



**Fraunhofer** Institute for Open  
Communication Systems

Competence Center  
**Modelling and Testing**



# An Overview on TTCN-3

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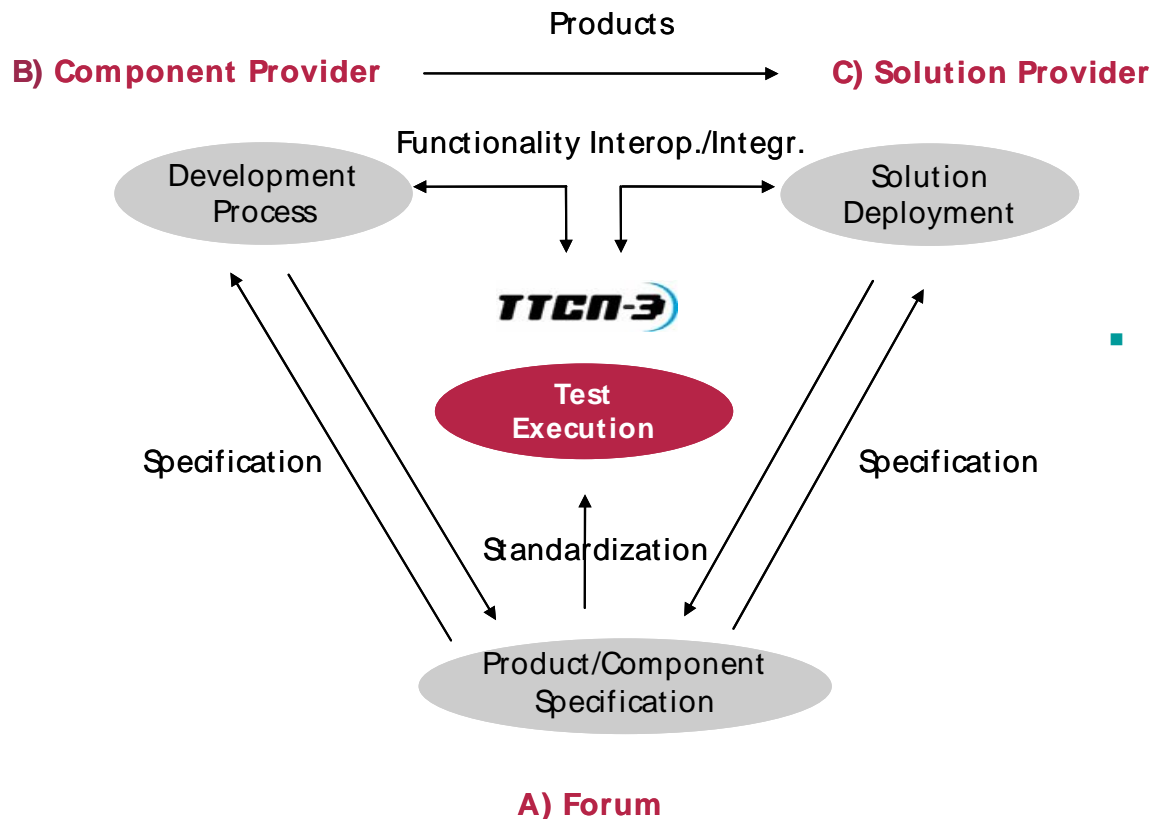
- Overview
- Main Concepts
- TTCN-3 in a Nutshell
- TTCN-3 based test systems
- An Example: IMS Benchmarking
- Summary

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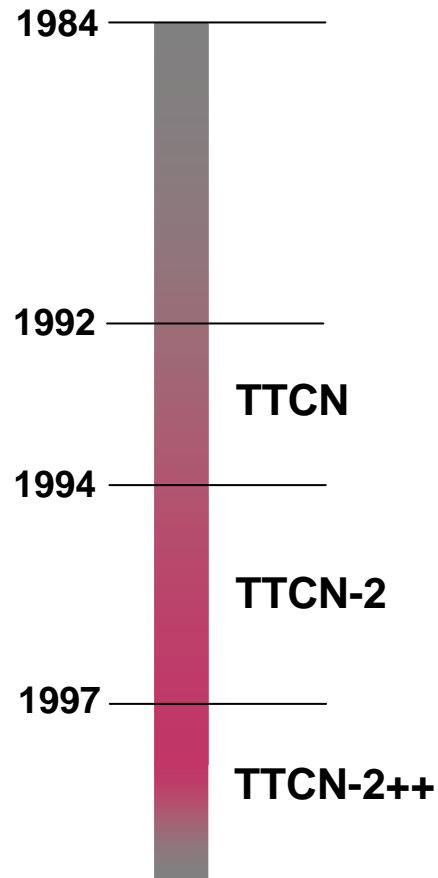
- 
- The **Testing and Test Control Notation**
  - A standardized alternative to proprietary test systems
    - Developed by a large group of testing experts
    - Used by a growing community
    - Proven by tools
    - Maintained at ETSI
  - A test specification and implementation language
  - A multipart standard covering
    - textual TTCN-3 core
    - graphical TTCN-3
    - execution interfaces TRI and TCI
    - language mappings to TTCN-3, e.g. for IDL

- Areas of Testing
  - Regression Testing
  - Conformance and Functionality Testing
  - Interoperability and Integration Testing
  - Load/ Stress Testing
- Applications
  - Mobile communications (GSM, GPRS, UMTS, TETRA)
  - Wireless LANs and MANs (Hiperlan, Hiperaccess), cordless phones (DECT)
  - Broadband technologies (B-ISDN, ATM)
  - Internet protocols (IPv6, SIP, Voice over IP)
  - Middleware platforms (CORBA, CCM, EJB, Web services)
  - Smart Card Testing, MOST, CAN, Powertrain

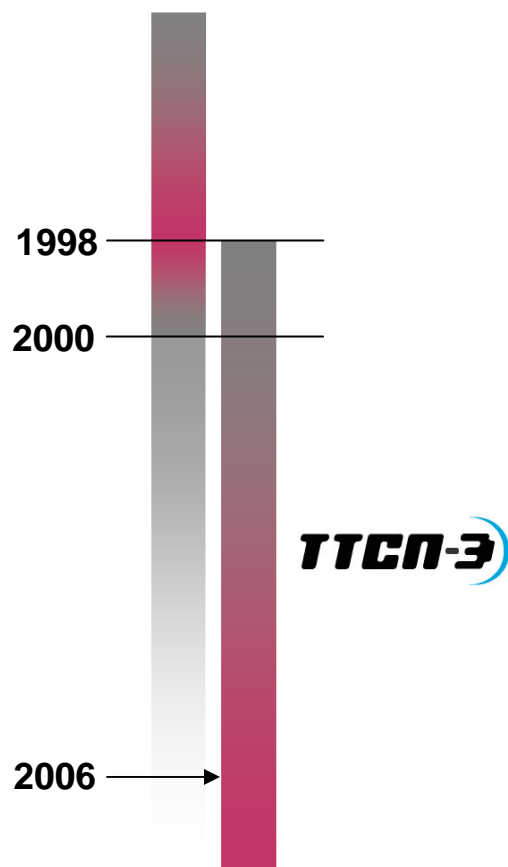
- One test technology for different tests
  - Distributed, platform-independent testing
  - Integrated graphical test development, documentation and analysis
  - Adaptable, open test environment



- The testing middleware
  - unifying the documentation and definition of tests
  - unifying the tests in IT, Internet- and Telco-based systems (supporting their convergence)
  - unifying the test infrastructure

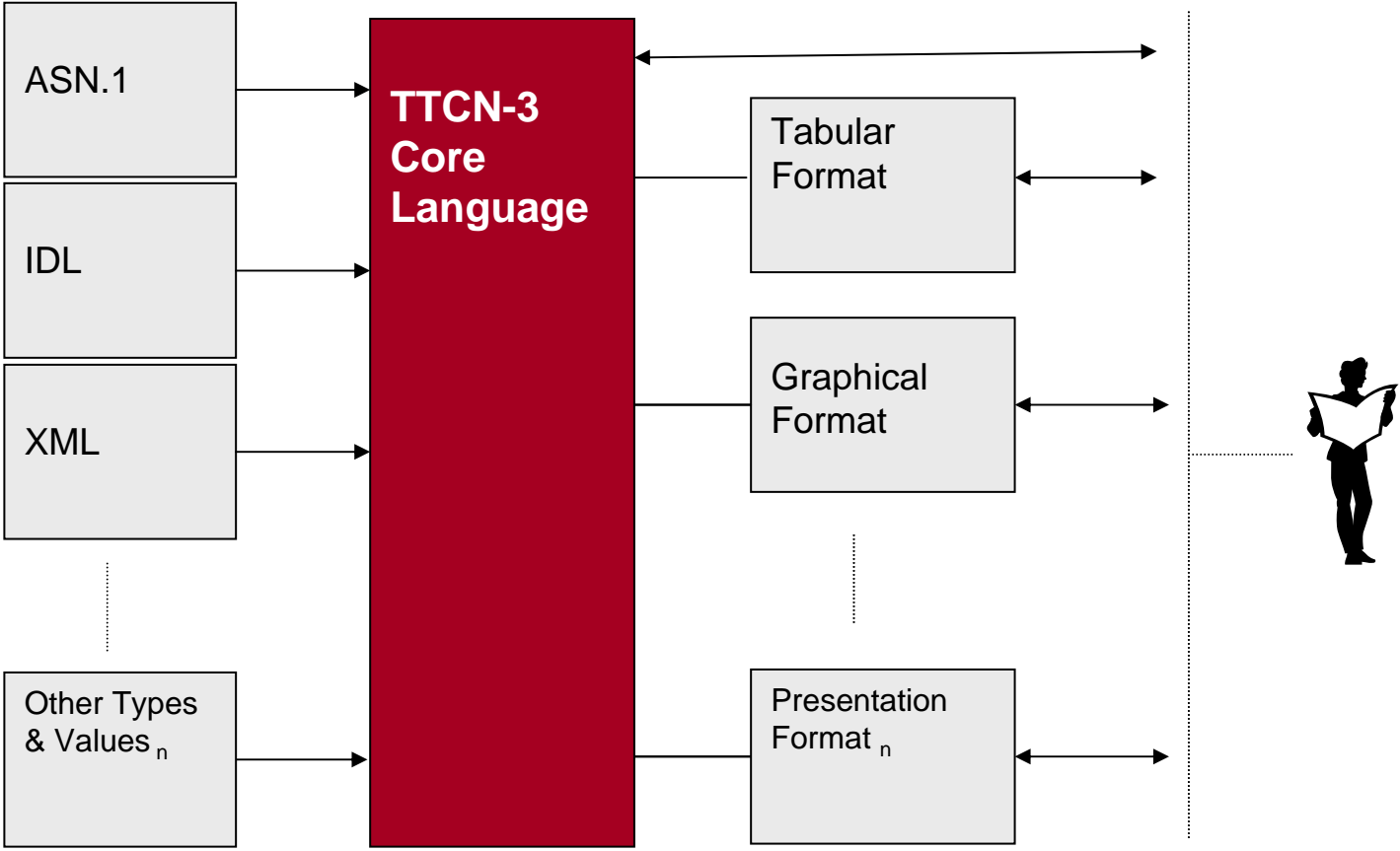


- **TTCN (1992)**
  - Published as an ISO standard
  - Tree and Tabular Combined Notation
  - Used for protocol testing (GSM, N-ISDN, B-ISDN)
- **TTCN-2/2++ (1997)**
  - Written by TC MTS
  - Published by ISO
  - Concurrent tests
  - Modularization
  - Manipulate external data
  - Rather for conformance testing



