International Telecommunication Testing Centre (ITTC)

Test creation principles

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International training seminar «Testing of System and Network Solutions»
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Contents

- TISPAN WG 6 and INT Test activity - overview
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- Demonstration of automatic test execution process based on TTCN-3

TISPAN WG 6 Test activity - Overview

WG 6 produces manual and automatic test suites to ensure the conformance to TISPAN, 3GPP and ITU standardized protocols. These tests ensure the global interoperability of ISDN, PES and IMS Core NGN R1/R2, QoS between networks and Performance Benchmarking for NGN.

TC INT (IMS Network Testing)

- INT technical committee was formed in March 2008.
- Initial mandate from 3GPP and TISPAN:
  - Develop IMS Core Network test specifications (interoperability, conformance, network integration etc.) according to 3GPP and TISPAN specifications.
  - Initiate and supervise interoperability events (such as IMS Plugtests).
  - Coordinate IMS interoperability efforts with other organisations such as the IMS/NGN Forum, GSMA, OMA, MSF.
  - Coordination with ETSI TC MTS in order to have the right methodologies and tools to ensure effective test specifications

WG6 Approved NGN documents

- TS 186 001 Network Integration Testing (NIT) between SIP and ISDN (TSS&TP, PICS, ETS) Rel 1
- TS 186 002 SIP/ ISUP Interworking conformance Tests (based on the EN 383 001/Q.1912.5) (TSS&TP, PICS, ETS)
- TS 186 005 TIP/TIR Conformance Tests (TSS&TP, PICS, ETS) Rel.1
- TS 186 005 TIP/TIR Conformance Tests (TSS&TP, PICS) Rel.2
- Conformance Tests (TSS&TP, PICS, ETS) Rel.2
- TS TS 186 006 OIP/OIR Conformance Tests (TSS&TP, PICS, ETS) Rel.1
- TS 186 006 OIP/OIR 186 007 Communication HOLD Conformance Tests (TSS&TP, PICS, ETS)
- TS 186 008 Performance Benchmarking for NGN
- TS 186 009 SIP/ ISUP Interworking conformance Tests (based on the ES 283 027 / 3GPP TS 29.163 TSS&TP)
- TS 186 010 CONF (TSS&TP)
- TS 186 012 SUB (TSS&TP and PICS)
- TS 186 016 CUG (TSS&TP and PICS)
- TS 186 017 ACR-CB (TSS&TP and PICS)
- TS 186 018 MCID (TSS&TP and PICS)
- TS 186 021 CCBS & CCBR (TSS&TP and PICS)
- TS 186 022 CW (TSS&TP and PICS)
- TS 186 020 IMS-based IPTV interoperability test specification

Work in progress of Conformance and Interoperability testing

- OIP/OIR Rel.2 (INT)
- UUS
- ECT
- CDIV
- CUG (ATS&PIXIT)
- MCID (ATS&PIXIT)
- ISDN-SIP INTERWORKING
- QoS performance test
- Network Integration Testing (NIT) between SIP and ISDN (TSS&TP, PICS, ETS) Rel 2
- Performance Benchmarking for PES

Specialist Task Forces (STF) (1)

- Finished STF to realize automatic testing and Interoperability Test Specifications

  - 297 Test SIP-ISUP profiles A&B
  - 301 SIP-ISUP test validation
  - 306 Test & Validation NIT SIP-ISDN
  - 310 Test SIP- ISUP Profile C
  - 328 Interop. IMS-NNI interworking based on 3GPP R6
  - 334 Test & validation TIP/TIR
  - 335 Test & validation OIP/OIR
  - 336 Test & validation HOLD
  - 347 Interop IMS NNI (3GPPR7)
  - 348 SIP-ISUP interworking mainten.
  - 366 SIP-ISUP (IMS) interwork

Specialist Task Forces (STF) (2)

- Current STF to realize automatic testing and Interoperability Test Specifications produced in TISPAN WG6 and TC INT

- 346 Valid. IMS SIP/SDP
- 368 Valid.4 suppl. serv.
- 369 Valid. NIT SIP-SIP 3GPP R7
- 387 Valid SIP/ISUP Profile C (SIP-I)

NGN testing methods

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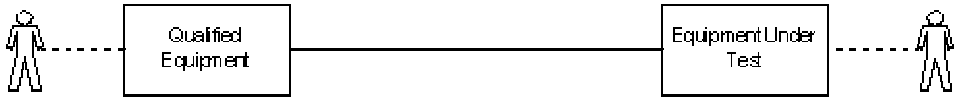
NGN testing methods

§ Conformance testing or type testing

Ø The purpose of conformance testing is to determine to what extent a single implementation of a particular standard conforms to the individual requirements of that standard.

• Interoperability testing

Ø Interoperability testing is the activity of proving that end-to-end functionality between (at least) two communicating systems is as required by those base systems' standards.



NGN - Interoperability testing methods

- Network Integration Tests / End-to-End Tests
- Benchmark / Load Tests
- QoS Tests
- Security Tests
- Roaming Tests
- Interconnection Tests
- Functional tests / Real Equipment Tests

Combining Interoperability and Conformance Testing

- **Conformance and Interoperability**
  - both important and useful approaches to the testing of standardized protocol implementations
  - although it is unlikely that one will ever fully replace the other

- **Conformance testing**
  - able to show that a particular implementation complies with all of the protocol requirements specified in the associated base standard
  - difficult for such testing is to be able to prove that the implementation will interoperate with similar implementations in other products

Combining Interoperability and Conformance Testing

- **Interoperability testing**

  can clearly demonstrate that two implementations will cooperate to provide the specified end-to-end functions
  cannot easily prove that either of these implementations conforms to the detailed requirements of the protocol specification

Conformance testing for interoperability

- ETSI test specifications are designed to concentrate on areas critical to interoperability, including testing an implementation's reaction to erroneous behaviour. The goal is conformance testing for interoperability.
- This should not be confused with interoperability testing, which is a useful, but different, activity. The two approaches are complementary rather than competitive,
  which is why ETSI also provides a Plugtests Service for interoperability events for standards and product validation. A focussed set of conformance tests can provide an excellent framework for subsequent interoperability testing.

