D-MINT
Deployment of Model-Based Technologies to Industrial Testing

The ITEA D-MINT Project; Overview, Results and Lessons Learnt

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Nokia Siemens Networks
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Presentation Outline

D-MINT
Deployment of Model-Based Technologies to Industrial Testing

- **Project Overview**
  - Project Goals
  - Project Relevance
  - Project Structure
  - Industrial Case Studies
  - Methodologies & Tools
- **Project Results**
- **Lessons Learnt**

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D-MINT
Deployment of Model-Based Technologies to Industrial Testing

D-MINT: Project Overview

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Project Goals

D-MINT
Deployment of Model-Based Technologies to Industrial Testing

- To develop the methodologies, tools and industrial experience to enable European industry to test more effectively and more efficiently

- To drive the deployment of Model-based testing technology into European industry

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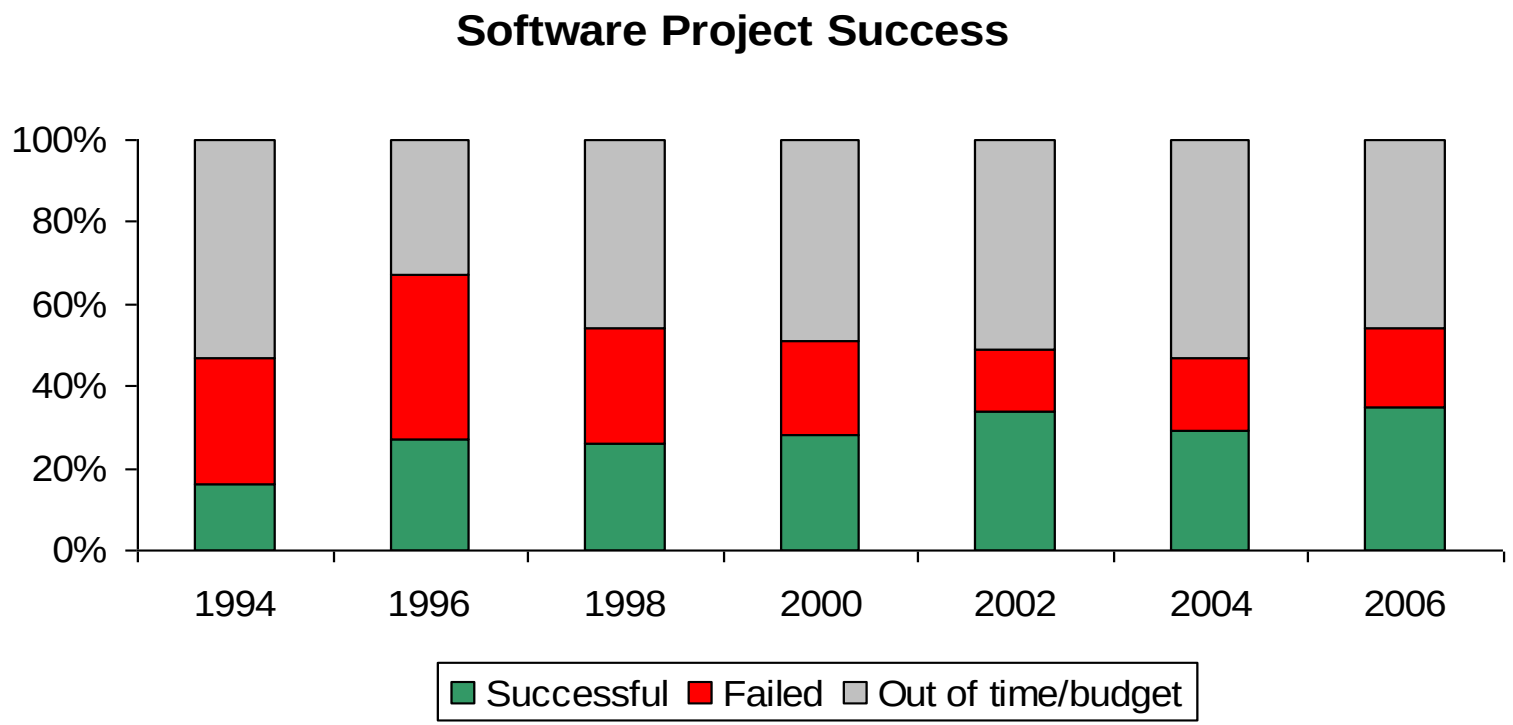
D-MINT: Project Relevance

Project Relevance

Number of successful software projects still less than 1/3[1]



[1]The Standish Group 2006; The Chaos Report

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Project Relevance

- The importance of software in product development is increasing
- 40-60% of product development costs goes in testing
- Improving testing will directly impact competitiveness
- In addition we are facing a series of new specific testing challenges

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Project Relevance

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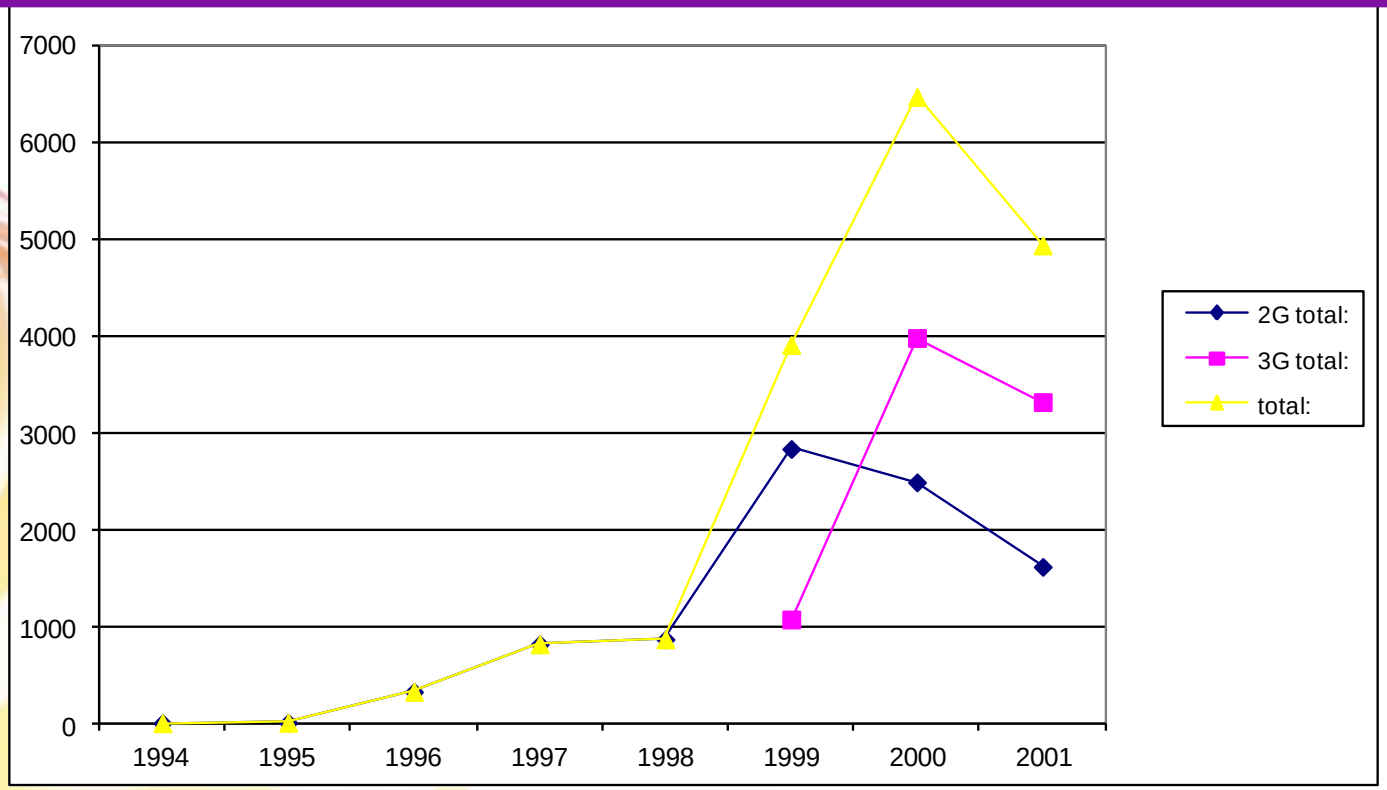
Increasing complexity of products

- GSM Specifications 1306
- 3G Specifications 2290



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Project Relevance

- Pressure to shorten time to market
  - New systems and services must be available quicker
  - How can we reduce testing time?
- Pressure to improve quality
  - SW outage average time for Network elements measured in seconds per year
  - How can we improve testing quality (and quantify it)

