# Validating Wireless Protocol Conformance Test Cases

Amresh Nandan

Paresh Jain

June 2004

# In this presentation…

- Objective
- Motivation
- Implementation
- Results
- Comparative Host Testing Methods
- Conclusion

# Objective

- Host testing as a prelude to Target testing in development of wireless protocol conformance test suites.

  - InterRAT (UTRAN ↔ GSM) ATS.

  - 3GPP 34.123-1 TC 8.3.7.X (X = 1 to 9)

- Use of TTCN-SDL co-simulation in protocol conformance host testing.

# Motivation

## Why Host Testing ?

Host testing is desirable due to the following reasons:

- Allows development of test cases independent of target system.
- Target systems become available late in the project.
- Tested and stable test suites help faster development of target system as well.
- Target systems are expensive and there are never enough of them. Consequently, the targets become a bottleneck during testing.
- Target systems are hardware intensive. If they become faulty, the whole schedule goes haywire.

# Implementation

## Host Testing & Co-Simulation

In practice, the most common way to test a TTCN ATS in development environment is a C test harness consisting of three modules to:

- establish communication link between the ATS and the harness.
- respond to SS and UE based messages being sent by the ATS.
- report the result and error messages to the user.

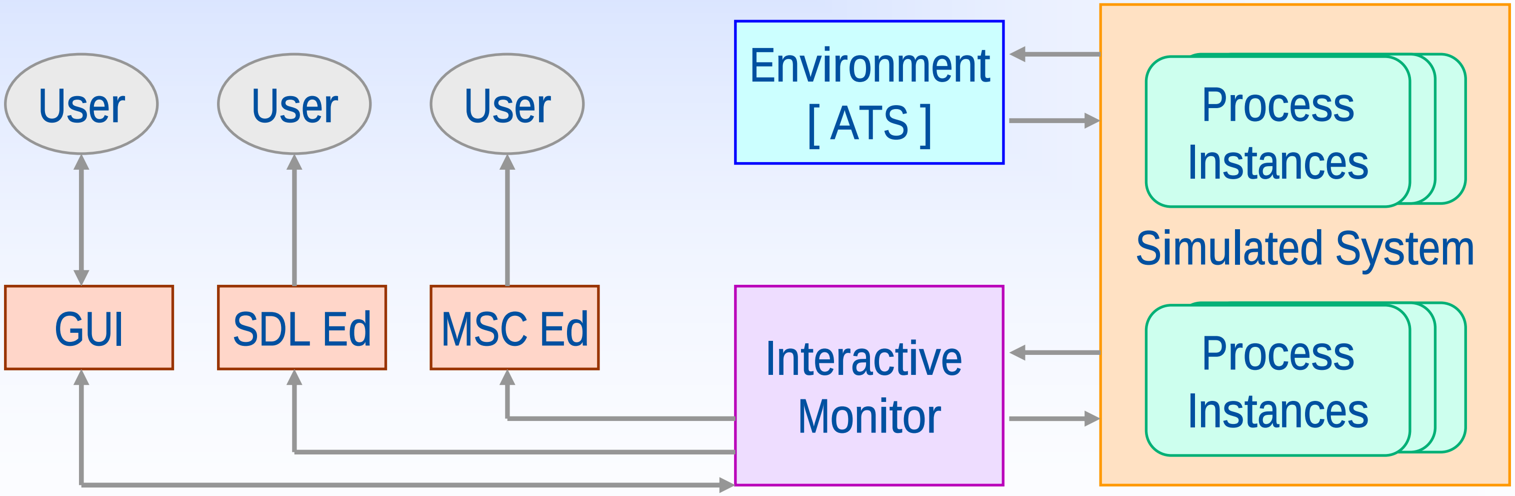
Other way could be use of co-simulation feature of Telelogic Tau, which provides inbuilt communication channel between TTCN and SDL.

