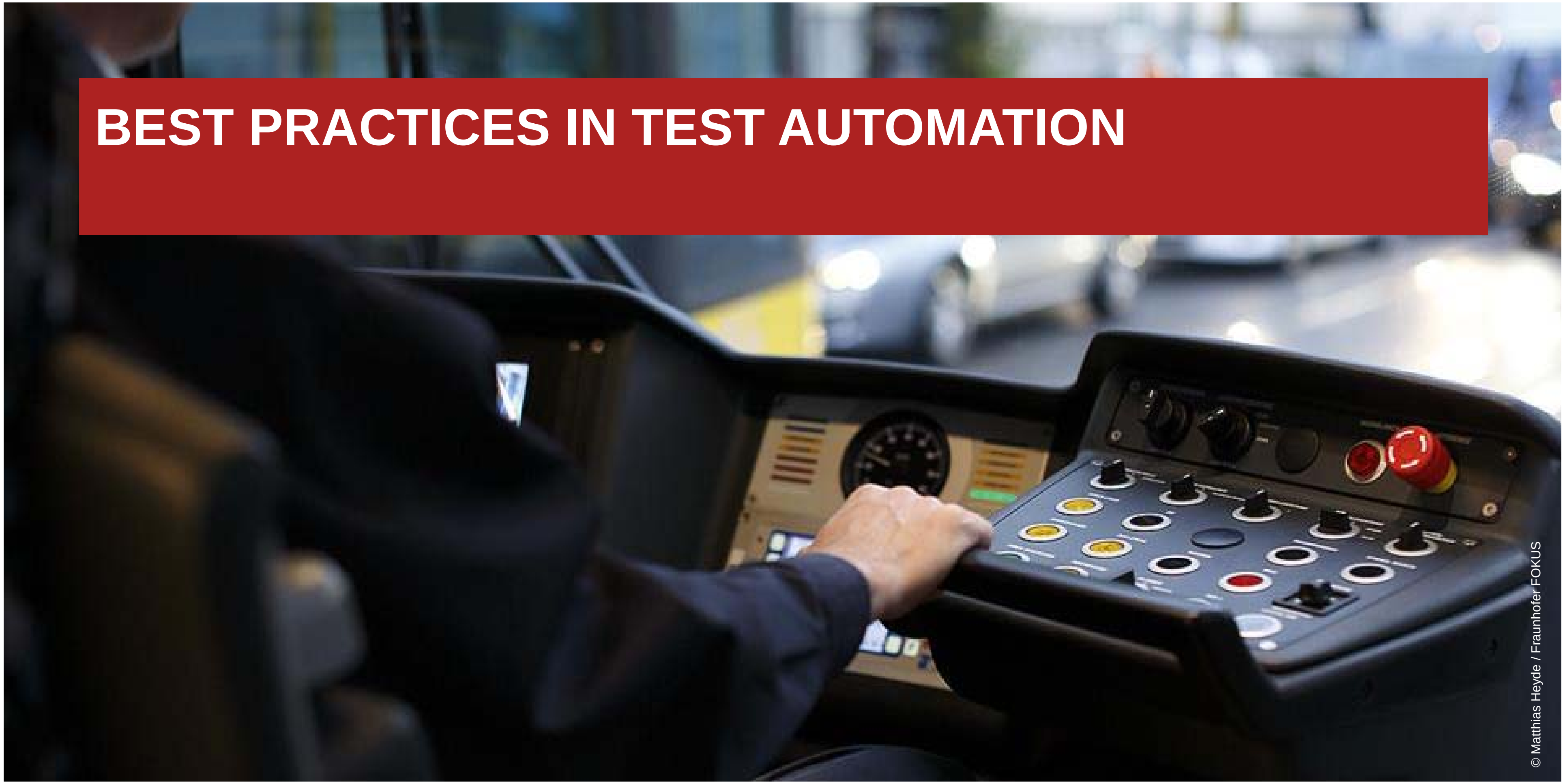
BEST PRACTICES IN TEST AUTOMATION



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Belgium Testing Day

Ina Schieferdecker, May 18, 2015

making cities smart

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ROUND CALL

Please introduce yourself

… and present your questions for today.

ABOUT ME

Scientiest ... in applied research

Fraunhofer FOKUS

Professor … in education

Freie Universität Berlin

Member of academy … for scientific recommendations

acatech
DEUTSCHE AKADEMIE DER TECHNIKWISSENSCHAFTEN

Vice president … for high-quality software-based systems

ASQF®
Arbeitskreis Software-Qualität und -Fortbildung e.V.

ROUND CALL

Please introduce yourself

… and present your questions for today.

OUTLINE

1. Introduction to Test Automation
2. Selected Examples
3. Interaction and Discussion
4. Challenges in Management of Test Infrastructures
5. Review of Test Technologies
6. Conclusions

TIME SCHEDULE

13:30 – 15:00	Introduction and discussion
15:00 – 15:30	Coffee break
15:30 – 17:00	Discussion and outlook

OUTLINE

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2. Selected Examples
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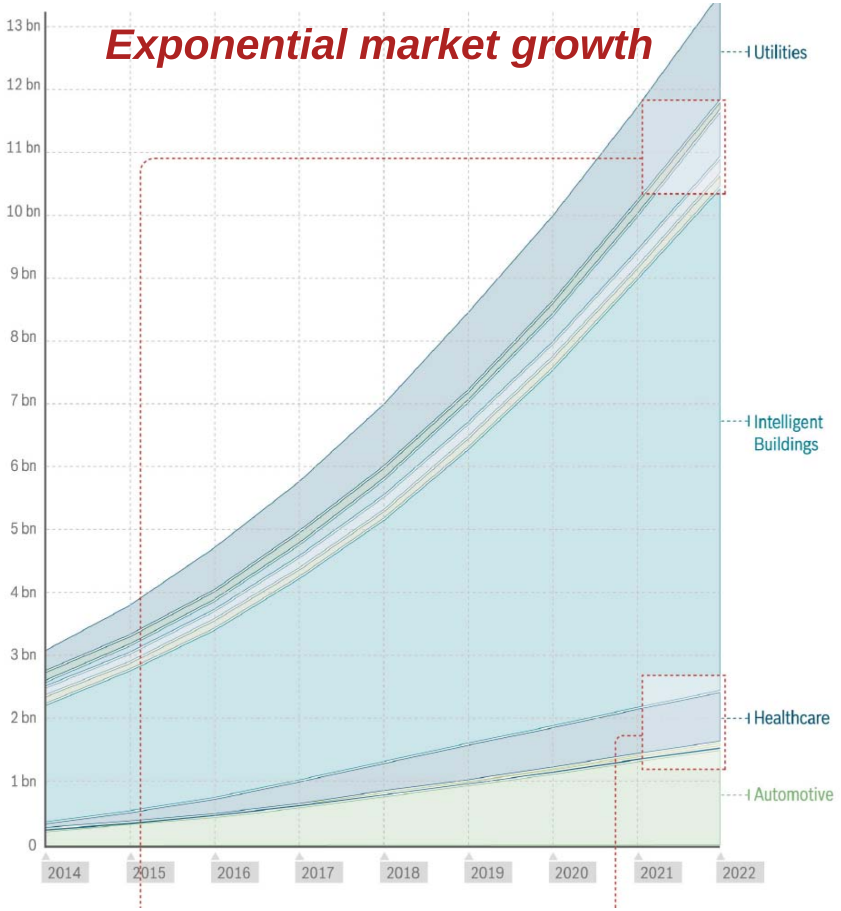
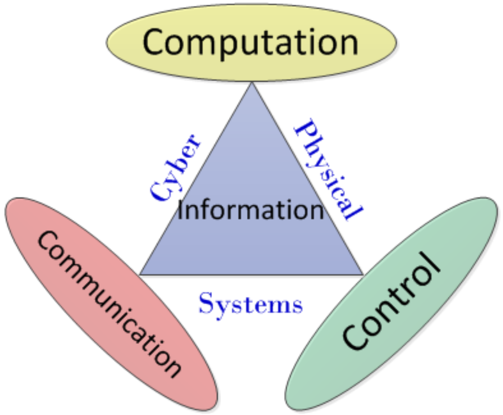
M2M, IOT AND INDUSTRY 4.0

Exponential market growth



BOSCH Invented for life

Interconnected software-based systems



In: Deploying RFID - Challenges, Solutions, and Open Issues, Cristina Turcu. 2011.

High quality demands in critical infrastructures

"Implementation of real-time enabled CPS solutions will place high demands on the availability of services and network infrastructure in terms of space, technical quality and reliability."

In: Securing the future of German manufacturing industry. Recommendations for implementing the strategic initiative INDUSTRIE 4.0, Forschungsunion, acatech, Apr. 2013.

TEST DEVICES IN RELATED DISCIPLINES

Function tester

for electronic devices

Electric test device used as binary I/O terminal

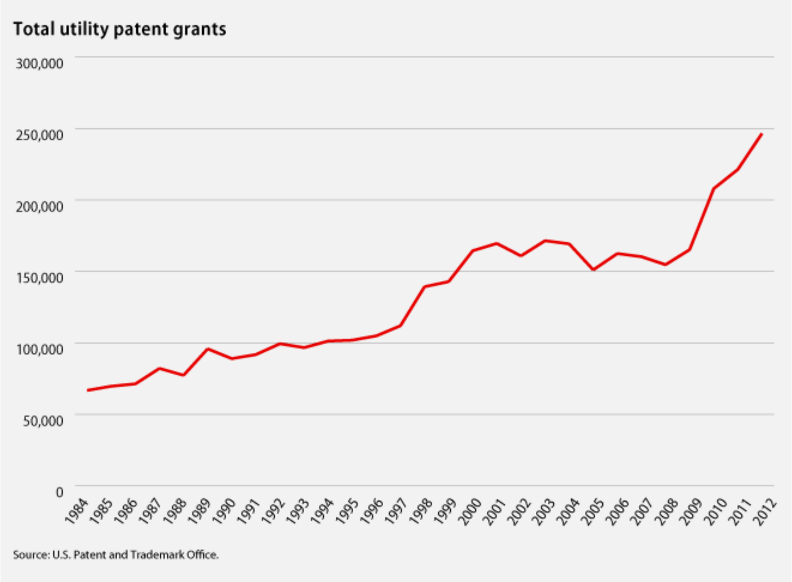
for substation automation systems

Fiber optic multi-test device / network

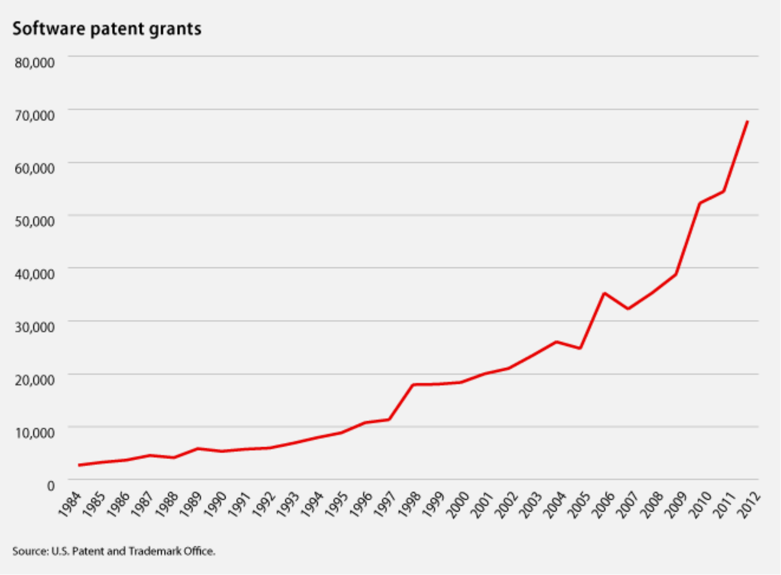
for data centers and storage fiber networks

Process interlocking solutions for
pressure relief valves

INNOVATION BY SOFTWARE



Source: U.S. Patent and Trademark Office.



Source: U.S. Patent and Trademark Office.

USPTO granted **51 percent** more utility patents in 2012 than it did in 2009

USPTO granted **75 percent** more software patents in 2012 than it did in 2009!

In: Software Patents: Separating Rhetoric from Facts, Brian Kahin, 2013.