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D-MINT: Project Structure

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Project Consortium

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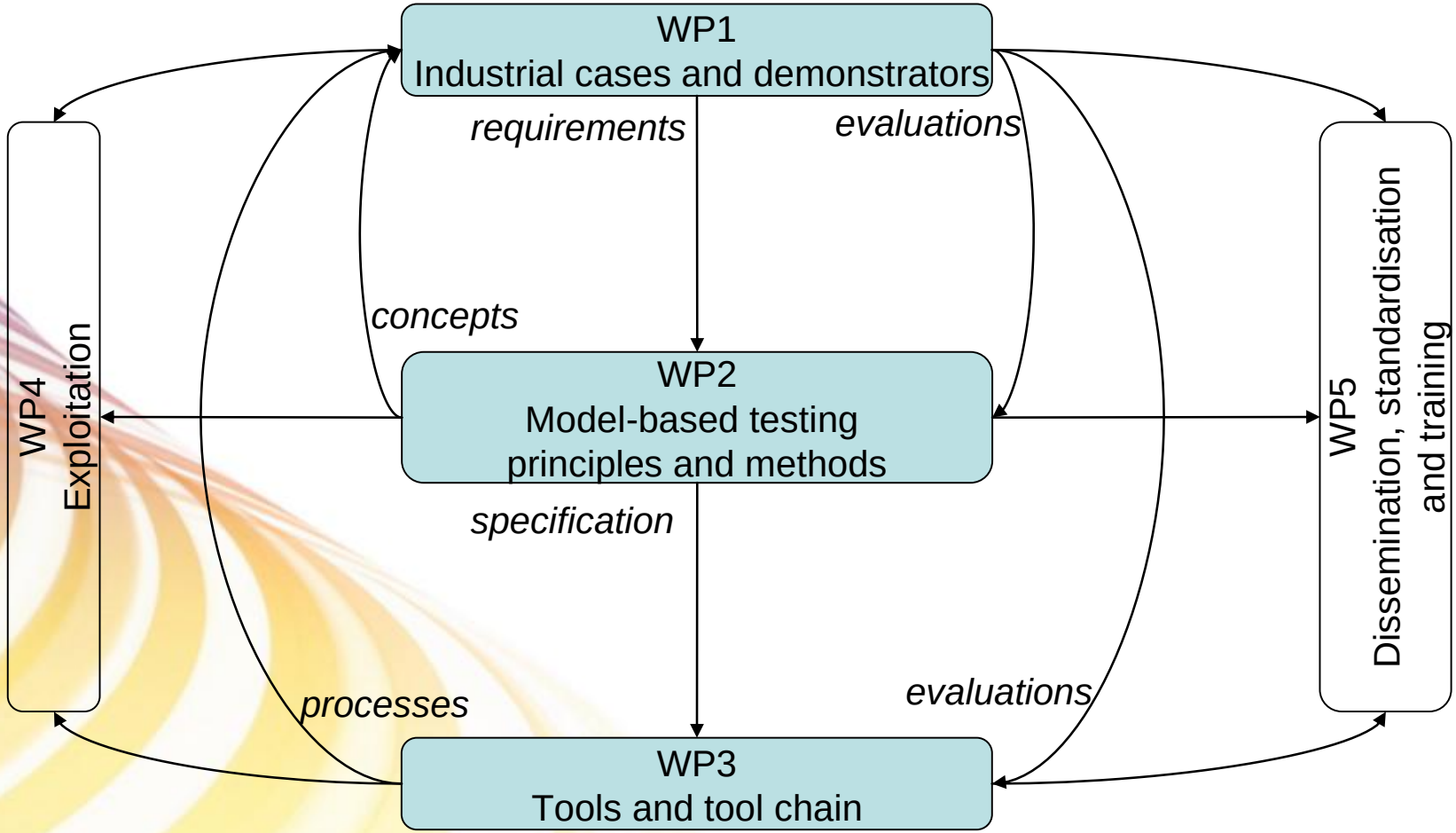
D-MINT Project Structure



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Application Areas

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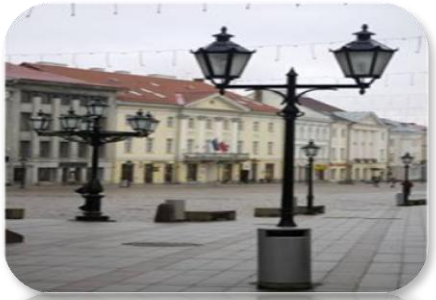
Milling Machines

Industrial Engineering

Cars



Street lights

Telecoms

Video Conferencing

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D-MINT: Industrial Case Studies

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Daimler Automotive Case Study

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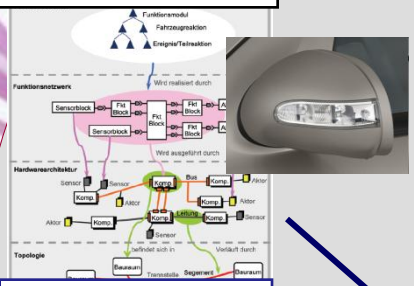
Daimler focus in D-MINT

Exterior door mirror

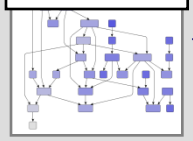


Car electronics architecture

Architecture-based approach

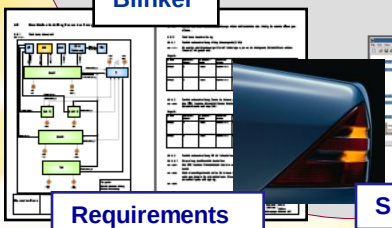
Test cases

Test model

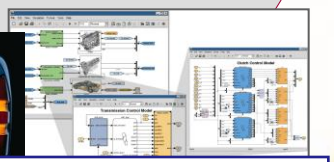


Usage-based approach

Blinker



Requirements



Simulink/Stateflow model

Daimler-internal TestSpec formalism

As target container for the test cases

Test script generation

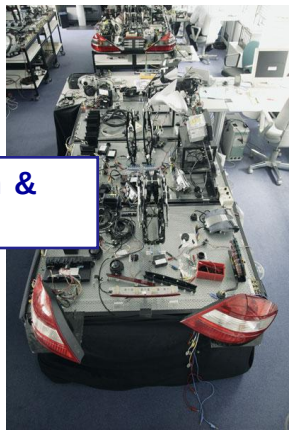
Test execution & evaluation

dSpace tools

PROVEtech:TA

TPT Time Partition Testing

Test cases to be executed in HIL test environment



Covering

- model lines
- test stages

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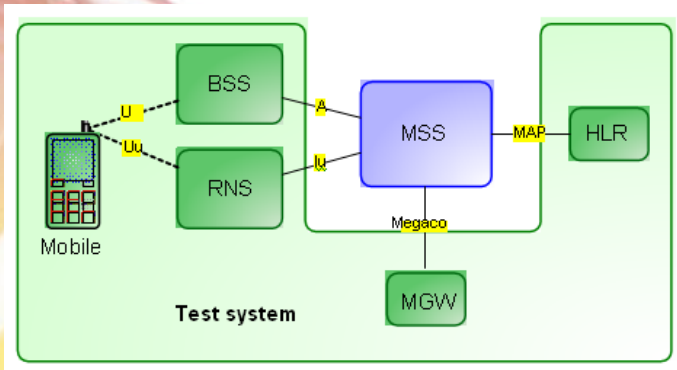
NSN Telecom Case Study

D-MINT Deployment of Model-Based Technologies to Industrial Testing

- SUT: *Mobile Switching Server* (MSS)
- MSS is responsible for establishing calls and to control the handover of mobiles among different cells
- Models are built and test cases are generated with QTronic tool

Test environment for MSS



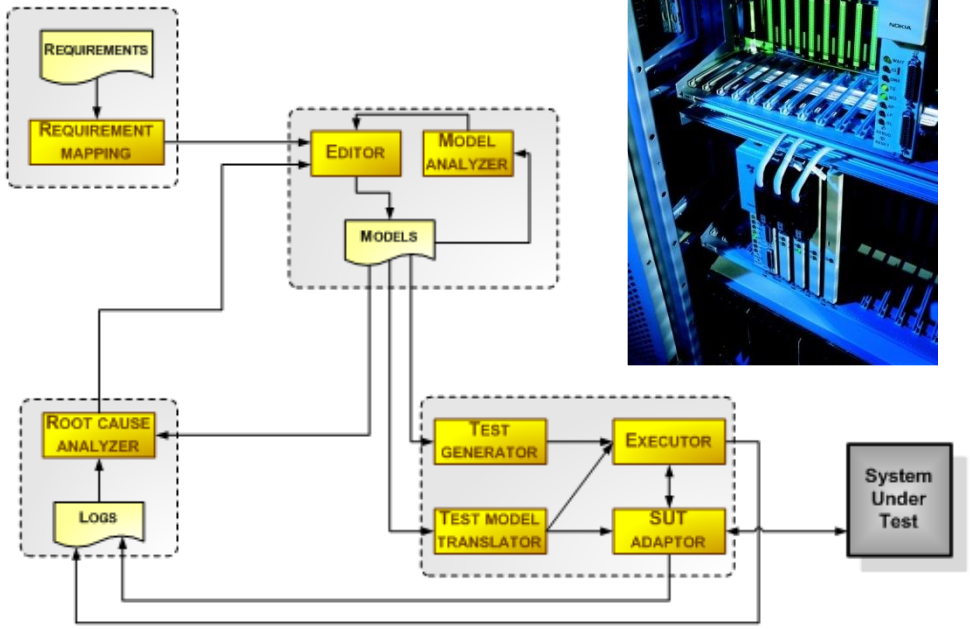


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ABB Production Engineering Case Study

