

# PROTOS



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## Hardware in the Loop for Everybody

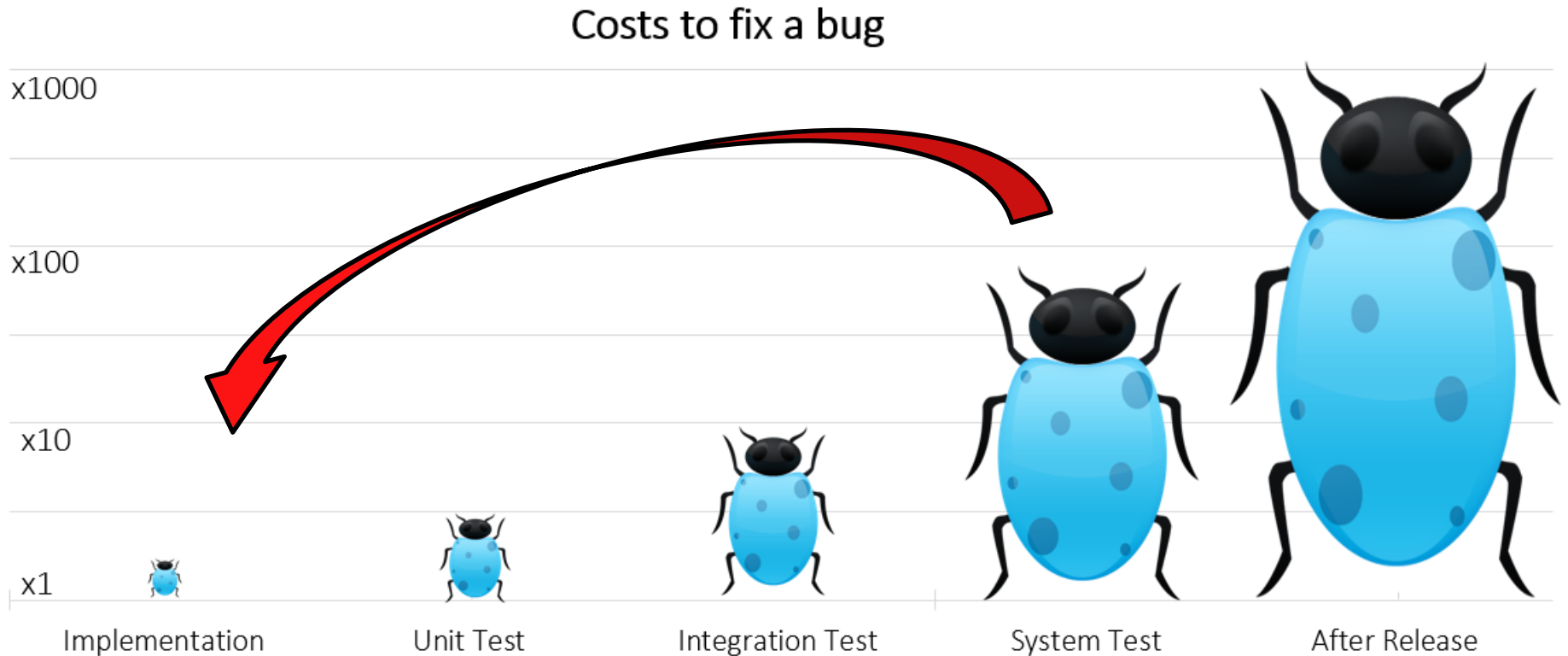