Examples for Network Integration and Conformance Tests

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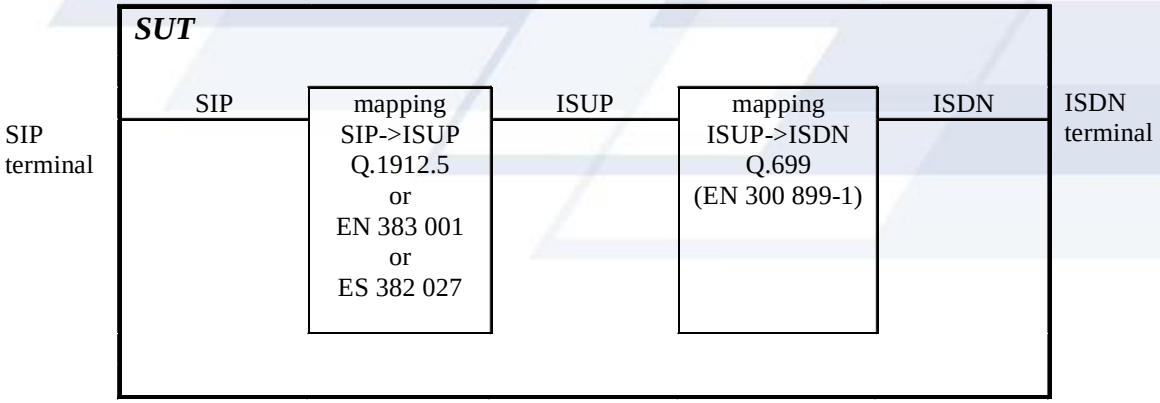
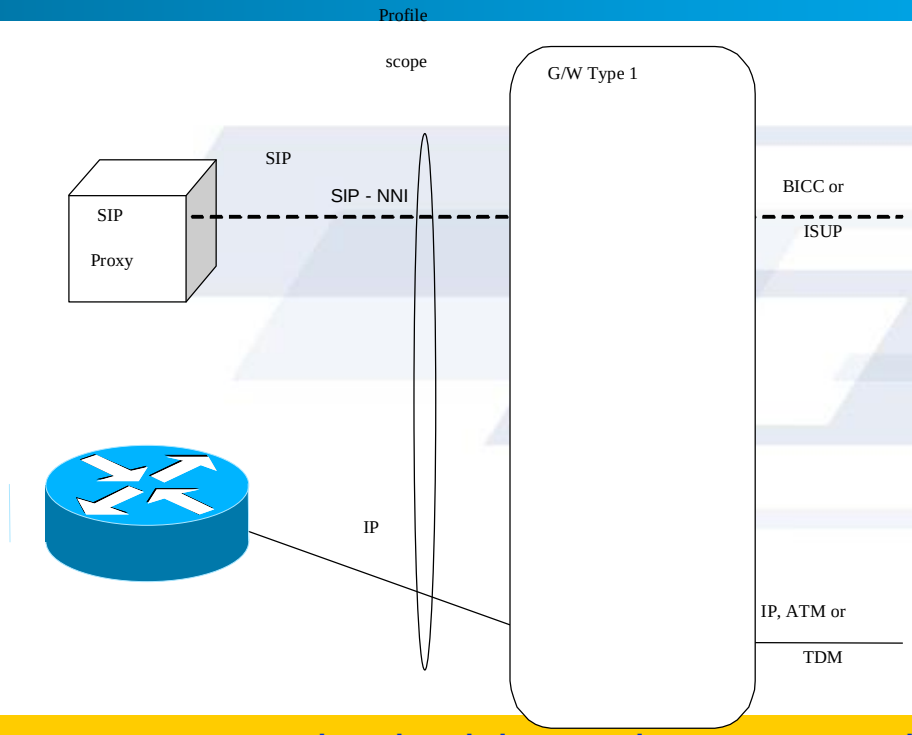
”Network Integration Testing (NIT) between SIP and ISDN, including validation” (1)

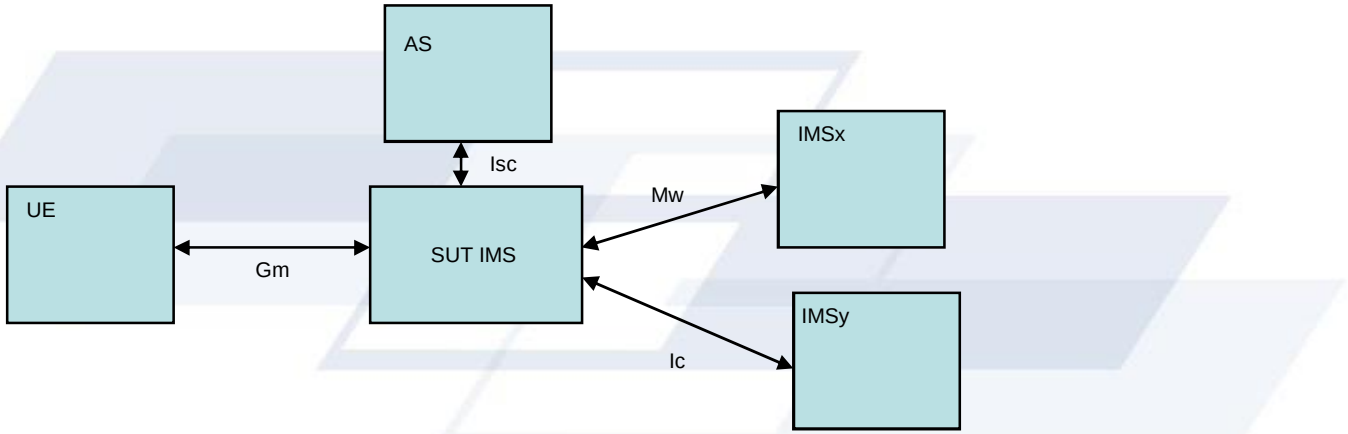
- **The TS 386 001 contains TSS &TP, ATS & PIXIT for the basic call functionality (SIP- ISDN, ISDN-SIP, SIP-SIP) and supplementary services CLIP/CLIR (OIP/OIR), COLP/COLR (TIP/TIR), Call HOLD, Call Diversion (CFU,CFB, CFNR), 3PTY, CONF**



Conformance Testing: Interworking between Session Initiation Protocol (SIP) and Bearer Independent Call Control Protocol or ISDN User Part, Profile A and B (Q.1912.5 C)



IMS Session Initiation Protocol (SIP) and Session Description Protocol (SDP); Conformance Tests of ES 283 003 (1)



IMS Session Initiation Protocol (SIP) and Session Description Protocol (SDP); Conformance Tests of ES 283 003 (2)

- The Mw interface is used in case of interworking or roaming between two different IMS core networks. This interface is used only if no border control functions like topology hiding are required.
- The Ic interface is used in case of interworking or roaming between two different IMS core networks. This interface is used only if border control functions like topology hiding are required.
- The Isc interface enables the IMS core network to communicate with a AS.

Conformance Testing Methodology

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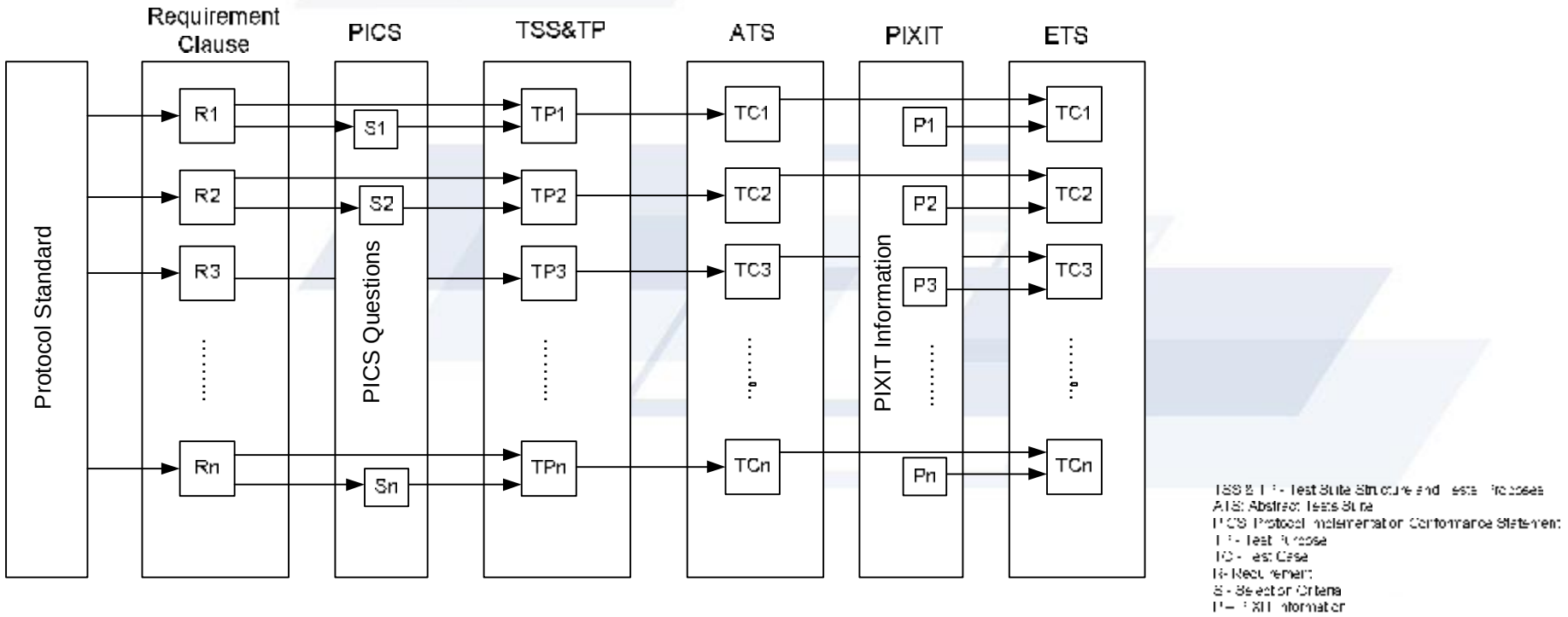
Conformance Testing Methodology Recommendations