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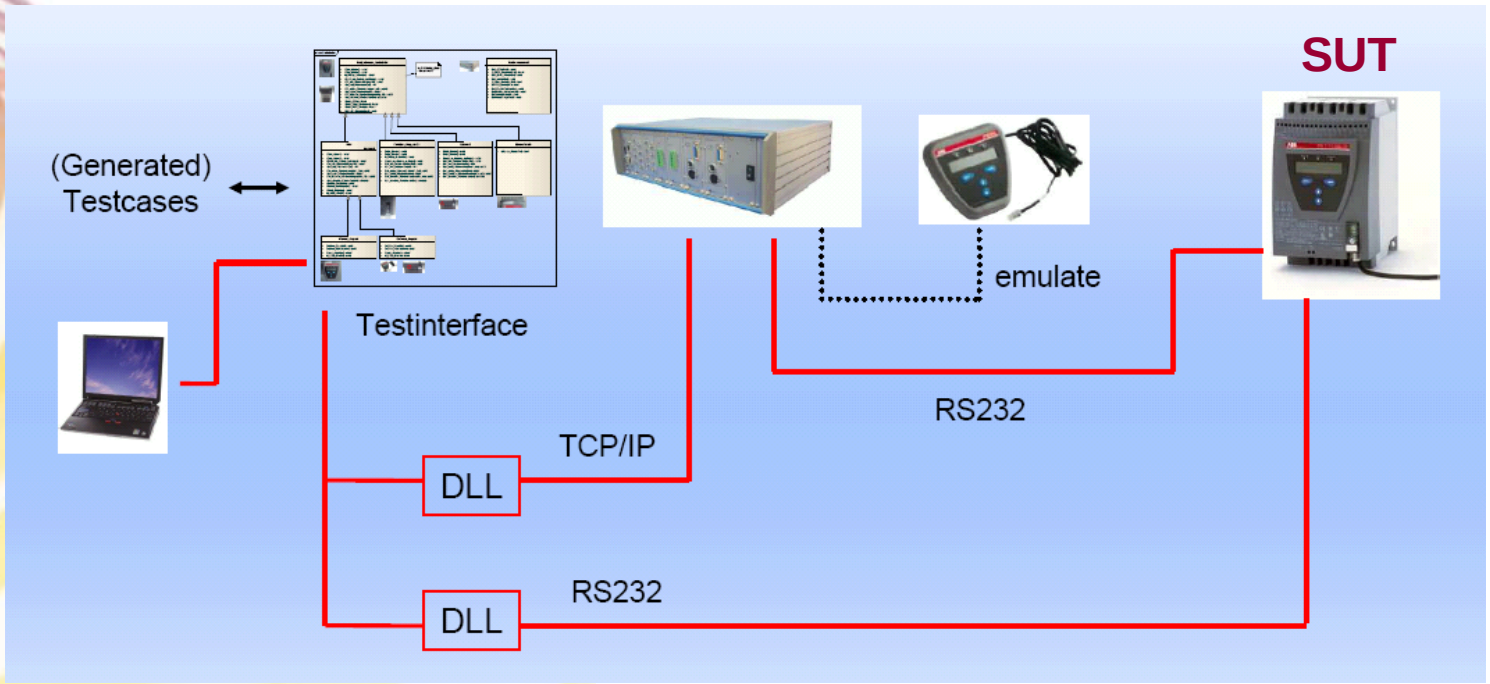
- SUT: *soft starter* (a device to smoothly start and stop an electrical motor)
- Design models in use: UML use cases and class diagrams
- Test model in use: usage model
- Test model derived from requirements and UML models, then test cases are derived from test model and executed



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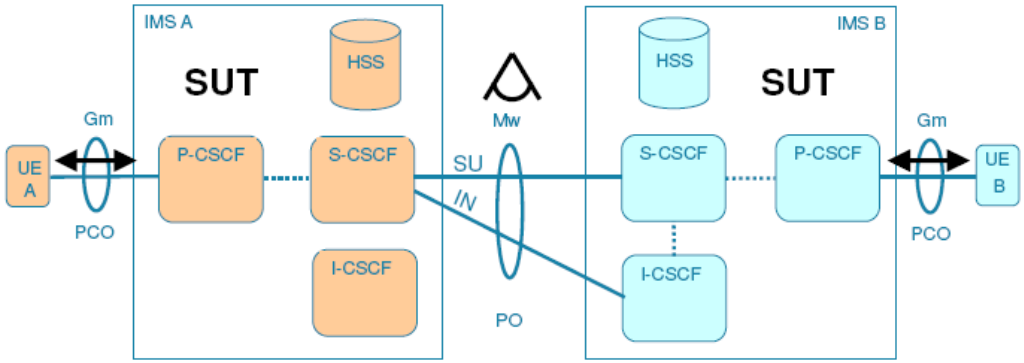
ETSI Telecom Case Study

- SUT: *IP Multimedia Subsystem* (IMS)
- The case study focuses on the assessment of interoperability of basic services such as basic Voice over IP (VoIP) call and instant messaging between two distinct IMS networks
- Both functional and conformance tests
- UML state charts are used to model the SUT, test cases are derived from this

SUT: System of 2 IP Multimedia networks



UE = User Equipment (Terminal)
CSCF = Call Session Control Function (~Proxy)
HSS = Home Subscriber Function (~User Database)

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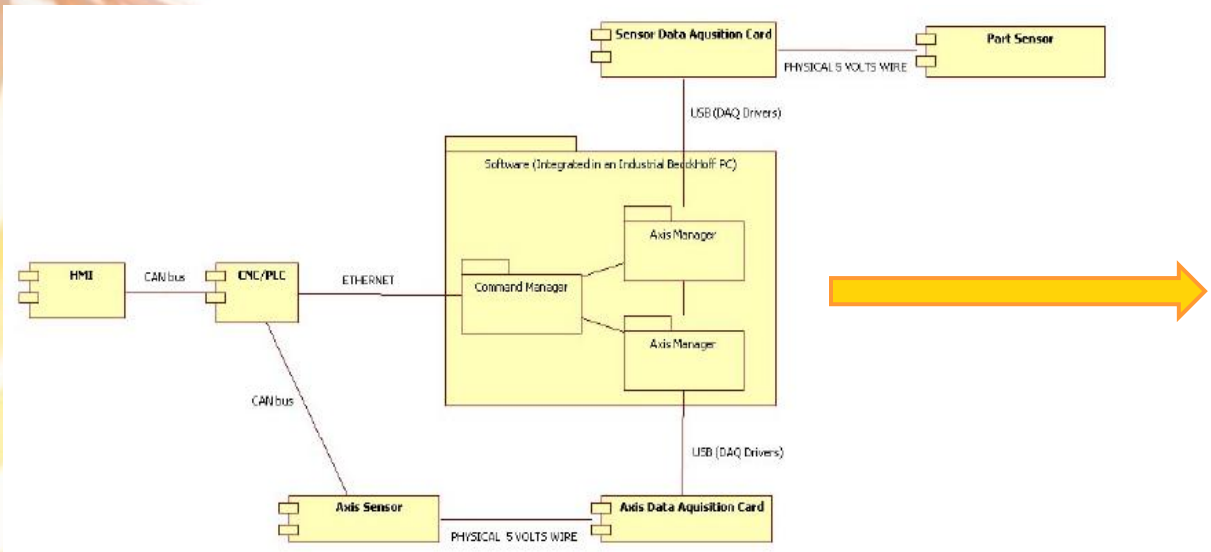
Soraluce/Ideko Production Engineering Case Study

- SUT: DIGITMILL mechatronic solution as part of a milling machine
- Focus in this case study is to get a more systematic test process based on model-based testing
- Models in use: several UML diagrams (component, architectural, sequence, state diagrams)
- Test case derivation from UML diagrams
- Demonstrator: DIGITMILL milling solution (used e.g. for manufacturing wind power towers)



SUT: DIGITMILL

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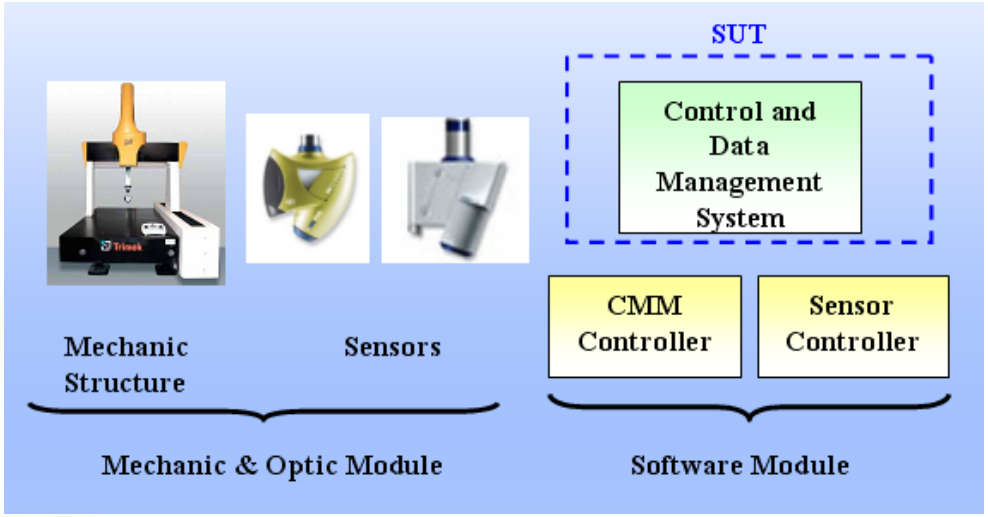
Trimek/Datapixel Production Engineering Case Study

D-MINT Deployment of Model-Based Technologies to Industrial Testing

- SUT: Coordinates Measuring Machines (CMM) control software (which is called CDMS) for controlling a measuring system
- Focus: test case derivation from UML models
- Models in use: UML class, sequence, state diagrams

SUT: measuring system



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Eliko City Street Lights Case Study