Thomas Schütz

Embedded Testing

München - 20.06.2018

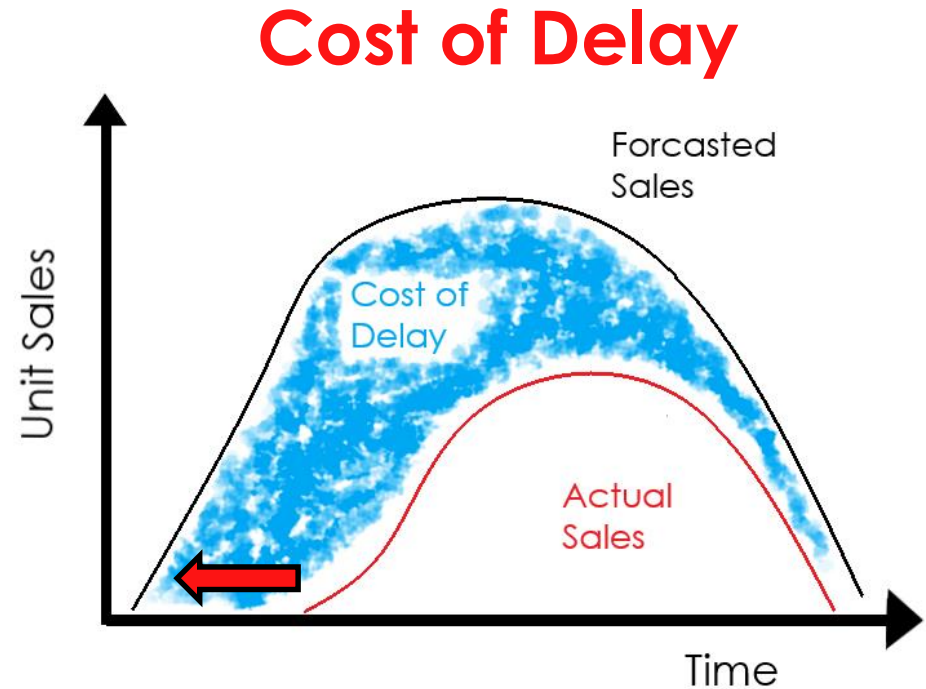
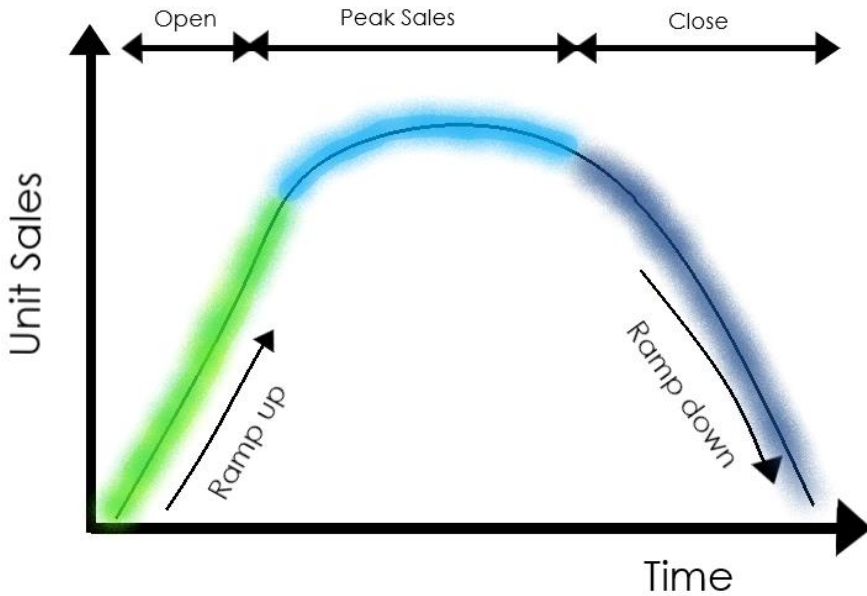
Why?

