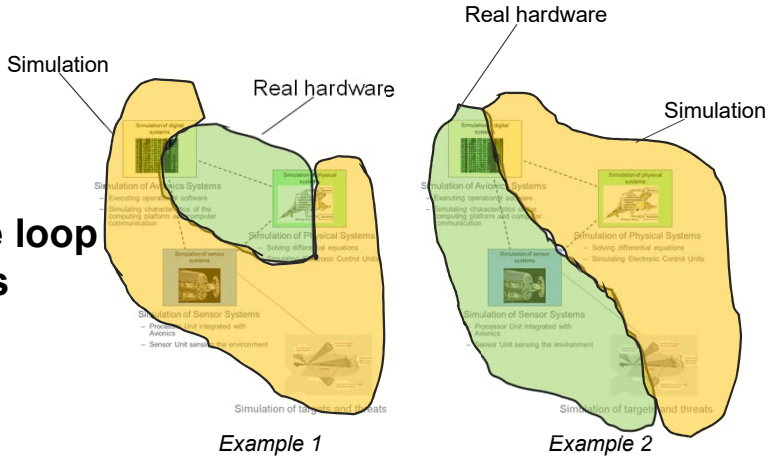
Simulation or real hardware?

Testing in different types of test environments

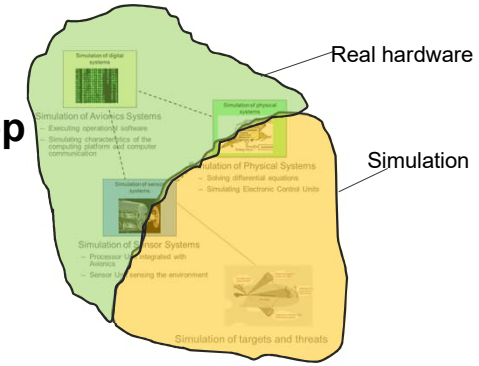
Software in the loop simulators



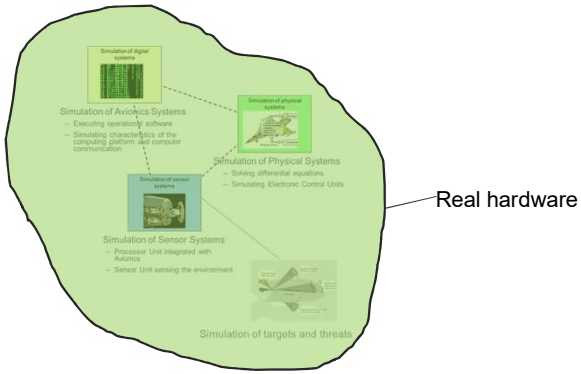
Hardware in the loop sub-system rigs



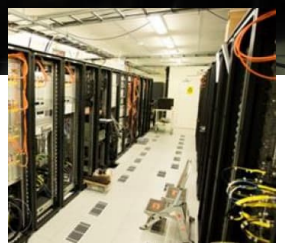
Hardware in the loop system rigs



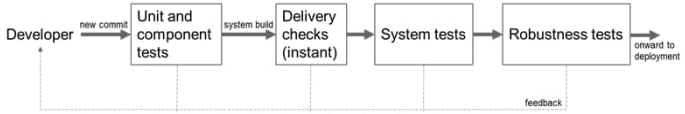
Test aircraft



Practices implemented in the Gripen E project



- **Testing in the continuous integration and delivery pipeline**



- **A simulator on every developer's desk**

- **Exploratory testing of the complete system**

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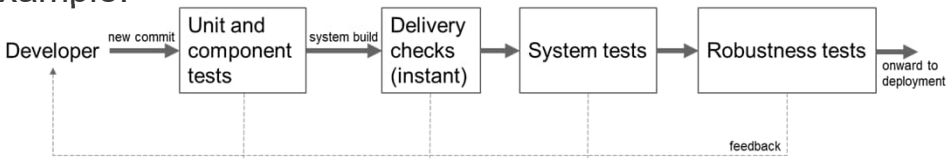
The continuous integration and delivery pipeline

- Creating a pipeline of test activities which evaluate software changes made by the developers
- Example:



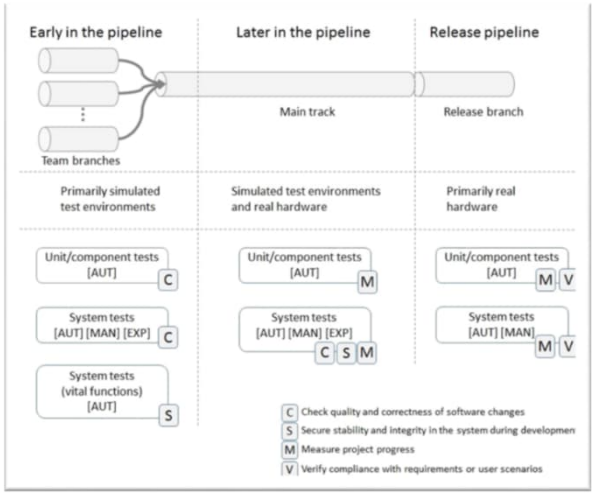
- Design the pipeline with…
  - Unit/component tests and system tests
  - Automated testing and manual testing
  - Testing in simulators and on real hardware

