Nokia Siemens Networks

# Model Based Testing deployment in Telecommunication project

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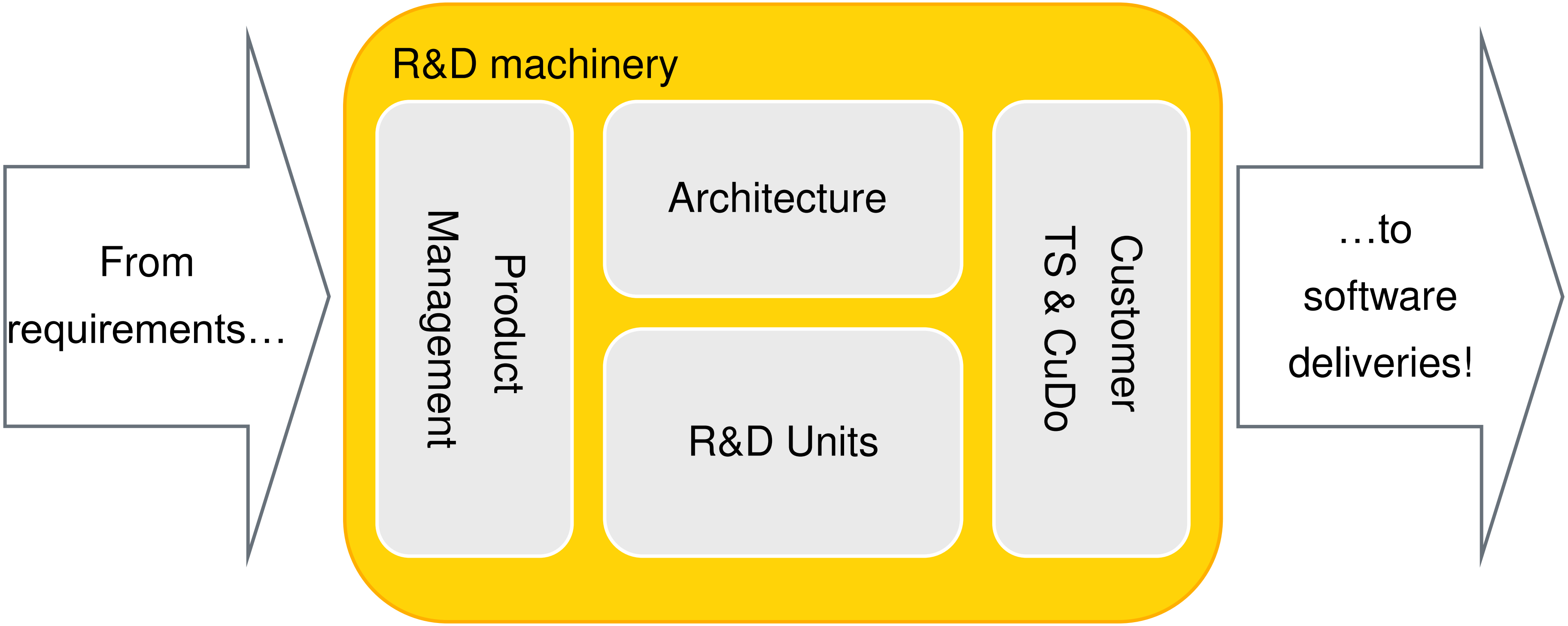
**MBTUC11 – Berlin, October 18-20, 2011**

# NSN Budapest - R&D center production chain



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# Challenges in Testing

- Huge amount of existing (legacy) functionality
  - ➢ More regression testing need
- Shorter release cycle
  - ➢ Less time for testing
- More customization
  - ➢ More specific function for smaller targets
- Economy
  - ➢ Pressure on cost effectiveness
- Quality goals
  - ➢ No quality sacrifice

**Speed up testing**

# Test Automation

So make it faster, let's automate

1. Automate Test Execution ✓
   - Make executable test case scripts
   - Schedule test run
   - Collect result

2. Automate Test result analysis ✓
   - Compare test outcome with expected result
   - Report test result
   - Store/Archive result

3. Automate Test Design ?
   - Test design specification
   - Selecting best test techniques
   - Find optimal coverage
   - Document test cases