- Feature originally designed to test protocol stacks designed using SDL.
- Signal based message communication between TTCN and SDL.
- Provides result in MSC format and textual log of ATS as well as SDL system.

# Implementation

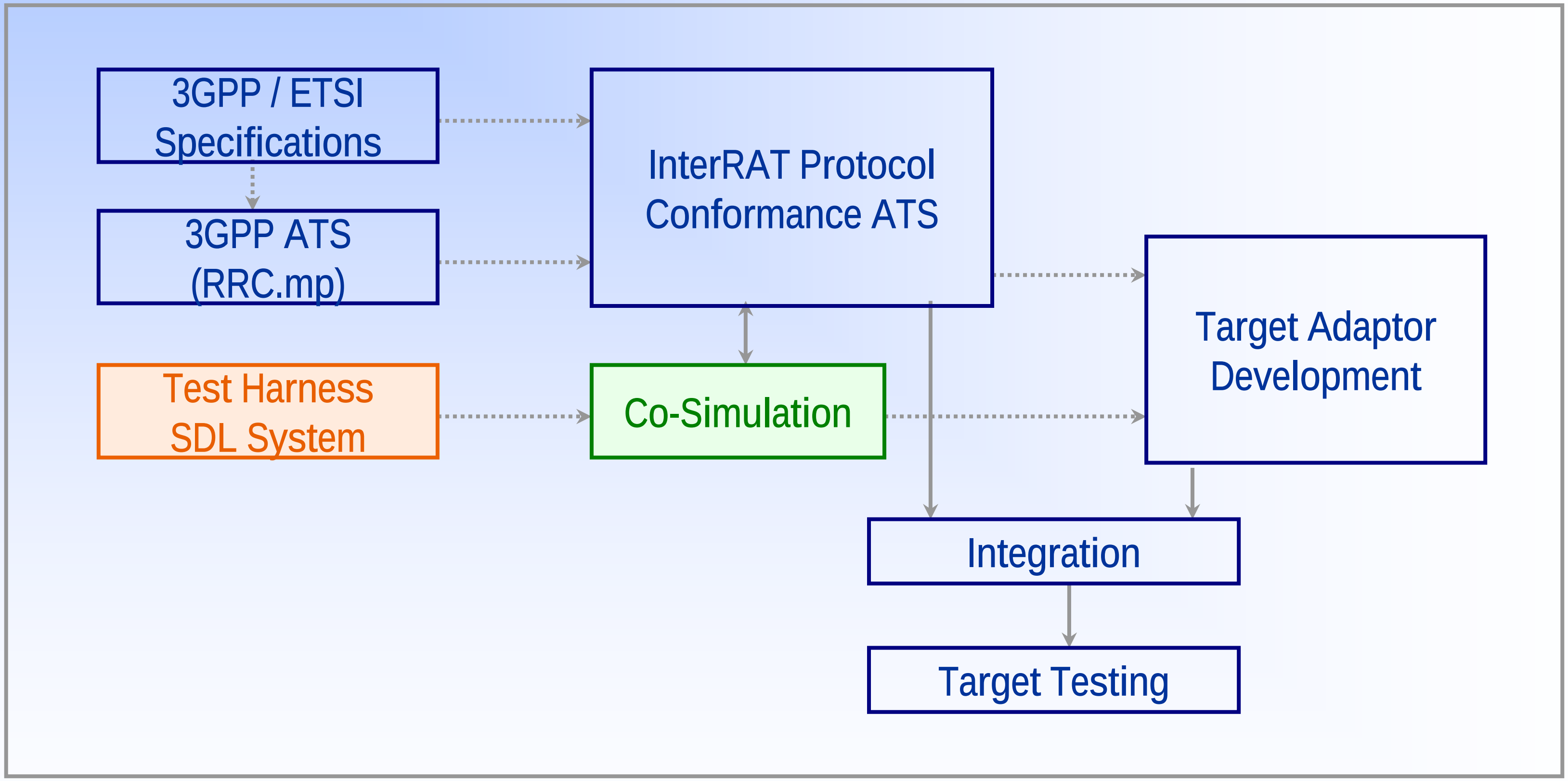
## Host Testing & Co-Simulation

- The TTCN-SDL Co-simulator allows to generate ETS for testing of simulated SDL systems. This allows the testing of the system design early in the design process and later during implementation as well.
- These ETSs allow to execute test cases and / or test groups or by single stepping through the selected tests with the possibility to set breakpoints.