CONFORMANCE AND INTEROPERABILITY

1. Interoperability:

   Interoperability is the ability of making systems and organizations to work together (inter-operate). While the term was initially defined for information technology or systems engineering services to allow for information exchange, … [Wikipedia]

2. Conformance

   Confirmation that a good, service, or conduct meets the requirements of legislation, accepted practices, prescribed rules and regulations, specified standards, or terms of a contract. [Business Dictionary]

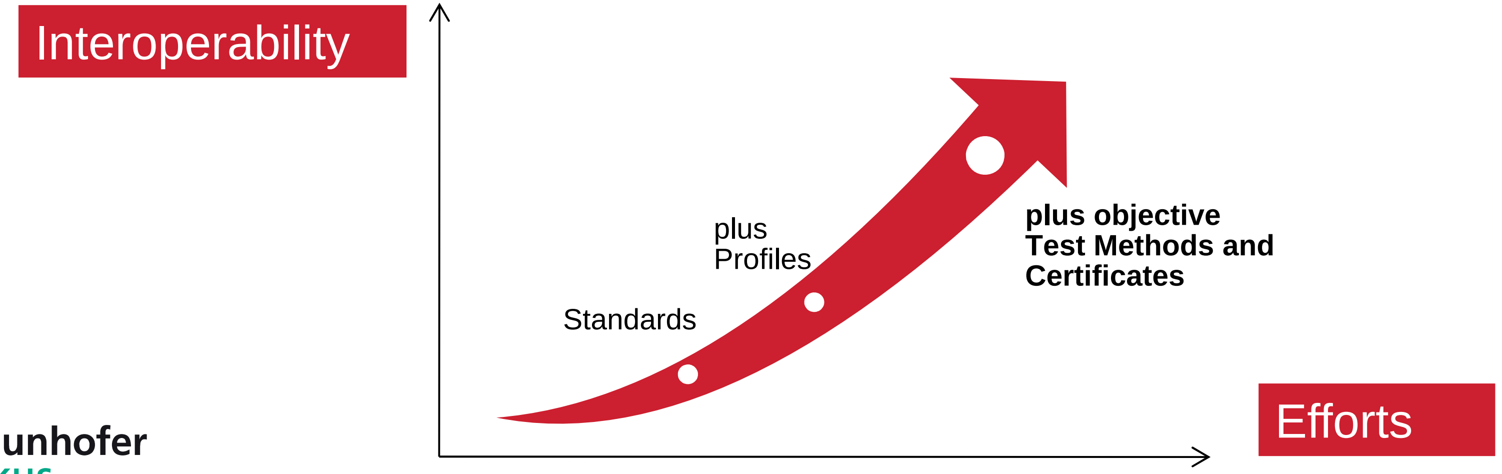
Interoperability is a precondition for the increasing integration and networking of systems and components. Conformance supports interoperability.

TOWARDS INTEROPERABILITY

1. (Open) standards are the basis
   However: Conformance to standards does not imply interoperability
   → Alternative interpretations, options and variants prevent interoperability

2. Profiling (detailed subsets of standards) define application targets, parameters and limits
   → Limit standard interpretations

3. Test methods check and certify interoperability
   → Close standard interpretations



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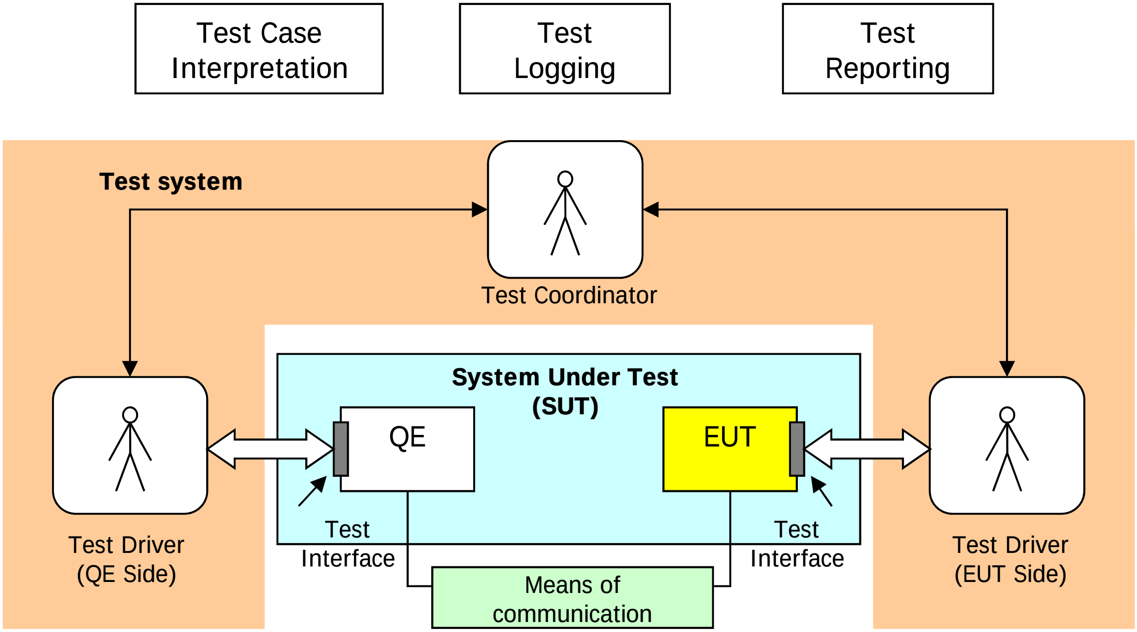
FUNDAMENTAL INTEROPERABILITY TEST METHOD

- A dynamic testing method
- Complements conformance testing



1. QE = Qualified Equipment (**previously** tested)

2. EUT = Equipment under Test (such as gateway, protocol layer, software component)

WHAT IS TEST AUTOMATION

1. ”The management and performance of test activities to include the development and execution of test scripts so as to verify test requirements, using an automated test tool” – Dustin, Rashka & Paul

2. ”Testing supported by software tool” – Faught, Bach

- Some believe that test automation is so expensive relative to its value that it should be used sparingly.

- Others, such as advocates of agile development, recommend automating 100% of all tests.

- A challenge with automation is that automated testing needs to be tested as well.

AREAS OF TEST AUTOMATION

1. Automated tests mainly on testing that requires **repeated effort** of similar tests cases
   - Regression testing
   - Portability testing
   - Performance and stress testing
   - Configuration testing
   - Smoke testing
   - ...

2. Automated tests **needed** where manual tests are impossible
   - Fast tests
   - Precise tests
   - Distributed tests
   - Coordinated tests
   - Remote tests
   - Tests via heterogeneous interfaces
   - ...

LEVELS OF TEST AUTOMATION

1. Automated test execution
   - Test cases to test scripts
   - Test execution engines

2. Automated test case generation
   - Automated test design
   - Models to test cases
   - Model-based testing

3. Automated test framework generation
   - Domain-specific test models
   - Metamodels to test metamodels

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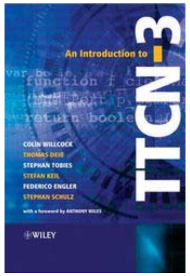
STATUS OF TESTING

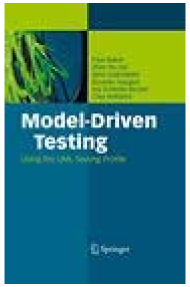
Basic test concepts/methods/processes/theories “solved

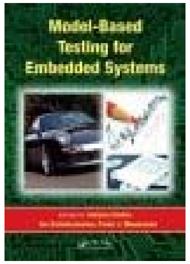
- Test automation “solved”
  - TTCN-3: Testing and Test Control Notation
  - Test-DSLs: different approaches
  - Numerous tools: GUI, unit, end-to-end
  - Integrated in Continuous integration/deployment approaches

- Automation of test generation – current research
  - UTP: UML Testing Profile
  - Model-based testing

- Selected further research
  - Model-based fuzz testing
  - Evolutionary testing
  - Models/testing at runtime
  - Data quality







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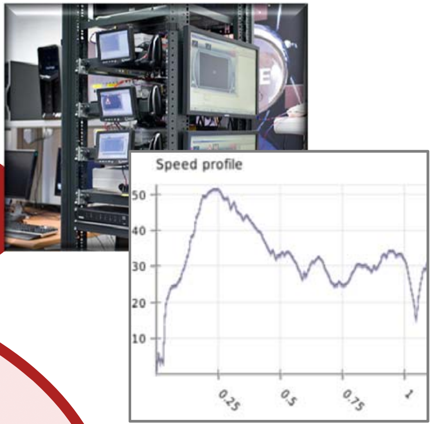
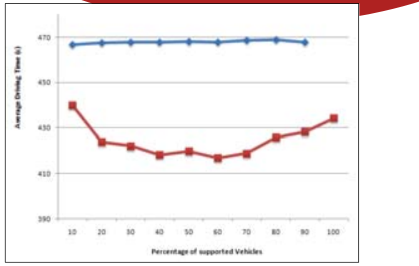
EX1: V2X TEST BED FOR TEST AUTOMATION

Test Automation

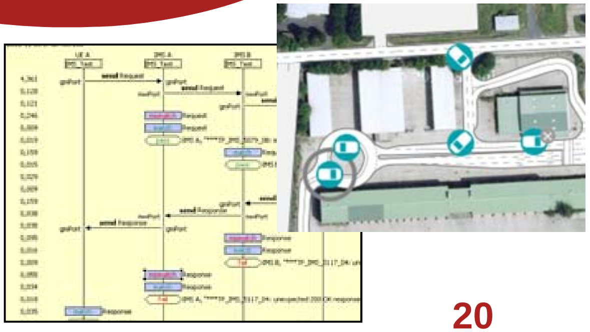


V2X Test Bed and Tool Suite

Test Data Generation (e.g. Traffic Simulation Data)



Log File Analysis and Visualization



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EX1: THE SIM^{TD} SET UP IN THE LAB