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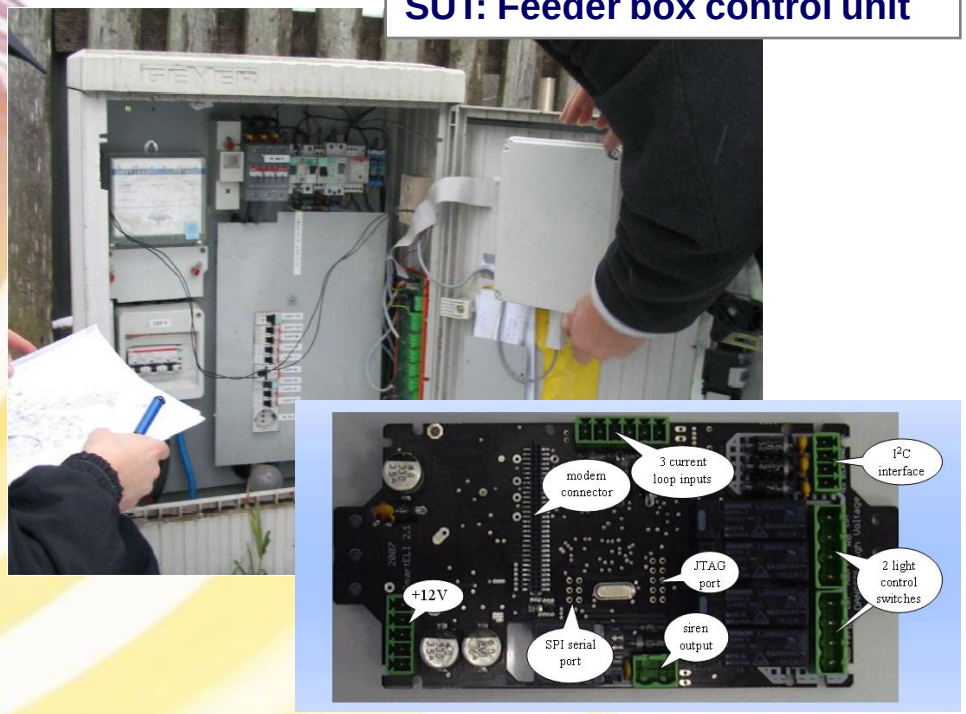
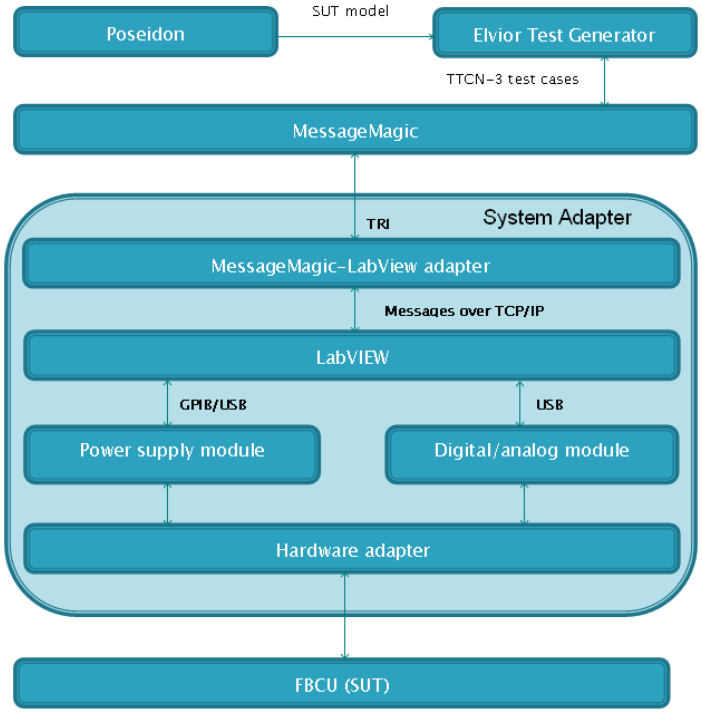
- SUT: Eliko street lighting control system feeder box control unit (FBCU)
- Models for the SUT: UML state charts, produced with tool Poseidon
- Elvior test generator derives test cases from state charts

SUT: Feeder box control unit





Test system architecture

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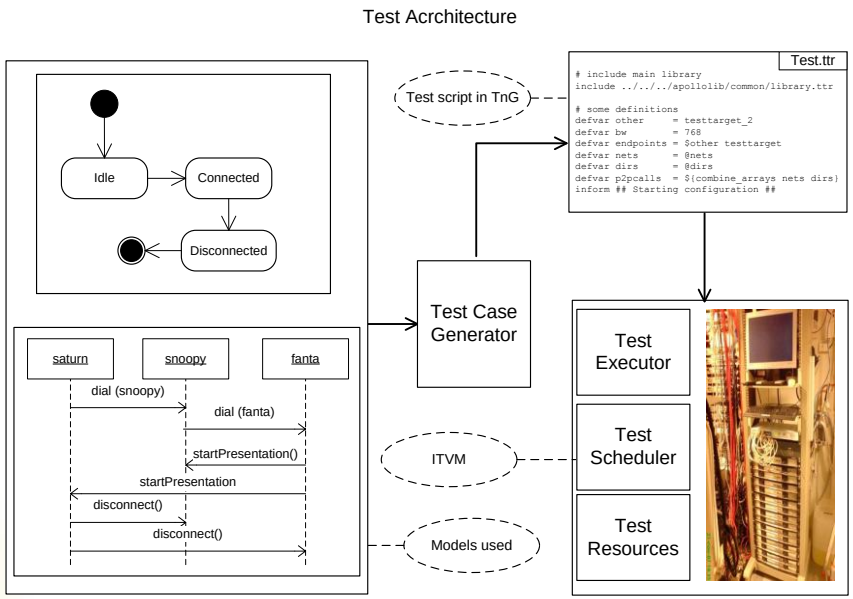
Tandberg case study

- SUT: Video conferencing systems with the support for multiple simultaneous calls and presentations
- Focus: Model-based functional, stress, and robustness testing
- Models in use: UML state machines, sequence diagrams, and profiles such as MARTE and UML Testing Profile



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D-MINT: Methodologies and Tools

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D-MINT basic technical idea
(automotive example)

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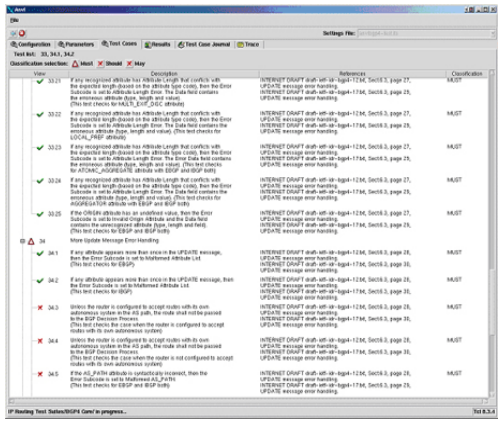
Model

Test Cases



On the basis of models test cases will be derived. Test cases will be used to dynamically check the system under test

System under Test

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Several technology application domains

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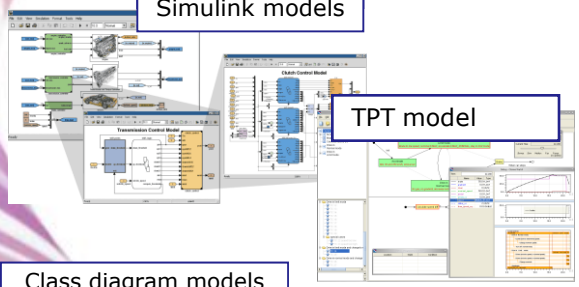
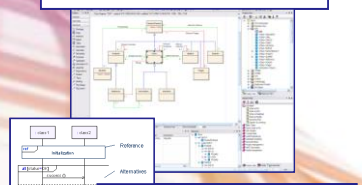
Models

Simulink models



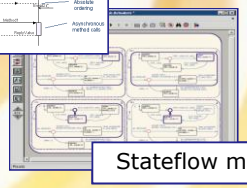
TPT model

Class diagram models

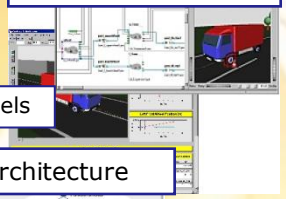


Interaction models

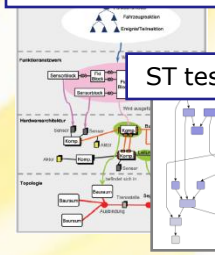
Stateflow models



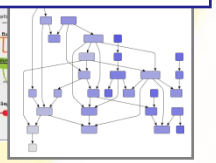
CamelView model



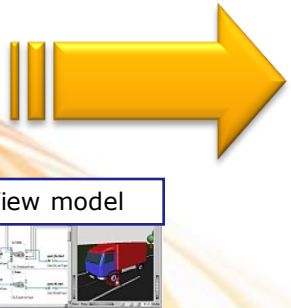
Architecture



ST test model



Use case models



D-MINT Test Framework

Test Cases

SUTs

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D-MINT Approach

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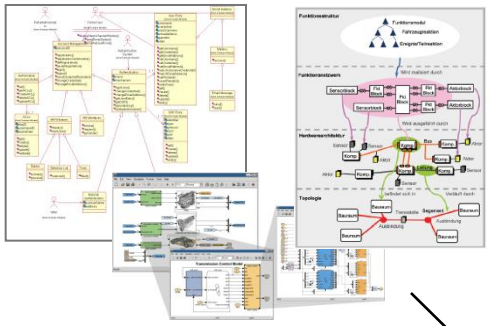
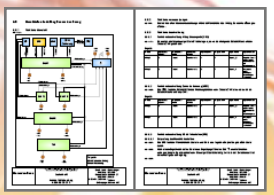
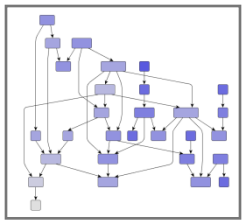
Design/development models