- X.290 - General Concepts
- X.291 - Abstract Test Suite Specification
- X.292 - (Superceded by Z.140 series Recommendations)
- X.293 - Test Realization
- X.294 - Requirements on Test Laboratories and Clients
- X.295 - Protocol Profile Test Specification
- X.296 - Implementation Conformance Statements
- Z.140 - through Z.146 - Testing and Test Control Notation

Overview of Conformance Testing Procedures



Test Suite Development Procedure

- **Start with a PICS**
  – This ensures that complete coverage is obtained
- **Develop *Test Suite Structure***
  – This logically groups the test cases
- **Develop *Test Purposes***
  – This defines the objectives of the *test cases*
- **Develop ATS**
  – This are automated test cases written in abstract language like TTCN-3
- **Develop PIXIT**
  – This defines the additional information required before testing can proceed
  adress of IUT, timer values, configuration, parameters, procedures
- **Production of ETS**
  "Compiled" ATS to run on specific test equipment

What are PICS and PIXIT ?

- ICS Proforma – Implementation Conformance Statement Proforma
  - formatted questionnaire for declaring what optional features have been implemented
- ICS Filled-out ICS Proforma

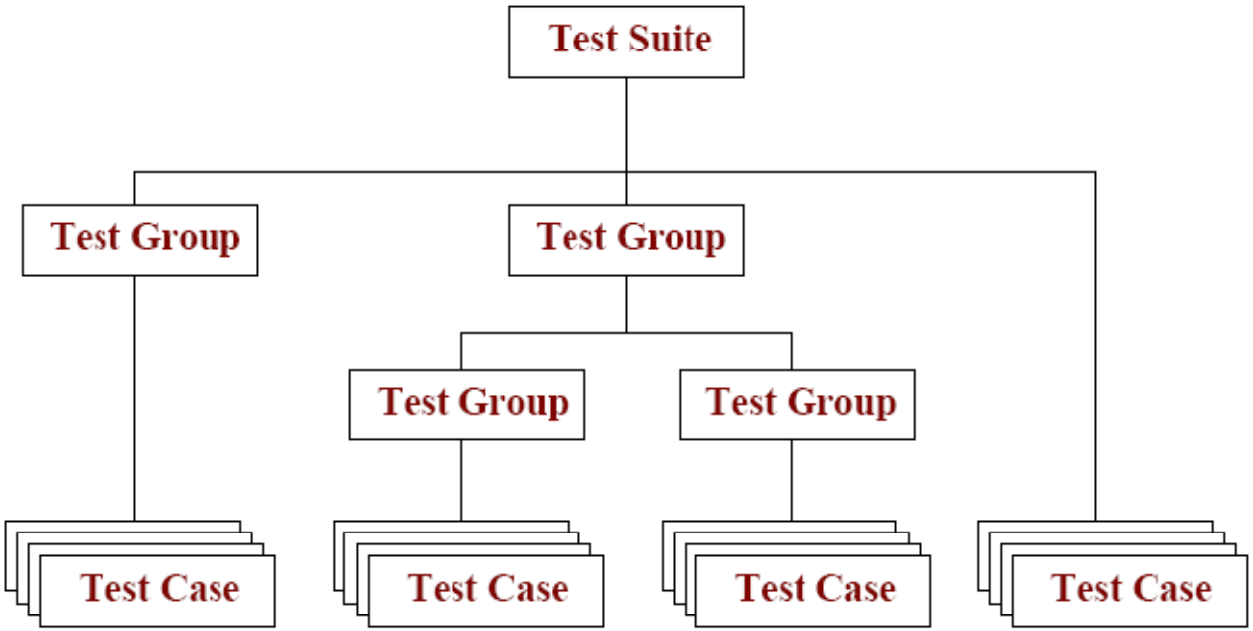
- IXIT Proforma
  - Additional information required before testing can proceed
    - administrative: identification of client, laboratory staff
    - technical: adrees of IUT, timer values, configuration, parameters, procedures

- IXIT – ICS Filled-out IXIT Proforma

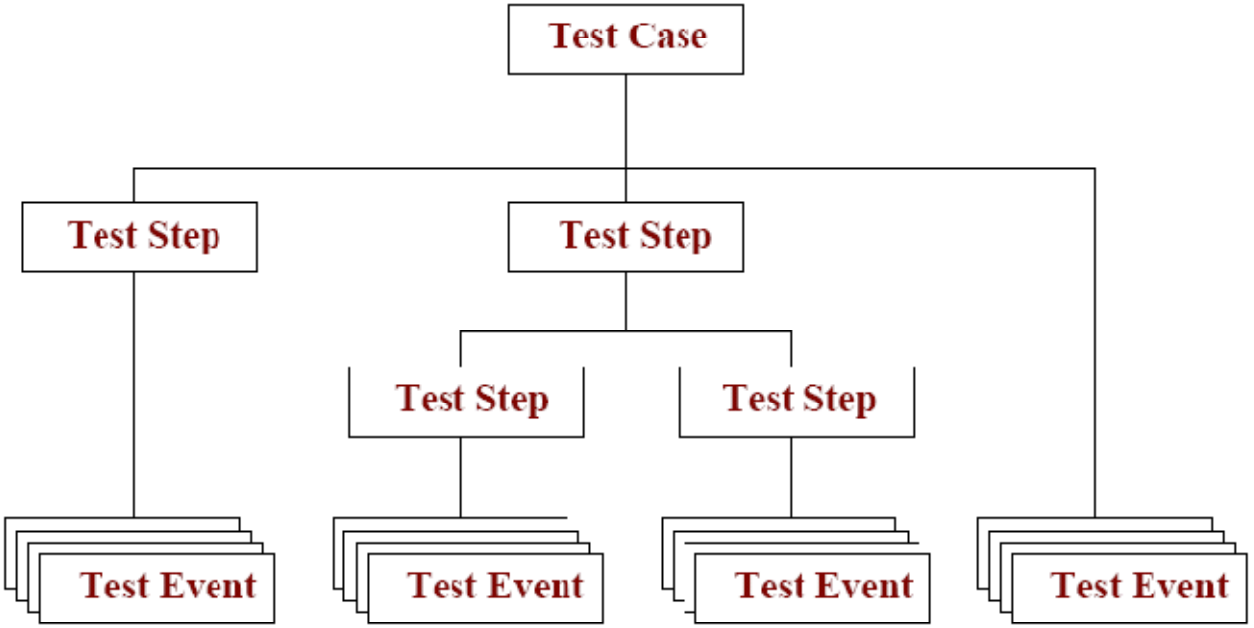
What is a Test Suite?