- **TTCN-3 (2000)**
  - Testing and Test Control Notation
  - Written by TC MTS
  - Published by ETSI and ITU
  - Proper language  
(well defined syntax and semantics)
  - Enhanced communication, configuration and control
  - Standard test specification  
(SIP, SCTP, HiperLan, HiperAccess, IPv6 etc.)
- **TTCN-3 (2006): version 3**
  - Ongoing maintenance for change requests and extension proposals



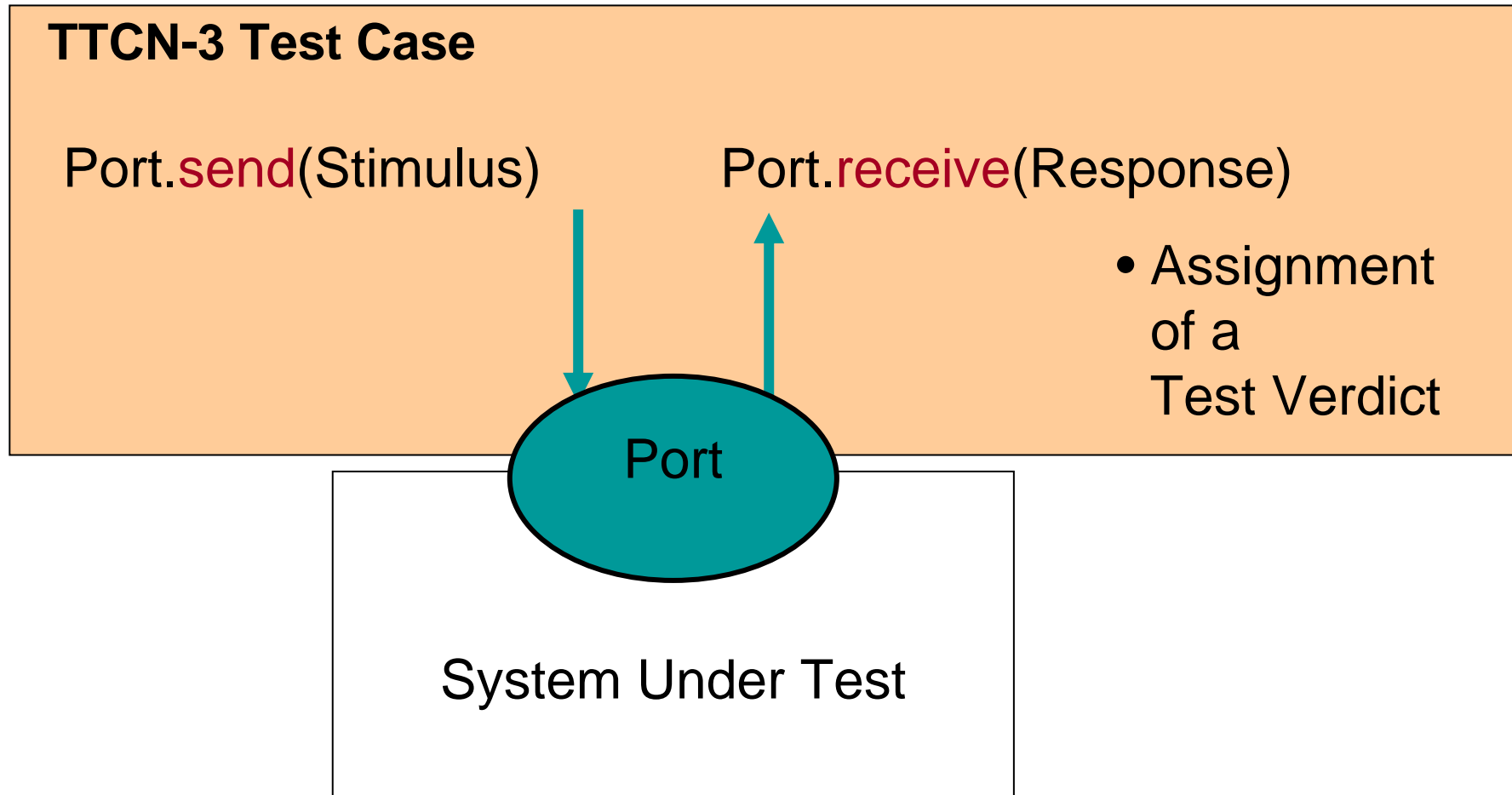


- ETSI ES 201 873-1 TTCN-3 Core Language (CL)
- ETSI ES 201 873-2 TTCN-3 Tabular Presentation Format (TFT)
- ETSI ES 201 873-3 TTCN-3 Graphical Presentation Format (GFT)
- ETSI ES 201 873-4 TTCN-3 Semantics
- ETSI ES 201 873-5 TTCN-3 Runtime Interfaces (TRI)
- ETSI ES 201 873-6 TTCN-3 Control Interfaces (TCI)
- *ETSI ES 201 873-7 ASN.1 to TTCN-3 Mapping*
- ETSI ES 201 873-8 IDL to TTCN-3 Mapping
- *ETSI ES 201 873-9 XML Schema to TTCN-3 Mapping*
- *ETSI ES 201 873-10 TTCN-3 Documentation*

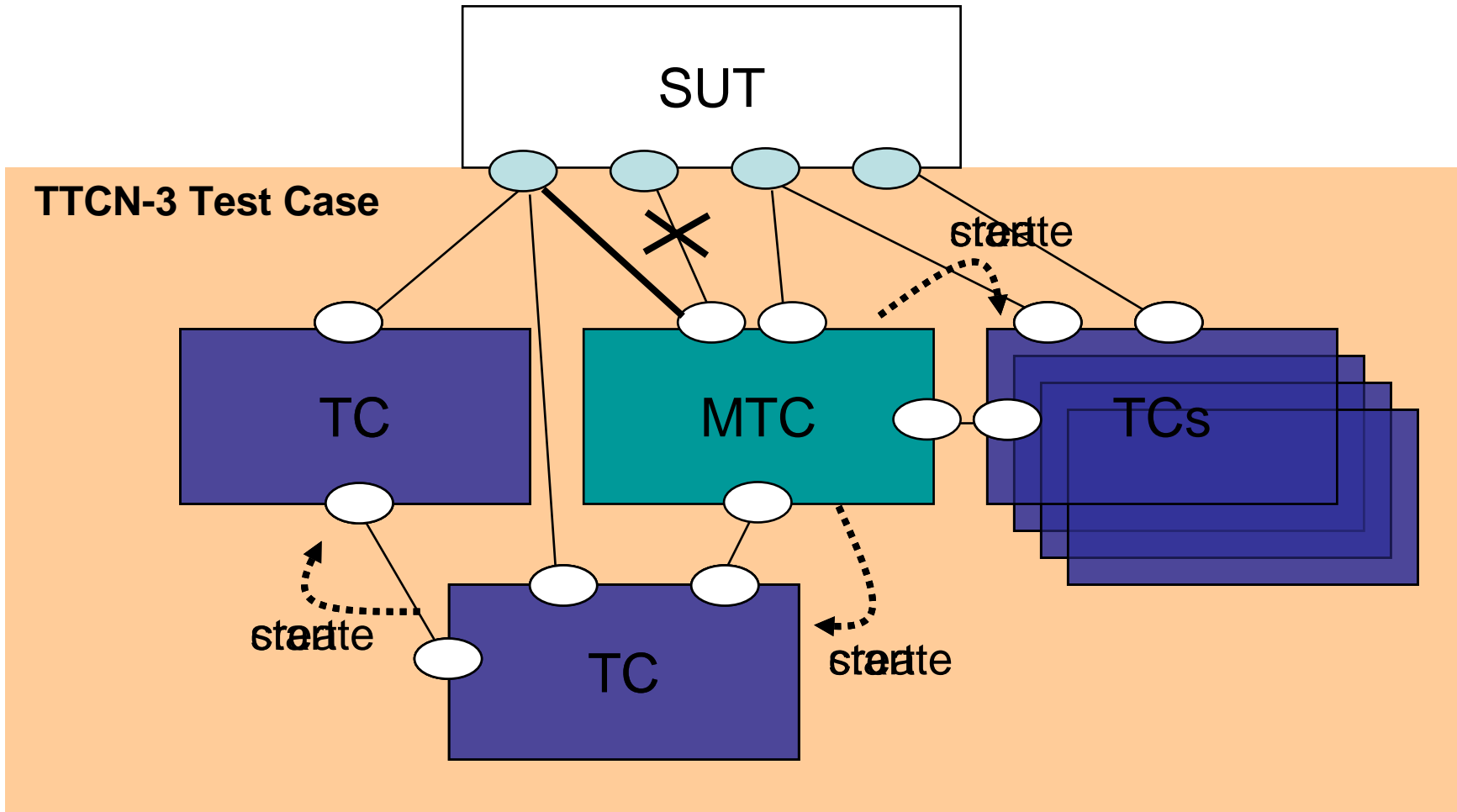
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# TTCN-3 – Based Black-Box Testing