# What is the Problem and why is it so big?

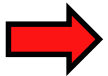


**➔ We need to learn and test earlier!**

# What is the Problem and why is it so big?

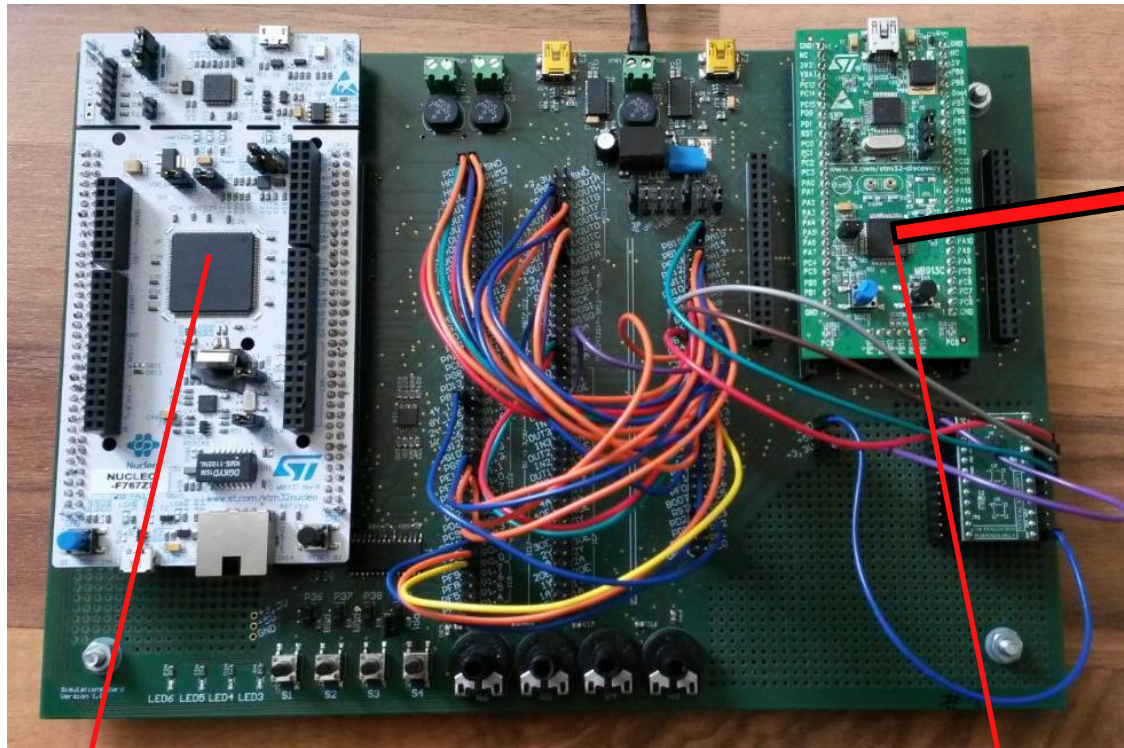


**We need to deliver earlier!**



**We need to be faster!**

# miniHIL Platform



HIL Tester

Application Software (SUT)

➔ 40 + Projects work at Hilti with the **miniHIL**, **eTrice** and **CaGe**

# miniHIL Hardware and Software



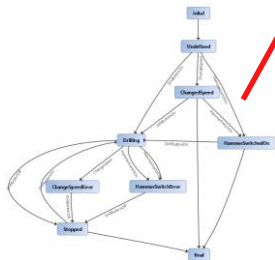
```

RootSequences:
  //SmokeTest
  Initialize
;

Step Initialize:
  action
    targetReset.tristate
    targetButton.tristate
    wait 100 ms
;

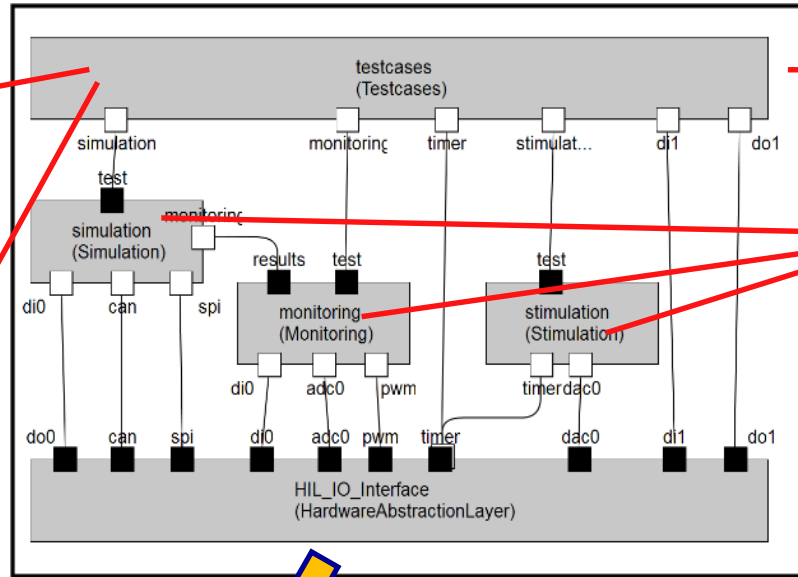
Step PedPressButton:
  action
    targetButton.off // off-on -> low active
    wait 100 ms
  action
    targetButton.tristate // tristate = off
  reaction
    pedGreenIn.on
;
    
```