- A *test suite* is a collection of *test cases*, one for each test purpose
- A test case verifies *conformance/interoperability* for a particular Requirement or Option according to the *test purpose*

Test Suite Structure



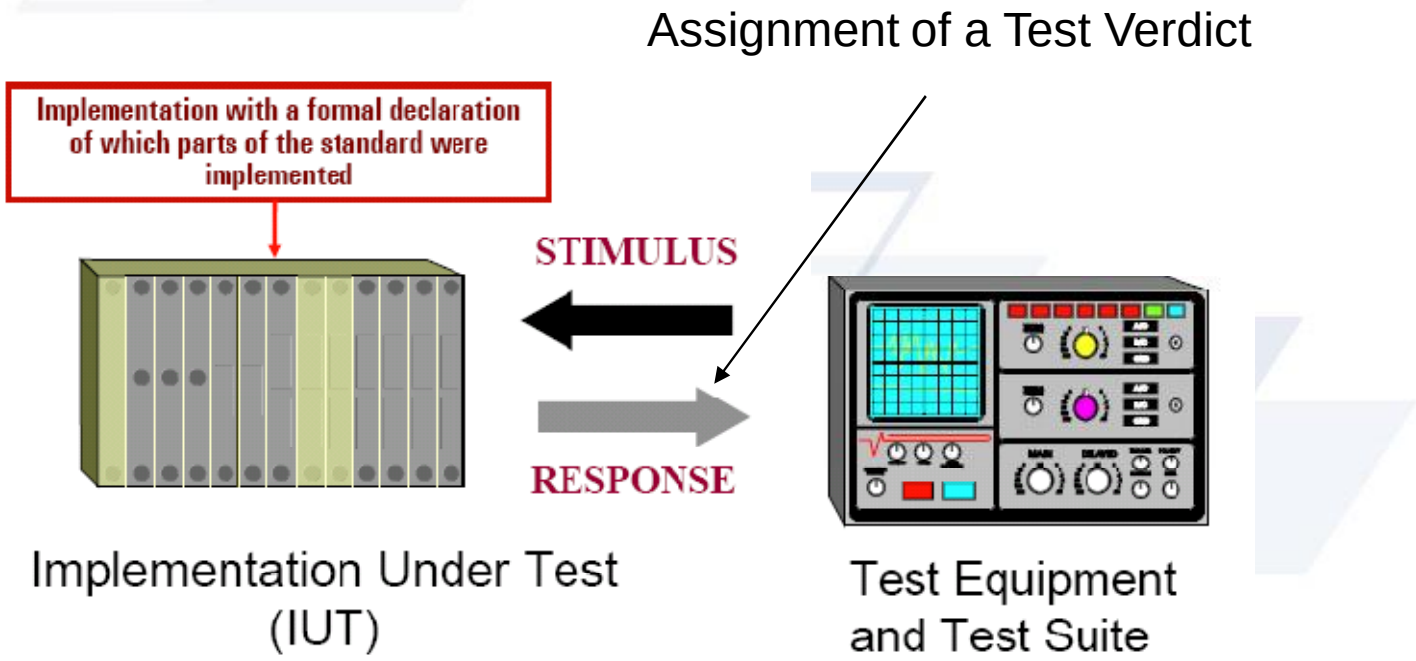
Test Case Structure



Test Case Architecture

- One Test Case for each Test Purpose representing one Requirement from the Requirements Clause
- To get a Pass verdict, the Implementation Under Test (IUT) must respond correctly when the Tester exhibits three different kinds of behaviour:
  – Valid
  – Invalid
  – Inopportune
- For each of the three Tester behaviours, the IUT may be assigned a Pass, Fail or Inconclusive verdict

Test Case Architecture



What are Abstract and Executable Test Suites?

- Abstract Tests Suite (ATS)

  - automated test cases defined by a standard organization, written in abstract language like TTCN-3

- Executable Tests Suite (ETS)

  - .mp file „compiled“ to run on specific test equipment
  - creation of the ETS is proprietary to the test equipment vendor

ITCN-3

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Test Technologie

- The Testing and Test Control Notation
- A standardized alternative to proprietary test systems
  - Developed by a large group of testing experts
  - Used by a growing community
  - Proven by tools
  - Maintained at ETSI
- TTCN- 3 is a test specification and implementation language

The TTCN-3 Standards (free download at http://www.ttcn-3.org/Specifications.htm)

- ES 201 873-1 (Z.140)
  - TTCN-3 Core Language
- ES 201 873-2 (Z.141)
  - TTCN-3 Tabular Presentation Format (TFT)
- ES 201 873-3 (Z.142)
  - TTCN-3 Graphical Presentation Format (GFT)

The TTCN-3 Standards (free download at http://www.ttcn-3.org/Specifications.htm)

- ES 201 873-4 (Z.143)
  - TTCN-3 Operational Semantics
- ES 201 873-5
  - TTCN-3 Runtime Interface (TRI)
- ES 201 873-6
  - TTCN-3 Control Interfaces (TCI)
- ES 201 873-7 and onwards (under development)
  - Using ASN.1, XML, IDL, C/C++ with TTCN-3

Main Capabilities of TTCN-3

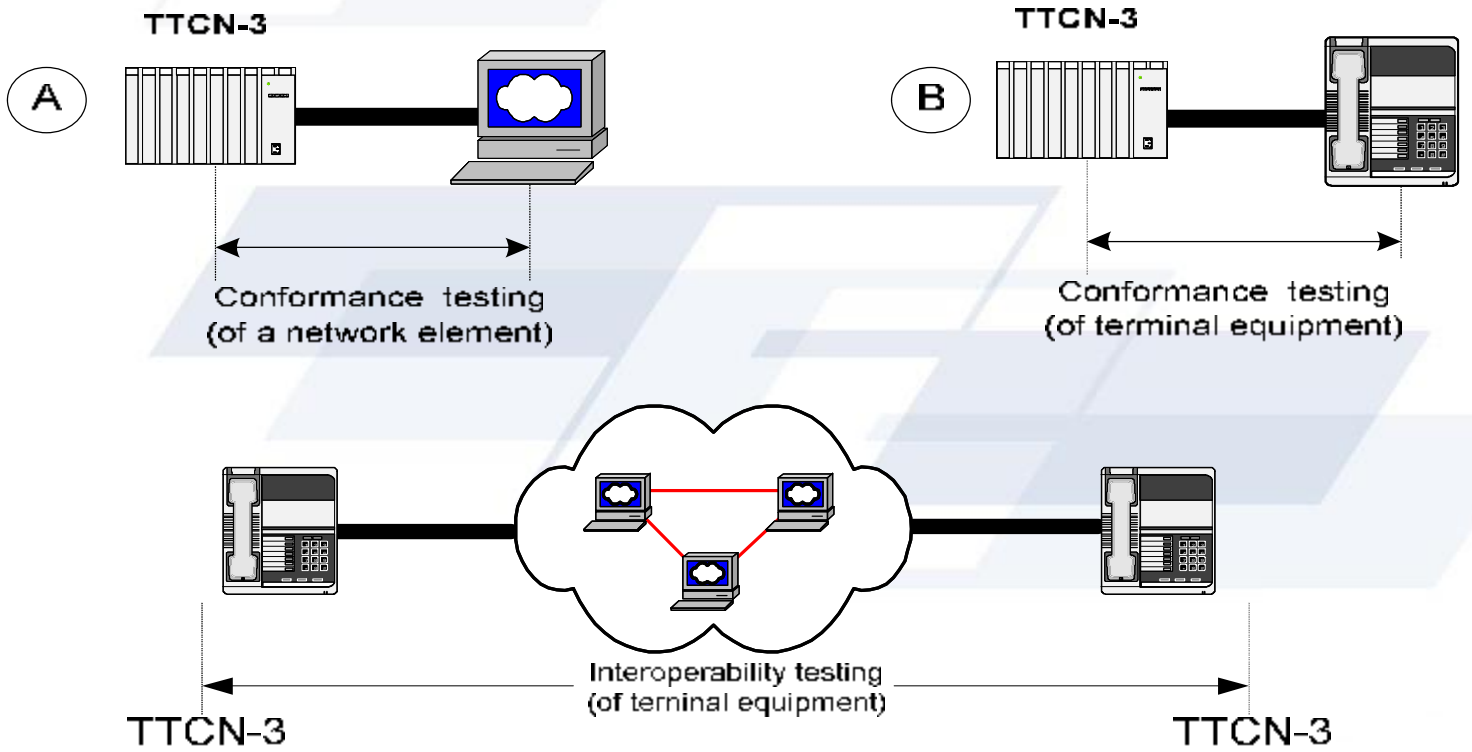
- Dynamic concurrent test configurations
- Synchronous and asynchronous communication mechanisms
- Data templates with powerful matching mechanism
- Assignment and handling of test verdicts
- Testcase selection mechanisms
- Test suite and test data parameterization