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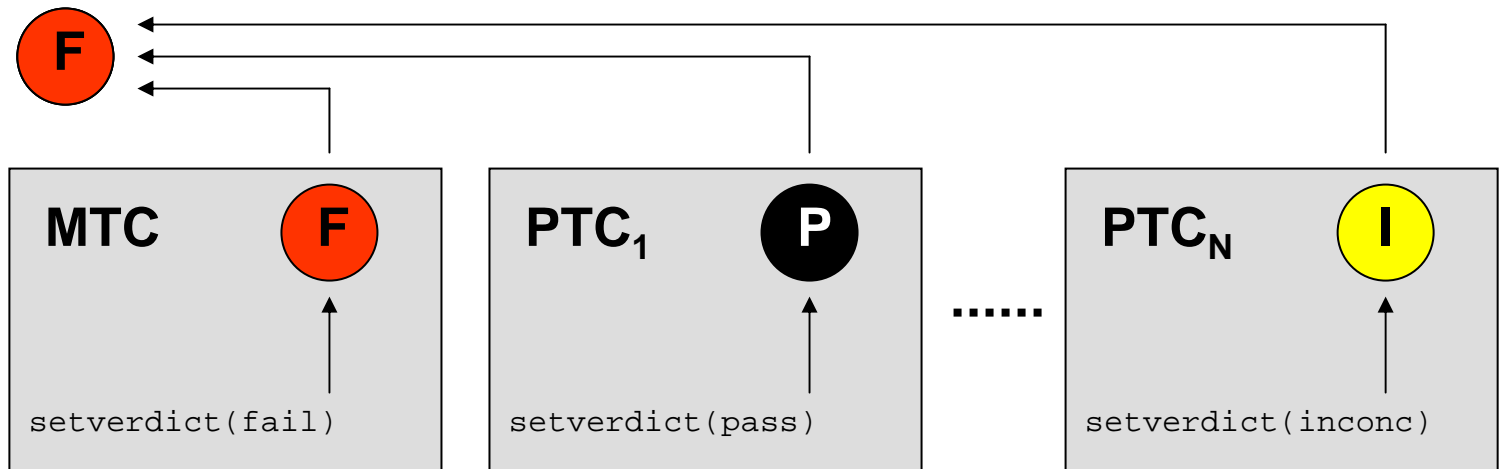
# TTCN-3 – Test Configuration

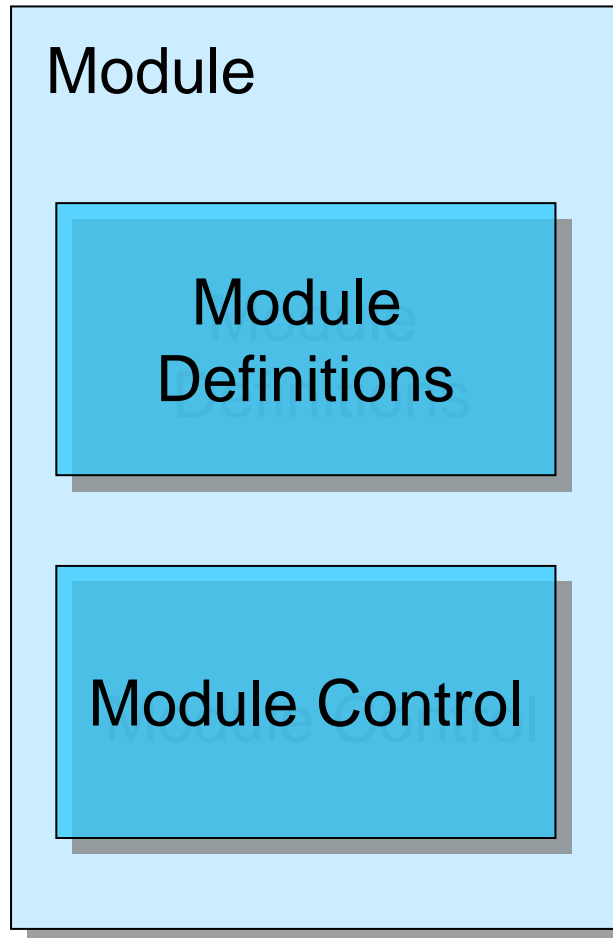


# TTCN-3 – Test Verdicts

- Test verdicts: none < pass < inconc < fail < error
- Each test component has its own local verdict, which can be set (setverdict) and read (getverdict).
- A test case returns a global verdict

*Verdict returned by the test case when it terminates*

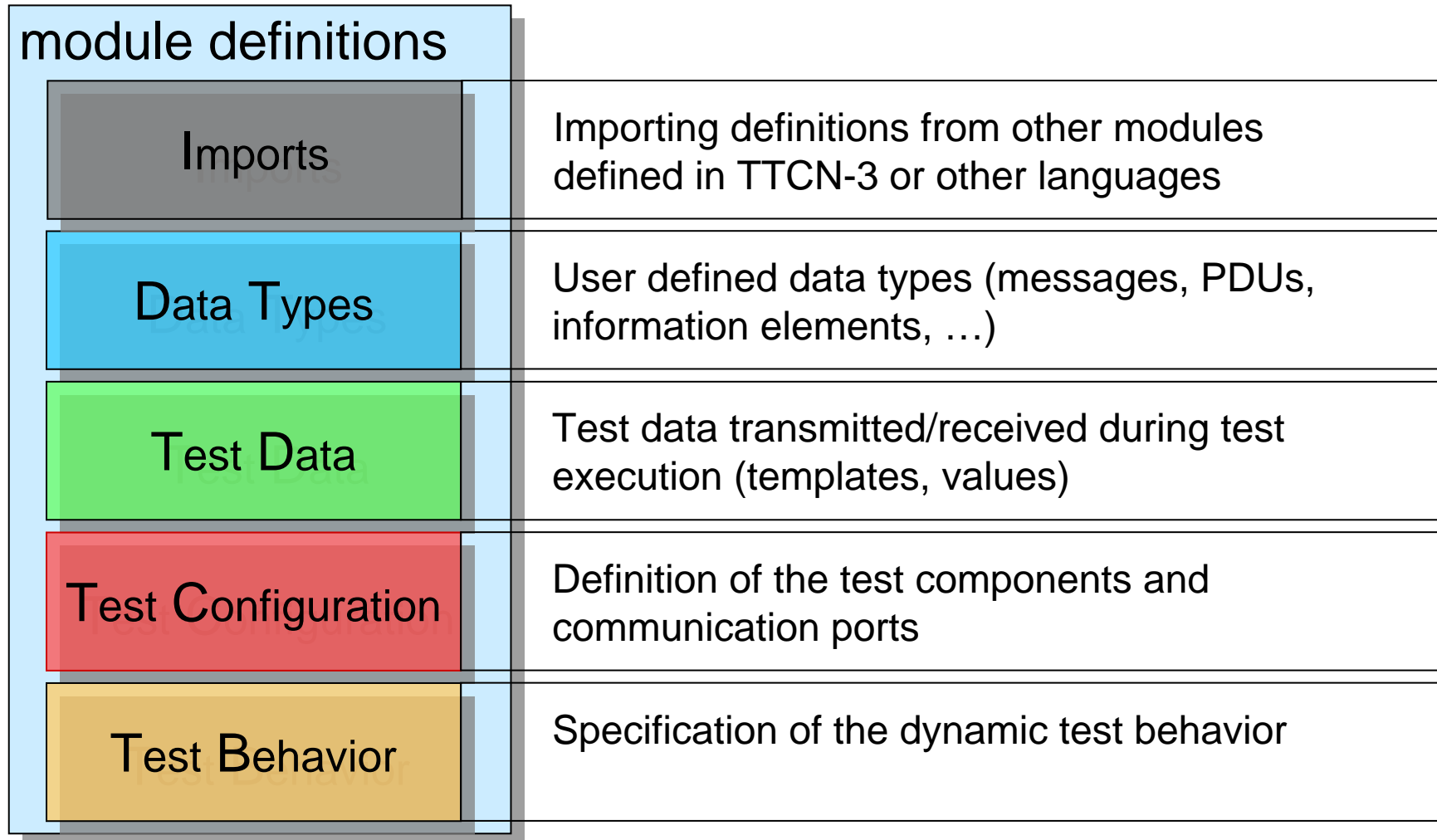




- The top level entity of TTCN-3 is module.
- A module can import definitions from other modules.
- A module contains a definition part and a control part.

```
module MyModule {  
    // definition part  
  
    control {  
        // test execution logic  
    }  
}
```