# History of MBT in NSN Budapest

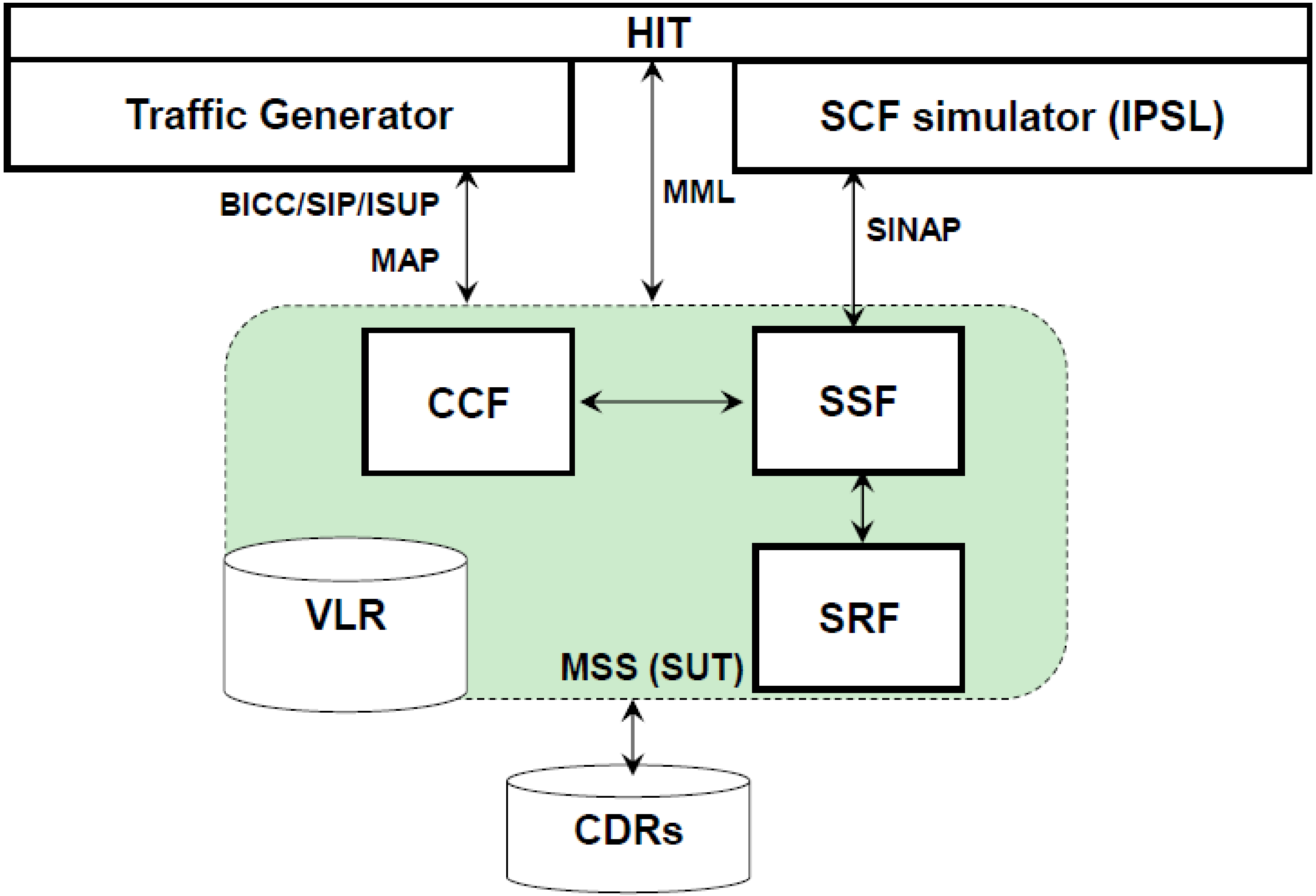
- First study on MBT in MSS during D-MINT project - 2008
  - Due to the existing partnership solution provided by Conformiq is used
- Initial presentation of MBT and pilot decision - 2009
- Pilot and Business case creation - 2010
  - Phase 1: clean the pipe - feasibility
  - Phase 2: ROI calculation - payback
- Decision and deployment in GSM-R - 2011

