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Architecture of ITS Interoperability Validation Framework

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Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Intelligent Transport Systems (ITS).

Modal verbs terminology

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Introduction

In response to EC mandate M/453 [i.6], ETSI Technical Committee (TC) ITS has standardized base and conformance test specifications for ITS protocols. In a following step a prototype TTCN-3 conformance test system was built and validated. The present document describes the design and validation of the prototype TTCN-3 interoperability test system, extending the previous prototype with interoperability features.

The action described in the present document has supported the implementation of ITS standards by:

- Making available a set of standardized interoperability test specifications for V2X Applications, CAM, DENM as well as Geonetworking functionality.
- A framework which will allow to run end-to-end interoperability test scenarios while at the same time assessing compliance of the air interface of all ITS-S devices.
- Releasing all software as open source and thus allowing industry to build and run their own interoperability validation framework.

The ITS Interoperability Validation Framework follows the principles of:

- Test automation.
- Support for various types of testing (conformance and interoperability testing).
- Flexible adaption to proprietary interfaces.

- Remote testing.
- Over-the-air interface triggering and observation.

1 Scope

The present document provides a description of the architecture of the ITS interoperability validation framework, including definition of the test environment, codec and test adapter. It provides, as well, all the necessary source code to build and run the ITS interoperability validation framework.

The ITS interoperability validation framework integrates the test suites defined in ETSI TS 103 192-3 [i.4].

2 References

2.1 Normative references

Normative references are not applicable in the present document.

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] ETSI ES 201 873-5 (V4.5.1): "Methods for Testing and Specification (MTS); The Testing and Test Control Notation version 3; Part 5: TTCN-3 Runtime Interface (TRI)".

[i.2] ETSI EG 201 015 (V2.1.1): "Methods for Testing and Specification (MTS); Standards engineering process; A handbook of validation methods".

[i.3] IEEE 802.11p™: "IEEE Standard for Local and Metropolitan Area Networks - Specific requirements; Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications; Amendment 6: Wireless Access in Vehicular Environments".

[i.4] ETSI TS 103 192-3 (V.1.1.1): "Intelligent Transport Systems (ITS); Testing; Interoperability test specifications for ITS V2X use cases; Part 3: Abstract Test Suite (ATS) and Protocol Implementation eXtra Information for Testing (PIXIT)".

[i.5] ETSI TR 103 099 (V.1.4.1):"Intelligent Transport Systems (ITS);Architecture of conformance validation framework".

[i.6] EC mandate M/453: "Standardisation mandate addressed to CEN, CENELEC and ETSI in the field of Information and Communication Technologies to support the interoperability of co-operative systems for Intelligent Transport in the European Community".

3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

API	Application Programming Interface
ARCI	Ambient or Road condition pictogram Class
ARNI	Ambient or Road condition pictogram Nature
AT	Authorization Ticket
ATS	Abstract Test Suite
BP	BrainPool

BTP	Basic Transport Protocol
CA	Cooperative Awareness
CAM	Cooperative Awareness Message
CC	Cruise Control
DEN	Decentralized Environmental Notification
DENM	Decentralized Environmental Notification Message
EC	European Commission
ETH	ETHernet
GN	GeoNetworking
HMI	Human-Machine Interface
IP	Internet Protocol
ITS	Intelligent Transportation Systems
ITS-S	Intelligent Transportation Systems - Station
IUT	Implementation Under Test
MAC	Media Access Control
MID	Mac ID
PC	Personal Computer
PDU	Protocol Data Unit
RT	Right Turn
SUT	System Under Test
TA	Test Adapter
TC	Test Cases
TRI	TTCN-3 Runtime Interface
TSB	Topology Scoped Broadcast
TSPC	Traffic Sign Pictogram Class
TSPN	Traffic Sign Pictogram Nature
TTCN-3	Testing and Test Control Notation 3
UDP	User Datagram Protocol
UT	Upper Tester

4 Test platform overview

4.1 Constraints and requirements

The purpose of the ITS test platform is to provide a reliable set of software and hardware equipment that can be used to validate TTCN-3 abstract test suites (ATS) developed in ETSI.