# Major elements of TTCN-3

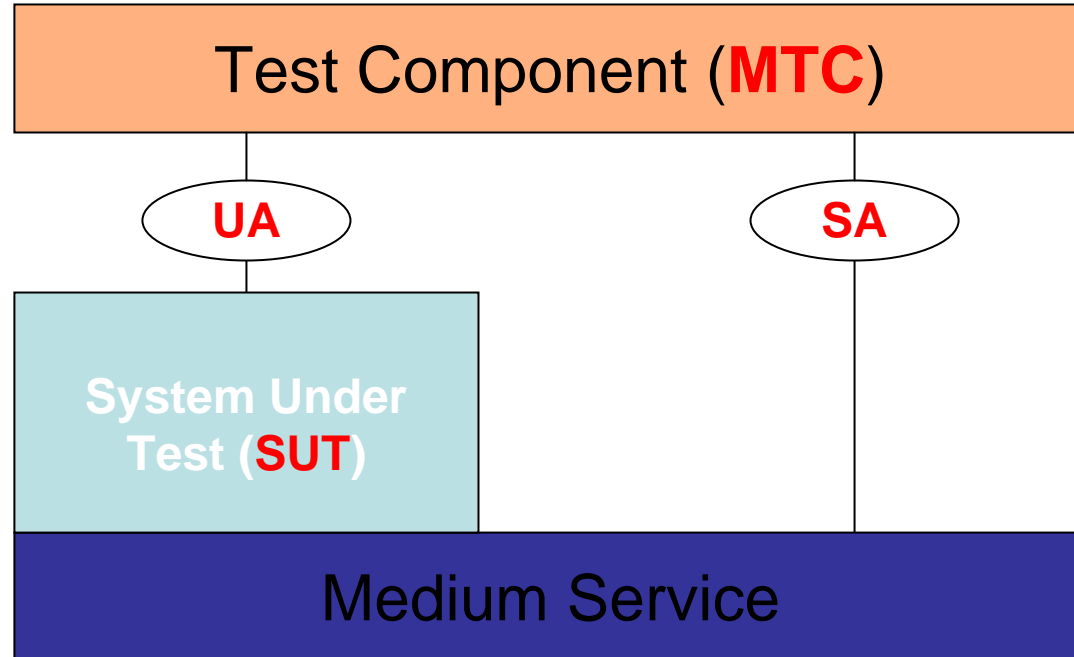




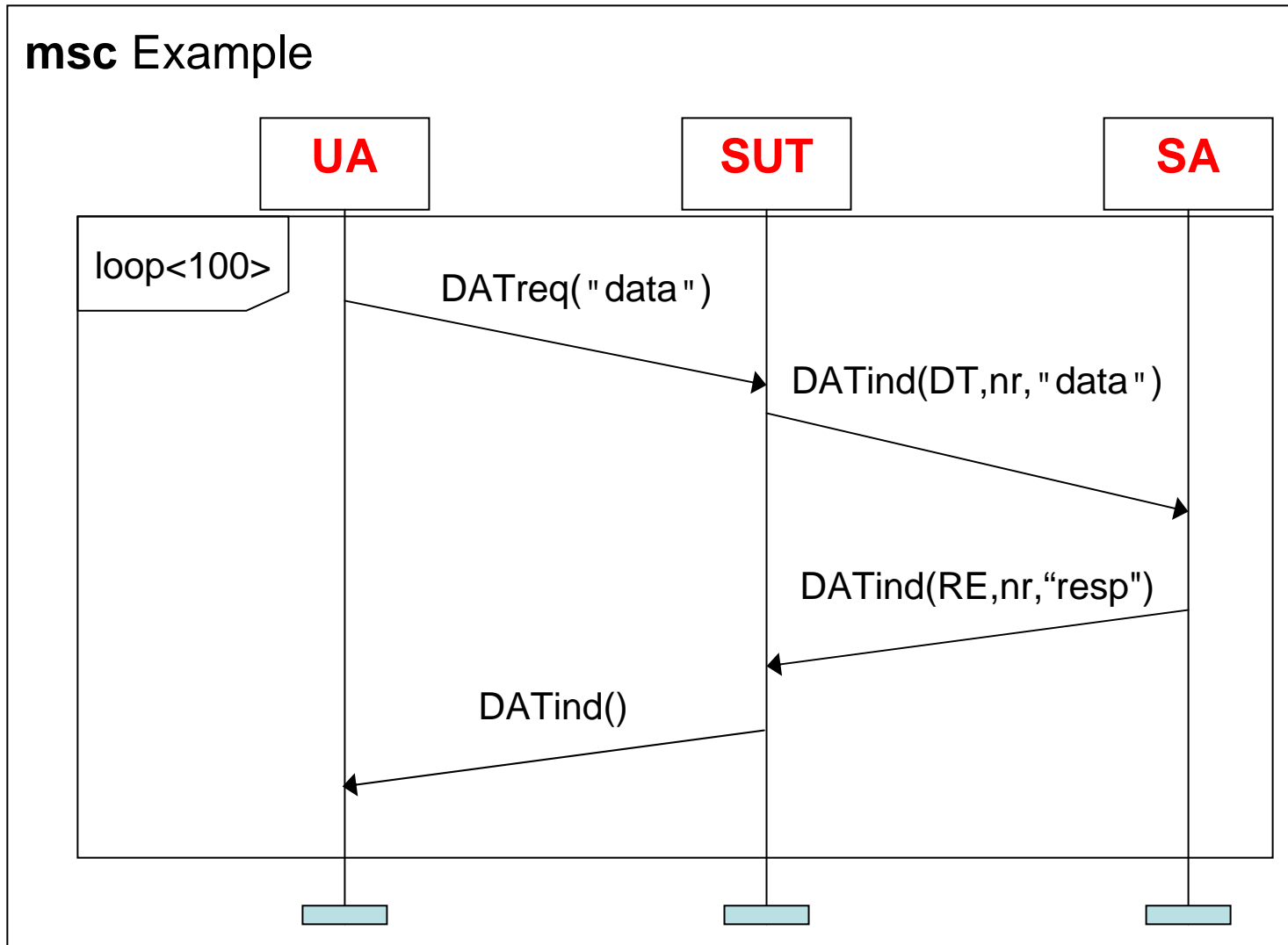
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# Example: Test Configuration

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# Example: Test Behavior



# TTCN-3 Test Case Example

```
testcase Example( )
```

```
  runs on MTC_Type {
```

```
    var default mydefault := activate (DefaultDef());
```

```
    T1.start;
```

```
    for (integer i:=1; i<=100; i:=i+1) {
```

```
      UA.send(DATreq:{"data"});
```

```
      SA.receive(DATind:{DT, nr, "data"});
```

```
      SA.send(DATind:{RE,nr, "resp"});
```

```
      UA.receive(DATind :{});
```

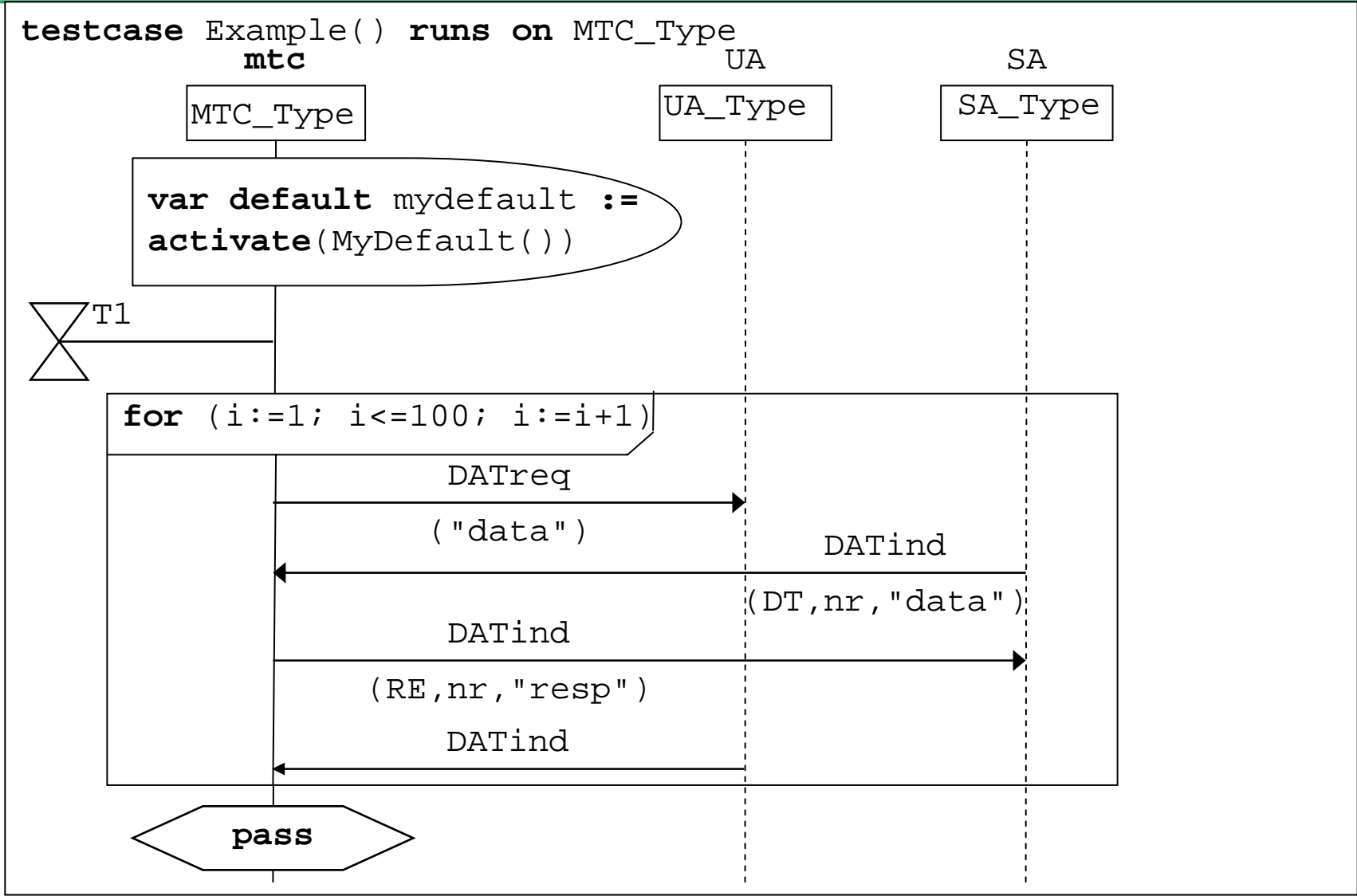
```
    }
```

```
    setverdict(pass);
```