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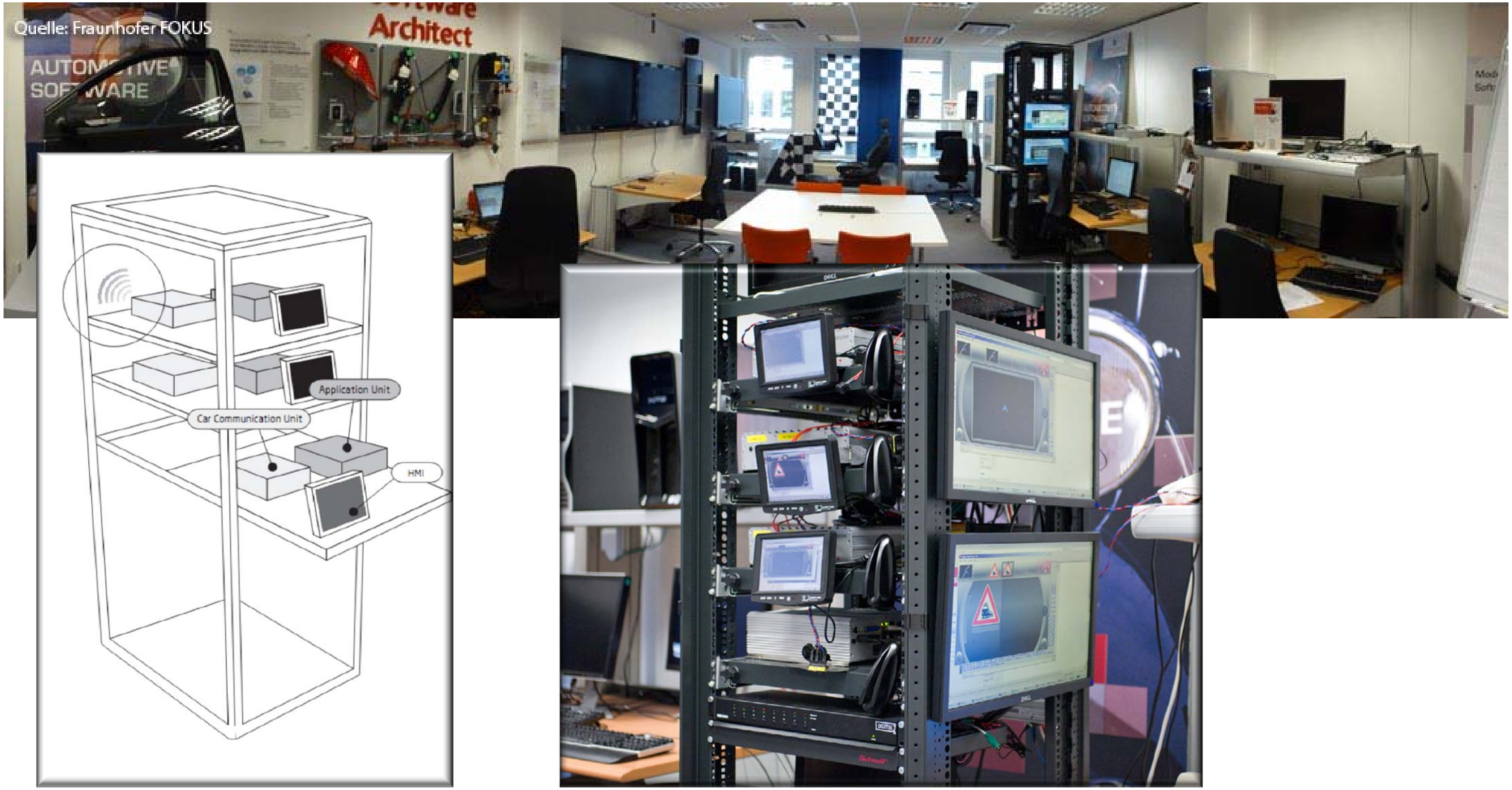
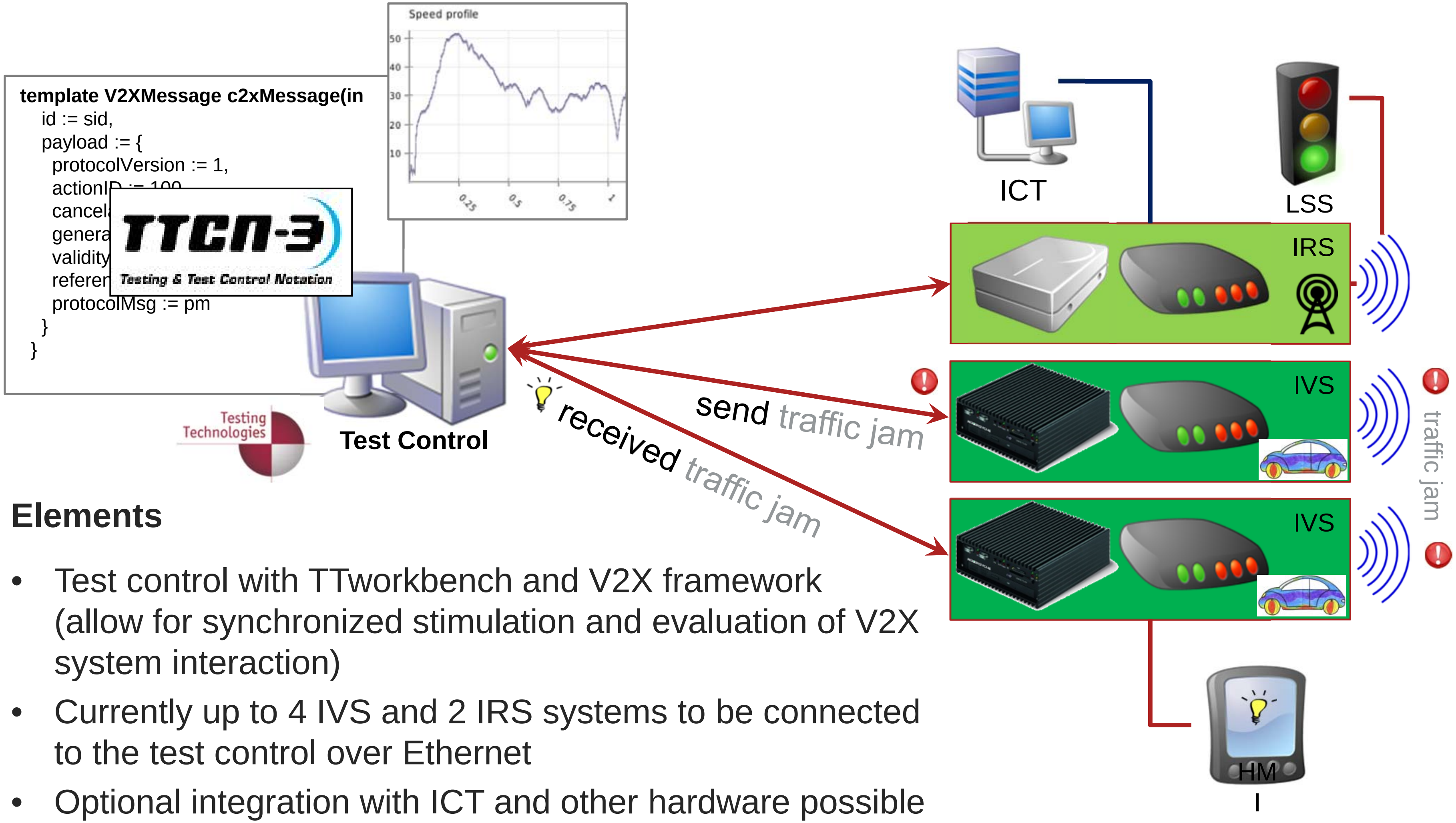

Quelle: Fraunhofer FOKUS

EX1: V2X TEST BED ARCHITECTURE

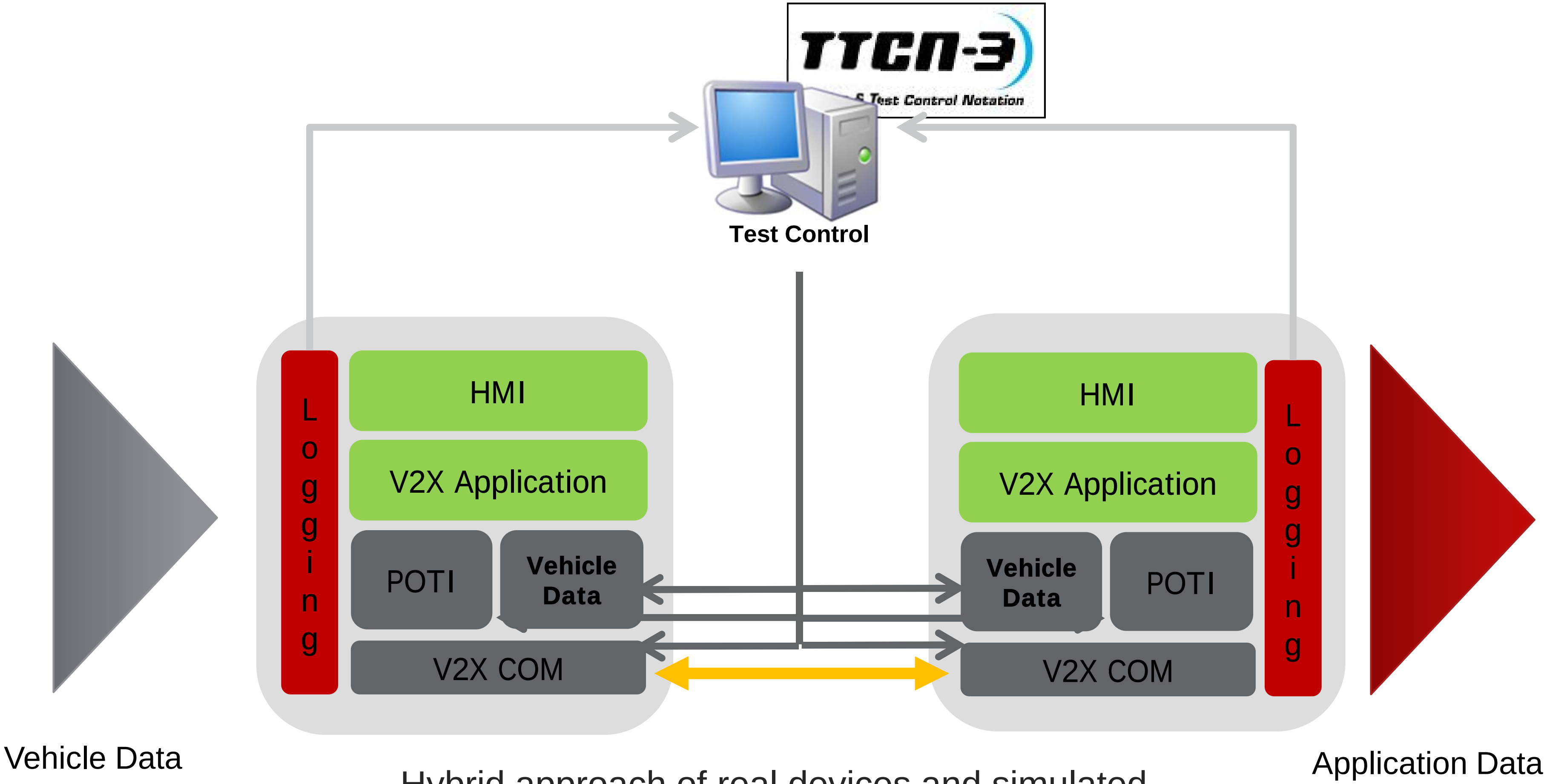


```
template V2XMessage c2xMessage(in
    id := sid,
    payload := {
      protocolVersion := 1,
      actionID := 100
      cancel
      genera
      validity
      referen
      protocolMsg := pm
    }
  }
```

Elements

- Test control with TTworkbench and V2X framework (allow for synchronized stimulation and evaluation of V2X system interaction)
- Currently up to 4 IVS and 2 IRS systems to be connected to the test control over Ethernet
- Optional integration with ICT and other hardware possible

EX1: DETAILS OF THE V2X TEST SYSTEM



- Hybrid approach of real devices and simulated environments
- Simulation, impairment and monitoring on all levels

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EX1: EXAMPLE TEST: WEATHER WARNING

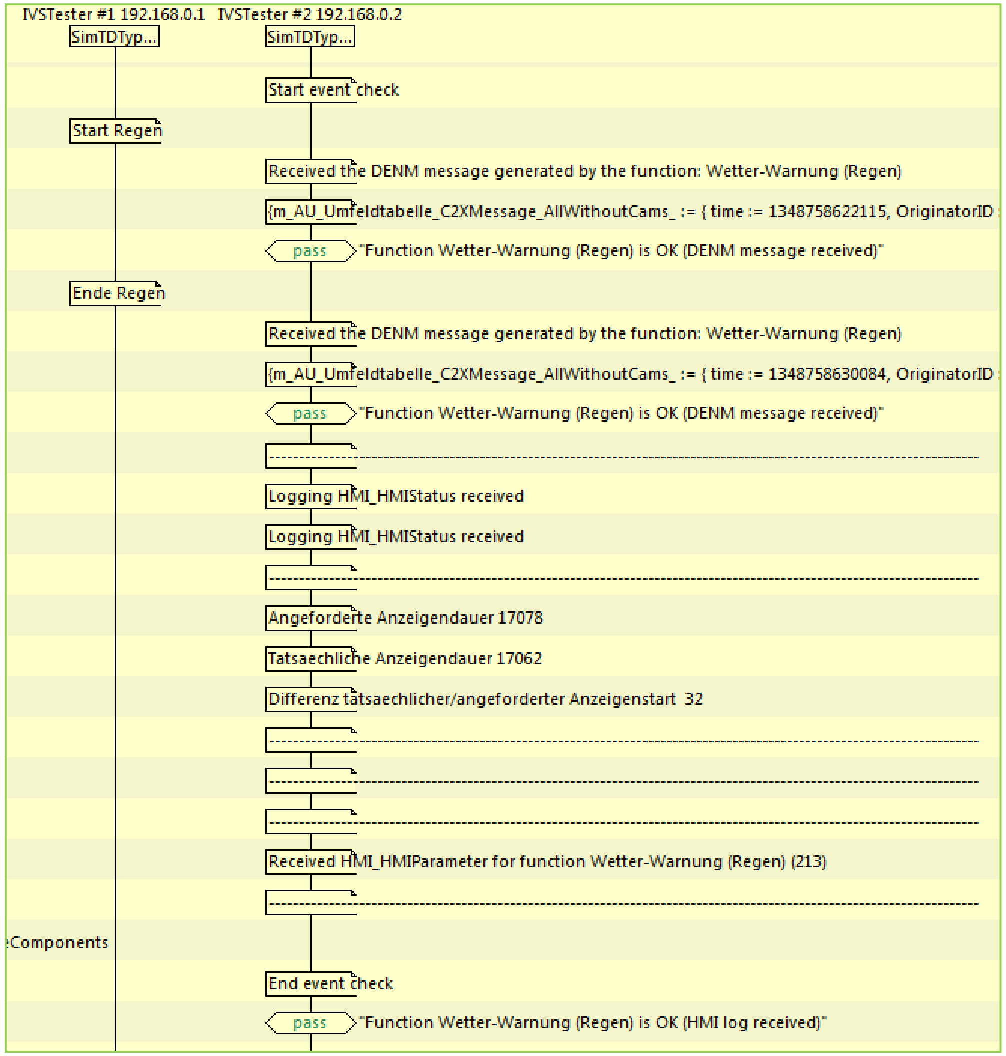
- IVS1: Generate situation

```
    WiperSystem := {
          Front  := "normal",
          Rear  := "idle" }

    WiperSystem := {
          Front  := "fast",
          Rear  := "idle" }
```

- IVS2: Check message reception
  – DENM message received ?

- IVS2: Check HMI interaction



IVSTester #1 192.168.0.1 IVSTester #2 192.168.0.2

SimTDTyp... SimTDTyp...