Test Case Model (CaGe)

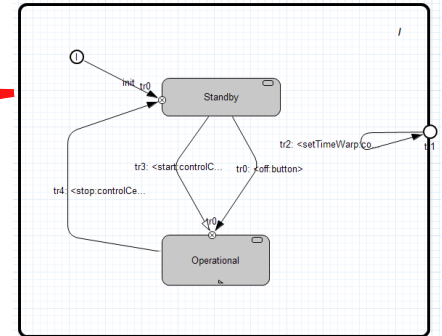


Combinatorial Tests (CaGe)

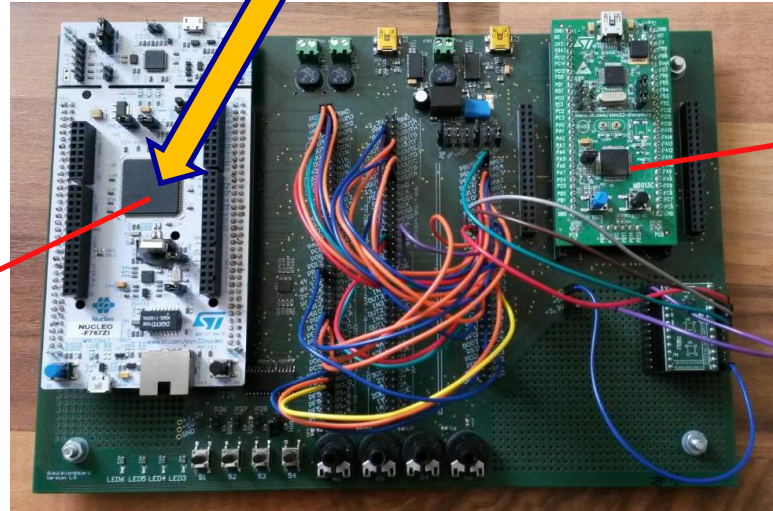
HIL Tester (e.g. STM32F7)



eTrice Structure Model



State machine Model (eTrice)



```

/* receiveEvent contains the main implementation of the FSM */
static void A_PML_receiveEventInternal(A_PML* self, InterfaceItem
int trigger_et = localId + EVT_SHIFTevt;
int chain_et = NOT_CAUGHT;
etInit0 catching_state_et = NO_STATE;
((void)trigger_et); /* avoids unused warning */

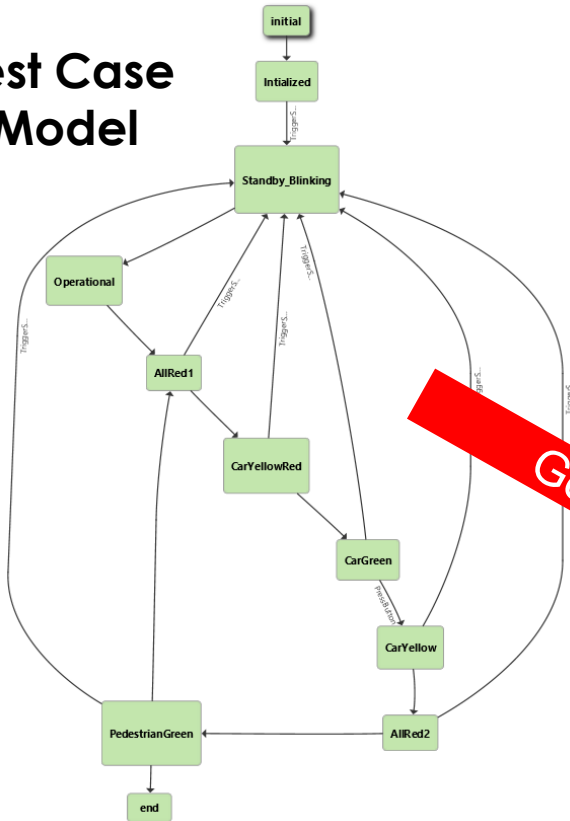
if ((handleSystemEvent(ifItem, evt, generic_data_et)) {
  switch (getState(self)) {
    case STATE_On_OnDelay:
      switch(trigger_et) {
        case TRIG_On_timeout:
          chain_et = CHAIN_On_TRANS_tr2_FRDP;
          catching_state_et = STATE_On;
          break;
        case TRIG_fct_off:
          chain_et = CHAIN_On_TRANS_tr4_FRDP;
          catching_state_et = STATE_On;
          break;
        default:
          break;
      }
    }
  }
}
    
```