Classical approach

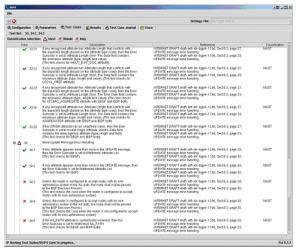


Requirements



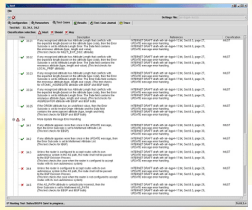
Test model

Advanced approach



Test Cases

Results of FMEA/Risk Analysis



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Architecture-Driven Test Design

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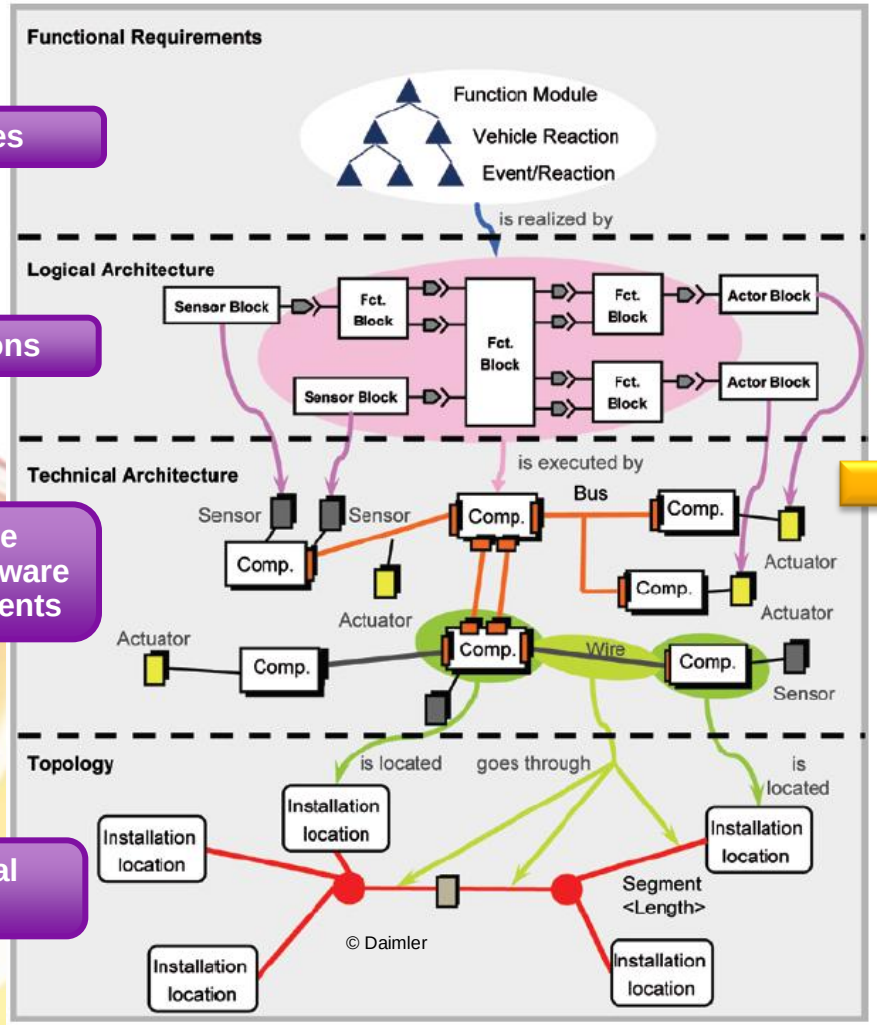
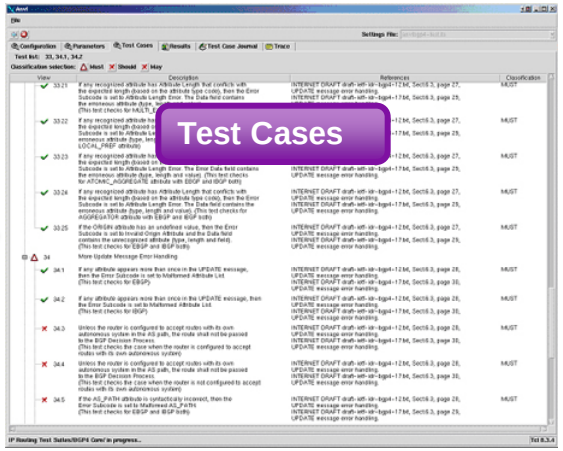
Features

Functions

Hardware and software components

Technical layout





Test Cases

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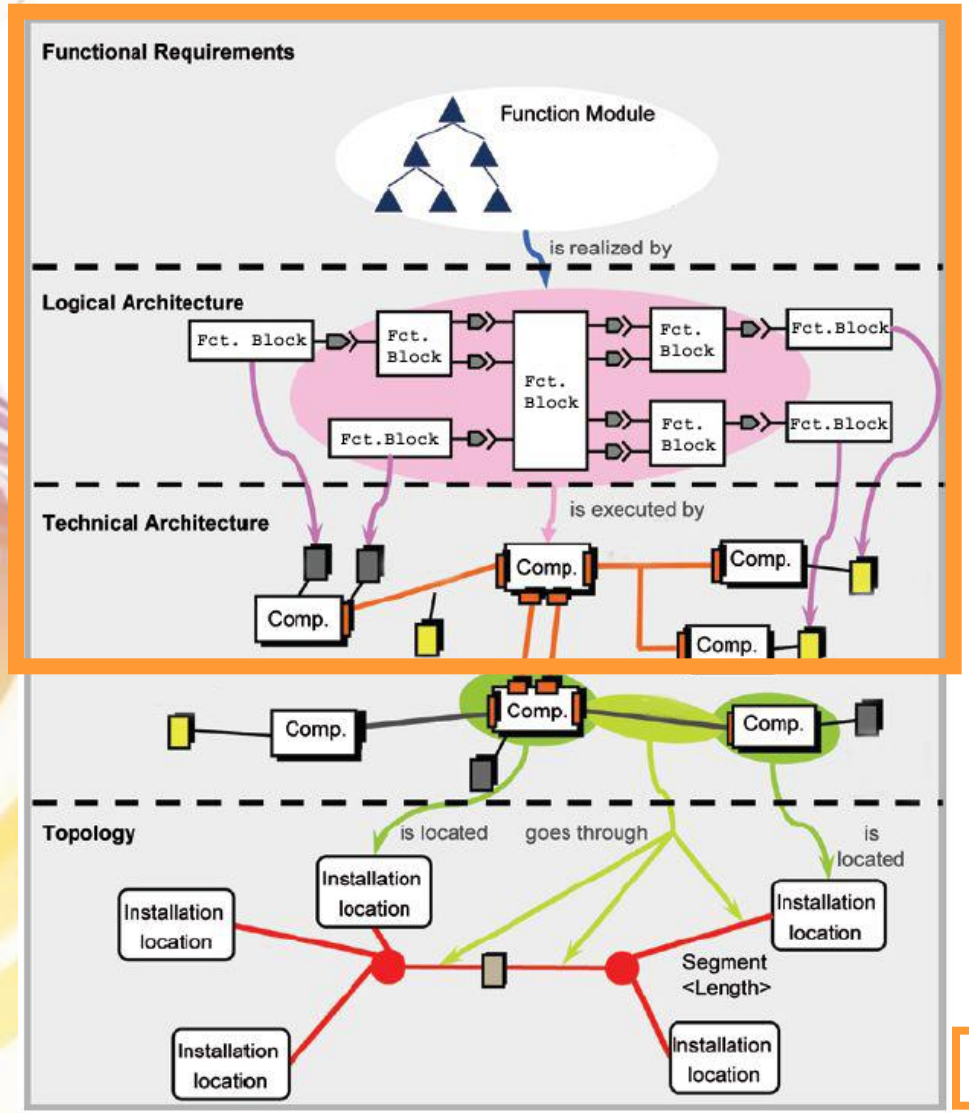
NSN Case Study Mapping



Functional requirements in Doors and SysML

UML structure, data and behavior models

Specific server configurations defined in product documentation

(not explicitly tested)