Placement of TTCN-3

§ Areas of Testing in the Telecom domain

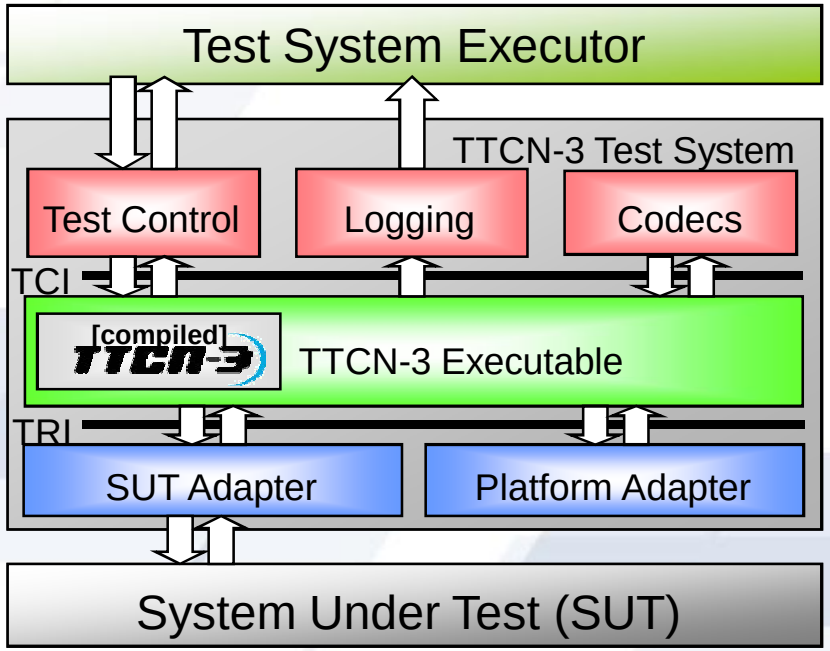
- § Regression Testing
- § Conformance/Functionality Testing
- § Interoperability/Integration Testing
- § Load/ Stress Testing

TTCN-3 can automate Conformance and Interoperability Testing



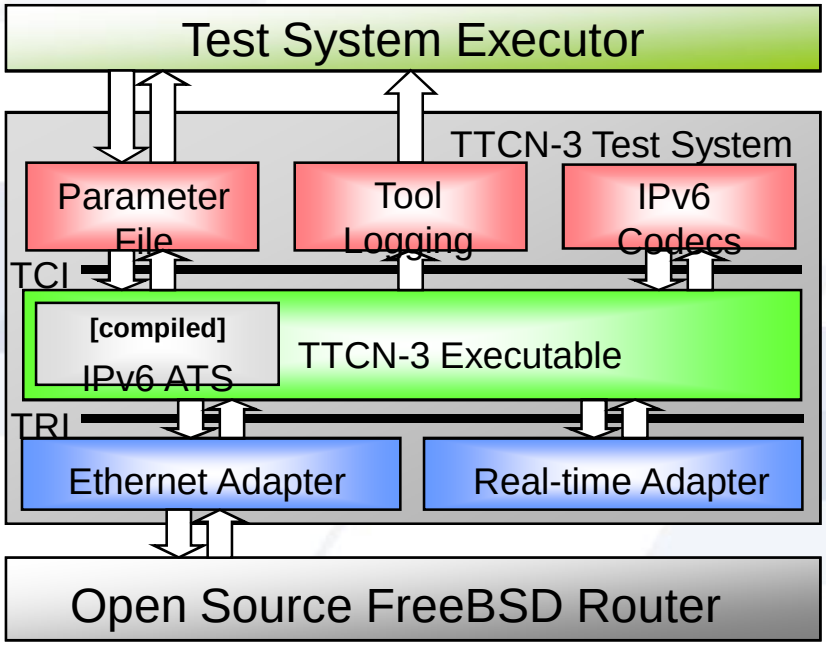
TTCN-3 test systems in a nutshell

- TTCN-3 specifies a test but a test system is needed for test execution
- The test system architecture is defined with the TRI (TTCN-3 Runtime Interface) and TCI (TTCN-3 Control Interface) standards
- TTCN-3 allows reuse of test platforms with different tools but also for different SUTs
- A test system requires
  - A TTCN-3 tool = TTCN-3 compiler and execution environment ()
  - A test platform for a specific device under test ( s +  s)