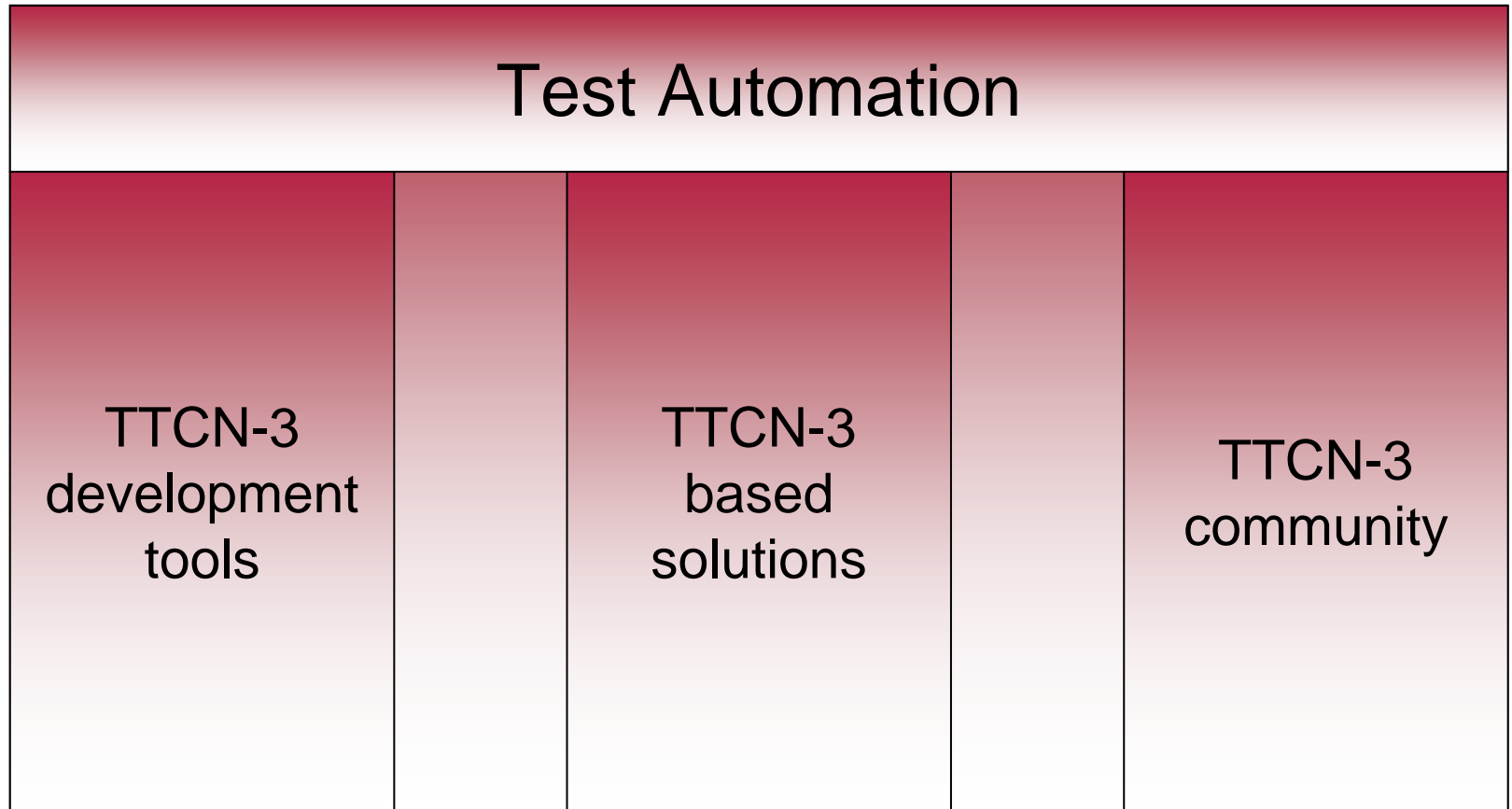
```
    T1.stop;
```

```
}
```

# The same graphically

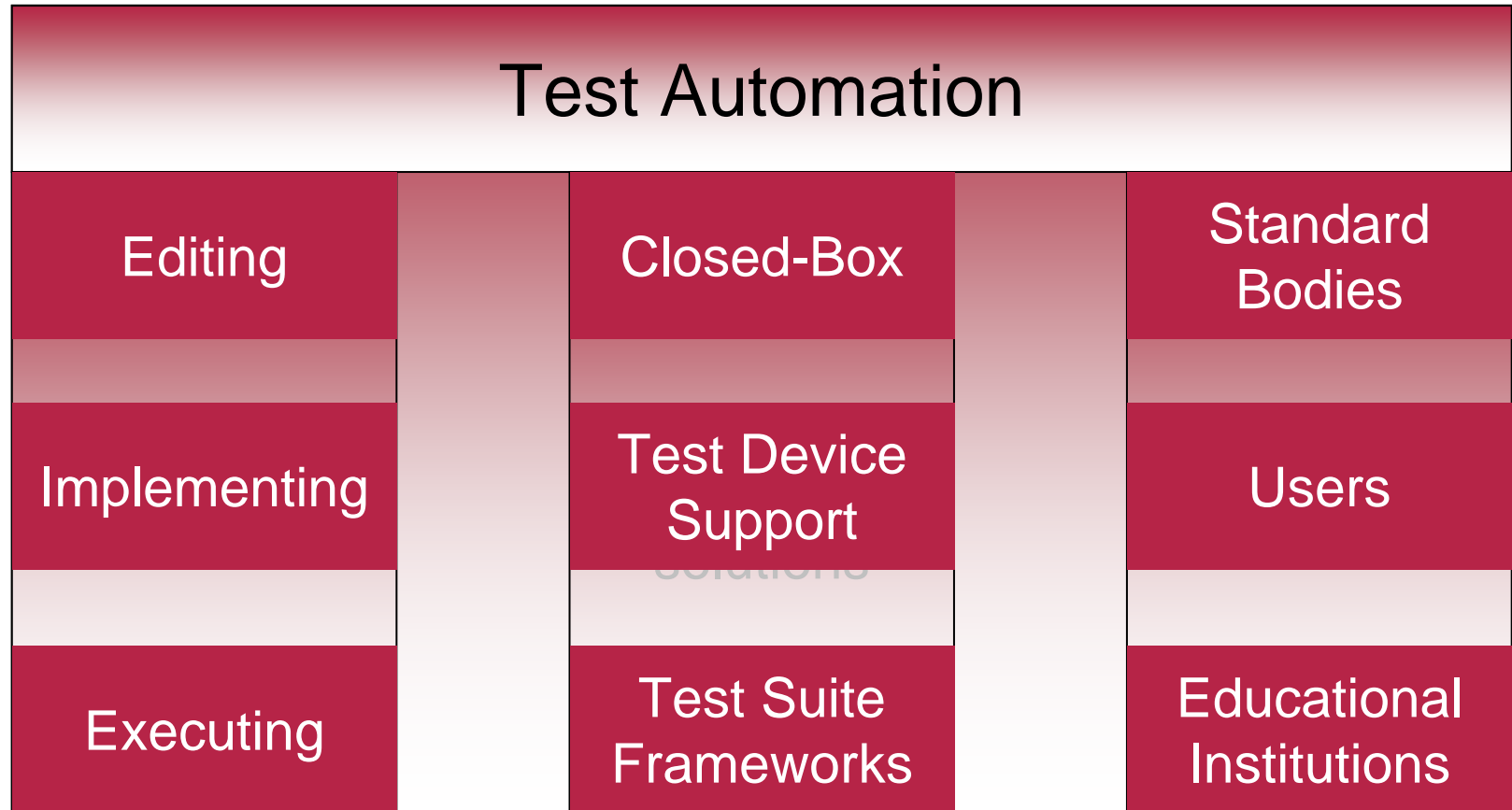


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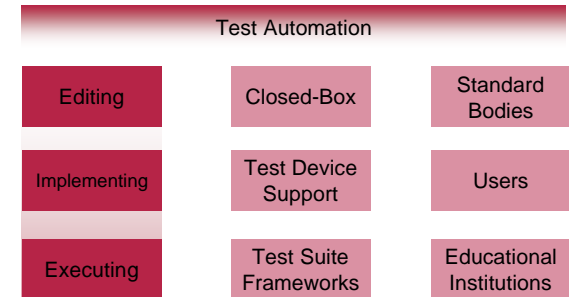
# Aspects of TTCN-3 Tooling

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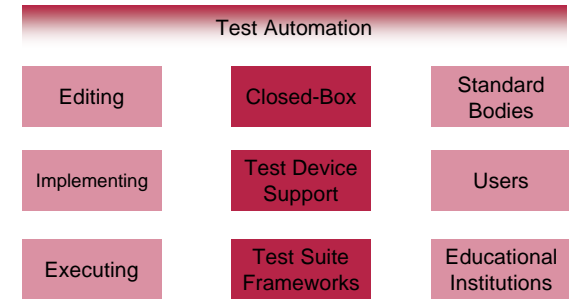




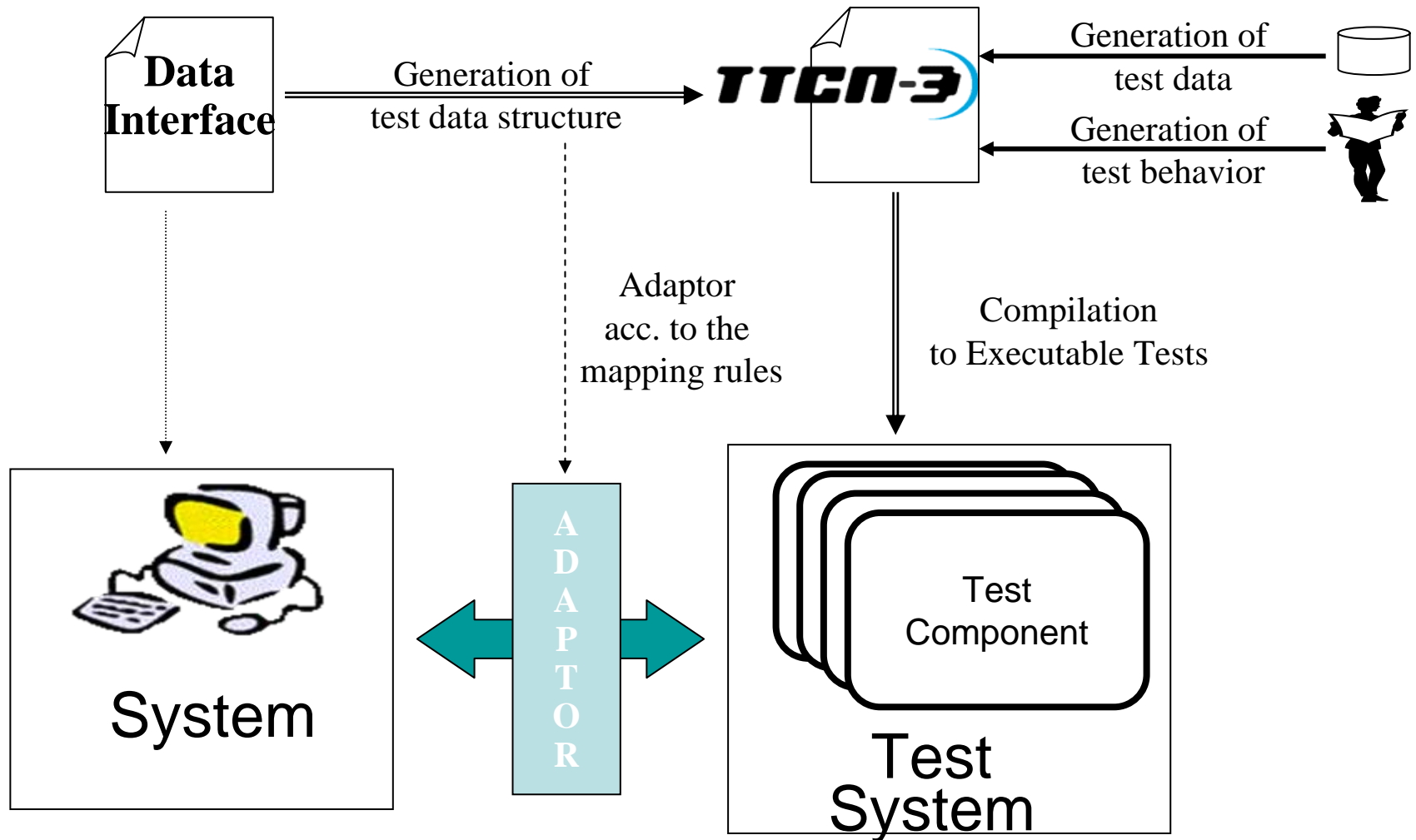
- Editing
  - Textual
  - Graphical
  - Tabular
- Implementing
  - Compilers / Interpreters
  - Standardized Implementation Interfaces (TRI / TCI)
  - Multiple Platform Support ( Java / C / C++)
- Executing
  - Interactive: Graphical user interfaces
  - Fully automated: Command line user interfaces
  - Distributed: Distributed execution environments
- Recently, test generation tools towards TTCN-3