System under Test e.g. STM32 (Cortex-M)

# State Transition Testing



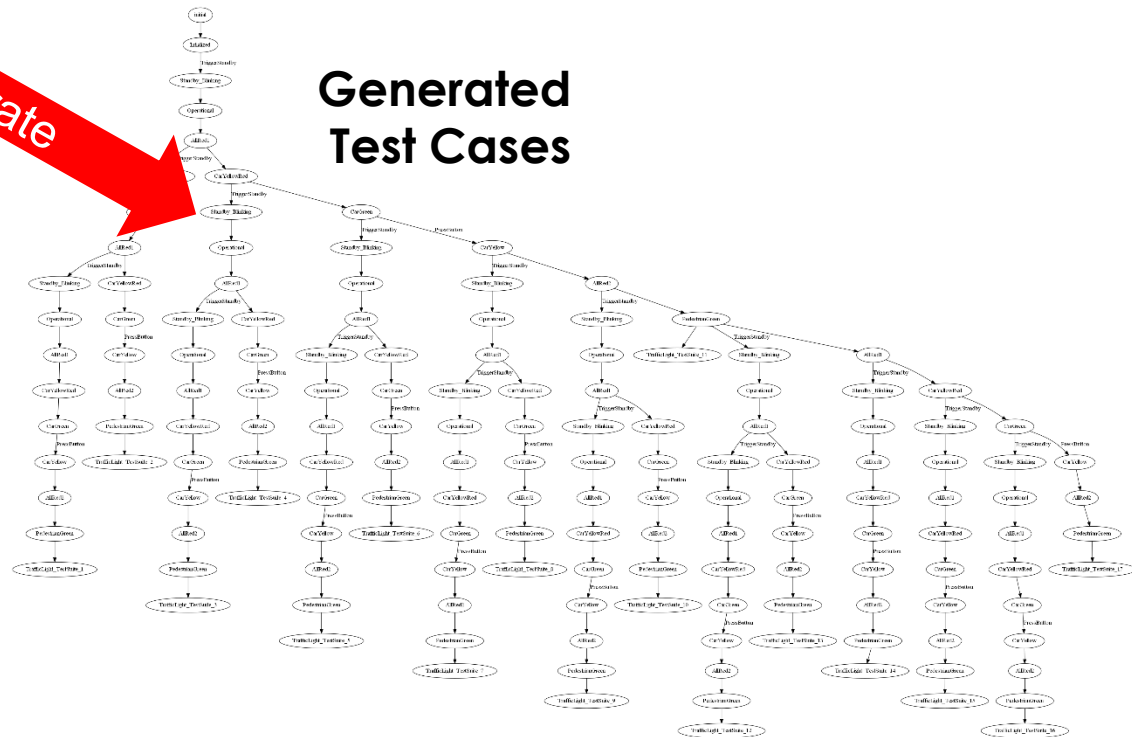
## Test Case Model



- Coverage for Data Combinations (n-wise)
- Coverage for Path Coverage (n-transition)
- Automatic Generation for all Test Cases

Generate

## Generated Test Cases



# Reporting and Feature/ Requirement Coverage



## Feature Coverage Report Overview

**Result: FAIL**

Project: **Project1**

Date: **23-08-2017**

Rev. Info:

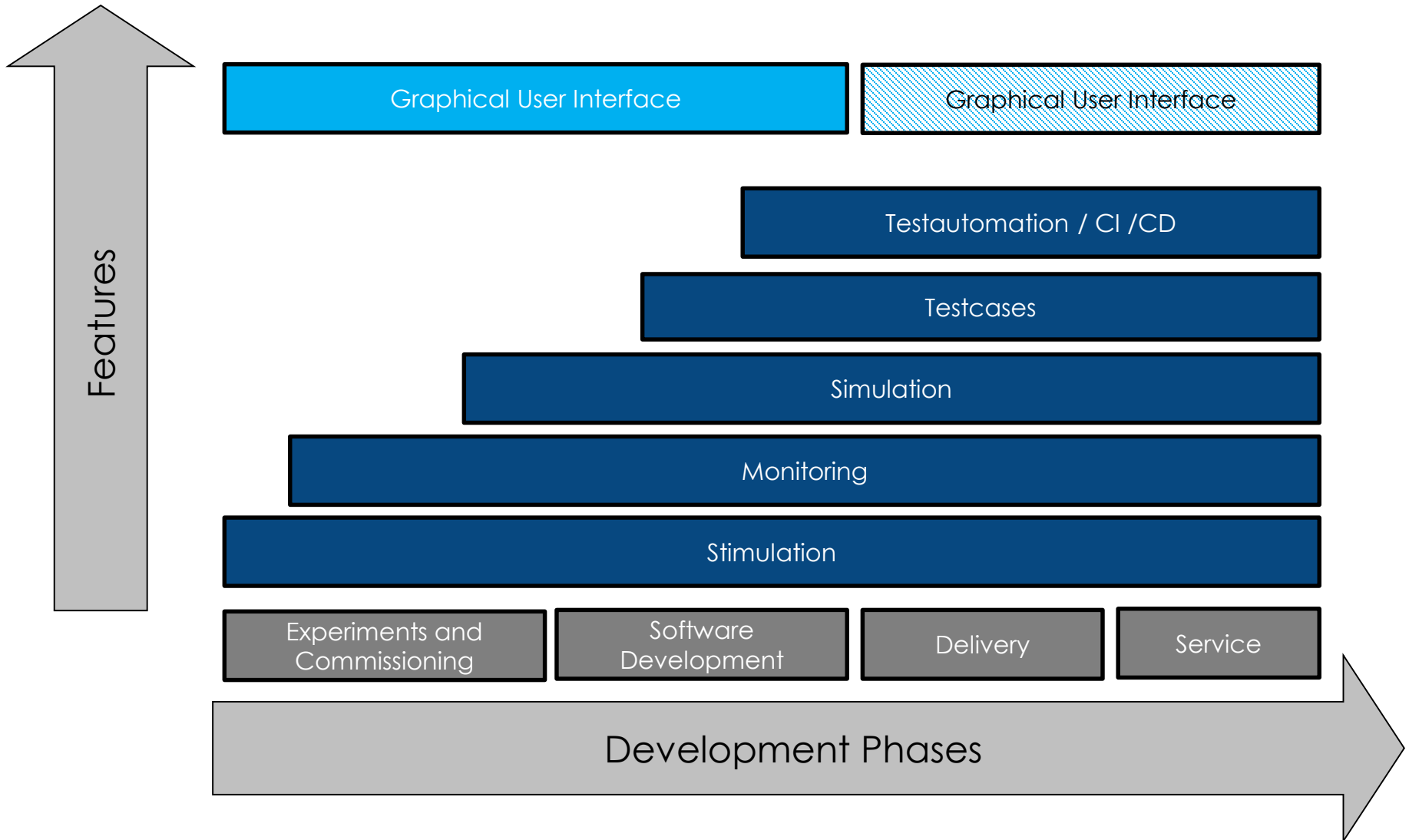
Legend: failing missing issues passing

	PASS	Total	Coverage
Features:	11	43	25.5 %
Testcases:	2652	2653	99.9 %

Feature	Testcases		
<a href="#">Feature 1</a>		100 %	8 / 8
<a href="#">Feature 2</a>		89.4 %	17 / 19
<a href="#">Feature 3</a>		79.3 %	23 / 29
<a href="#">Feature 4</a>		90.9 %	20 / 22
<a href="#">Feature 5</a>		100 %	8 / 8
<a href="#">Feature 6</a>		65.6 %	21 / 32
<a href="#">Feature 7</a>		92.8 %	13 / 14
<a href="#">Feature 8</a>		90 %	18 / 20
<a href="#">Feature 9</a>		85.7 %	6 / 7
<a href="#">Feature 10</a>		80 %	12 / 15
<a href="#">Feature 11</a>		68.4 %	13 / 19
<a href="#">Feature 12</a>		90.6 %	29 / 32
<a href="#">Feature 13</a>		83.3 %	5 / 6
<a href="#">Feature 14</a>		75 %	3 / 4
<a href="#">Feature 15</a>		100 %	9 / 9
<a href="#">Feature 16</a>		82.7 %	24 / 29