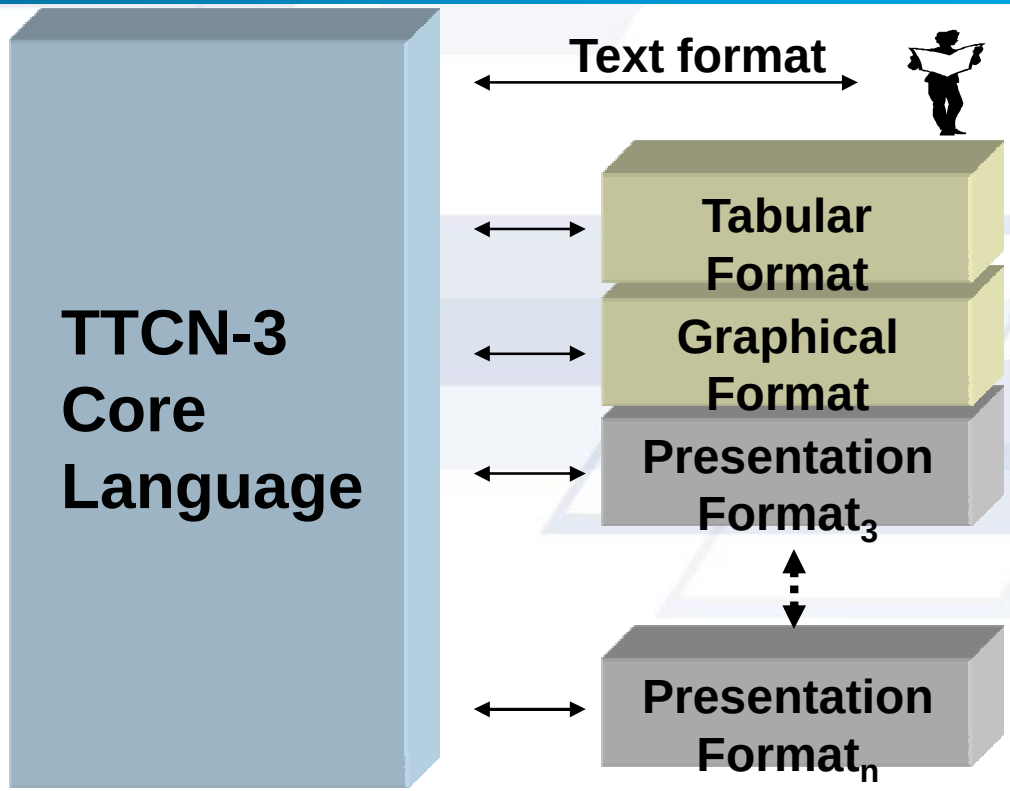


TCI = TTCN-3 Control Interface
TRI = TTCN-3 Runtime Interface

An example adaptation: A IPv6 test system



The Core Language and Other Presentation Formats

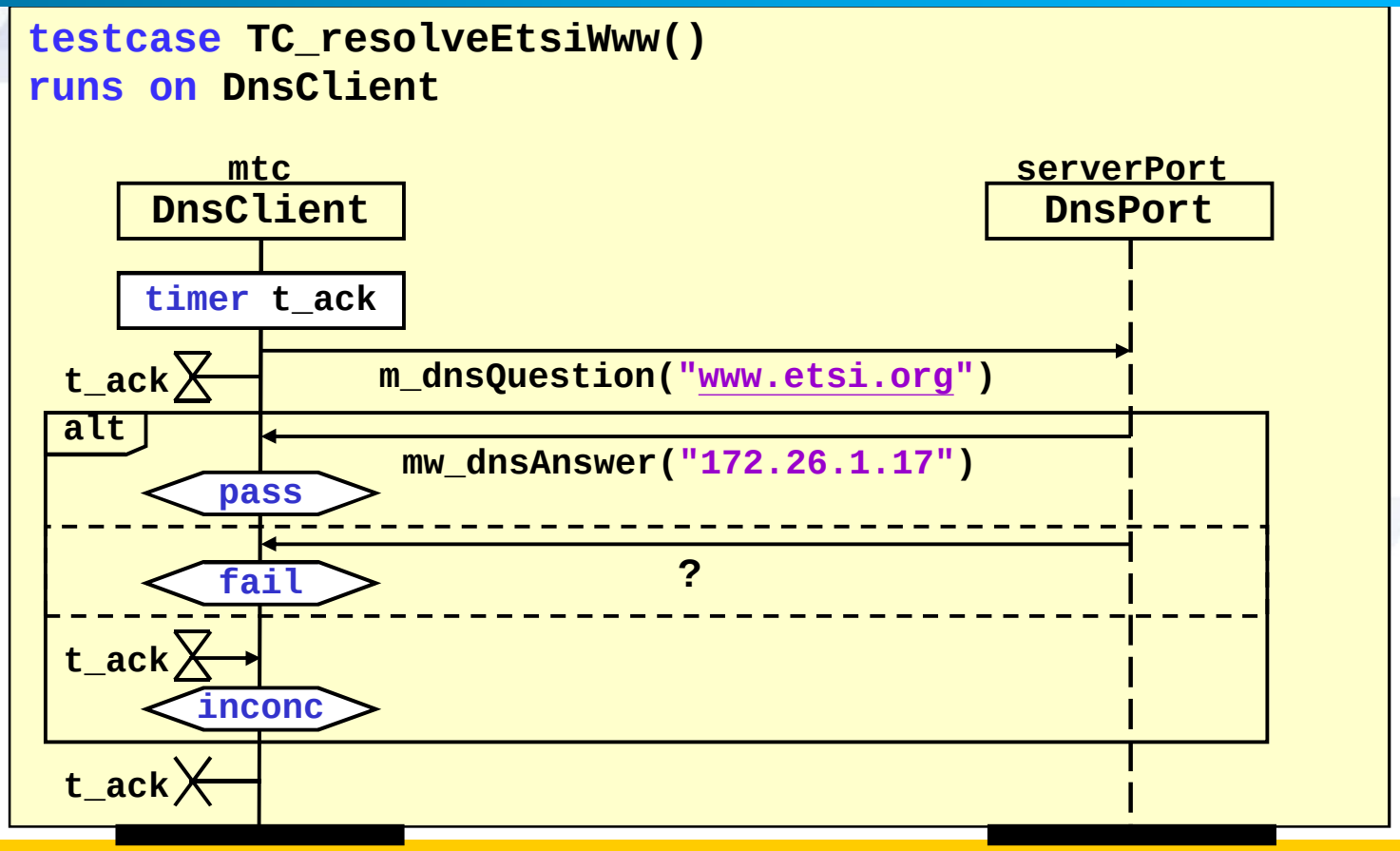


- Core format is text based (most popular)
- TTCN-3 can be edited or viewed in other formats
  - **Tabular format (for TTCN-2 people)**
  - **Graphical format (good for visual overview)**
  - **Other standardized formats in the future?**
  - **Proprietary formats possible**

Example Core (Text) Format

```
testcase TC_resolveEtsiWww() runs on DnsClient
{
    timer t_ack;
    serverPort.send(m_dnsQuestion("www.etsi.org"));
    t_ack.start(1.0);
    alt {
        [] serverPort.receive(mw_dnsAnswer("172.26.1.17")) {
            setverdict (pass);
           }
        [] serverPort.receive { // any other message
            setverdict(fail);
           }
        [] t_ack.timeout {
            setverdict(inconc);
           }
    }
   t_ack.stop;
}
```

Example Graphical Format



Example Tabular Format

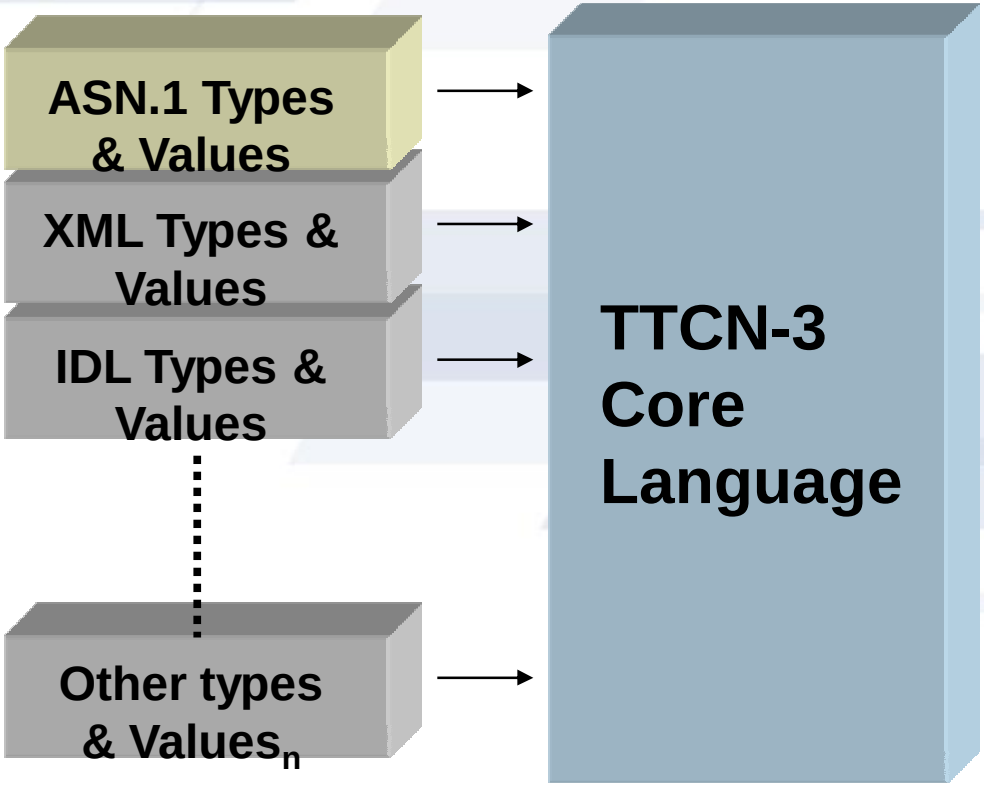
Testcase			
Name	TC_resolveEtsiWww()		
Group			
Purpose			
System Interface			
MTC Type	DnsClient		
Comments			
Local Def Name	Type	Initial value	Comments
t_ack	Timer		