# Pilot phase 1 - Project Scope and Goals

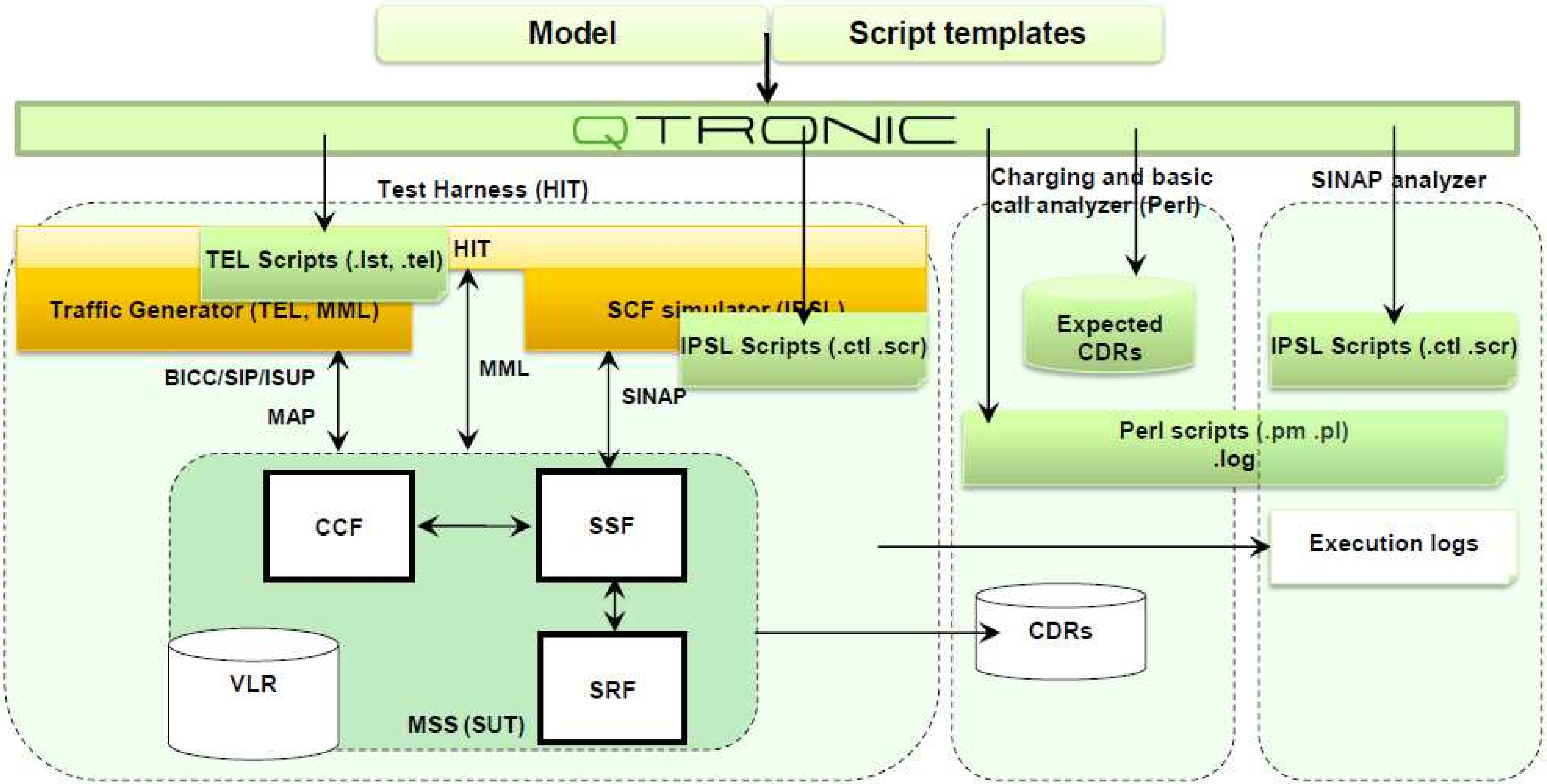
- Goals of the project
  - Introduce the concept of Automated Test Design to Intelligent Network Scrum team
  - Demonstrate that Conformiq Designer suite can be integrated with existing test harness in short term (3 weeks)
  - Create reusable assets of Automated Test Design

- What was the scope of the project
  - SUT: Release 4 Open Mobile Softswitch (MSS)
  - Testing objective: SINAP Charging
  - SUT accessed through Man Machine Interface (MML) using HIT test script language, and SINAP interfaces (IPSL protocol test tool)