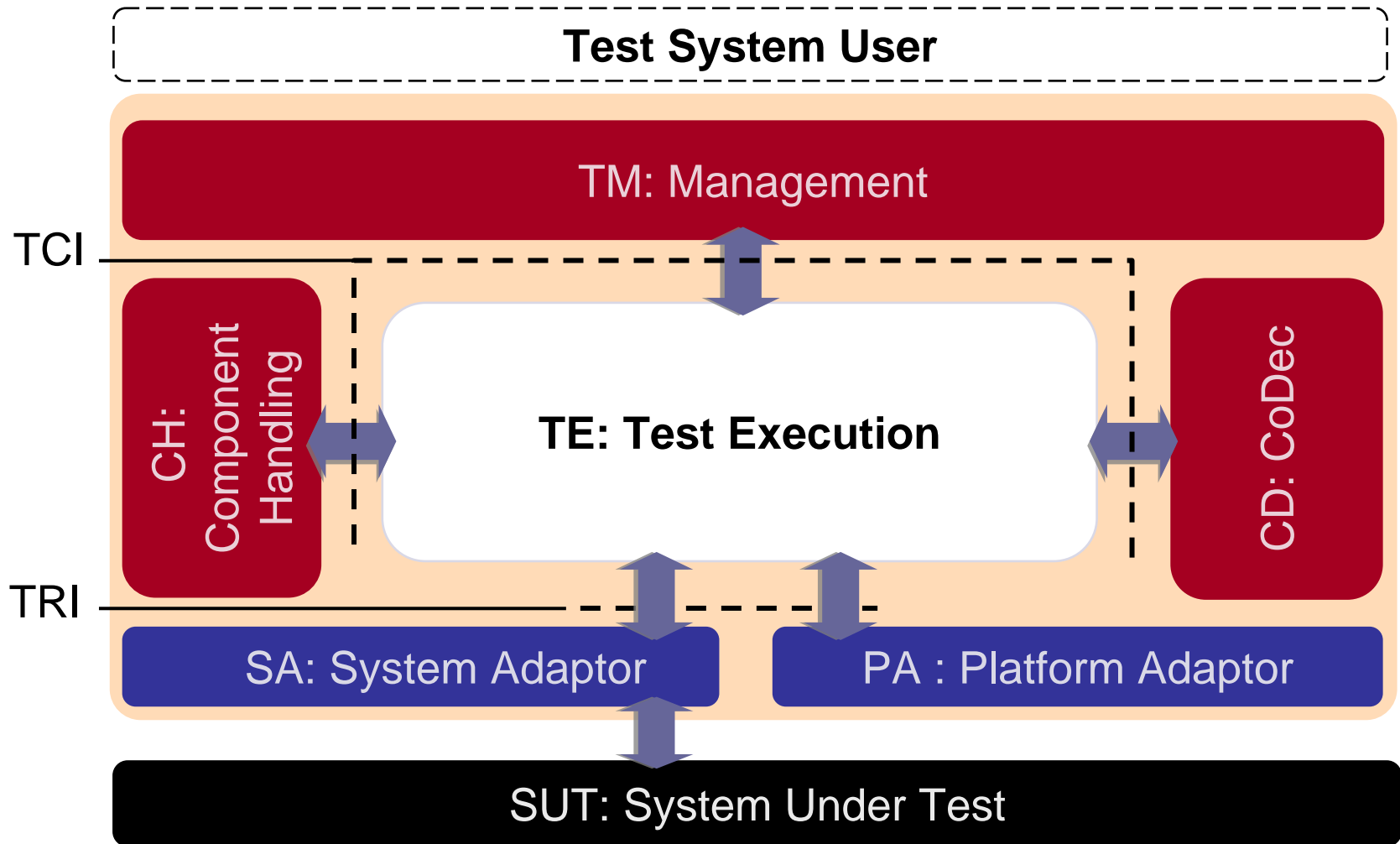
- Closed-Box Solutions
  - Ready-to-Run
  - Optimized application
    - Conformance test scenario
- Test Device Support
  - Test scripting language
  - Multiple interface support
    - User defined test scenarios
- Test Suite Frameworks
  - Ready-to-Run
  - Modifiable and extensible
    - Combining compliance and development tests



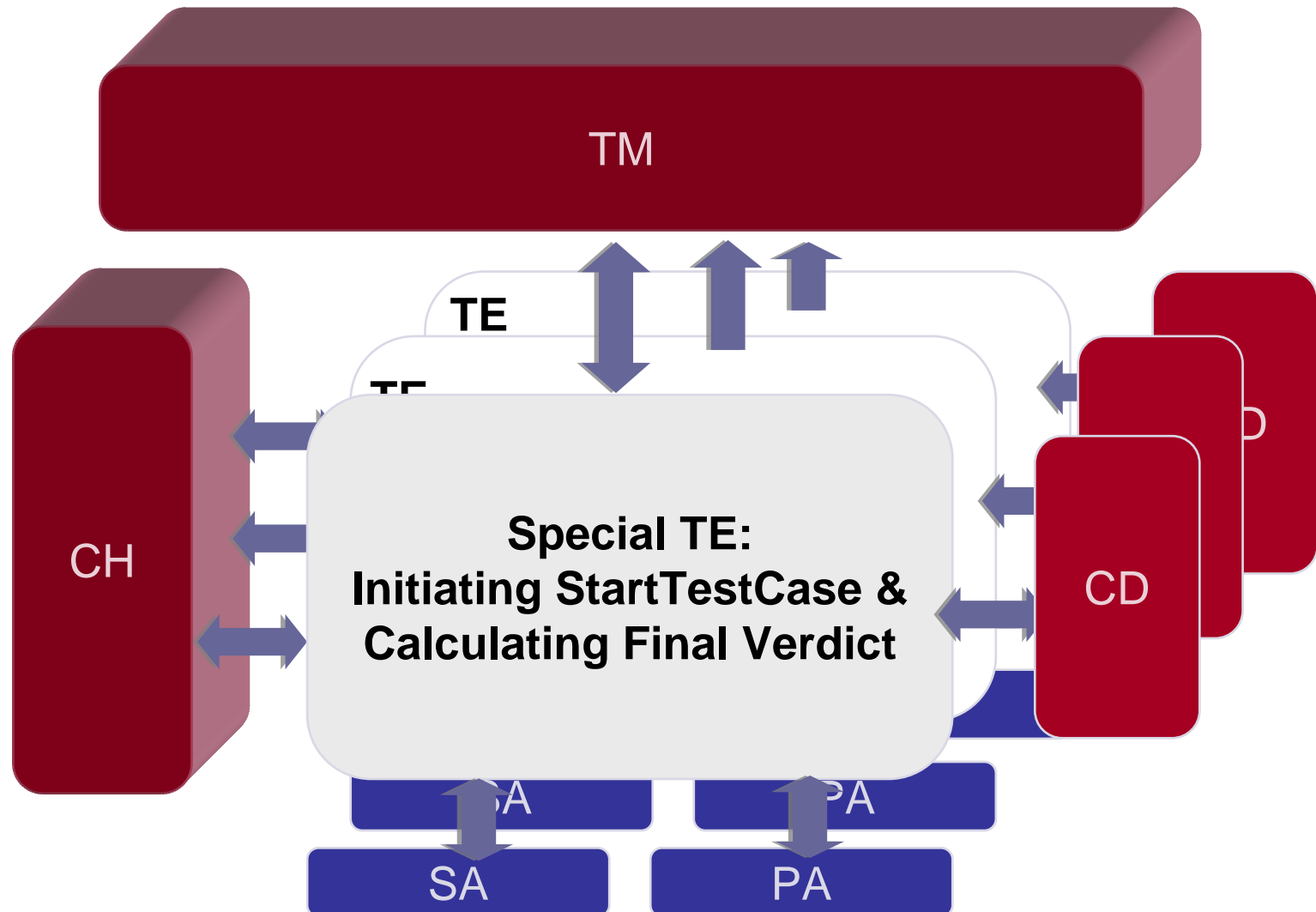
# Overall Picture

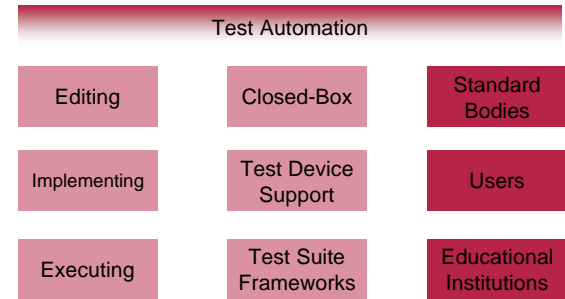


# The Execution Interfaces



# Local and distributed test setups





- Standard Bodies

- ETSI, ITU, WiMAX, 3GPP, others
  - *Standard bodies produce TTCN-3 test suites*
- TTCN-3 Web Site/Forum at ETSI ([www.ttcn-3.org](http://www.ttcn-3.org))

- Educational Institutions

- Universities, Research Institutes
- European Research Projects
  - *Free academic licenses available*

- Users

- Different Domains: Telco, IT, Automotive, Embedded Systems
- Education Tracks available
  - *TTCN-3 Users Conference*
  - *TTCN-3 Certificate*

# An Example: TTworkbench – textual test design

The screenshot displays the Eclipse IDE with the TTworkbench plugin. The main editor shows the source code for a TTCN-3 module named 'aB'. The code defines several types: 'Contact' (a union of 'PhoneNumber' and 'EmailAddress'), 'Gender' (an enumeration with 'e\_male' and 'e\_female'), 'Digit' (an integer), and 'PhoneNumber' (a record of 'Digit').

