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TECHNICAL REPORT

Intelligent Transport Systems (ITS);
Pre-standardization study of ITS test mode
for operational devices in the field

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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

ITS station communication devices require testing to verify their conformance regarding the ITS protocol stack implementation as well as the transmission and reception parameters. Therefore, an additional implementation of a test mode and a corresponding message set is proposed. The present document shows the ability of testing the communication of the devices under test in non-shielded environments. This includes but is not limited to over the air tests that do not interfere with operational devices. Furthermore, it enables the identification of non-working and damaged components crucial to the ITS communication using the test mode message set. This allows pro-active failure detection as well as prevention of devices in the field. In context with Vision Zero efforts of the European Union [i.3], it contributes largely to a reliable communications network upon which road safety is enhanced.

1 Scope

The present document describes a test mode for the ITS protocol stack. The test mode provides the ability of testing RF and functional requirements regarding the communication of devices. This includes but is not limited to over the air tests in non-shielded environments without affecting operational ITS stations not targeted by the message.

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 TS 102 941: "Intelligent Transport Systems (ITS); Security; Trust and Privacy Management".

[i.2] ETSI TS 103 097: "Intelligent Transport Systems (ITS); Security; Security header and certificate formats".

[i.3] VISION ZERO White Paper: "Roadmap to a Single European Transport Area".

NOTE: Available at https://ec.europa.eu/transport/sites/transport/files/themes/strategies/doc/2011_white_paper/white-paper-illustrated-brochure_en.pdf.

[i.4] ETSI TS 102 940: "Intelligent Transport Systems (ITS); Security; ITS communications security architecture and security management".

3 Definition of terms, symbols and abbreviations

3.1 Terms

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

Test ITS-AID: ITS-AID that is used for sending ITS facility layer message for test purposes

Test Mode (TM): state that enables specific tests of the ITS-S on functional and radio-frequency level

Test Mode ITS-AID: ITS-AID that is solely used for TMM

Test Mode Message (TMM): dedicated message type carrying test mode payload data

Test Mode Service (TMS): facility at the ITS-S facilities layer to generate, receive and process TMM

3.2   Symbols

Void.

3.3   Abbreviations

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

AA	Authorization Authority
AID	Application Identifier
AT	Authorization Tickets
BTP	Basic Transport Protocol
CA	Cooperative Awareness
CAM	Cooperative Awareness Message
CRL	Certificate Revocation List
CTL	Certificate Trusted List
DENM	Decentralized Environmental Notification Message
DTS	Dedicated Test System
EOL	End Of Line
GN	GeoNetworking
GNSS	Global Navigation Satellite System
IFI	In-Field Inspection
ITS	Intelligent Transport Systems
ITS-S	Intelligent Transport Systems Station
MAC	Medium Access Control
OBD	On Board Diagnostics
OBU	On Board Unit
PDU	Protocol Data Unit
PTI	Periodic Technical Inspection
RF	Radio Frequency
SSP	Service Specific Permission
SUT	System Under Test
TMS	Test Mode Service
V2X	Vehicle to Everything

4   Test mode specification

4.1   Test mode overview

The test mode is a means to verify RF and functional requirements of the ITS protocol communications. This requires access to functionality located in the facility layer of the ITS protocol stack as well as new functionality to conduct these tests. Therefore, a Test Mode Service (TMS) with specific permissions to access this functionality is needed. The test mode should be usable in non-shielded environments without affecting operational ITS stations. Hence, a separation of traffic, provided by usage of a dedicated certificate chain, is required.