Start event check

Start Regen

Received the DENM message generated by the function: Wetter-Warnung (Regen)

{m_AU_Umfeldtabelle_C2XMessage_AllWithoutCams_ := { time := 1348758622115, OriginatorID

pass "Function Wetter-Warnung (Regen) is OK (DENM message received)"

Ende Regen

Received the DENM message generated by the function: Wetter-Warnung (Regen)

{m_AU_Umfeldtabelle_C2XMessage_AllWithoutCams_ := { time := 1348758630084, OriginatorID

pass "Function Wetter-Warnung (Regen) is OK (DENM message received)"

Logging HMI_HMIStatus received

Logging HMI_HMIStatus received

Angeforderte Anzeigendauer 17078

Tatsaechliche Anzeigendauer 17062

Differenz tatsaechlicher/angeforderter Anzeigenstart 32

Received HMI_HMIParameter for function Wetter-Warnung (Regen) (213)

:Components

End event check

pass "Function Wetter-Warnung (Regen) is OK (HMI log received)"

EX1: DRIVE C2X REFERENCE TESTS

- Compatible with ETSI Standards
- Virtualized Test Environment

Tests available for:

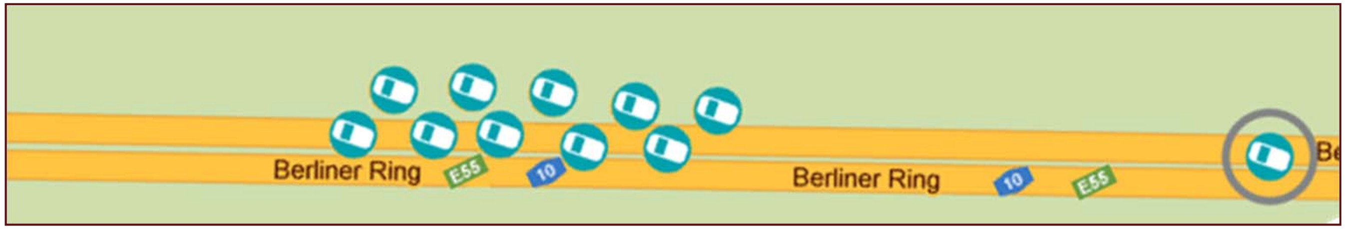
- Stationary vehicle warning
- Road works warning
- Slow vehicle warning
- Traffic jam ahead warning
- In vehicle signage
- Emergency vehicle warning,
- Emergency electronic brake lights

Example Traffic Jam Ahead Warning (TJAW):

Tests TJAW with different jam configurations by varying:

- number of vehicles in jam
- velocity of vehicles
- distance to EGO
- velocity of EGO

JAM is simulated by injecting CAM messages for the individual vehicles



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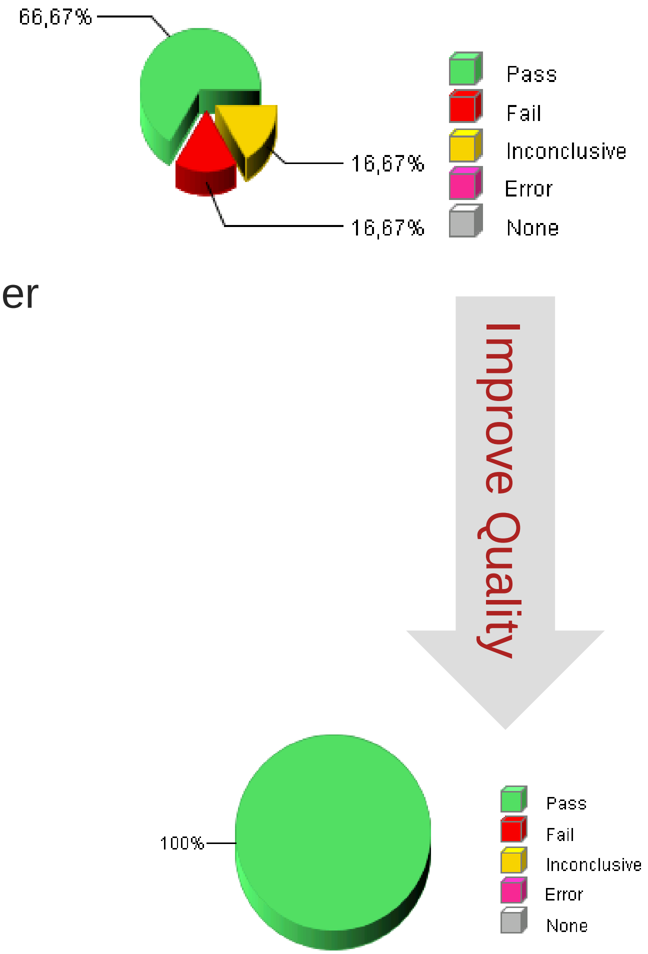
EX1: SIM^{TD} REFERENCE TESTS

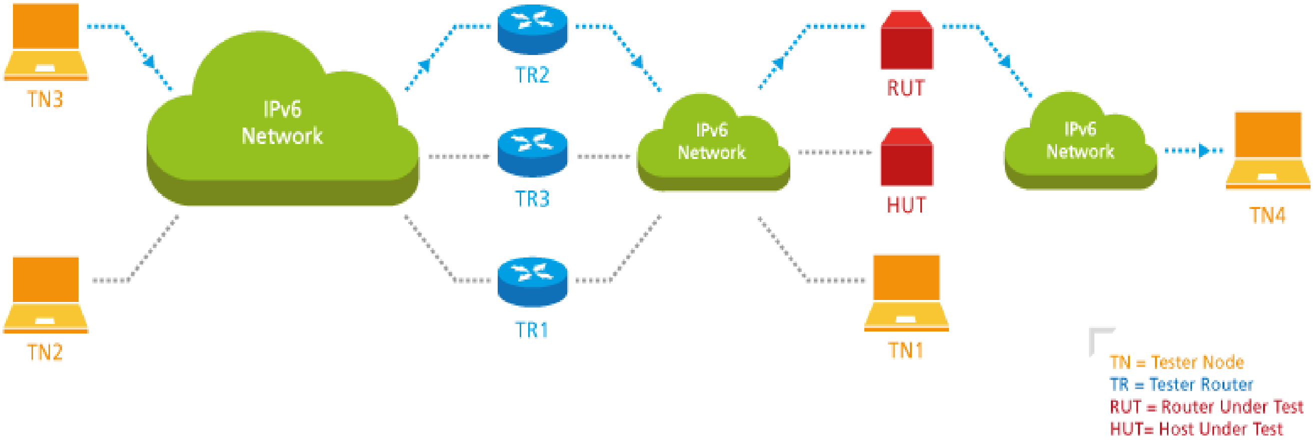
- **40 Communication tests and test variants**
  - CAM variants
  - CAM frequencies, message life time handling etc.
  - DENM variants
- **20 Application tests**
  - testing event detection, propagation, handling and user notification for several V2X applications
- **Reference circuit**
  - event handling and user notification for several V2X applications
- **Reference circuit with load**
  - event handling and user notification for several V2X applications by applying networked and CPU load
- **Goals: <u>Integration</u>, <u>regression</u> and acceptance testing**

Financed by: Audi, Bosch, BMW, Continental, Daimler, Opel, Telekom, VW



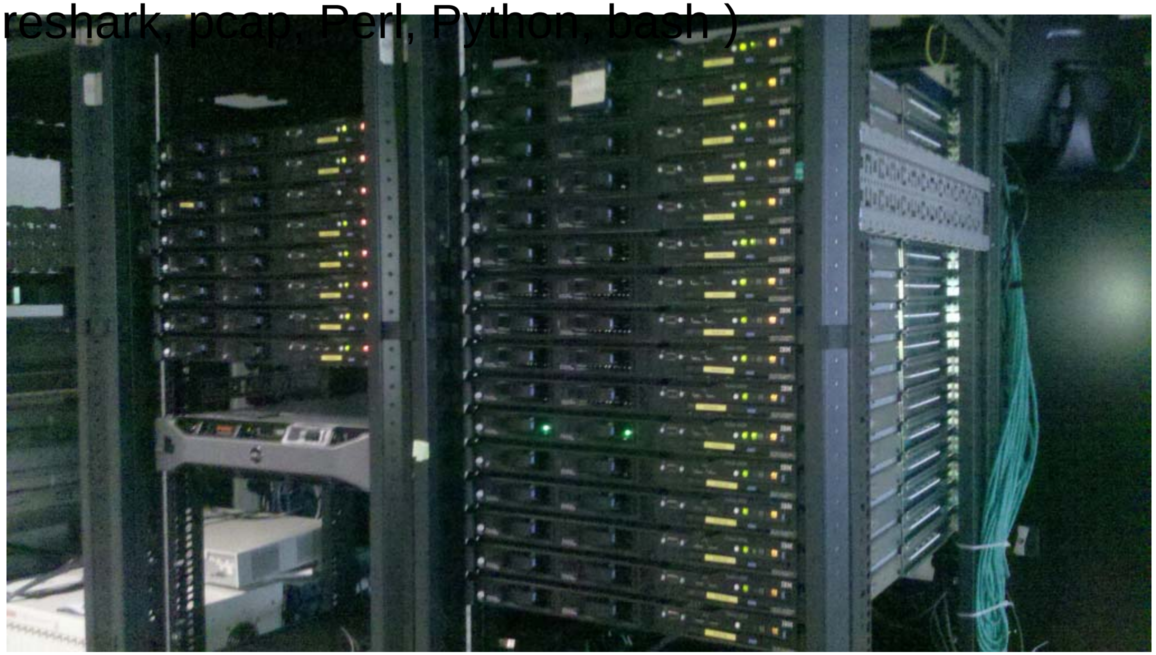
EX2: IPV6 TEST AND NETWORK SIMULATION LAB

- Load and stress tests of industrial products
- IPv6 conformance and interoperability testing
- IPv6 Ready Logo certification tests
- Client support relating to configuration and initial implementing of an IPv6 testbed - amongst others testbed for IPv6 Ready Logo Certification Tests
- Security testing based on Fuzzing technologies



EX2: IPV6 TESTBED INFRASTRUCTURE

- **Hybrid infrastructure** running **virtualized images and real physical devices**
  - IPv6 Linux/FreeBSD/NetBSD/OpenBSD soft routers – XORP, Quagga, Zebra
  - Physical vendors‘ hardware (e.g. Cisco Routers)
  - Virtualization and Virtualization Management - VMware ESXi, Virtual Box, Xen and OpenStack/CloudStack (in the pipeline)
  - Test automatization and reporting based on scripting and various tools (tcpdump, wireshark, pcap, Perl, Python, bash)



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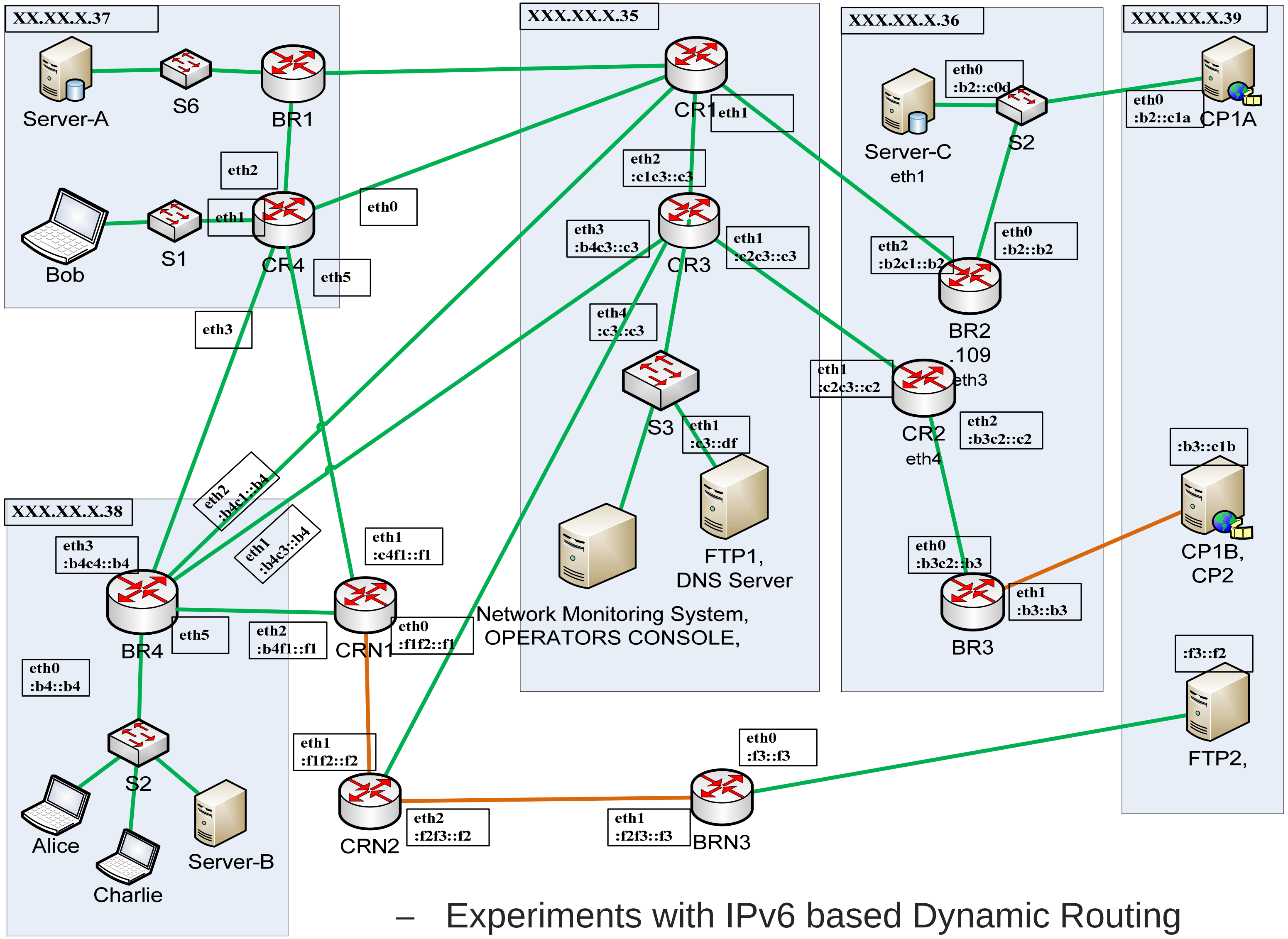