Behavior

```
serverPort.send(m_dnsQuestion("www.etsi.org"));
t_ack.start(1.0);
alt {
       [] serverPort.receive(mw_dnsAnswer("172.26.1.17"))
   {   setverdict (pass); }
       [] serverPort.receive // any other message
   {   setverdict(fail); }
       [] t_ack.timeout
   {   setverdict(inconc); }
}
t_ack.stop;
```

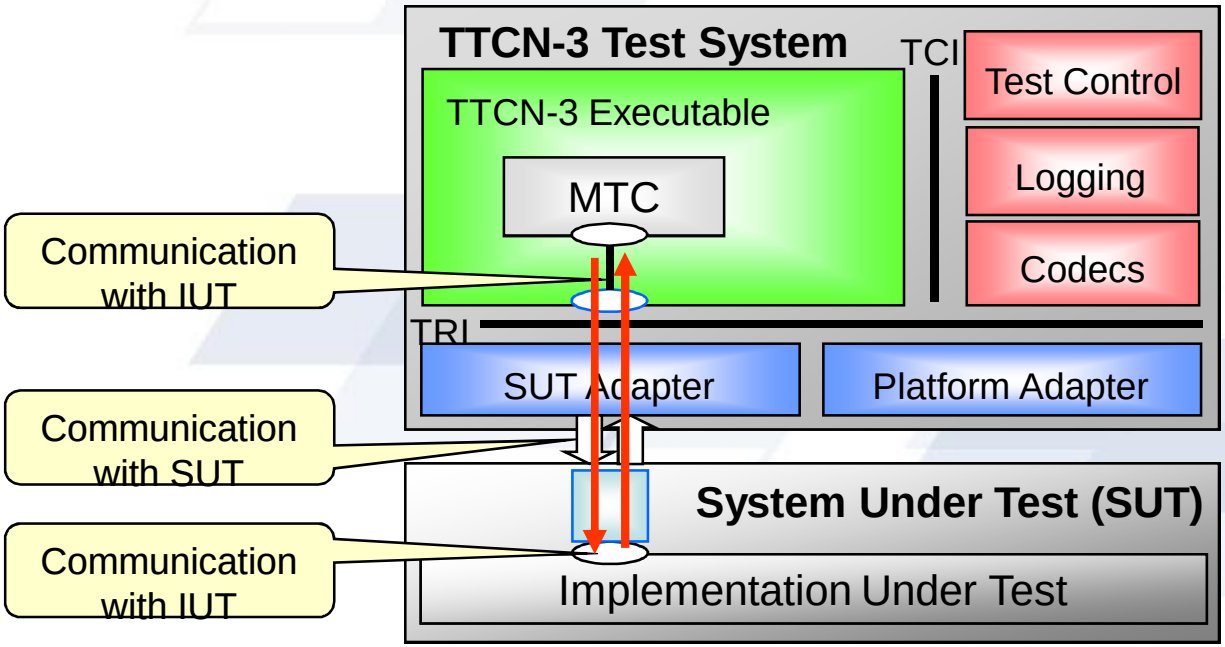
Detailed Comments:	

Use of TTCN-3 with Other Languages



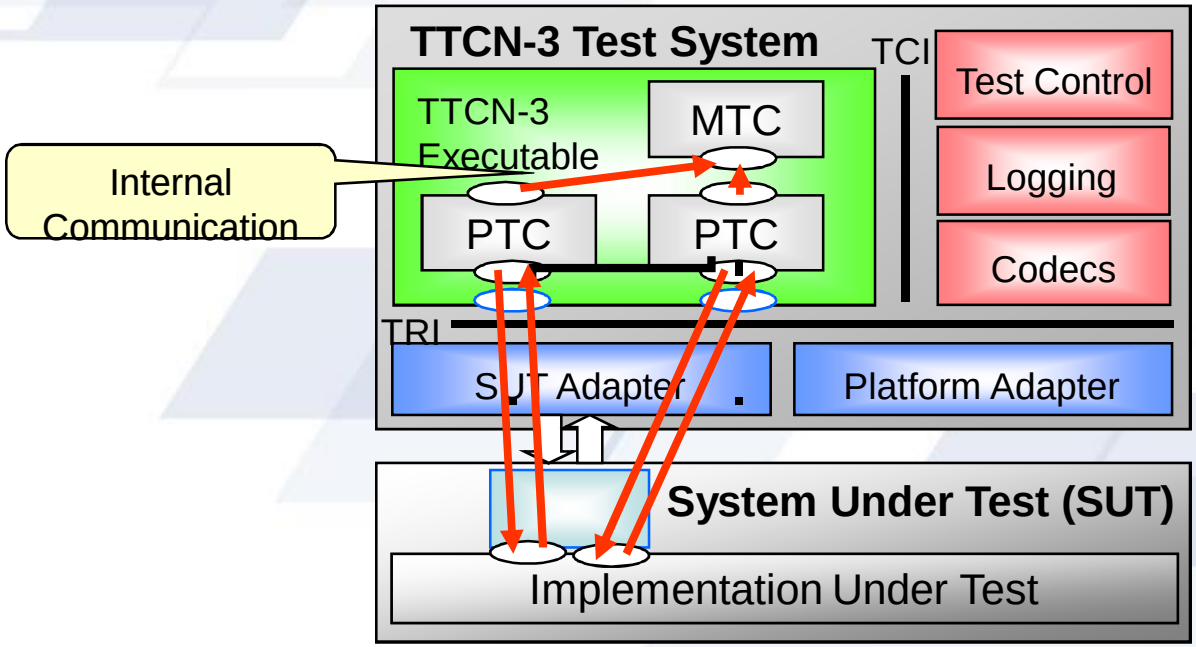
- TTCN can be integrated with types systems of other languages
- Fully harmonized with ASN.1 (1997)
- Harmonized with other languages
  - **IDL, XML, C/C++**