4.2   Test mode service

The test mode service should be located within the facility layer. It should have the ability to send proprietary message types (test mode messages) and have specific permissions to access ITS stations protocol functions. TMS should only receive messages over a dedicated BTP port. It should be able to trigger CAMs, DENMs or other messages at their respective facility layer services for testing purposes when in test mode state and only then. To protect operational ITS station traffic from interference as well as the test mode service from abuse, a dedicated certificate chain is used once test mode is activated. These certificates have strong restrictions and apply separate SSPs to the service. Only DTS should have permission to trigger events through test mode messages, while SUTs should only receive certificates with permissions to send test mode message response messages. TMS should only be able to trigger events within the ITS protocol stack if a corresponding test mode AT certificate is active.
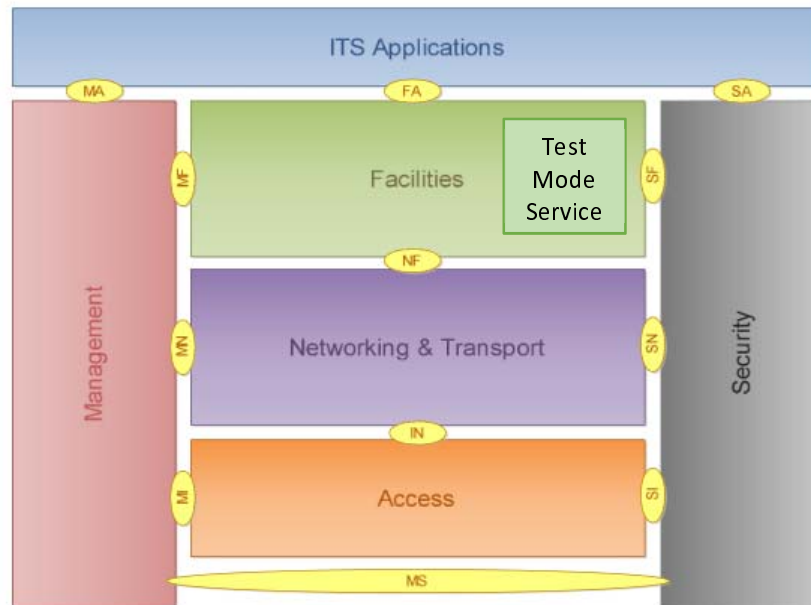
**Figure 1: Test mode service in V2X architecture
(Original image source: ETSI TS 102 940 [i.4])**

4.3   Test mode message format

Test mode test messages refer to messages being sent and processed by the test mode service. These messages should be routed over a dedicated BTP port and are optionally encrypted.

Data fields contained in test mode message transmitted by DTS:

- Signed by test certificate (public key attached to message)

- Requested message type to be returned (Test mode message, CAM, DENM, etc.)

- Requested data fields to be transmitted

- Requested mode of transmission for reply (either wirelessly or via OBD)

- Requested transmission power to be used

- Requested frequency/channel to be used

- Requested antenna to be used by OBU for reception of test mode messages

- Requested antenna to be used by OBU for transmission of test mode messages

- Target temporary MAC

- Time

- Message counter

Data fields contained in test message transmitted by SUT:

- Signed by test certificate (public key attached to message)

- Selected transmission power

- Selected antenna

- Selected frequency/channel

- Software/V2X protocol stack version

- Hash of software/stack version

- Hardware version

- GNSS position

- Time

- Message counter

4.4 Test mode activation

Test mode of the SUT should only be activated by authorized ITS-S DTS. Therefore, test mode messages should be signed with AT certificates carrying a test mode dedicated ITS-AID. AT certificates should be signed by a dedicated AA certificate. A dedicated test mode AA is an AA that operates according to the accepted Certificate Policy and is additionally allowed by the Policy Authority to issue test mode ATs. Depending on the criteria of the Policy Authority this may be a dedicated test AA or an AA that also issues regular ATs. The DTS should choose a SUT and send a message to activate the test mode. As this message should be signed by a test mode AT, the SUT will request a corresponding AA to validate the certificate chain, in case it is unknown. This should be done in accordance to the general certificate exchange approach for message types like DENM or CAM.