- Experiments with IPv6 based Dynamic Routing (e.g. OSPFv3, BGP), QoS, and OpenFlow/SDN

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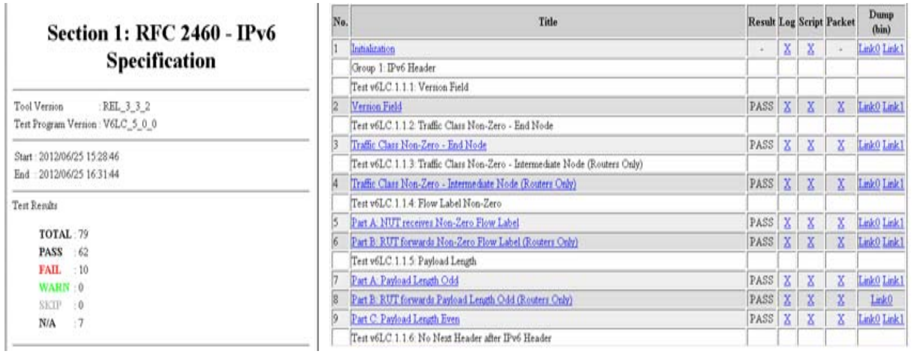
EX2: IPV6READY LOGO PROGRAM

Conformance Testing

- TAHI Test suite
- ~320 IPv6 Core Specification test cases for router components + additional test cases for host → ~400 test cases.
  - Section 1: RFC 2460 - IPv6 Specification
  - Section 2: RFC 4861 - Neighbor Discovery for IPv6
  - Section 3: RFC 4862 - IPv6 Stateless Address Autoconfiguration
  - Section 4: RFC 1981 - Path MTU Discovery for IPv6
  - Section 5: RFC 4443 - ICMPv6
- Test cases for additional protocol features
  - IPsec, IKEv2, MIPv6, NEMO, DHCPv6, SIP (IPv6), IMS UE (IPv6) (Trial), IKEv1 (Experimental), MLDv2

Interoperability Testing

- Testing scenarios including eight nodes in addition to the machine that is being tested
- The nodes include a test manager, a traffic dumper and reference machines



Section 1: RFC 2460 - IPv6 Specification

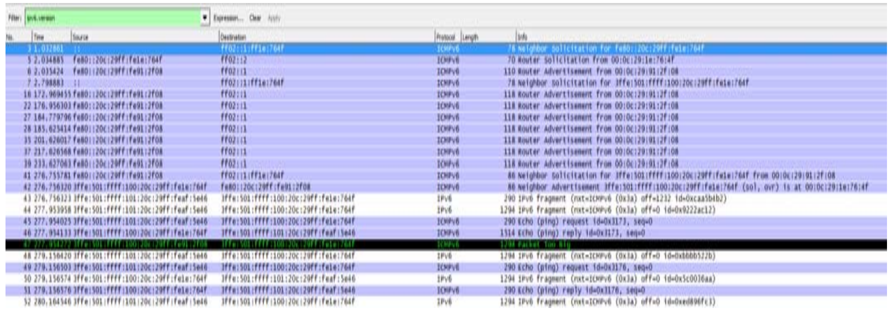
Tool Version : REL_3_3_2
Test Program Version : V6LC_5_0_0

Start : 2012/06/25 15:28:46
End : 2012/06/25 16:31:44

Test Results

TOTAL	: 79
PASS	: 62
FAIL	: 10
WARN	: 0
SKIP	: 0
N/A	: 7

No.	Title	Result	Log	Script	Packet	Dump (bin)
1	Initialization	-	X	X	-	Link0 Link1
	Group 1: IPv6 Header					
	Test v6LC.1.1.1: Version Field					
2	Version Field	PASS	X	X	X	Link0 Link1
	Test v6LC.1.1.2: Traffic Class Non-Zero - End Node					
3	Traffic Class Non-Zero - End Node	PASS	X	X	X	Link0 Link1
	Test v6LC.1.1.3: Traffic Class Non-Zero - Intermediate Node (Routers Only)					
4	Traffic Class Non-Zero - Intermediate Node (Routers Only)	PASS	X	X	X	Link0 Link1
	Test v6LC.1.1.4: Flow Label Non-Zero					
5	Part A: NUT receives Non-Zero Flow Label	PASS	X	X	X	Link0 Link1
6	Part B: RUT forwards Non-Zero Flow Label (Routers Only)	PASS	X	X	X	Link0 Link1
	Test v6LC.1.1.5: Payload Length					
7	Part A: Payload Length Odd	PASS	X	X	X	Link0 Link1
8	Part B: RUT forwards Payload Length Odd (Routers Only)	PASS	X	X	X	Link0
9	Part C: Payload Length Even	PASS	X	X	X	Link0 Link1
	Test v6LC.1.1.6: No Next Header after IPv6 Header					



```
No.  Time        Source                               Destination                          Protocol Length Info
   3 1.032861    ::                                   ff02::1:ff1e:764f                    ICMPv6     78 Neighbor Solicitation for fe80::20c:29ff:fe1e:764f
   5 2.034885    fe80::20c:29ff:fe1e:764f             ff02::2                              ICMPv6     70 Router Solicitation from 00:0c:29:1e:76:4f
   6 2.035424    fe80::20c:29ff:fe91:2f08             ff02::1                              ICMPv6    110 Router Advertisement from 00:0c:29:91:2f:08
   7 2.798883    ::                                   ff02::1:ff1e:764f                    ICMPv6     78 Neighbor Solicitation for 3ffe:501:ffff:100:20c:29ff:fe1e:764f
  16 172.969455  fe80::20c:29ff:fe91:2f08             ff02::1                              ICMPv6    118 Router Advertisement from 00:0c:29:91:2f:08
  22 176.956303  fe80::20c:29ff:fe91:2f08             ff02::1                              ICMPv6    118 Router Advertisement from 00:0c:29:91:2f:08
  27 184.779796  fe80::20c:29ff:fe91:2f08             ff02::1                              ICMPv6    118 Router Advertisement from 00:0c:29:91:2f:08
  28 185.625414  fe80::20c:29ff:fe91:2f08             ff02::1                              ICMPv6    118 Router Advertisement from 00:0c:29:91:2f:08
  35 201.626017  fe80::20c:29ff:fe91:2f08             ff02::1                              ICMPv6    118 Router Advertisement from 00:0c:29:91:2f:08
  37 217.626568  fe80::20c:29ff:fe91:2f08             ff02::1                              ICMPv6    118 Router Advertisement from 00:0c:29:91:2f:08
  39 233.627063  fe80::20c:29ff:fe91:2f08             ff02::1                              ICMPv6    118 Router Advertisement from 00:0c:29:91:2f:08
  41 276.755781  fe80::20c:29ff:fe91:2f08             ff02::1:ff1e:764f                    ICMPv6     86 Neighbor Solicitation for 3ffe:501:ffff:100:20c:29ff:fe1e:764f from 00:0c:29:91:2f:08
  42 276.756320  3ffe:501:ffff:100:20c:29ff:fe1e:764f fe80::20c:29ff:fe91:2f08             ICMPv6     86 Neighbor Advertisement 3ffe:501:ffff:100:20c:29ff:fe1e:764f (sol, ovr) is at 00:0c:29:1e:76:4f
  43 276.756323  3ffe:501:ffff:101:20c:29ff:feaf:5e46 3ffe:501:ffff:100:20c:29ff:fe1e:764f IPv6      290 IPv6 fragment (nxt=ICMPv6 (0x3a) off=1232 id=0xcaa5b4b2)
  44 277.953958  3ffe:501:ffff:101:20c:29ff:feaf:5e46 3ffe:501:ffff:100:20c:29ff:fe1e:764f IPv6     1294 IPv6 fragment (nxt=ICMPv6 (0x3a) off=0 id=0x9222ac12)
  45 277.954025  3ffe:501:ffff:101:20c:29ff:feaf:5e46 3ffe:501:ffff:100:20c:29ff:fe1e:764f ICMPv6    290 Echo (ping) request id=0x3173, seq=0
  46 277.954133  3ffe:501:ffff:100:20c:29ff:fe1e:764f 3ffe:501:ffff:101:20c:29ff:feaf:5e46 ICMPv6   1514 Echo (ping) reply id=0x3173, seq=0
  47 277.954272  3ffe:501:ffff:100:20c:29ff:fe91:2f08 3ffe:501:ffff:100:20c:29ff:fe1e:764f ICMPv6   1294 Packet Too Big
  48 279.156420  3ffe:501:ffff:101:20c:29ff:feaf:5e46 3ffe:501:ffff:100:20c:29ff:fe1e:764f IPv6     1294 IPv6 fragment (nxt=ICMPv6 (0x3a) off=0 id=0xbbbb522b)
  49 279.156503  3ffe:501:ffff:101:20c:29ff:feaf:5e46 3ffe:501:ffff:100:20c:29ff:fe1e:764f ICMPv6    290 Echo (ping) request id=0x3176, seq=0
  50 279.156574  3ffe:501:ffff:100:20c:29ff:fe1e:764f 3ffe:501:ffff:101:20c:29ff:feaf:5e46 IPv6     1294 IPv6 fragment (nxt=ICMPv6 (0x3a) off=0 id=0x5c0036aa)
  51 279.156576  3ffe:501:ffff:100:20c:29ff:fe1e:764f 3ffe:501:ffff:101:20c:29ff:feaf:5e46 ICMPv6    290 Echo (ping) reply id=0x3176, seq=0
  52 280.164546  3ffe:501:ffff:101:20c:29ff:feaf:5e46 3ffe:501:ffff:100:20c:29ff:fe1e:764f IPv6     1294 IPv6 fragment (nxt=ICMPv6 (0x3a) off=0 id=0xed896fc3)
```

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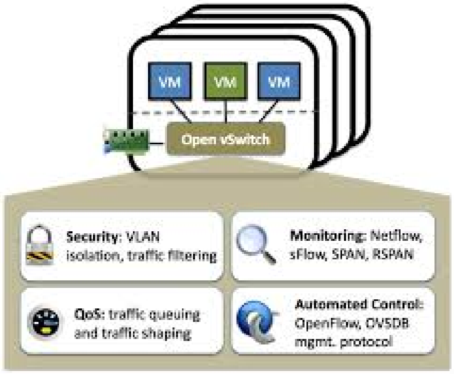
EX2: INTEGRATION OF SIMULATORS/EMULATORS

- Performant distributed Simulation/Emulation of large scale Networks and Data Centers based on GNS3
  - Usage of emulated commercial Router Architectures, e.g. Cisco c7200
  - Integration of real Hardware, e.g. Cisco/HP Router
  - Integration of Open Source Routing Platforms – e.g. Quagga and XORP on top of Linux/FreeBSD/OpenBSD
  - Integration of SDN (Software Defined Networking) Components possible, e.g. Open vSwitch
  - GNS3 Extensions for Traffic Visualization

- Simulation of Network Architectures – including Data Centers – and Network Protocols based on the OMNET++ Discrete Event Simulator