The architecture of this test platform has been designed with respect to the following constraints:

- to be compatible with the requirements expressed in the validation handbook (see ETSI EG 201 015 [i.2]);
- to be independent of the platform used to implement the test system (see ETSI ES 201 873-5 [i.1]);
- to be independent of the TTCN-3 tool provider;
- to be configurable and customizable;
- to provide tools and well-defined interfaces to system under test (SUT), allowing test automation;
- to be easily extensible for future ITS protocols;
- to provide generic components that can be reused in other test platforms.

In addition, great care has been taken to separate ITS specific functionalities from generic test platform tasks in order to provide a maximum number of reusable components for future test platforms.

4.2 General architecture

Typically, a TTCN-3 test platform is composed of four different components:

- The TTCN-3 test tool providing necessary software to execute the abstract test suites.
- The hardware equipment supporting TTCN-3 test execution and adaptation to SUTs.
- The codecs which convert protocol messages into their abstract TTCN-3 representation.
- The Test Adapter (TA) implementing interfaces with the device under test.

The interaction of these components is described in figure 1.

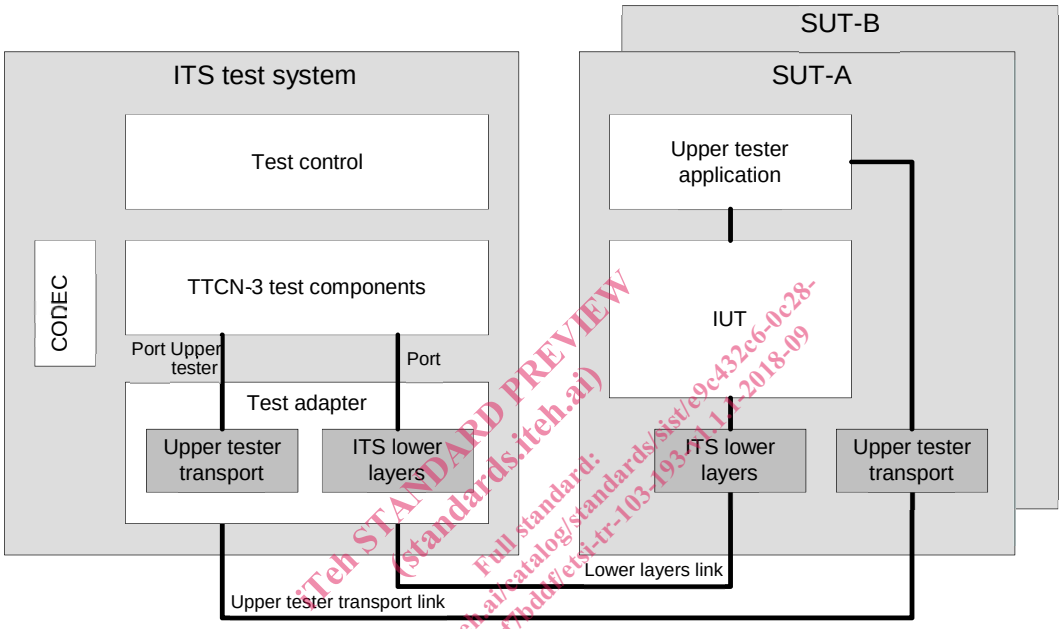

Figure 1: General architecture

The TTCN-3 test tools are usually provided by commercial companies and their description is out of the scope of the present document. The implementation details of the other components are described in the present document.

4.3 Interoperability-specific architecture

In order to handle multiple equipment under test in interoperability scenarios, each SUT is managed by a TTCN-3 test component. Protocol messages exchanged between SUTs are captured by the Test System and mimicked as internal messages between the TTCN-3 components. Figure 2 illustrates this mechanism in the case of CAM messages exchanged amongst 2 SUTs.