Annotations in the image point to various components:

- Compile Button**: Points to the 'Run' button in the toolbar.
- Problems**: Points to the 'Problems' view at the bottom, which shows two errors: 'unexpected token: type' and 'expecting ")", found '}'.
- The TTCN-3**: Points to the main code editor.
- Outline view**: Points to the 'Outline' view on the right, which shows a tree structure of the module's types and methods.
- File Overview**: Points to the 'Package Explorer' on the left, which shows the project structure.

Description	Resource	In Folder	Location
unexpected token: type	aB.ttcn3	CORBATutorial/Excercises/samples/01	line 0
expecting ")", found '}'	aB.ttcn3	CORBATutorial/Excercises/samples/01	line 16

**3. Data Import**

**1. Project View**

**2. Full GFT Support**

**4. TTCN-3 Code Im- and Export**

The screenshot shows the GFT-Editor interface for a module named 'SIP\_FullCall'. On the left is a project tree with a folder 'SIP\_CC\_TE\_CR\_V\_001' containing components like 'mtc', 'SIPP', 'cpA', and 'cpB'. The main area displays a test case 'testcase SIP\_CC\_TE\_CR\_V\_001' with a state machine diagram. The diagram starts with 'v\_Default = activate(defaultCCTE ())', followed by 'initPort (mtc, system)', 'uASEstablishedState (loc\_CSeq\_s)', and 'awaitingOkResponse (loc\_CSeq\_s)'. A 'clear' arrow points to the right. Below the diagram are four lifelines: 'SIPP SipPort', 'cpA Coordination', and 'cpB Coordination'. The bottom panel shows 'Properties: To Do Items TTCN-3 Core Language' with a table containing one row: 'Item: Ok.' and 'Problem: Nothing to be done.'

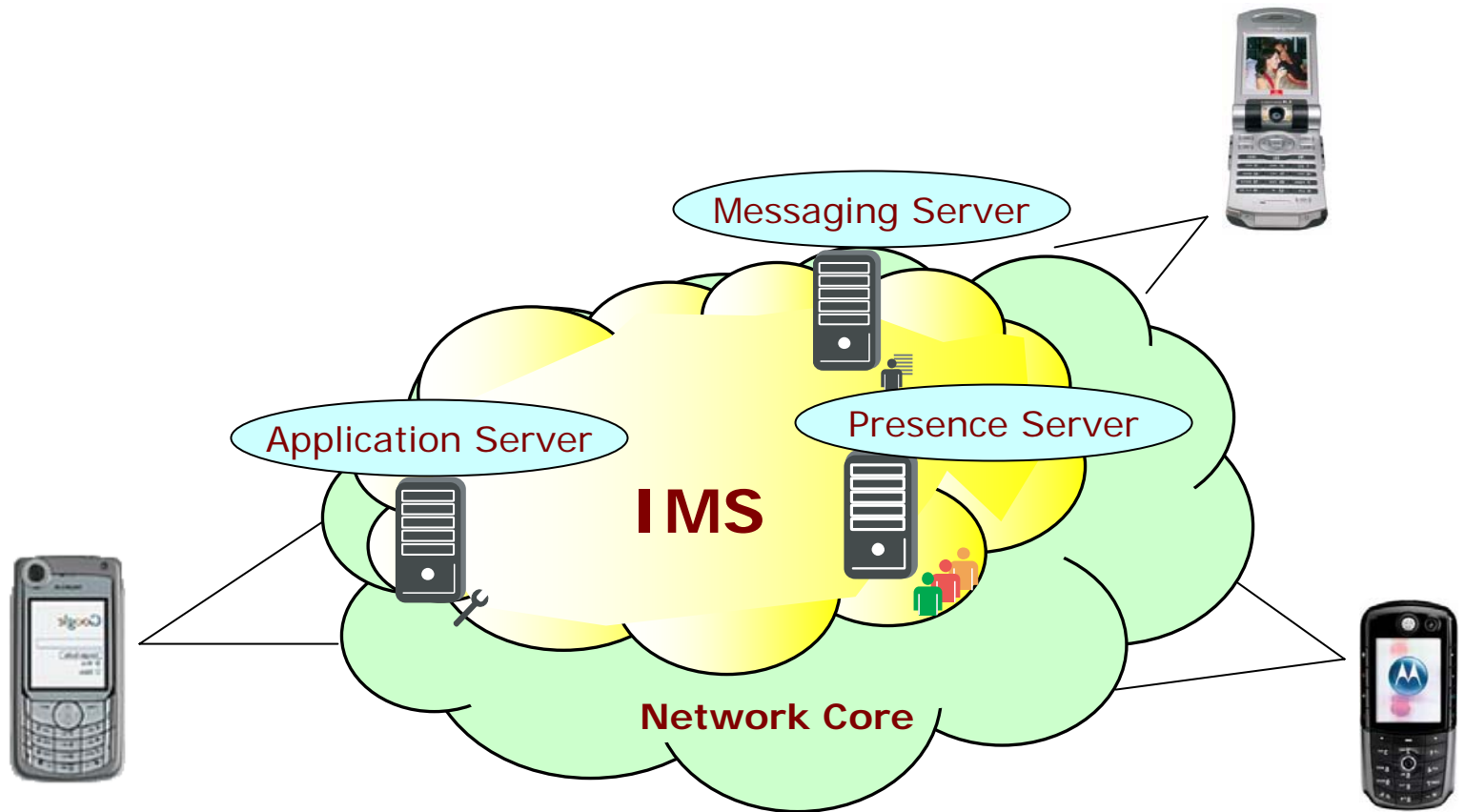


The screenshot displays the TTworkbench Professional interface for TTCN-3 Execution Management. The main window is titled "TTCN-3 Execution Management - SIP\_FullCall.ttcn3 - TTworkbench Professional". It features several panes:

- 1. Test Case Management:** Located in the top-left pane, showing a tree view of test cases under "SIP\_CC\_TE\_CR\_V\_001".
- 2. Parameterization:** Located in the bottom-left pane, showing a "Properties View" table with columns for Property, Value, and Description. The table contains entries for ID, Verdict, Description, and Status.
- 3. Test Data View:** Located in the top-right pane, displaying a table of test data with columns for TTCN-Type, User Type, Name, and Value. It shows various SIP-related parameters like statusLine, sipVersion, and statusCode.
- 4. Detail Logging:** Located in the middle-bottom pane, showing a "TTCN-3 Logging" table with columns for Sequence, Time, and Description. It lists execution events such as "Component #MTC.SIPP:-1 sending" and "Message received by #MTC MATCHES".
- 5. Graphical Logging:** Located in the bottom-right pane, showing a "TTCN-3 Graphical Logging" diagram. This diagram illustrates the sequence of messages between SIPP and UDP1, including INVITE Request, ACK Request, and BYE Request, along with response handling and timer events.
- 6. Test Report Generation:** Located in the middle-left pane, showing a "Test Data View" table with columns for TTCN-Type, User Type, Name, and Value. It displays test results for various SIP-related parameters.

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- IMS = IP Multimedia Subsystem