# Test architecture view of the scope of Phase 1



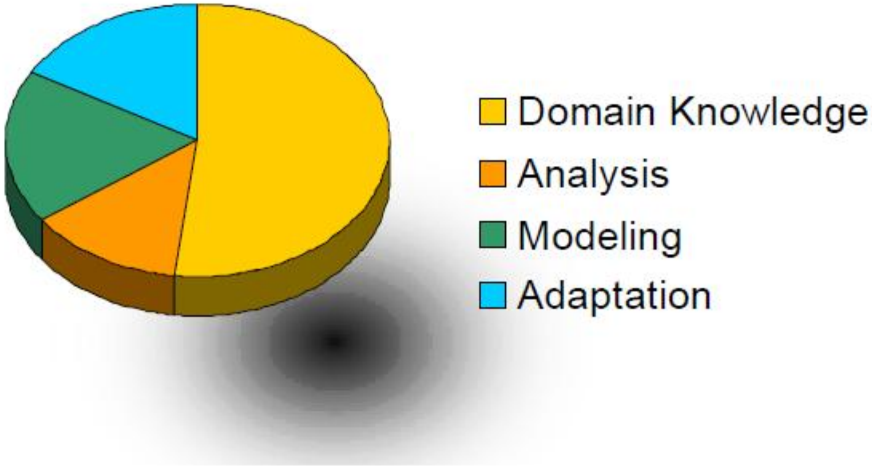
# Test Architecture with ATD



# Results from Pilot

During the pilot we reached

- Resources spent
  - Obtain domain knowledge 128 h
  - Work with model 45 h
  - Analyze system + logs 32h
  - Backend work 41 h



- MBT Training: 7 Certified Conformiq Technology Associate
- Conformiq Designer is integrated with esiting Test Automation framework in 3 weeks
- Reusable components ready
  - call state machine
  - template based reusable backend for different test tools (HIT, IPSL, CHA analyzer, Basic MSS Analyzer)

# Phase 1 conclusion

- Integrating Conformiq Designer into our Test Harness was done with reasonable effort
- MBT **enforces understanding (thereby indirectly enforcing cooperation between teams) and documenting correct system behavior in form of models**
- Due to the complex domain MBT with proper model architecture is very likely to **increase test design efficiency due to possibility for incremental changes.**
- In Automated Test Design both test cases and execution scripts are generated with guaranteed traceability mapping at once. This avoids multi-stage human error

**GO for phase 2**

# Phase 2 – additional goals

- By comparison to previously available manually generated test suites (or appropriate estimates), assess what gains Automated Test Design can provide in the areas of
  - Productivity
  - test case quality
  - requirement coverage
  - requirements traceability
  - and ease of maintenance

# Phase 2 result – ROI and Business Case

- Productivity
  - 100% Requirement coverage with 2/3 of original test cases (based on 7 requirements)
    - 20 test cases → 14 test cases
  - Less time spent
    - 650 → 550 hours: 15% improvement during initial model based testing (creating reusable asset)
    - 278 → 172 hours: 40% improvement during incremental add-on built on top of existing reusable assets
  - Better functionality coverage
    - 3 minor bugs found during pilot in an already tested feature (in live usage already)
  - Documentation inconsistencies
    - Revealed challenges due to scattered documentation (common in Telco industry)
- Positive Business Case