Incorporated in test system design – no explicit model

Addressed in the case study

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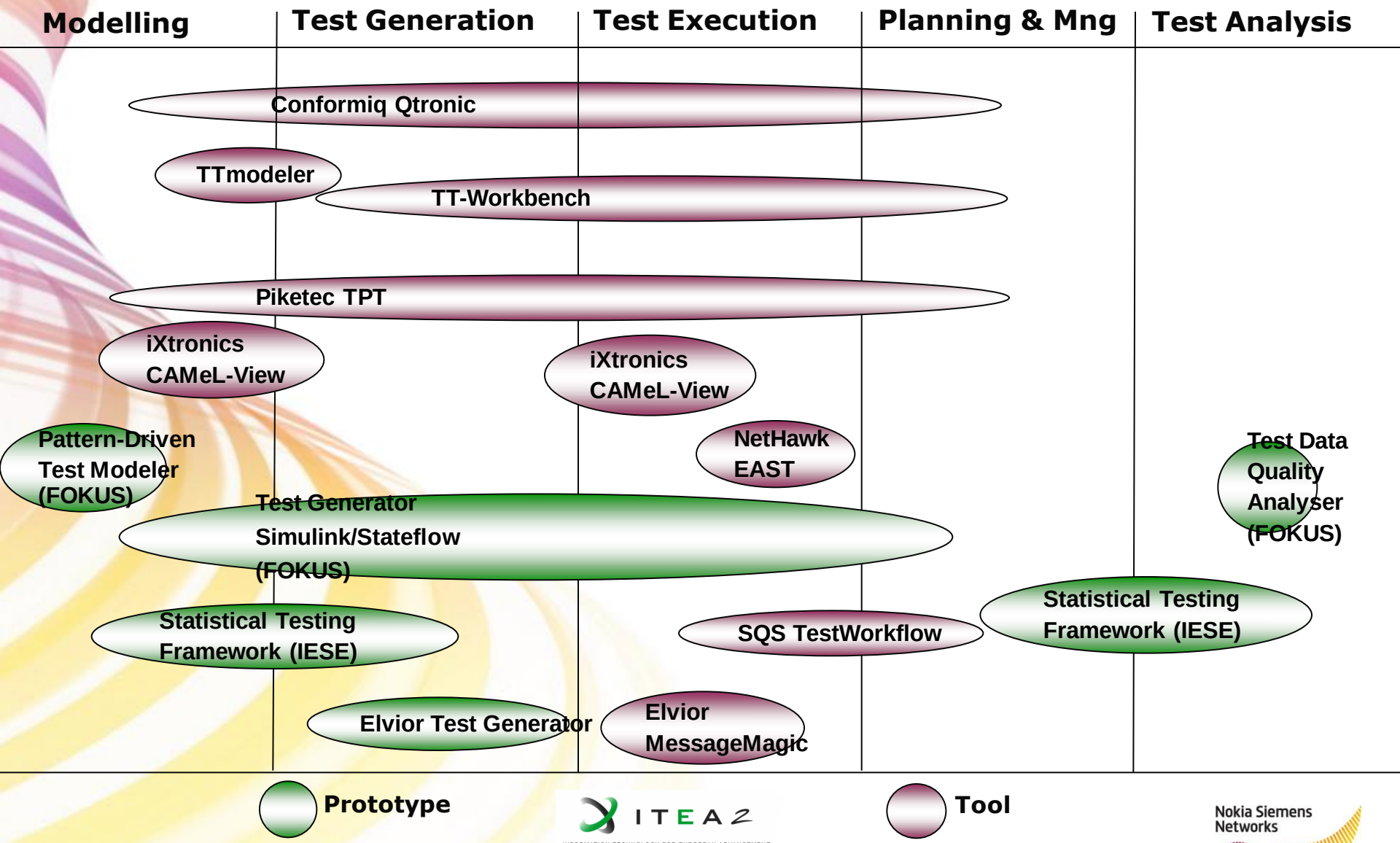
D-MINT Tools



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Key Model Based Testing Tools

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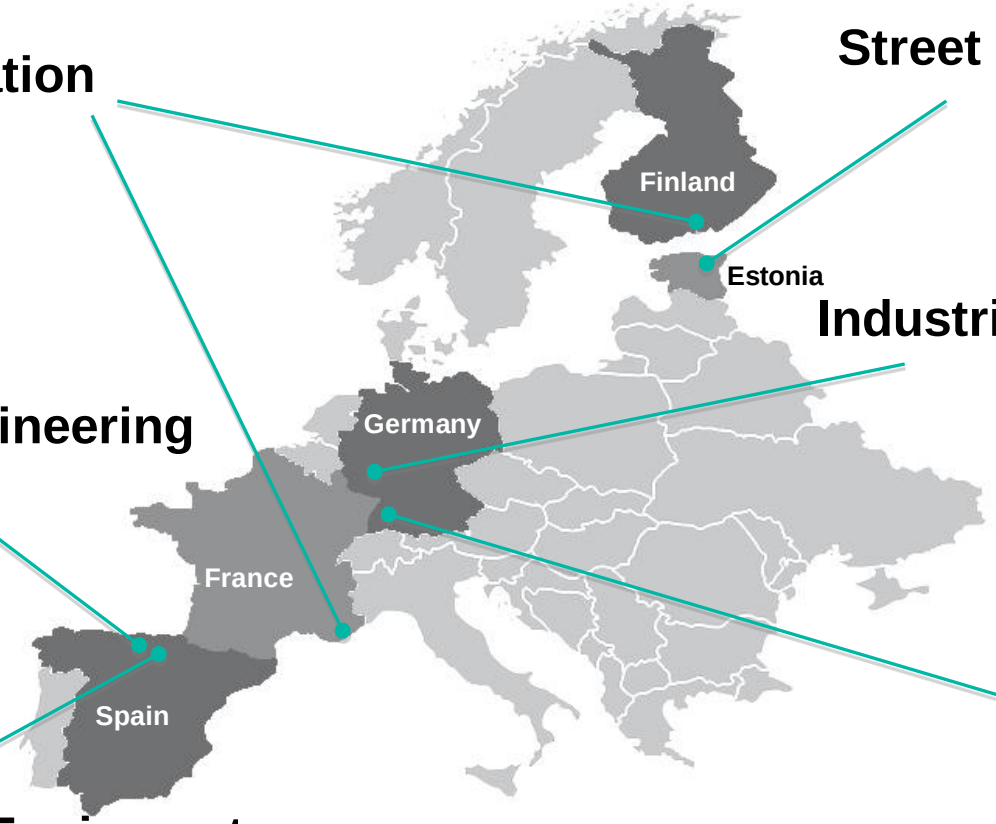
Deployment of Model-Based Technologies to Industrial Testing

Telecommunication

QTRONIC™

Street Lights Control

MOTES



Industrial Automation

TTmodeler

TPT Time Partition Testing

Production Engineering

TTmodeler

Automotive

TPT Time Partition Testing

QTRONIC™

Manufacturing Equipment

TTmodeler

MOTES

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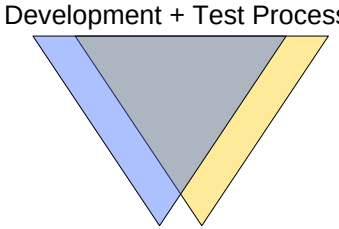
D-MINT: Project Results

Demonstrators

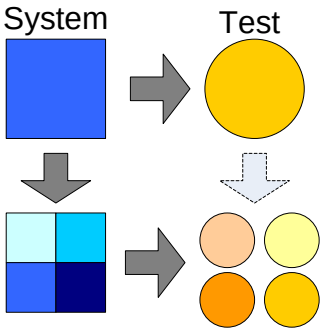
D-MINT Innovations

1. System-architecture-driven testing

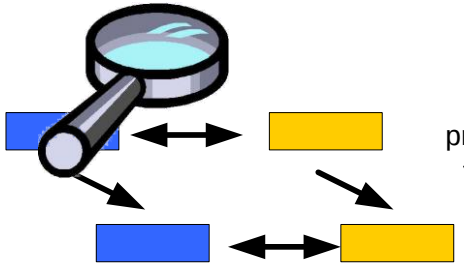
2. Model-based integrated system and test development



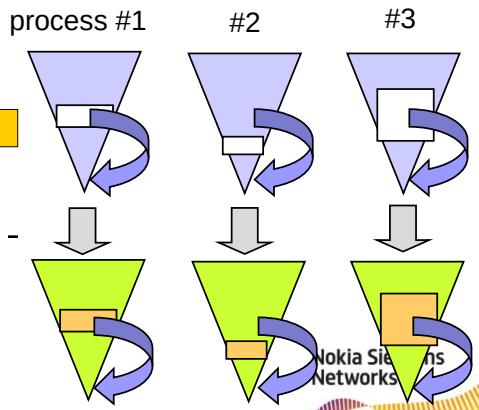
3. Automated test-case refinement in sync with system model refinements



4. Automated consistency checks of requirements, models and test cases



5. Statistically controlled model-based test processes



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Competitive Comparison Criteria

	Comparison Criteria	Comments
Test Design Tool	Ease of use	For e.g. a simpler notation such as OCL vs. fully blown language such as Java & UML etc.
	Execution	Ability to execute generated test cases automatically against real SUTs
	Scalability	Scalability of the tool for large and complex models
	Reporting	Reporting on coverage, test cases and their linkage to the model
	Debugging	Ability to debug models and test cases, simulate
	Test Case Formats	Test cases in many formats from human readable documents to standard languages such as C, C++, Java, TTCN-3 etc.
Integration	Requirement Mgmt. Tools	Work with requirement management tools such as DOORS or ability to integrate with such in-house tools
	Test Management Tools	Work with test management tools such as HP Quality Centre or ability to integrate with such in-house tools
	System Modelling	Work modelling tools such as Tau, Rhapsody, Enterprise Architect or ability to integrate with other tools
	Eclipse Support	Support for Eclipse for seamless working with other testing and development tools such as modelling, requirement management or test management tools