Minimal Test Configuration



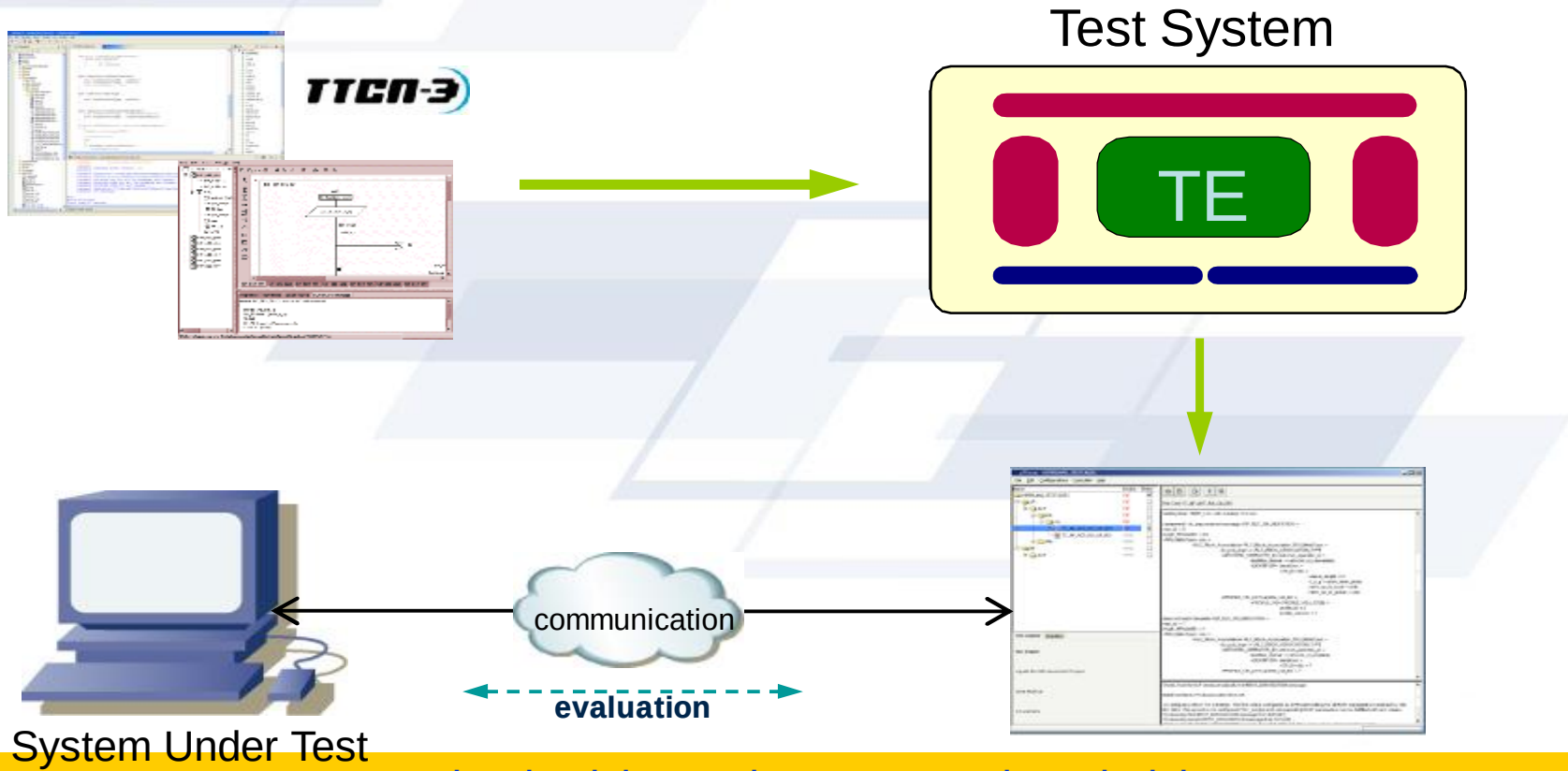
- All test behavior is executed on one (main) test component

Example Concurrent Test Configuration



- A test involves execution of many parallel test components
- Dynamic instantiation of components and communication links

Test Execution with TTCN-3



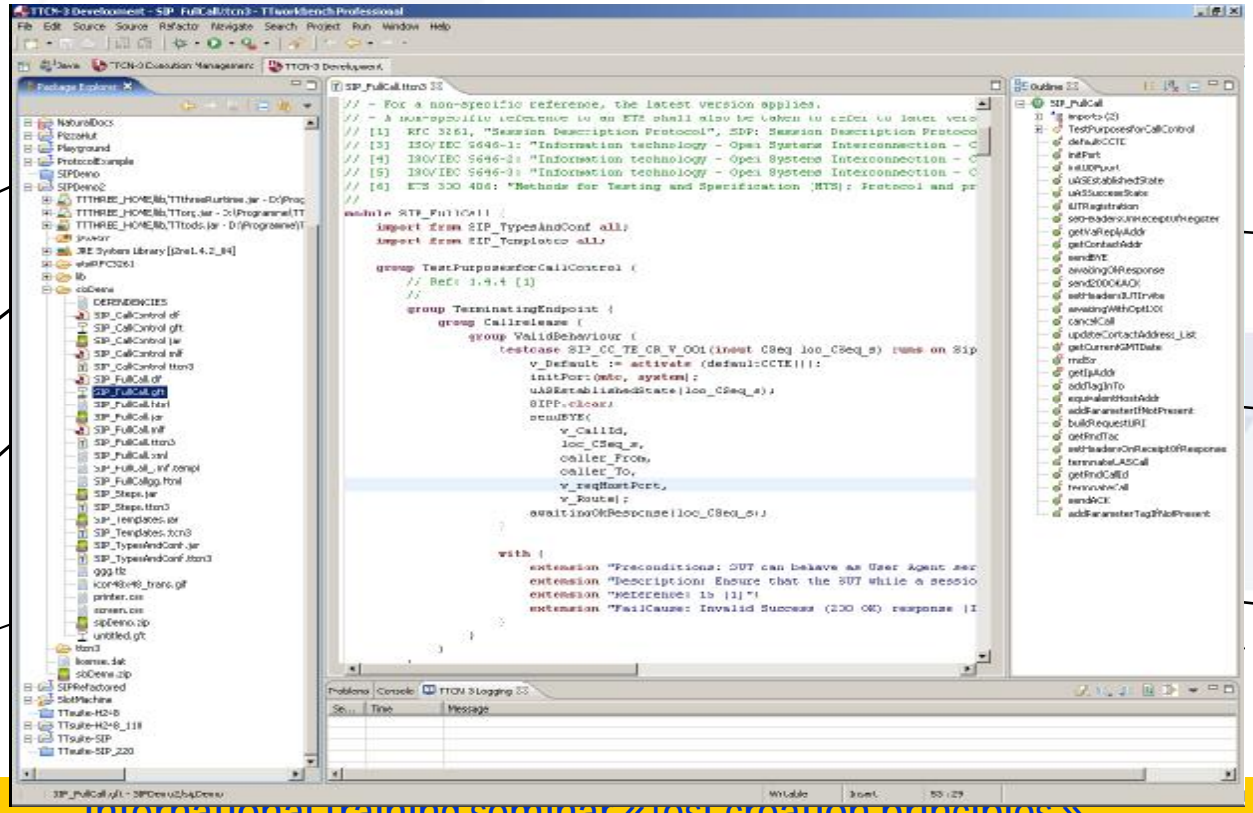
An Impression of TTCN 3 Tooling

Developers Perspective for Modification

Test Execution

Test Campaign Designer (Test Automation)

Test Parametrization



Result Analyzer

Test Report

Online Logging, Filter, Reporting

TTCN-3 today

- A successful testing technology
  - Used in telecommunication, software industry, automotive
- A textual and graphical test scripting language
  - Human readable
- A test implementation language
  - Automated test execution is built-in
- A test realization framework
  - A variety of ready-to-use tools and test assets provided by an agile community
- A philosophy
  - Specifically made for testers

TTCN-3 Success stories

- TTCN-3 home page (www.ttcn-3.org):
  - ETSI test suite standards
  - accepted by the industry

- TTCN-3 user conferences
  - Europe: 2004, 2005, 2006, 2007 (S), 2008 (E), 2009 (F)
  - Asia: 2007 (China), 2009 (India)
- Tools:
  - Commercial vendors
  - Open source community projects
- International Software Quality Institute (www.isqi.com)
  TTCN-3 tester

The TTCN-3 Certificate

TTCN-3 domains: Telecom

- Industrial use
  - Big companies with hundreds of TTCN-3 engineers: Ericson, Nokia, Siemens, Motorola, ISKRATEL
  - large distribution among SME
- ETSI / 3GPP and its members
  - standardized test suites in several technical committees
  - IMS performance benchmark project:
  - Intel, HP, BT, FOKUS and others
- Test tool manufacturer:
  - Commercial Tektronix, Catapult, Nexus, R&S, …
  - Open source community projects
- Certification program based on TTCN-3: WiMax forum

Summary / benefits

- TTCN-3 as standardized test language and implementation
- Easy (human readable) description of test scenarios
  - free from programming issues,
  (transparent framework for end-customers)
  - platform and tool vendor independence
  - different presentation formats
- Clear separation of testing issues:
  - test configuration, data and behaviour
  - SUT specific adaptation and codec
- Wide range of applicability
  - different communication paradigms, testing types
  - domains: Telecom, Automotive, Medicine, Finance, Railways,…
  - used in research and industry
- International community, expertise, commercial and open source tools

Thank you for your attention !!!