Security: VLAN isolation, traffic filtering

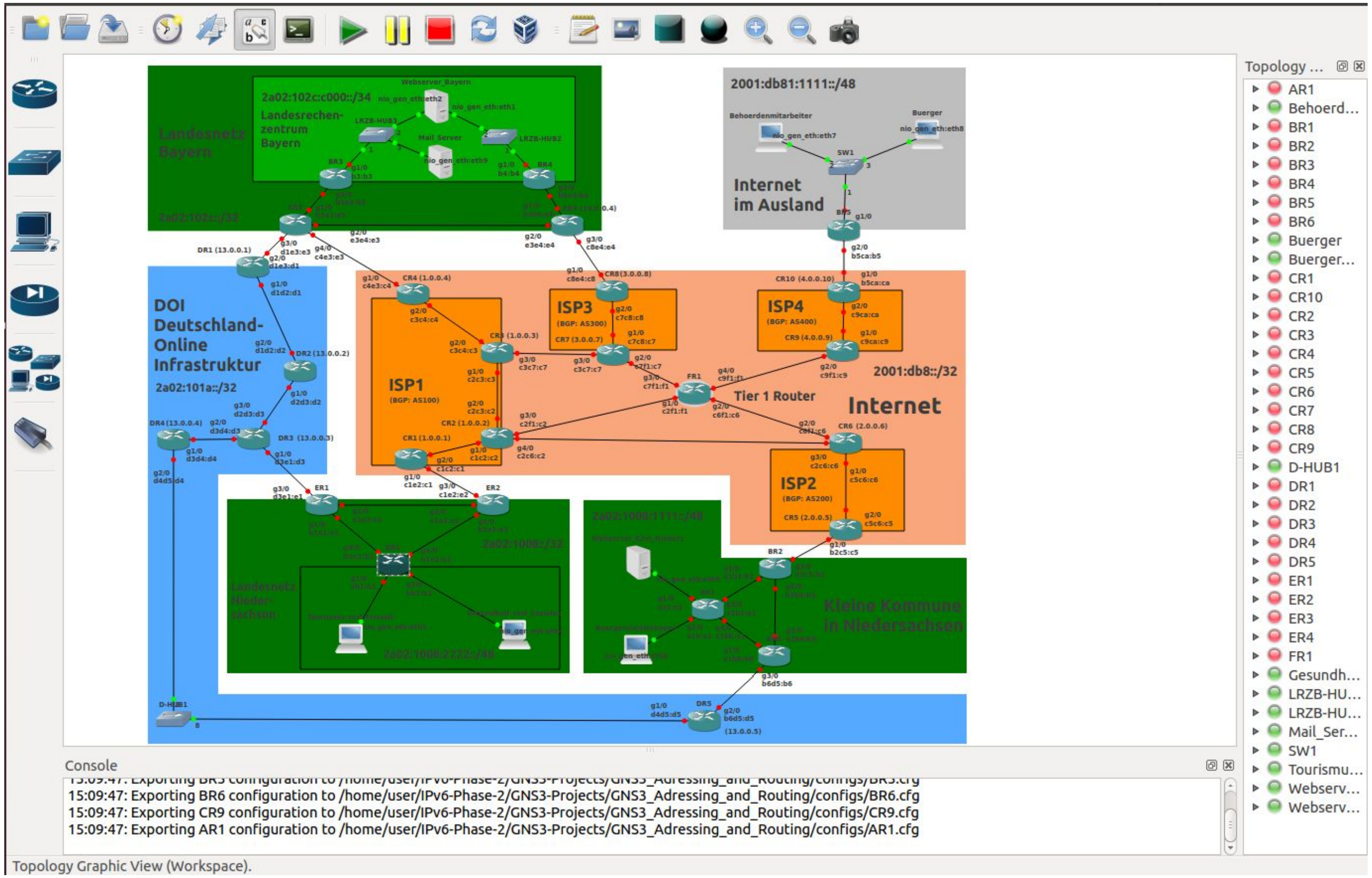
Monitoring: Netflow, sFlow, SPAN, RSPAN

QoS: traffic queuing and traffic shaping

Automated Control: OpenFlow, OVSDB mgmt. protocol

EX2: NETWORK SIMULATION

Simulation and Analysis of a Routing and Addressing Concept in German Public Networks



```
15:09:47: Exporting BR5 configuration to /home/user/IPv6-Phase-2/GNS3-Projects/GNS3_Adressing_and_Routing/configs/BR5.cfg
15:09:47: Exporting BR6 configuration to /home/user/IPv6-Phase-2/GNS3-Projects/GNS3_Adressing_and_Routing/configs/BR6.cfg
15:09:47: Exporting CR9 configuration to /home/user/IPv6-Phase-2/GNS3-Projects/GNS3_Adressing_and_Routing/configs/CR9.cfg
15:09:47: Exporting AR1 configuration to /home/user/IPv6-Phase-2/GNS3-Projects/GNS3_Adressing_and_Routing/configs/AR1.cfg
```

FURTHER EXAMPLES

- HL7/IHE testing in eHealth
- TCMS testing in transport
- Performance testing in mobile communication
- Data platform testing in open data
- etc.

LET US TURN TO EXAMPLES THAT WENT WRONG

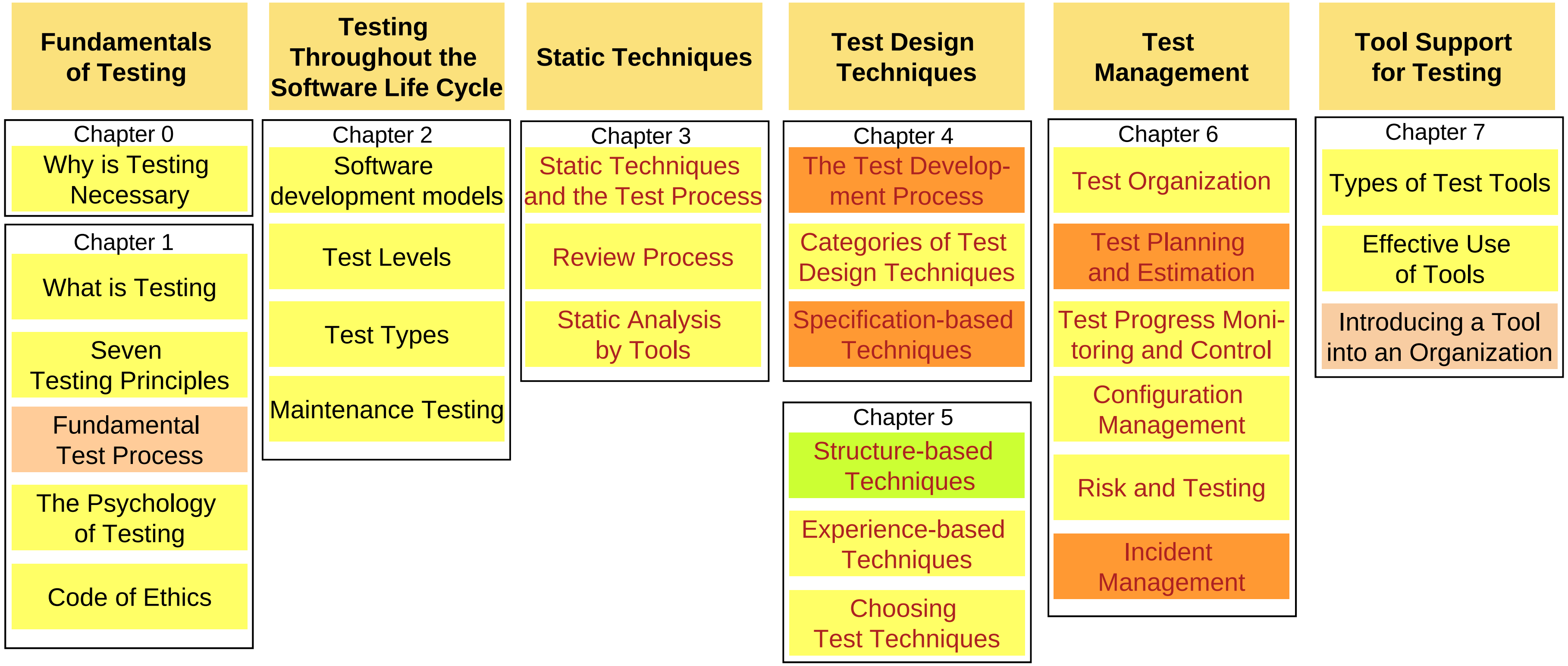
... and discuss

AN EXAMPLE FROM GERMANY

WHAT WENT WRONG

- Testware is „black-box“, closed system – no technical information provided, no detailed logging offered
- Tests are described only, but not specified – gives quite a lot of space for interpretation
- Test architecture is complicated and inflexible – no interfaces, no modularity, built-in configuration and data
- No dedicated test designs – universal preambles and postambles which lead to up to 15min per test run (which makes 2000 test cases not manageable in time)
- Engineers but not test engineers developed the solution

TEST AUTOMATION IN CTFL



Fundamentals of Testing

Chapter 0
- Why is Testing Necessary

Chapter 1
- What is Testing
- Seven Testing Principles
- Fundamental Test Process
- The Psychology of Testing
- Code of Ethics

Testing Throughout the Software Life Cycle

Chapter 2
- Software development models
- Test Levels
- Test Types
- Maintenance Testing

Static Techniques

Chapter 3
- Static Techniques and the Test Process
- Review Process
- Static Analysis by Tools

Test Design Techniques

Chapter 4
- The Test Development Process
- Categories of Test Design Techniques
- Specification-based Techniques

Chapter 5
- Structure-based Techniques
- Experience-based Techniques
- Choosing Test Techniques

Test Management

Chapter 6
- Test Organization
- Test Planning and Estimation
- Test Progress Monitoring and Control
- Configuration Management
- Risk and Testing
- Incident Management

Tool Support for Testing

Chapter 7
- Types of Test Tools
- Effective Use of Tools
- Introducing a Tool into an Organization

Learning objectives (Cognitive levels)

🟫 K1: Remember 🟨 K2: Understand 🟧 K3: Apply 🟩 K4: Analyse

TEST AUTOMATION IN CTEL

1. Introduction and Objectives for Test Automation
2. Preparing for Test Automation
3. The Generic Test Automation Architecture
4. Deployment Risks and Contingencies
5. Test Automation Reporting & Metrics
6. Transitioning Manual Testing to an Automated Environment
7. Verifying the TA-S
8. Continuous Improvement

TEST AUTOMATION IN CTEL

ISTQB Certified Tester

Introduction and Objectives for Test Automation
- Purpose of Test Automation
- Success Factors in Test Automation

Preparing for Test Automation
- Test Automation requirements for the SUT and its context
- Tool Evaluation and Selection Process
- Design for Testability and Automation

The Generic Test Automation Architecture
- Introduction to gTAA
- TAA Design
- TAS Development

Deployment Risks and Contingencies
- Selection of Test Automation Approach and Planning of Deployment/ Rollout
- Implementation of Test Automation
- Technical Risk Assessment and Mitigation Strategies
- Test Automation Maintenance

Test Automation Reporting and Metrics
- Selection of TAS Metrics
- Implementation of Measurement
- Logging of the TAS and the SUT
- Test Automation Reporting

Transitioning Manual Testing to an Automated Environment
- Criteria for Automation
- Identify Steps needed to Implement Automation within Regression Testing
- Factors to consider when Implementing Automation within New Feature Testing
- Factors to consider when Implementing Automation for Defect Re-test

Verifying the TAS
- Verifying Automated Test Environment Components
- Verifying the Automated Test Suite

Continuous Improvement
- Options for Improving Test Automation
- Planning the Implementation of Test Automation Improvement

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FOKUS

PURPOSE OF TEST AUTOMATION

Test automation (often meant to be test execution automation) is one or more of the following tasks:

- Using special software tools to control and set up test preconditions
- Executing tests
- Comparing actual outcomes to predicted outcomes

Test automation is expected to help run many test cases consistently and repeatedly on different versions of the SUT.