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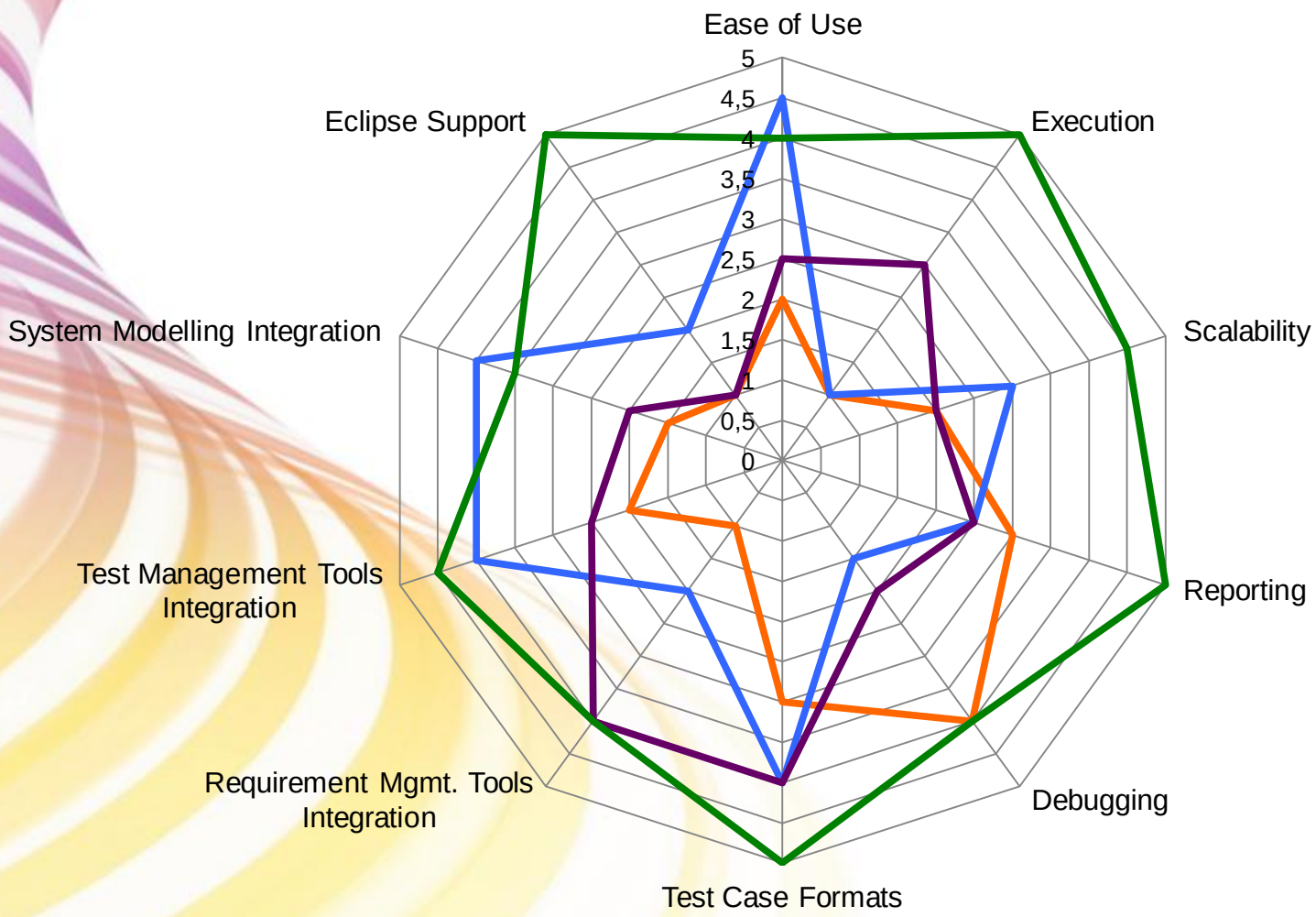
Competitive Position



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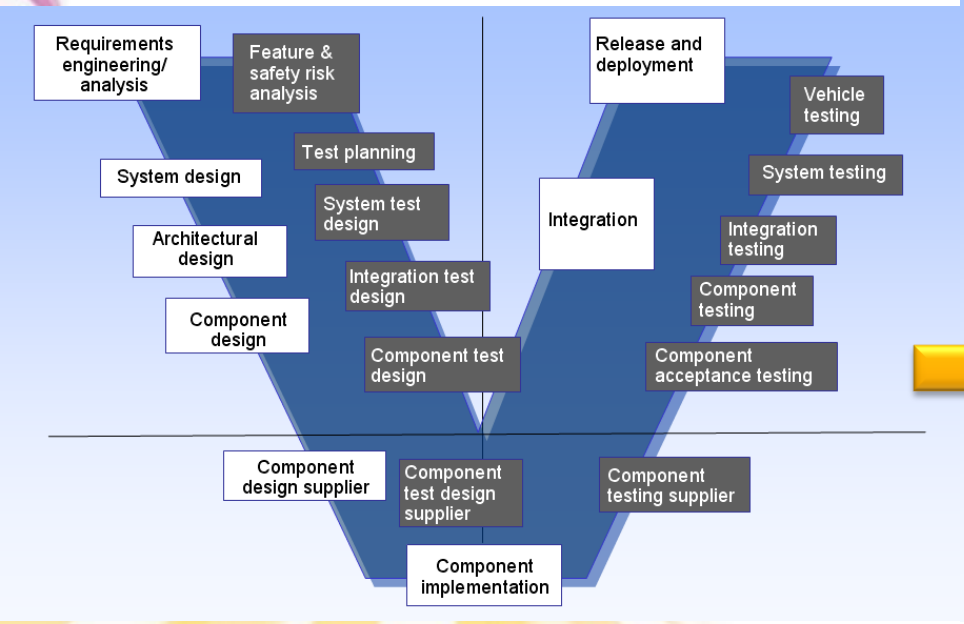
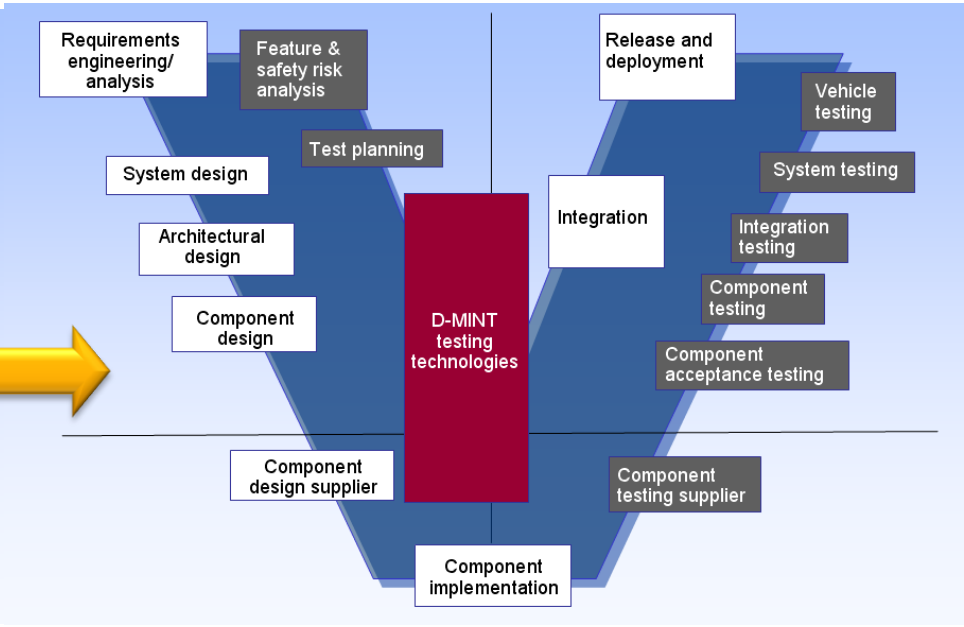
Test process improvement measuring

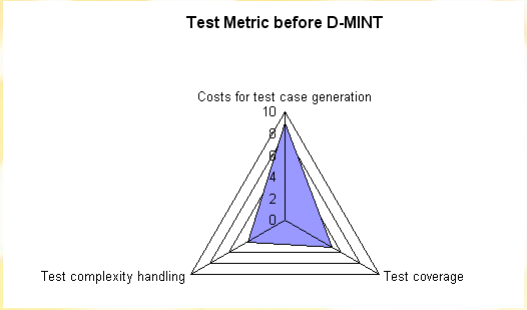
D-MINT Deployment of Model-Based Technologies to Industrial Testing

Process now

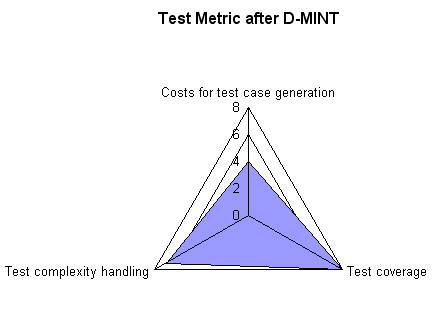


Process after integration of D-MINT MBT





Based on metrics and numbers



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Overall Case Studies Evaluation Results

The D-MINT case studies have shown that

- adaptation efforts for MBT (initial investments in training, integration in existing test processes,…) are high, but this effort is seen as an one-time activity
- MBT is very benefical for testing activities with several iterations

D-MINT technologies enable

- **test cost reduction** of at least **15%** by automation and efficient test case generation (reduction of time to locate defects as well as test case generation & execution efforts)
- a **higher test coverage** of at least **10%**
- **improved handling of increased test complexity** by means of systematic appyling (reusable) models (here, the vision of test models instead of test cases is supported)