# Development Phases and Features



Features

Graphical User Interface

Graphical User Interface

Testautomation / CI / CD

Testcases

Simulation

Monitoring

Stimulation

Experiments and  
Commissioning

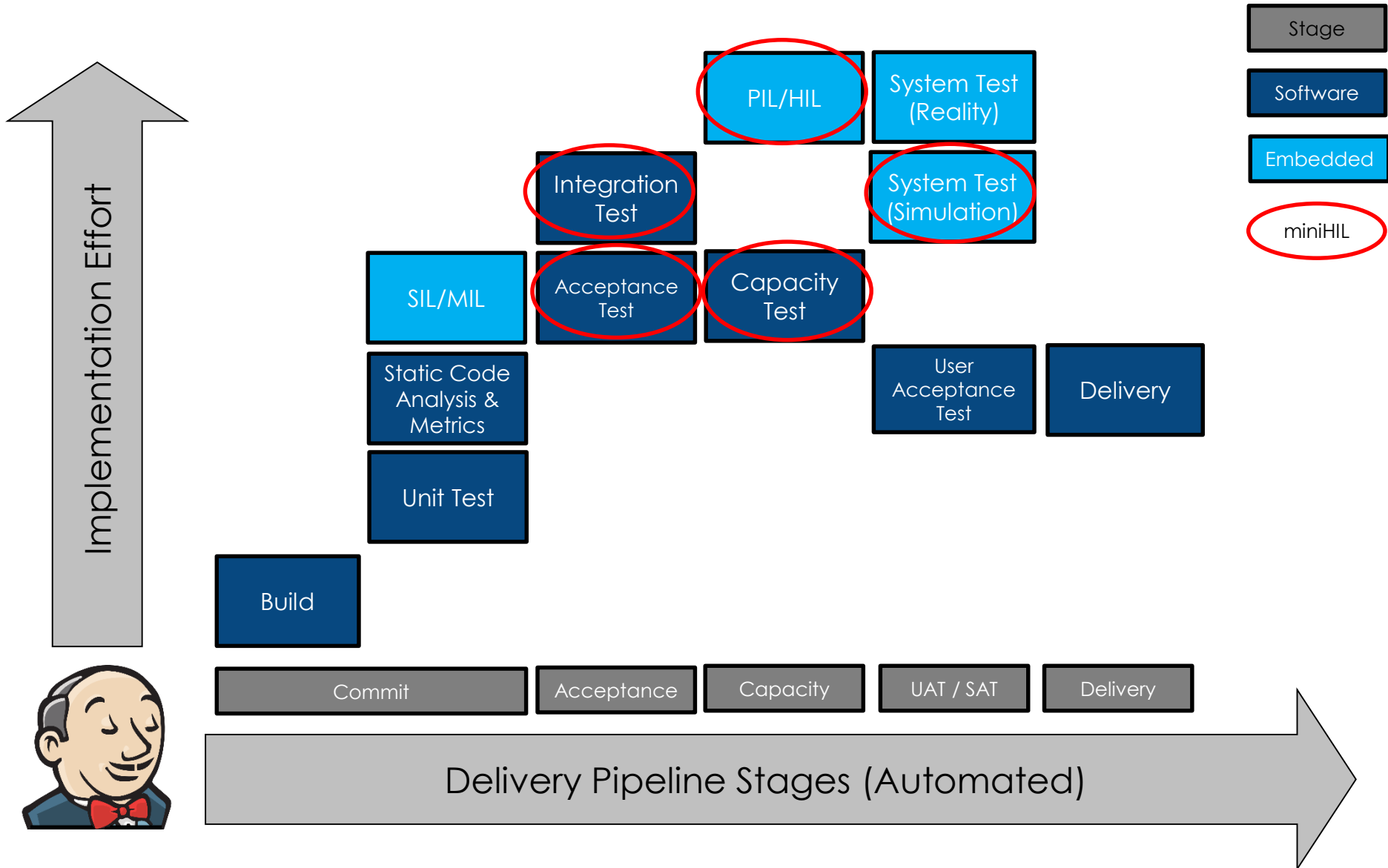
Software  
Development

Delivery

Service

Development Phases

# Automation: Continuous Integration and Delivery Pipeline



# Demo



HIL-Demo-MBT - org.eclipse.etrice.template.c/model/TrafficLightTest.actortest - Eclipse

File Edit Source Refactor Navigate Search Project eTrice Run Window Help

Project Explorer

- de.protos.actortest.rt
- org.eclipse.etrice.examples.c
- org.eclipse.etrice.modellib.c
- org.eclipse.etrice.runtime.c
- org.eclipse.etrice.template.c
  - Binaries
  - Includes
  - doc
  - mscuml
  - doc-gen
  - log
  - mscseq
  - readme.txt
  - results.etu
  - results.xml
  - model
  - model-pool
  - src-gen
  - WindowsMinGW
  - src-gen-info
  - build.gradle
  - checklaunch
  - generate\_Template.launch
  - src

```
195 => C_Defined [ SetParameterC(5) ]
196
197 ; State C_Defined:
198 => Initialized [ ]