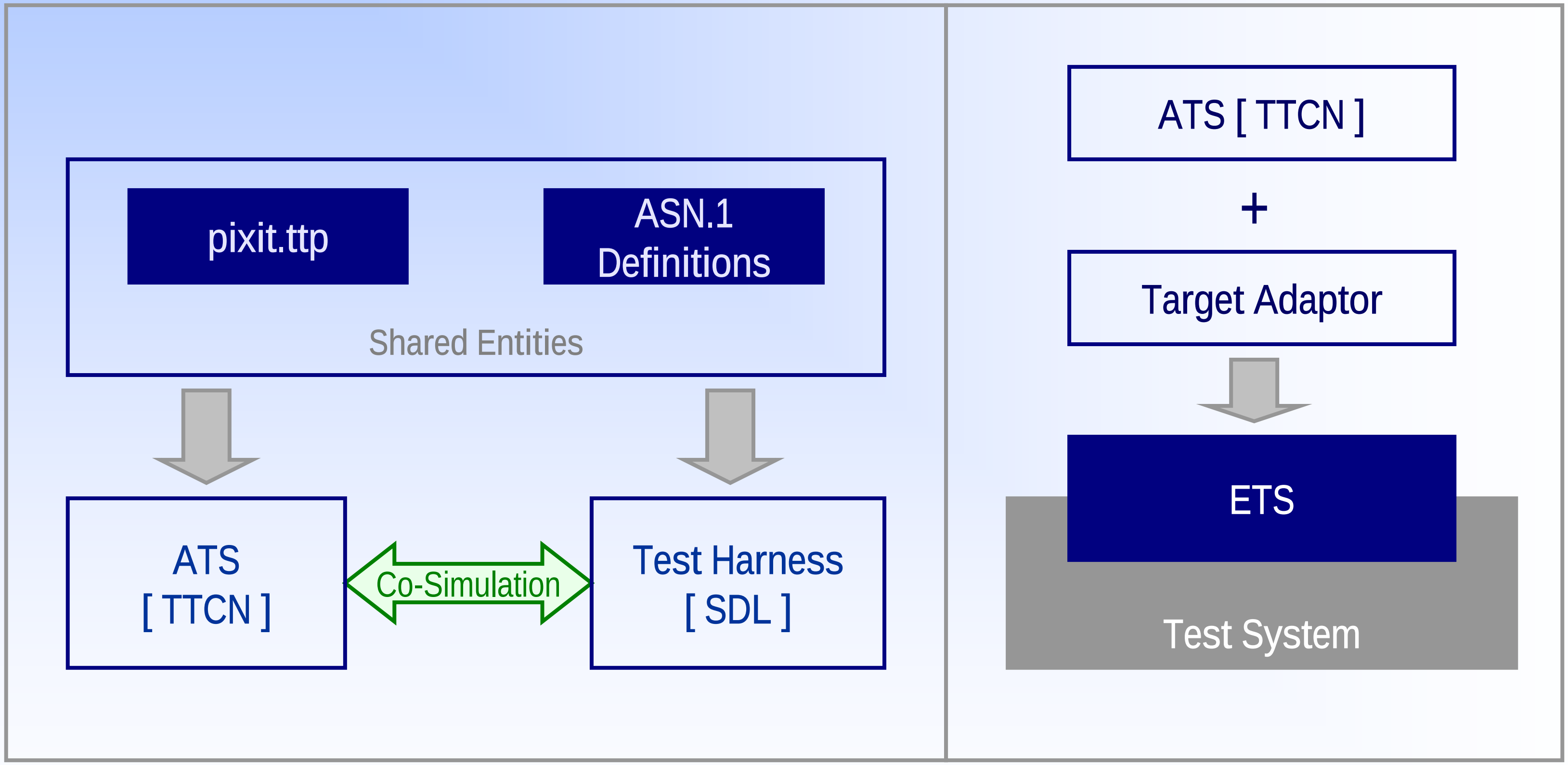
# Implementation

## Testing System


3GPP / ETSI Specifications
3GPP ATS (RRC.mp)
Test Harness SDL System
InterRAT Protocol Conformance ATS
Co-Simulation
Target Adaptor Development
Integration
Target Testing

# Implementation

## Co-Simulation Test Architecture



# Implementation

## Test Harness - SDL System

The SDL system in this case would be the test harness with following capabilities:

- Appropriate response signals for SS configuration messages from the ATS and for protocol messages from the network to UE.
- Handling of boundary conditions and exception scenarios.
- Protocol specific procedures for handling test case scenarios.

# Implementation

## Test Harness - SDL System

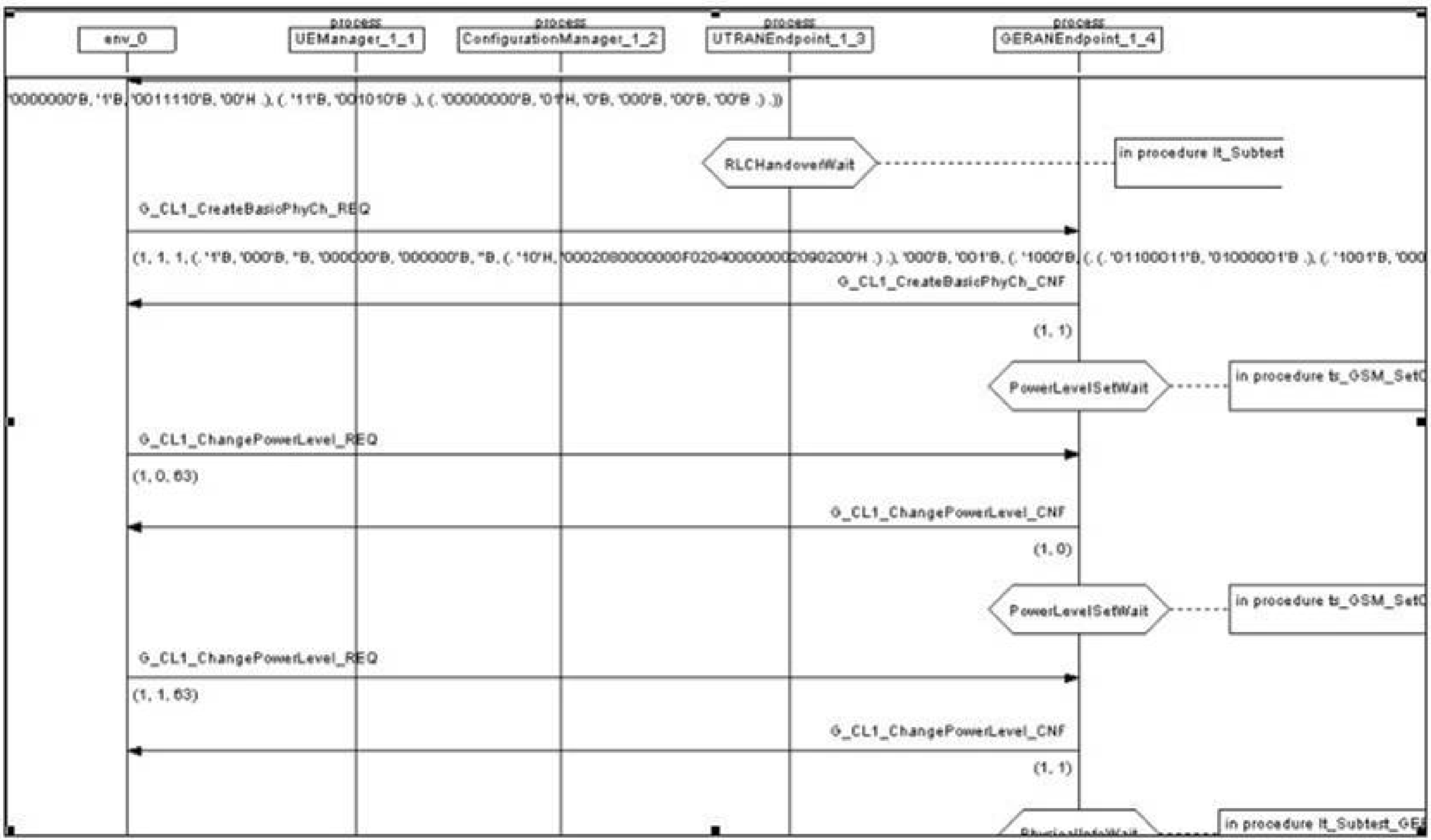
The SDL system in our exercise was comprised of three processes:

- UE Manager : To handle common messages and configure UTRANEndPoint & GERANEndPoint processes.
- UTRANEndPoint : handles all messages coming from UTRAN cell and responds with messages to UTRAN cell.
- GERANEndPoint : handles all messages coming from GERAN cell and responds with messages to GERAN cell.

Message data structures and signal definitions were defined in ".pr" files.

# Results

## Message Sequence Chart


process
env_0
UEManager_1_1
process
ConfigurationManager_1_2
process
UTRANEndpoint_1_3
process
GERANEndpoint_1_4
'0000000'B, '1'B, '0011110'B, '00'H ), ( '11'B, '001010'B ), ( '00000000'B, '01'H, '0'B, '000'B, '00'B, '00'B ) ))
RLCHandoverWait
in procedure lt_Subtest
G_CL1_CreateBasicPhyCh_REQ
(1, 1, 1, ( '1'B, '000'B, ''B, '000000'B, '000000'B, ''B, ( '10'H, '0002080000000F020400000002090200'H ) ), '000'B, '001'B, ( '1000'B, ( ( '01100011'B, '01000001'B ), ( '1001'B, '000
G_CL1_CreateBasicPhyCh_CNF
(1, 1)
PowerLevelSetWait
in procedure ts_GSM_SetC
G_CL1_ChangePowerLevel_REQ
(1, 0, 63)
G_CL1_ChangePowerLevel_CNF
(1, 0)
PowerLevelSetWait
in procedure ts_GSM_SetC
G_CL1_ChangePowerLevel_REQ
(1, 1, 63)
G_CL1_ChangePowerLevel_CNF
(1, 1)
PhysicalInfoWait
in procedure lt_Subtest_GE