**break even during the 2nd year after ramp-up**

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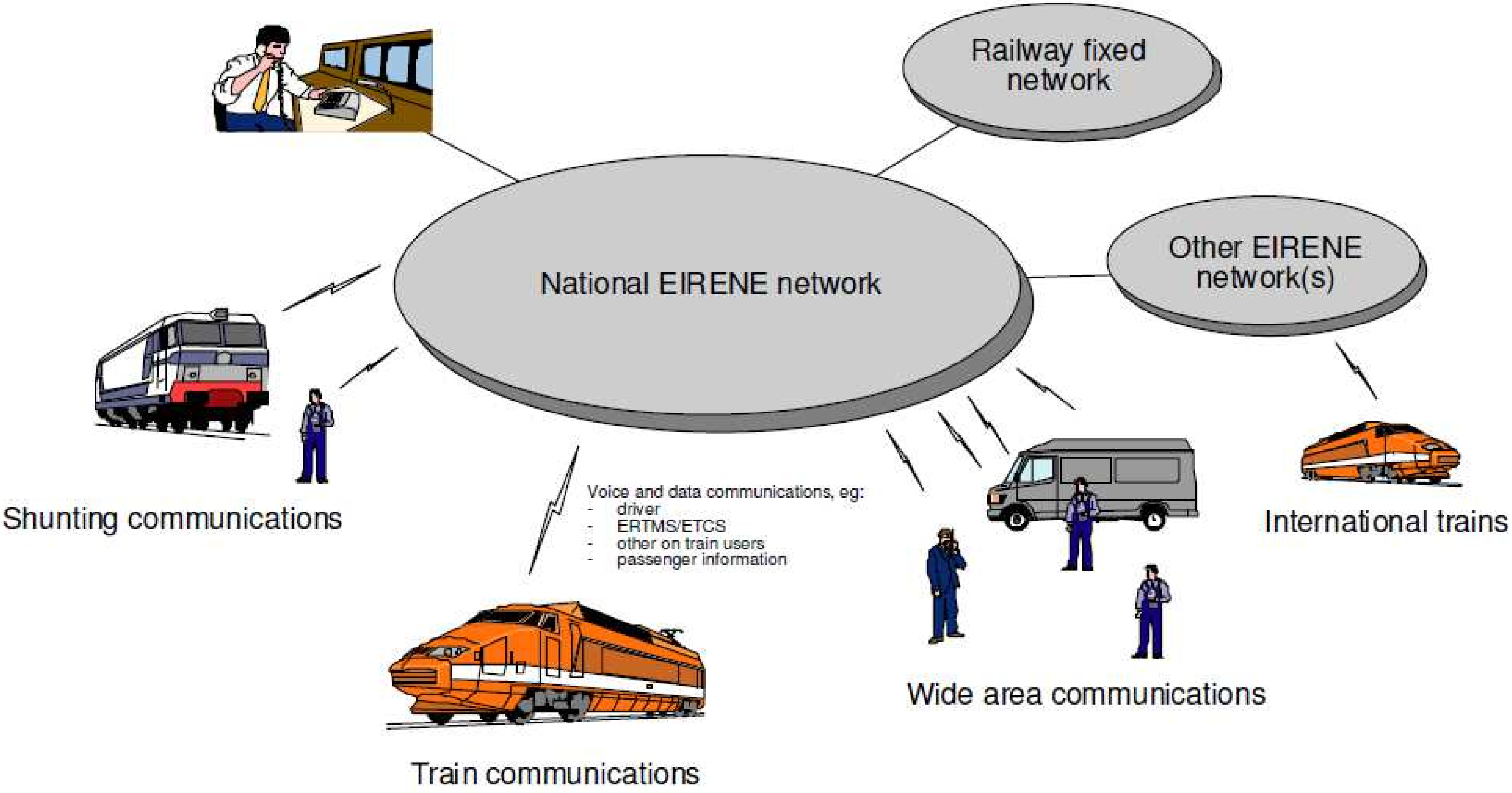
# GSM-R in general



Railway fixed network

National EIRENE network

Other EIRENE network(s)

Shunting communications

Voice and data communications, eg:
- driver
- ERTMS/ETCS
- other on train users
- passenger information

International trains

Wide area communications

Train communications

# Deployment in GSM-R

- Goals of the deployment
  - Confirm MBT pilot results in real project environment in GSM-R program
  - Confirm business case
  - To show that technology can be adapted by MSS developers
  - Define Mode of Operation
  - Engineer feedback
- Scope of deployment
  - SUT: Open Mobile Softswitch for Railways
  - SUT accessed through Man Machine Interface (MML) using HIT test script language, H.248 and A interfaces (TTCN3 protocol test tool)
  - Test levels of deployment
    - Component Testing
    - Functional Testing

# Deployment results
# Work hour analysis

| Reference | Component Test Ratio | | |
|---|---|---|---|
| Reference program estimation (manual) | 36,8% | for reference | Legacy reference data |
| Reference program reported (manual) | 44,3% | | |
| GSM-R Component1 historical expert opinion (manual) | 40% | Component 1 | |
| GSM-R Component1 phase1 reported (MBT) | 30% | | GSM-R |
| GSM-R Component1 phase2 reported (MBT) | 28,3% | | |
| GSM-R Component2 estimated (manual) | 44,1% | Component 2 | |
| GSM-R Component2 reported (MBT) | 34,6% | | |

# Deployment results
# Code coverage analysis

| Area | Coverage Points | Code Coverage | |
|---|---|---|---|
| Component1 (manual) | 410 | Phase1 80.7% | GSM-R |
| Component1 (MBT) | 410<br>609 | Phase1 87%<br>Phase2 92% | |
| Component2 (MBT) | 119 | 97% | |
| Component2 Database (MBT) | 862 | 93% | |
| Legacy example1 (manual) | 20445 | 83.9% | Legacy reference data |
| Legacy example2 (manual) | 20360 | 74.5% | |

# Deployment results
# Fault findings in Component1

- Component1 testing done both manually and model based
- Fault findings:

| Component1 | Faults found | Code coverage |
|---|---|---|
| Manual testing | 12 | 80.7% |
| Model based testing | 12 + 9 | 87% |

- According to root cause analysis results, 3 faults would be probably caught only during very late test phase