- The importance of testing

- ... to validate

- P
  - Service-oriented testing

- Combines research and industrial interests

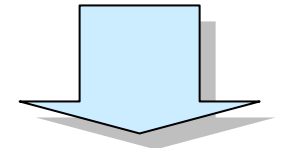
- ... to complete

- Metrics for the correctness, reliability and scalability of IMS solution

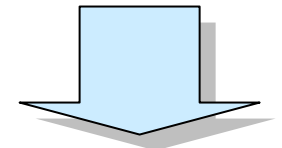
- ... to understand

- Objective performance comparison for network/service providers

Protocol Conformance

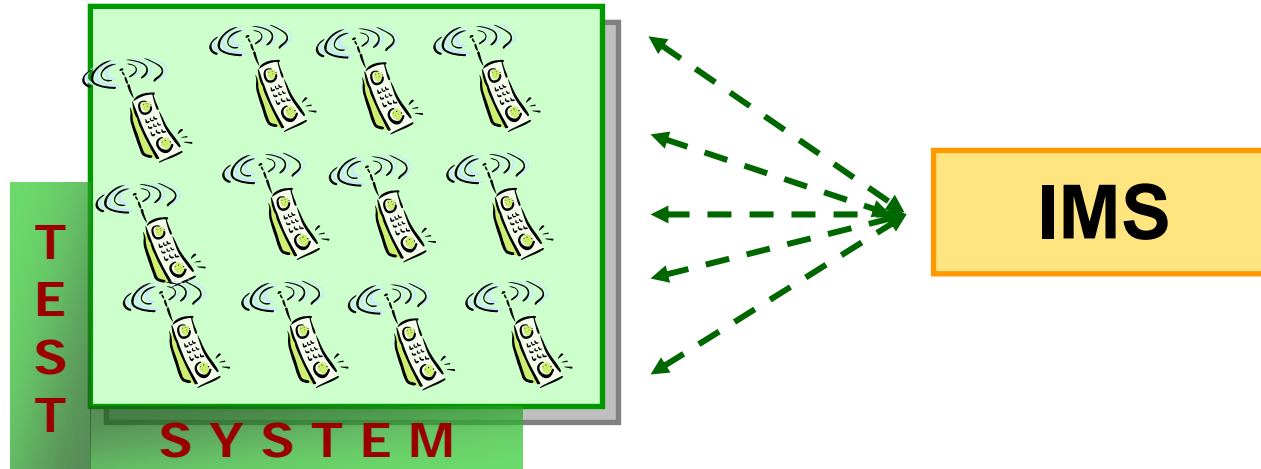


Protocol Interoperability



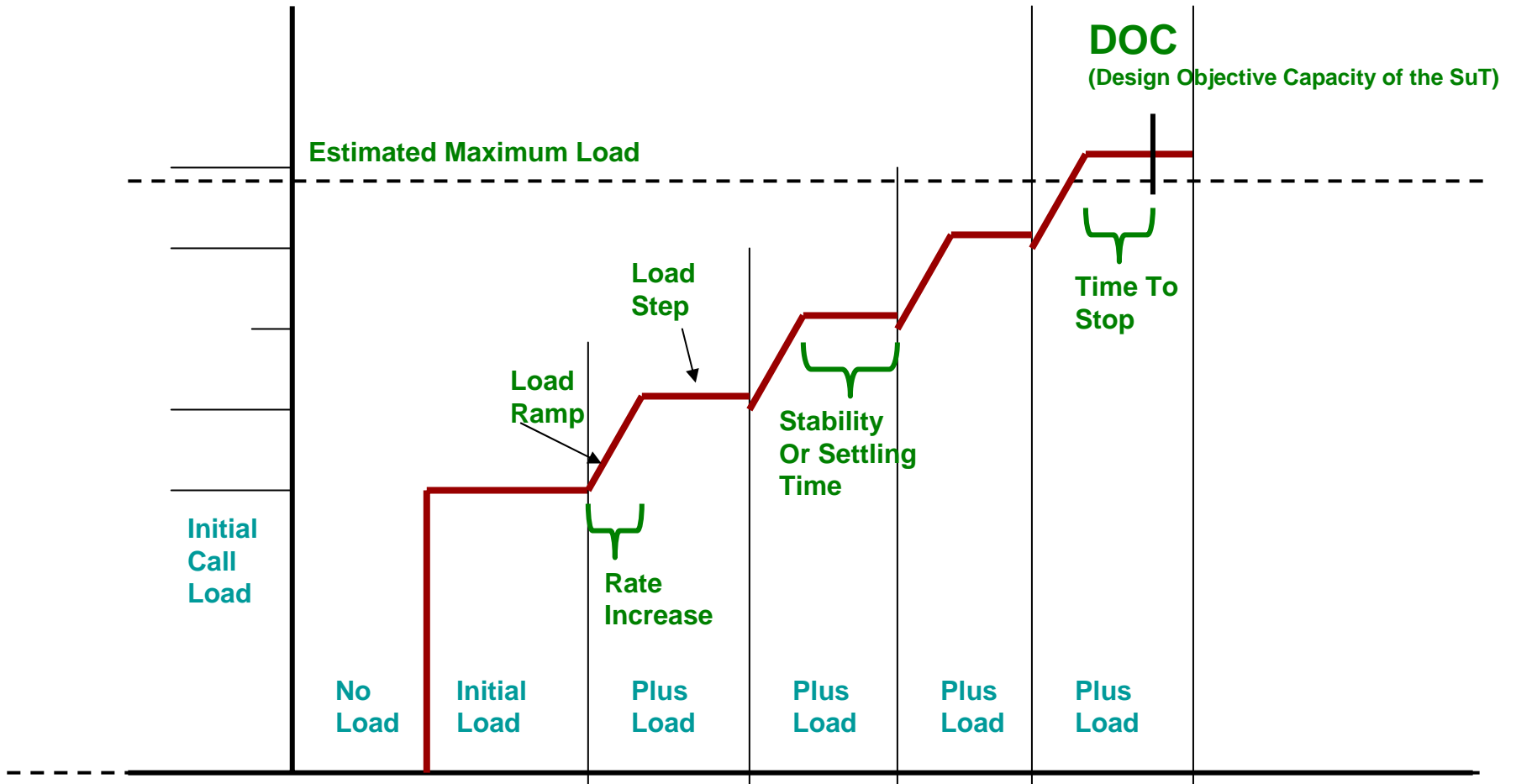
Service Conformance and Performance

# IMS Performance Testing



- Benchmarking
  - for comparison
- Load/stress
  - how system performs under load conditions
- Capacity testing
  - max load the system can handle before failing
- Scalability testing
  - to plan capacity improvements

# Benchmark Procedure





- ETSI
  - Methodology for IMS network integration testing
  - SIP testing
- SIG
  - IMS benchmarking methodology
- TISPAN
  - Standardisation of converged networks
  - IMS benchmark

- a Home Subscriber Server
- 3GPP compliant IMS Call Session Control Functions (CSCFs)
- a SIP2IMS gateway



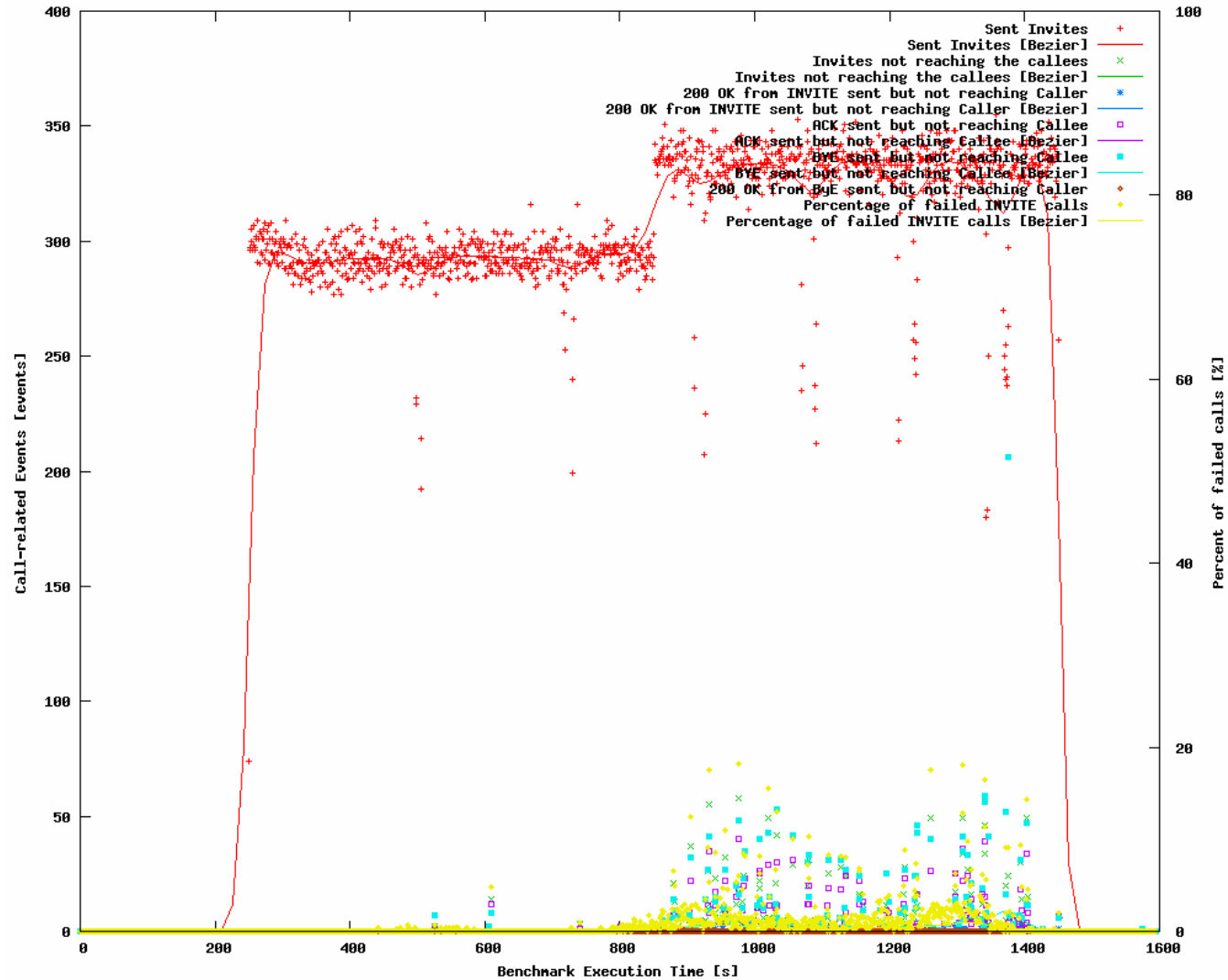


- **Scenario Description** → **TTCN-3**
  - Standardized implementation-independent test notation
- **Execution Platform** → **TTworkbench Enterprise** 
  - Distributed Test Execution Platform
  - Deploys, creates and coordinates distributed parallel test components emulating user equipment on several hosts
  - Synchronized traffic load, measurement and logging of results
- **Visualization** → **TraVis** 
  - Merge CSV files logged separately by Test Daemons
  - Various graphs & statistics

# First Benchmark Examples

<i>scenario</i> <i>server</i>	5.1.2.1 Scenario 1.1 Successful Initial Registration (SAPS)	5.2.2.4 Scenario 2.4- Successful Call (SAPS)	5.3.2.1 Scenario 3.1 Successful Message Exchange (SAPS)
kennicot	80	200	500
DTI	140	310	690
damascus	110	390	900

# Example: Visualization of Fail Rate



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- Is
  - a test specification and implementation technique
  - open to various domains
  - open to various development and test processes
  
- For conformance, interoperability and performance testing!
  
- TTCN-3 is widely supported by tools
  
- TTCN-3 is the choice for technical testing and automated test execution
  
- It supports the development of telecommunication, Internet and IT standards via well-defined test suites

- adopted by ITU-T
- taken for numerous ETSI test suites
  - SIP
  - IPv6
  - SIP/ISUP
  - Hiperlan/Hiperman
- taken for tests of other consortia like AutoSar, MOST Forum, WiMax Forum



- Users of TTCN-3 report that ...
  - productivity,
  - system quality and
  - test reuse **... are doubled**
- SUT coverage is substantially increased
- Testers can concentrate on the test logic
  - i.e. what to test
- The test execution is fully automated
  - i.e. how to test technically

# At the End: Standardized Test Specifications

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- Well-defined test notation for many testing applications
  - Universally understood syntax and operational semantics
  - Off-the-shelf tools
  - Cheaper education and training costs
  - Standardization, exchange and reuse of test suites
  - Easier maintenance of test suites
- 
- Transparency for the test process
  - Increase of the objectiveness of tests
  - Comparability of test results



# Thank You!

Any Questions?

Please be invited to the  
4th TTCN-3 User Conference  
@ Ericsson, Sweden, May 2007