199
200 ; State Initialized:
201 => Blinking [ ]
202
203 ; State Blinking:
204 => Started [ ]
205
206 ; State Started:
207 => CarGreen [ ]
208 => StandbyTriggered [ ]
209
210 ; State CarGreen:
211 => ButtonPressed [ ]
212 => StandbyTriggered [ ]
213
214 ; State StandbyTriggered:
215 => Initialized [ ]
216
217 ; State ButtonPressed:
218 => CarGreen [ ]
219 => PedGreen [ ]
220 => StandbyTriggered [ ]
221
222 ; State PedGreen:
223 => CarGreen [ ]
```

PlantUML

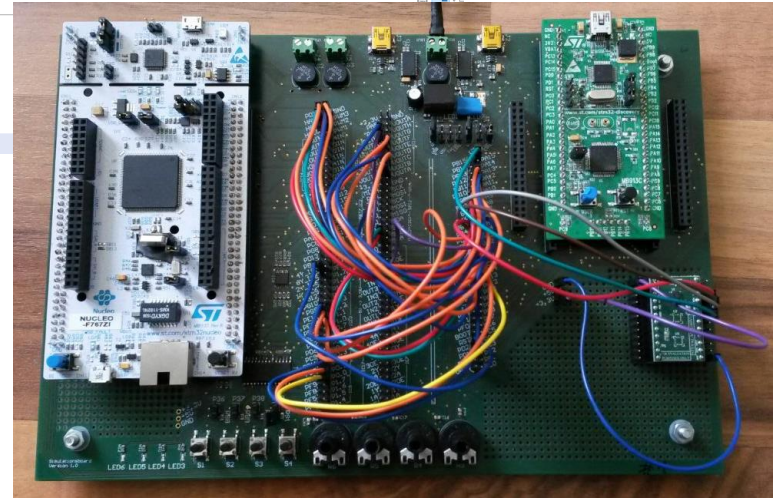
Export SVG

Problems Tasks Console Properties Gradle Tasks Gradle Executions JUnit

TrafficLight\_TestSuite

Runs: 17/17 Errors: 0 Failures: 0

- TrafficLight\_TestSuite (174.000,000 s)
- TrafficLight\_TestSuite\_1 (900,000 s)
- TrafficLight\_TestSuite\_2 (1.600,000 s)
- TrafficLight\_TestSuite\_3 (2.600,000 s)
- TrafficLight\_TestSuite\_4 (3.500,000 s)
- TrafficLight\_TestSuite\_5 (4.000,000 s)
- TrafficLight\_TestSuite\_6 (5.500,000 s)



... any questions?

Thomas Schütz (PROTOS GmbH)

<http://www.eclipse.org/etrice>

<http://www.protos.de>