# Deployment results
# Summary

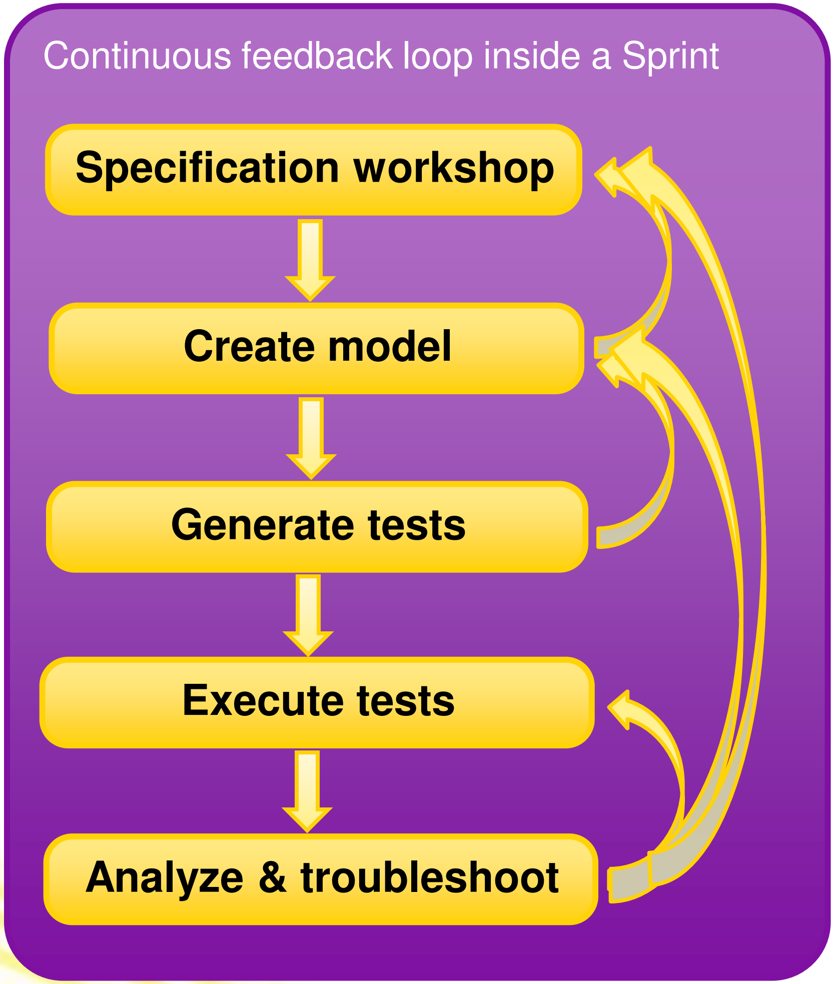
- Very good experience with database modeling
  - 20-30% gain in speed
  - Outstanding level of code coverage reached
- Results with MML modeling dissatisfactory
  - MML: commands in hierarchical structure used for system configuration via telnet interface
- Good experience with state-chart based component modeling
  - 25% gain in speed
  - Higher code coverage compared to manual test planning
  - Addition faults found after manual component test ready
- Positive results expected from Functional Testing

# Integration into Agile work practices

- Continuous communication sessions established in all areas
  - 2 review levels must be ensured for feedback
- Model review
  - With modelers, specificators, lead designers
- TC review
  - With all the engineers in the effected domain

- New roles in Scrum team
  - Modeler
  - Backend scripter

- Automatic documentation into QC



# Engineer satisfaction survey

- „A nicely built model can be understandable for anyone. There is no need to check several other documents, only the model”
- „This method is requires a systematic approach, so it decreases the negative effect of human factor”
- „Modeling is fast and comfortable after having experience. Longer TC generation times can be obstacle”
- „During the model creating very deep knowledge can be gathered about the system. This is challenging and motivating”
- „It is also motivating that serious code defects were found with MBT (after manual testing was done)”

# Lessons learned

- MBT technology can be adopted with significant improvement on complex projects
- Step-by-step Pilot and deployment approach is needed with
  - Clear goals
  - Go/No-Go decision criteria
  - Business sponsorship
- Strict reporting practices needed for Business case validation
  - Fault reporting
  - Effort reporting for different activities
- Technology support is needed for proper ramp-up
  - On-site / remote support as requested
  - Attending an all reviews
  - To review also scripting backend
- Train not only modelers
  - Specificators (one per area)
  - Lead designers (one per area)
  - Test architects (one per area)

# Questions?

# Thank you!