- There is **no optimal pipeline for every product** and every organization
- Designing the pipeline with **a systematic approach** rather than making changes and hoping for the best

Duvall: “Stage builds”

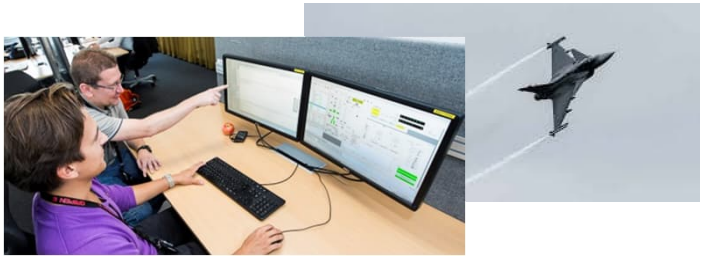
Larman and Vodde: “multi-stage CI system”

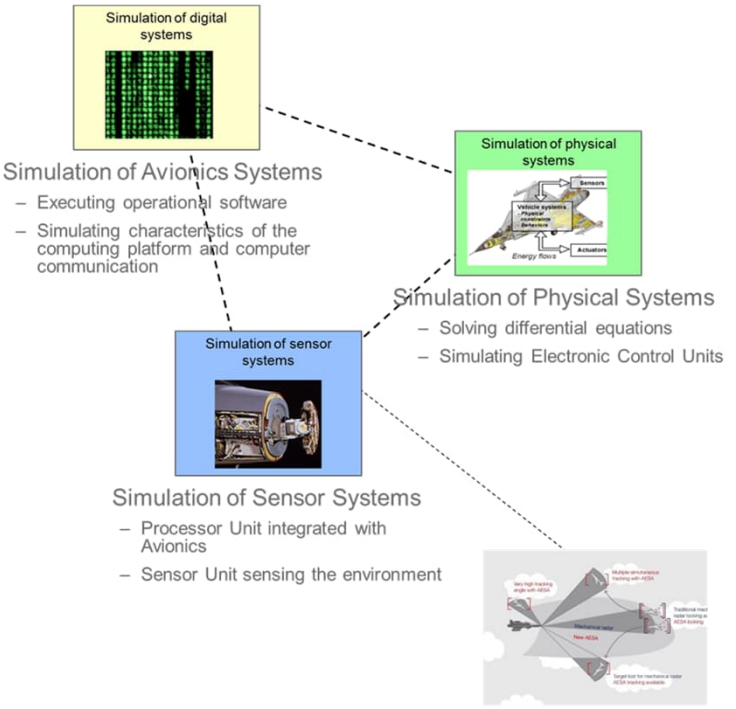
Humble and Farley: “deployment pipeline” or “integration pipeline”



A simulator on every developer's desk

- The MySim simulator is available for all developers from the developer's own desk
- The **developers are more confident** that their software is working





- MySim is also used for automated regression testing on different levels of the product
- **Faster feedback** to the developers

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Exploratory testing of the complete system

- Exploratory testing with **experienced engineers** representing different subsystems
- The test teams identify **complex integration problems** which are difficult to find with automated testing

"We could test according to the ideas we had. We wanted to understand the system that we were building and to find the weaknesses in the system".

"The quality of the problem reports improves if there are people from different subsystems participating at the test".

- The developers test **the complete system** together – not just a software module or a subsystem

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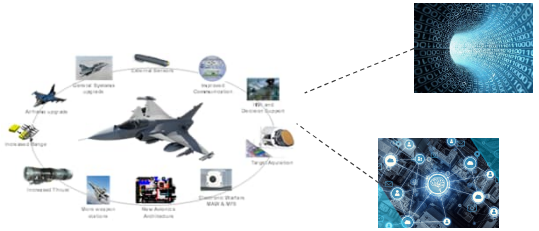
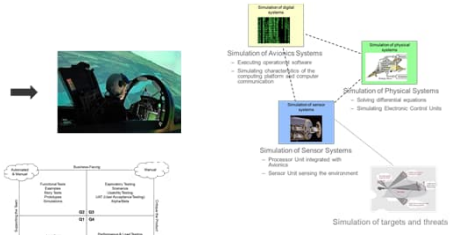
Summary and takeaways

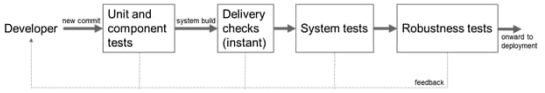
- What is Gripen E?
  - A completely new aircraft
  - A large-scale and complex software system



- Testing a large-scale and complex software system – how is it done?
  - Testing on different levels
  - Combining different test techniques
  - Testing in different types of test environments



- Three examples of practices implemented in the Gripen E project
  - Testing in the continuous integration and delivery pipeline
  - A simulator on every developer's desk
  - Exploratory testing of the complete system

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24