# Results

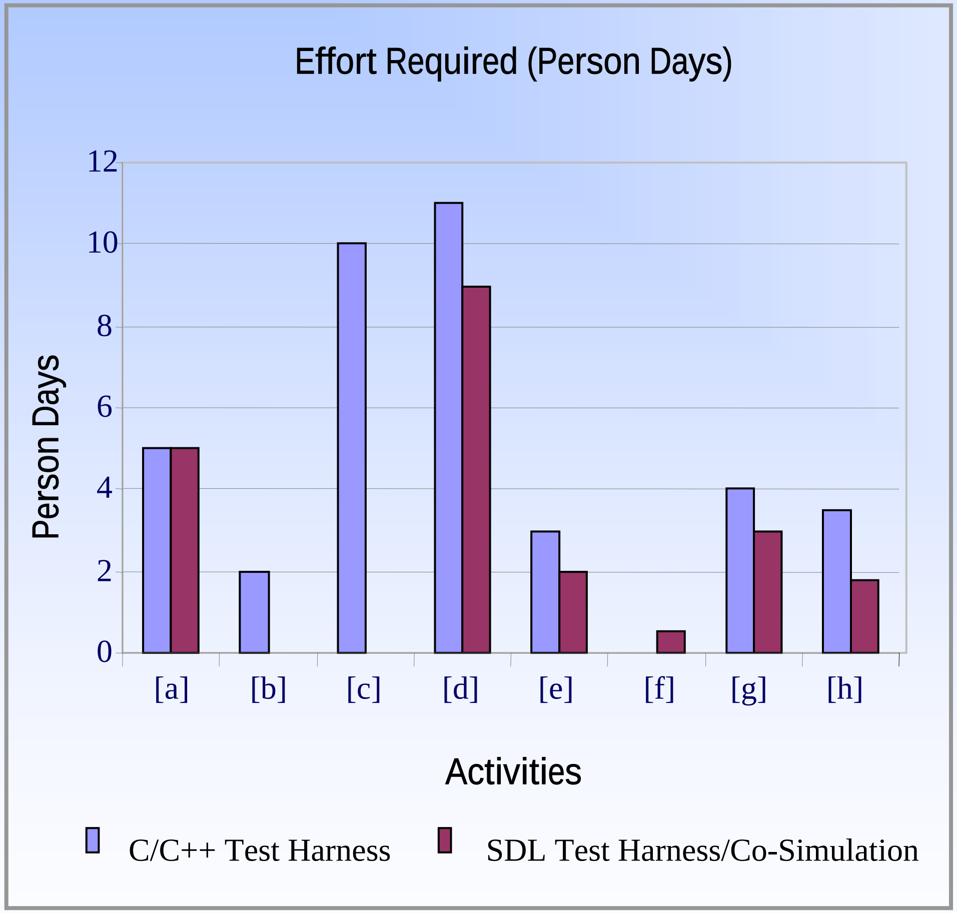
## Co-Simulation Benefits

- SDL allows faster test harness development.
- Co-Simulation gives graphical logging in the form of Message Sequence Charts (MSC) during testing, which allows easier verification of messages being transferred between ATS and the harness.
- Development and testing is independent of external components such as CODECs, adaptation libraries and communication mechanism modules.
- In 3G conformance test cases, a large percentage of test steps are reused and so test harness developed in SDL can reuse processes and procedures for different test cases. This reduces the effort and complexity of the harness when large numbers of test cases are to be developed.

# Results

SAM'04

## Effort Comparison: C/C++ & SDL



[a] Design of test harness

[b] Development of communication mechanism between TTCN test suite and test harness

[c] Development of message encoders and decoders

[d] Development of test case.

[e] Implementation of error and boundary conditions

[f] Development of PICS & PIXIT files for test harness

[g] Testing

[h] Addition of another similar test cases to the test harness (with logical conditioning for test cases selection).

# Results

## Errors detected during Co-Simulation

- In some cases standard protocol procedures were not followed as per the specifications. Using test harness the flow of test cases was corrected.
- Table Reference was missing in several PICS/PIXIT parameter tables.
- In few test steps such as ts_GSM_SS_CellRelease, the indentation of rows was logically incorrect.
- In some of the test steps where timers were being used, the cancel timer step was missing for the timer started earlier in other test steps.
- Few test case variables were not initialized properly or at all.
- There was no handling of else / other wise conditions for some parameters if certain logical conditions do not hold true.

# Conclusion

## Co-Simulation Test Outcome

| Sl. No. | Development Stage and Activity | Number of errors detected |
|---|---|---|
| 1. | Analysis (in Telelogic Tau) of TTCN 2 ATS. | 7 |
| 2. | Manual review of ATS with respect to 3GPP test specification and core specifications. | 14 |
| 3. | Host testing using Co-Simulation. | 9 |
| Total | | 30 |

Approximately 30% of errors found before target testing were detected during co-simulation and these were those errors which could not get detected during manual review of the test suite.

# Thank You