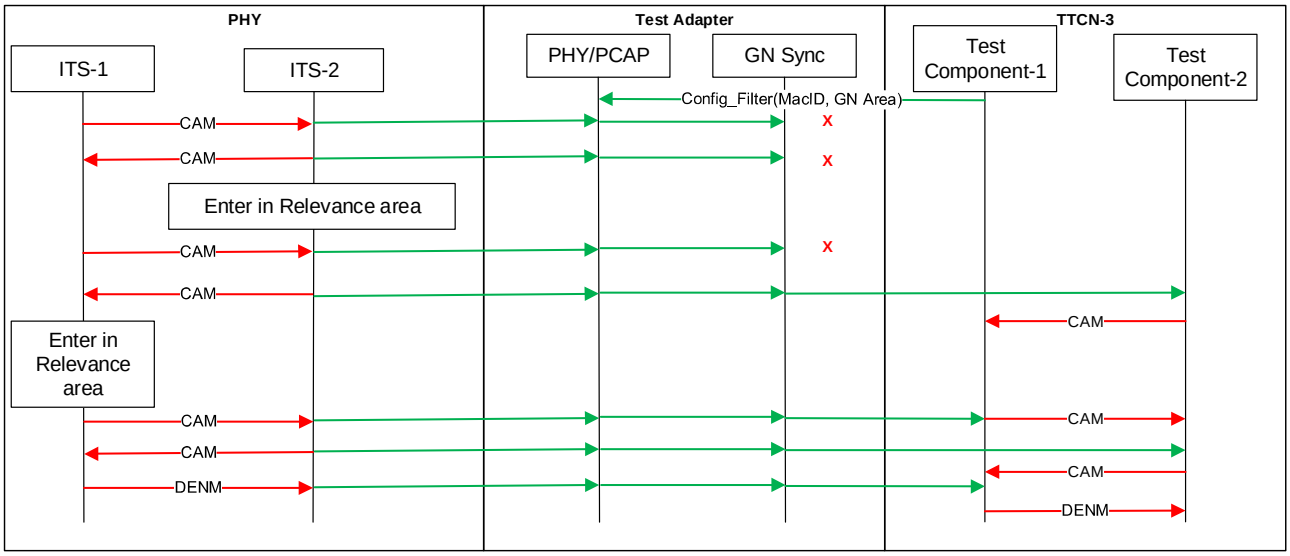

Figure 2: TTCN-3 mapping of interoperability scenario

The Test Adapter plays a very important role in this architecture as it is responsible for filtering and dispatching captured messages to the adequate component. Configuration of filtering and dispatching rules are performed during the testcase initialization phase.

5 Hardware equipment

5.1 Introduction

As an extension of the TTCN-3 conformance test system, the Interoperability Validation Framework reuses all the hardware specifications defined in ETSI TR 103 099 [i.5].

5.2 PC

The main hardware component of the ITS test platform is a standard PC. Its role is to host the execution of the test suites using a commercial TTCN-3 test tool.

Whatever operating system is installed on the computer, it is necessary to ensure that the following points are considered:

- No firewall interference with traffic generated by the Test System and/or SUT;
- Excellent time synchronization between the SUT and the test system;
- Test system processes (especially the test adapter) need to be granted unrestricted control to telecommunication hardware.

Time synchronization is maybe the most critical point to be checked before starting any test session, as it can be the source of strange SUT behaviour and generate incoherent results. Indeed, most ITS protocol messages feature a time tag used by the receiver to determine if the information it carries is still valid; if the test system is ahead in time, all messages it sends will be considered either as coming from the future or from a very old date and will be discarded.

This PC is equipped with two network cards, one being used for ITS communication with SUT (lower layers link), the other one being used for exchanging upper tester messages (upper tester transport link). Separating these two communications on different hardware interfaces is not an absolute necessity, but it is a good practice and it ensures that there will be no interaction between the flows.

The communication between the SUT and the test system is achieved through Ethernet if the SUT supports it or using a G5 adaptation box, as shown in figure 3 and in figure 4.