Test automation is more than a mechanism for running a test suite without human interaction. It is a process of designing the testware, including the following:

- Software
- Documentation
- Test cases
- Test environments
- Data

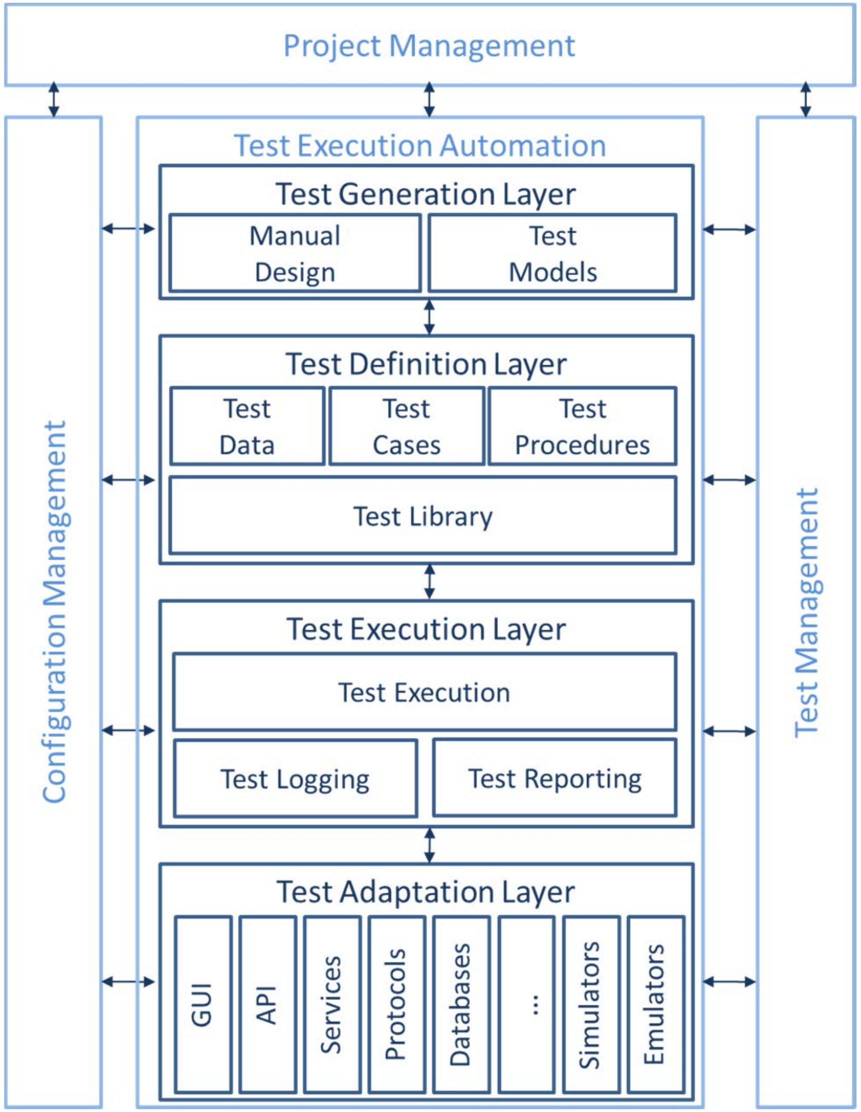
PURPOSE OF TEST AUTOMATION

Objectives of test automation include:

- Improving test efficiency
- Providing wider coverage
- Reducing the total test cost
- Performing non-human-capable testing
- Shortening the test period
- Increasing the test frequency/reducing the time required for test cycles

TEST AUTOMATION IN CTEL

Generic Test Automation Architecture



OUTLINE

1. Introduction to Test Automation
2. Selected Examples
3. Interaction and Discussion
4. Challenges in Management of Test Infrastructures
5. Review of Test Technologies
6. Conclusions

BENEFITS IN CREATING, APPLYING AND EVOLVING TEST AUTOMATION

What are the top three benefits that you see in test automation?

ADVANTAGES OF TEST AUTOMATION

- More tests are run per build
- Tests that cannot be done manually are enabled (real-time, remote, parallel tests)
- Tests can be more complex
- Tests run faster
- Tests are less subject to operator error
- More effective and efficient use of testers
- Better co-operation with developers
- Improved system reliability
- Improved quality of tests

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THREATS IN CREATING, APPLYING AND EVOLVING TEST AUTOMATION

What are the top three threats that you see in test automation?

POSSIBLE THREATS IN TEST AUTOMATION

- The tool’s interface does not work with other tools that are already in place
- Some SUT dependencies are changed to ones not supported by the test tool
- Object on GUI could not be captured
- Tool looks very complicated
- Conflict with other systems
- Impact to SUT
- Access to code
- Limited resources (mainly in embedded environments)
- Updates
- Security
- Incompatibility between different environments and platforms

LET US DISCUSS …

… how to implement test automation and how to overcome hurdles

SUCCESS FACTORS FOR TEST AUTOMATION

- A “good” test automation architecture – modular, extendible, flexible, reusable
- A “good” SUT – the SUT is designed for testability
- A “good” test strategy - testable parts of the SUT should be targeted first
- A “good” test automation process – practical, well documented and flexible
- A “good” test support – logging, tracing, bug tracking, report generation, progress tracking, metrics generation

SUCCESS FACTORS FOR TEST AUTOMATION

- Do not create code that is sensitive to the interface (i.e., it would be affected by changes in the graphical interface or in non-essential parts of the API)
- Do not create test automation that is sensitive to data changes or has a high dependency on particular data values (e.g., test input depending on other test outputs)
- Do not create an automation environment that is sensitive to the context (e.g., OS system date and time, OS localization parameters or the contents of another application).

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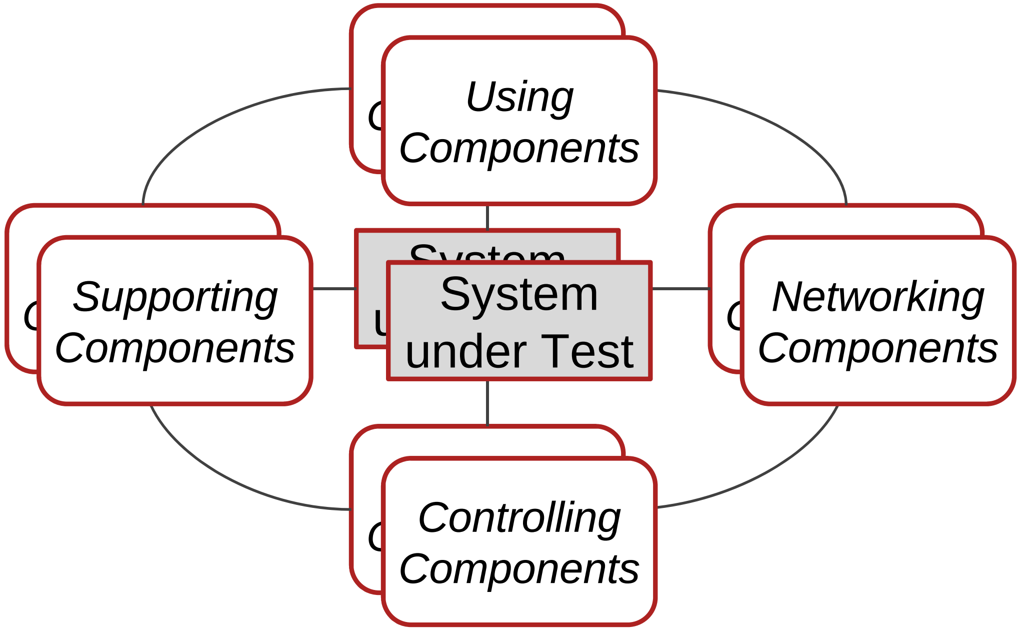
CHALLENGES

- Test environments as part of test setups



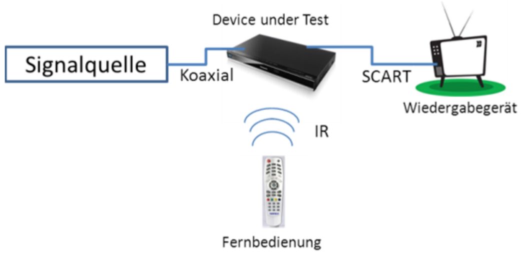
Using Components

Supporting Components

System under Test

Networking Components

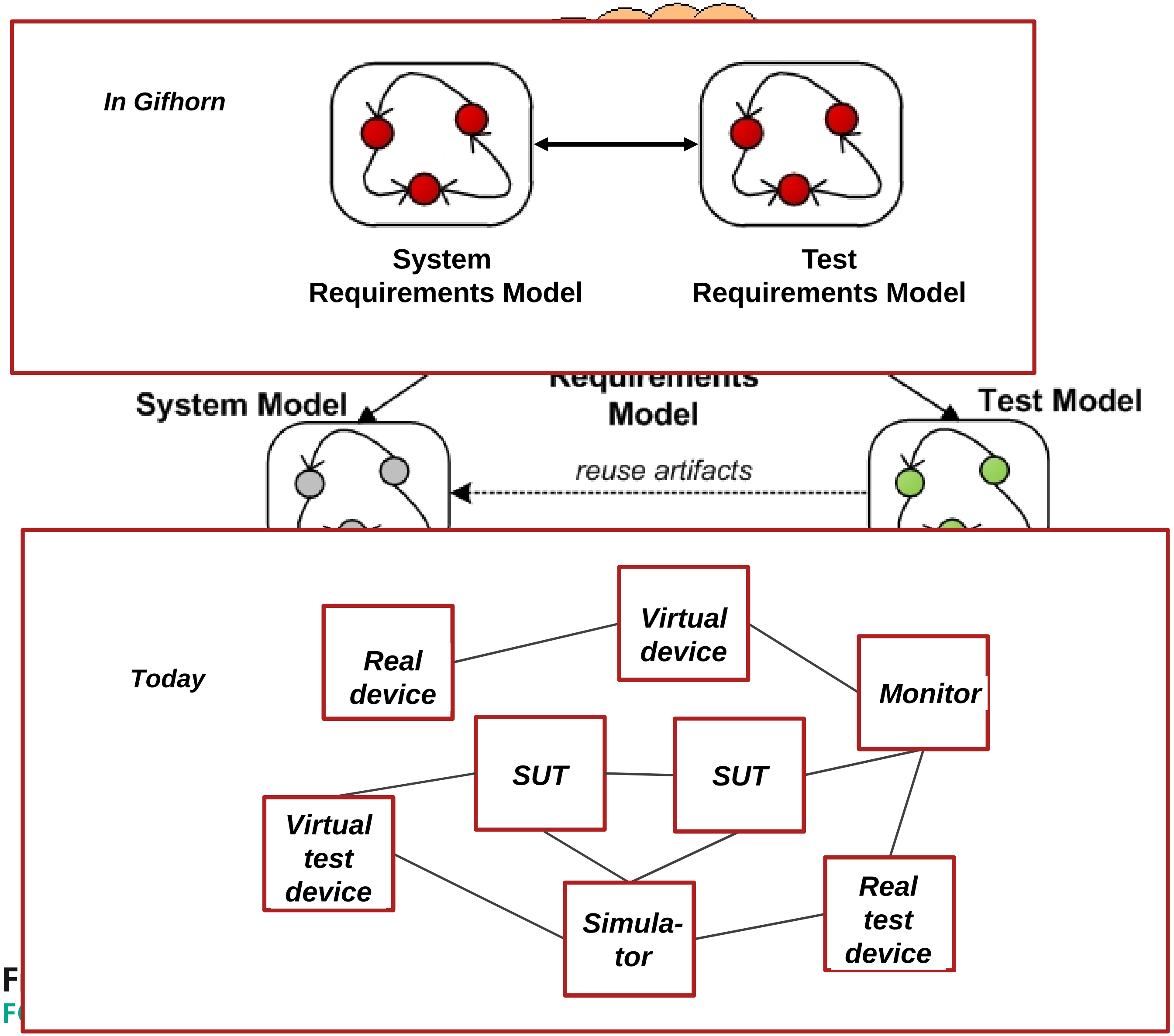
Controlling Components



In: Testumgebungen für eingebettete Systeme im Griff. Carsten Weise, SIGS Datacom Online Testing Issue, 2012

- Combinations of real, virtualized and simulated components
- Integration of monitors and impairment components
- Management of test environments (configurations, versions, connections)