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Fast Exploitation During the Project

D-MINT Deployment of Model-Based Technologies to Industrial Testing

Usage of D-MINT technology by the Transfer Partners

- ELIKO has used D-MINT tools and technology for products that are already delivered and in use in the field
- ABB decided to use D-MINT results for the next version of the Softstarter
- Daimler has decided to use D-MINT technologies for ECU-Software Testing

Tool Vendors who already put their Products on the Market

- iXtronics Toolbox
- Testing Tech TTmodeler
- Conformiq Qtronic

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D-MINT: Lessions Learnt

Lessons Learnt

D-MINT
Deployment of Model-Based Technologies to Industrial Testing

1. MBT can be successfully applied in many industrial domains

- 1a. The initial effort is high, but the payback is worth it

2. Be aware and take into account the industrial realities

- 2a. Simple examples are not relevant
- 2b. Do not try and change the world overnight
- 2c. Usability is important

3. Don't try and reinvent the wheel

- 2a. Use standardized interfaces
- 2b. Use open source frameworks

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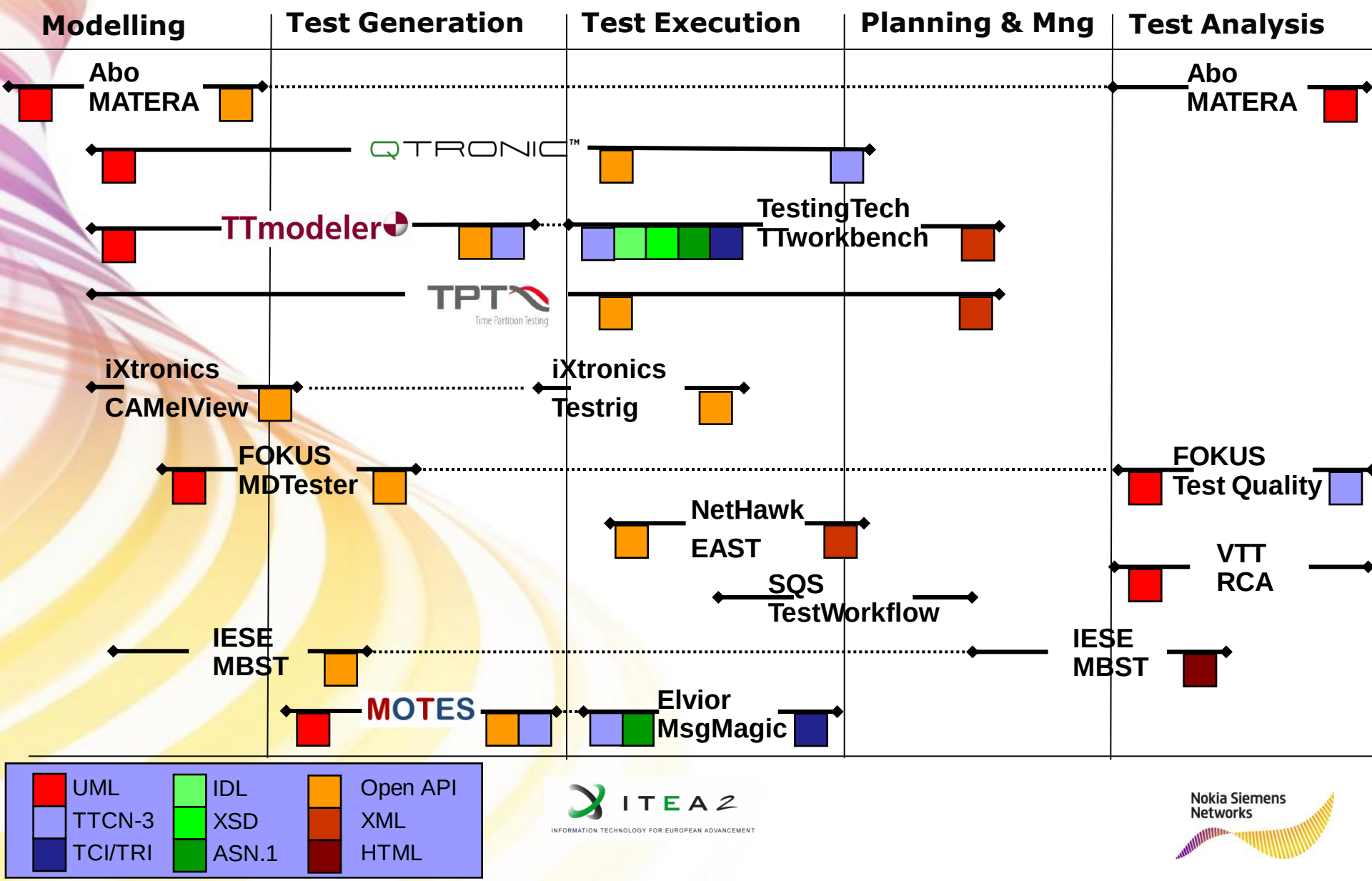
Changing the World

Be realistic when trying to develop and deploy new technologies. Whole-scale replacement of toolchains overnight is not the industrial reality

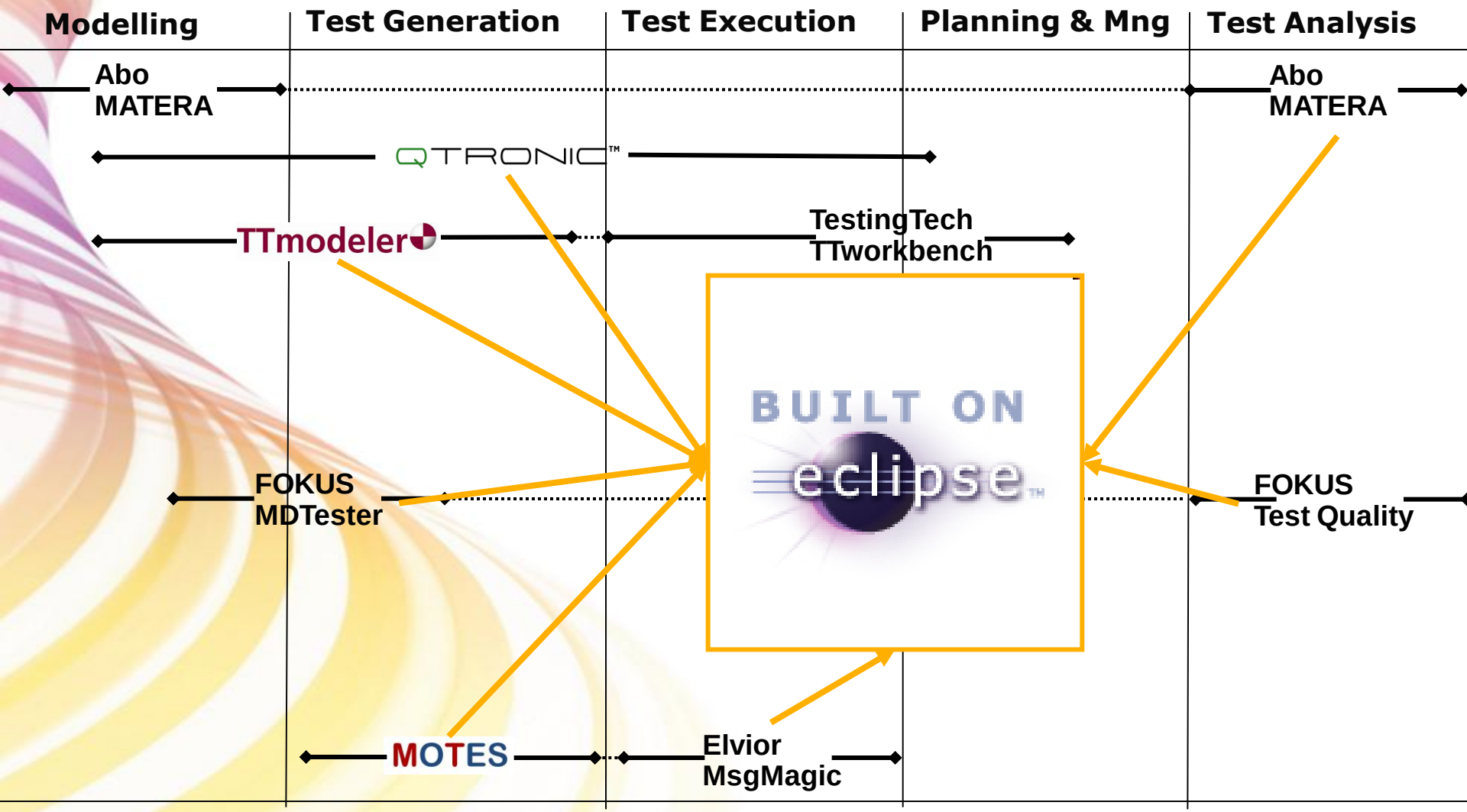
Usability Matters

In an industrial setting usability and stability are not just, nice to have, but deciding factors in any possible future technology selection

D-MINT Tools Open Interfaces



D-MINT Tools in Eclipse



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Conclusion

D-MINT has shown 8 case studies in 5 quite different application domains using a common methodological framework

By means of the case studies it could be shown that cost reduction, higher coverage and better test complexity management is possible by using D-MINT test technologies

Several D-MINT technologies are already in industrial use (i.e. fast exploitation was already accomplished during project run (ABB, Daimler, Eliko))

Experience Package Asset Box and Learning Package published on D-MINT website www.D-MINT.org

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