TEST DUALITY AT A GLANCE



In Gifhorn

System Requirements Model

Test Requirements Model

Requirements Model

System Model

Test Model

reuse artifacts

Today

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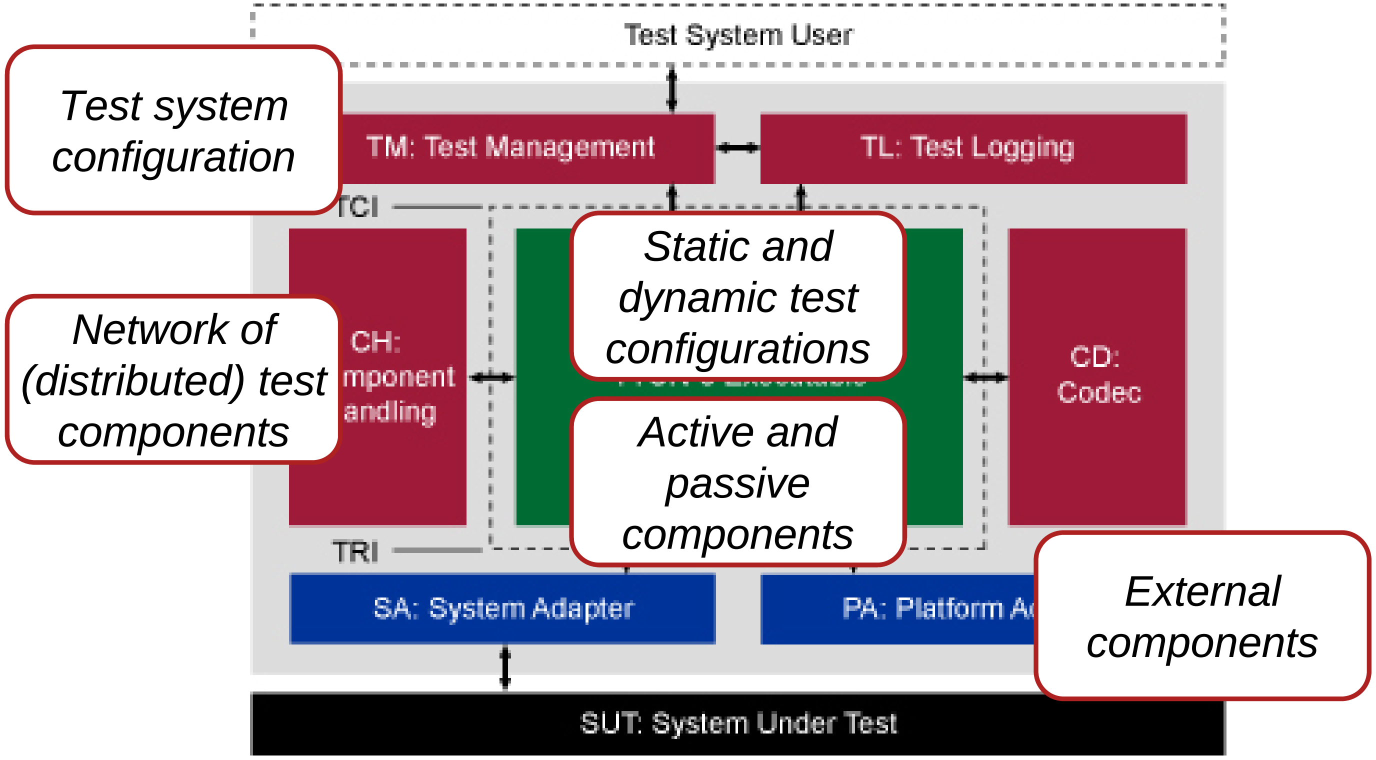
SOFTWARE TESTING AND TEST DEVICES ?

1. ETSI TTCN-3
2. IEEE ATML
3. ISTQB Certified Software Tester

ETSI TESTING AND TEST CONTROL NOTATION

TTCN-3



Test system configuration

Network of (distributed) test components

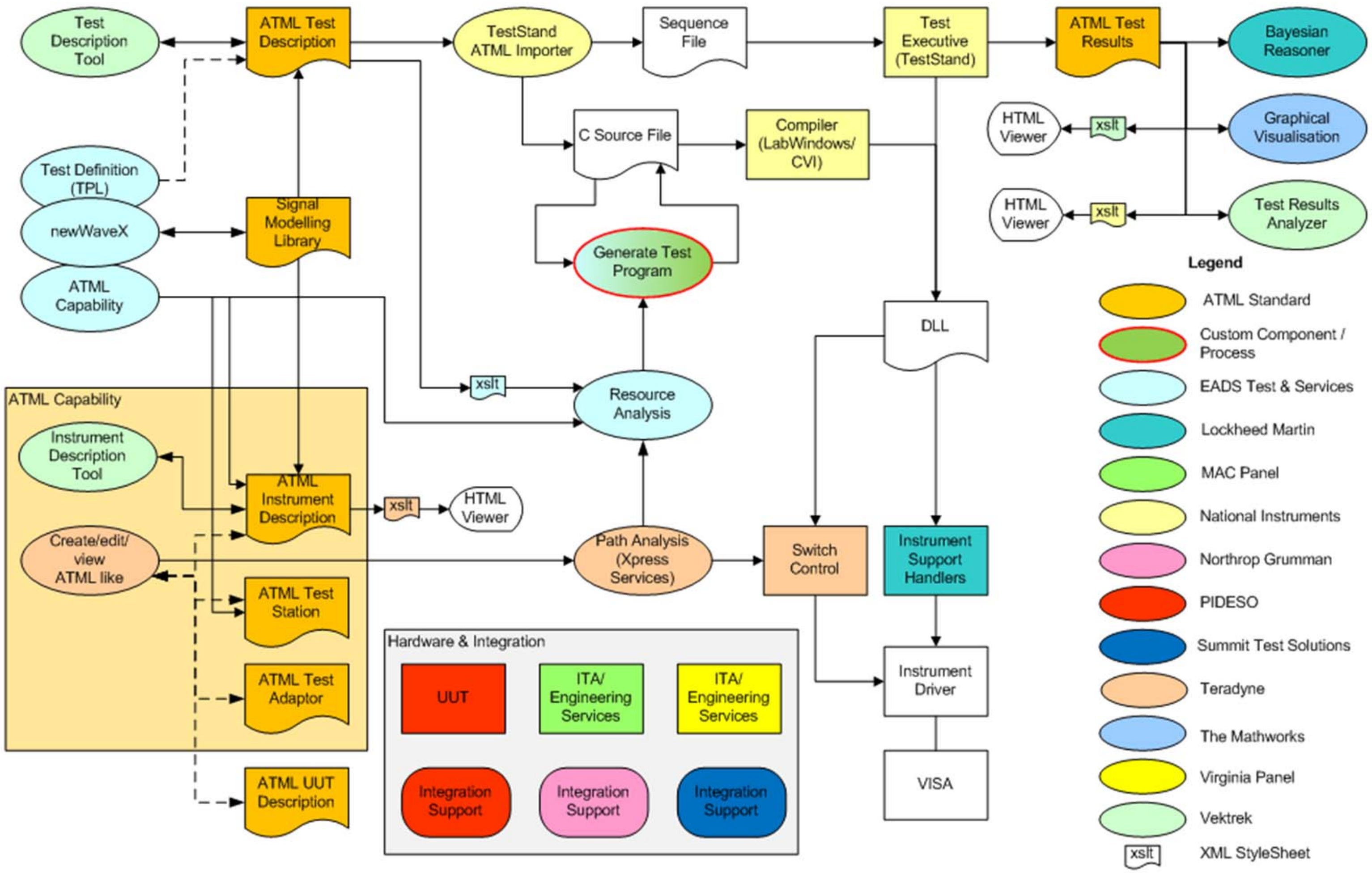
Static and dynamic test configurations

Active and passive components

External components

IEEE AUTOMATIC TEST MARK-UP LANGUAGE

<ATML/>
Automatic Test Mark-up Language



Test Description Tool

ATML Test Description

TestStand ATML Importer

Sequence File

Test Executive (TestStand)

ATML Test Results

Bayesian Reasoner

C Source File

Compiler (LabWindows/ CVI)

HTML Viewer

xslt

Graphical Visualisation

Test Definition (TPL)

newWaveX

Signal Modelling Library

Generate Test Program

HTML Viewer

xslt

Test Results Analyzer

ATML Capability

DLL

xslt

Resource Analysis

ATML Capability

Instrument Description Tool

ATML Instrument Description

xslt

HTML Viewer

Create/edit/ view ATML like

Path Analysis (Xpress Services)

Switch Control

Instrument Support Handlers

ATML Test Station

ATML Test Adaptor

ATML UUT Description

Hardware & Integration

UUT

ITA/ Engineering Services

ITA/ Engineering Services

Integration Support

Integration Support

Integration Support

Instrument Driver

VISA

Legend

ATML Standard

Custom Component / Process

EADS Test & Services

Lockheed Martin

MAC Panel

National Instruments

Northrop Grumman

PIDESO

Summit Test Solutions

Teradyne

The Mathworks

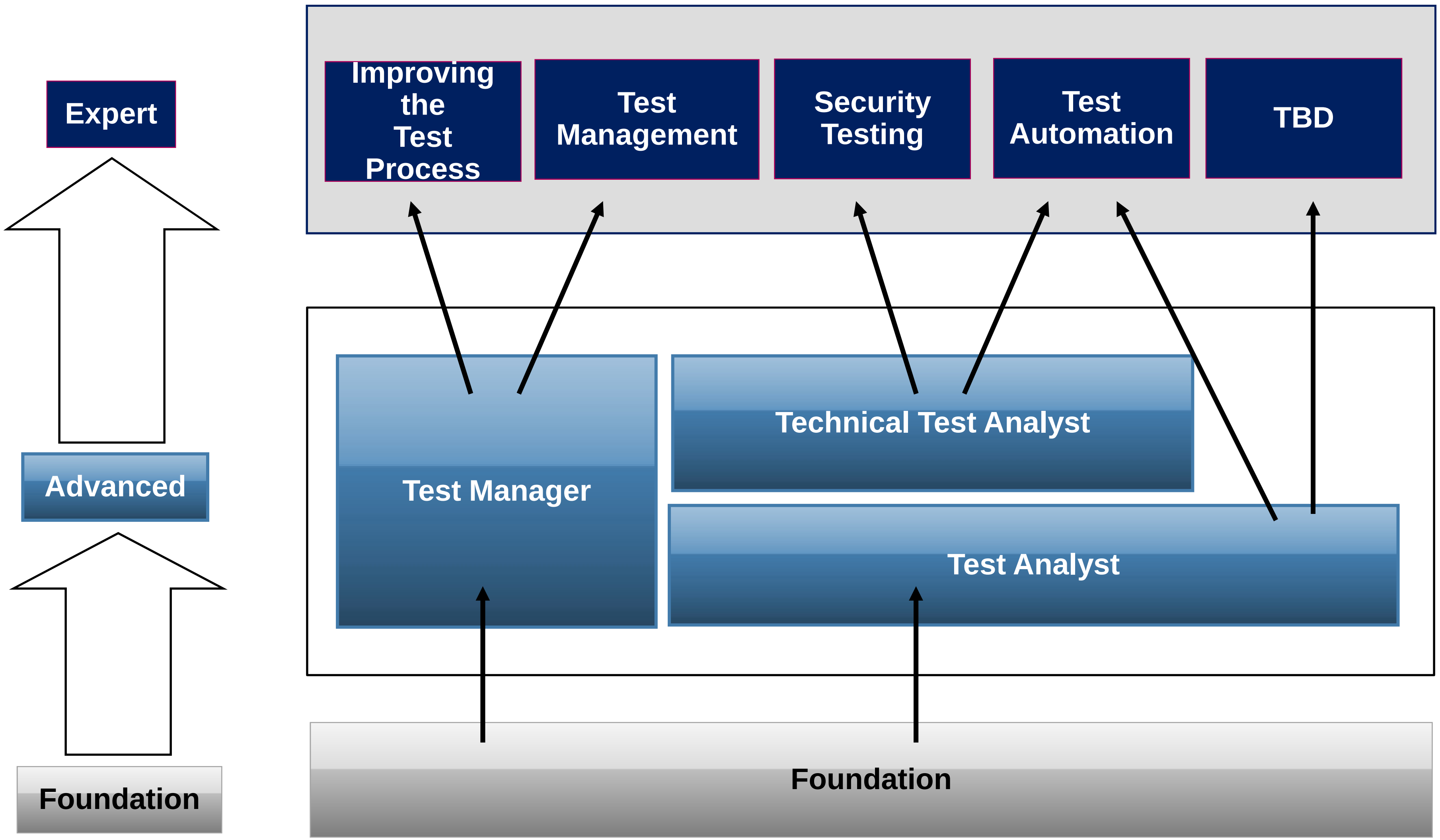
Virginia Panel

Vektrek

xslt XML StyleSheet

In: ATML Demonstration Baseline, AutoTestCon, 2008.

CERTIFIED TESTER - 3-STEP CERTIFIED TRAINING



Expert

Advanced

Foundation

Improving the Test Process

Test Management

Security Testing

Test Automation

TBD

Test Manager

Technical Test Analyst

Test Analyst

Foundation

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CONCLUSIONS

1. Developments in mobile communications, Internet of Things or Industry 4.0 require automated test methods for interconnected embedded systems (aka cyber-physical systems)

2. Although many best practices and test technologies exist, test automation still does not explore its potentials

3. Software in such open systems is (and has always been) influenced by hardware, network and additional environmental components

4. Single or simple test configuration setups are insufficient (as discussed e.g. in articles on mobile app testing) - virtualized and real test devices are needed for today‘s software testing

5. Test automation should be trained and carefully approached

THANK YOU FOR YOUR ATTENTION ! QUESTIONS ?

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