Once the request has been verified, the SUT should retrieve own test mode AA and AT certificates with its enrolment credentials from the test mode AA. If the retrieval has been successful, the SUT awaits a test mode trigger message for test mode activation addressed only at the SUT. Once the SUT has retrieved the test mode AT, it should change its currently used AT to the time and area limited test mode AT and acknowledge successful test mode activation to the DTS. All further messages will be signed with the test mode AT until it expires, the SUT leaves the validity area defined in the certificate, test mode is terminated via message set, a new AT is loaded or the SUT is restarted.
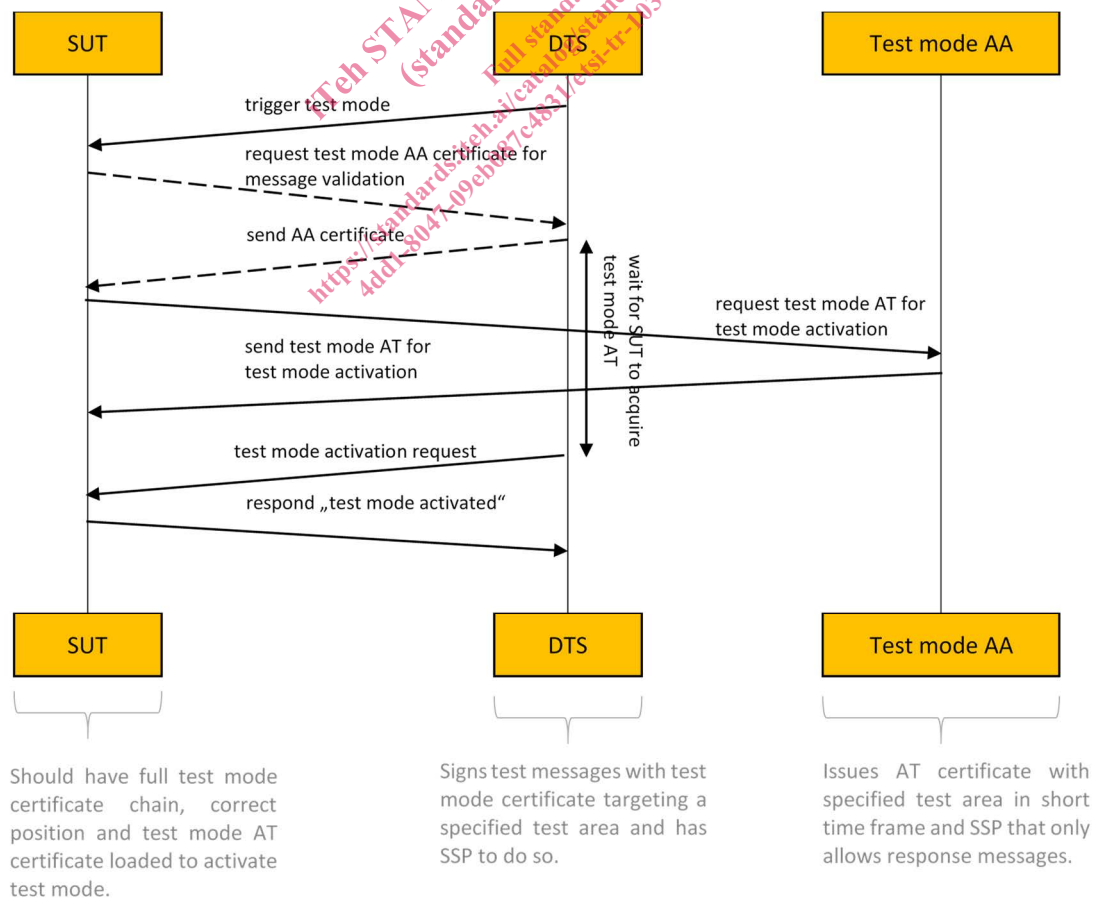

Figure 2: Test mode activation sequence

4.5   Separation of traffic

4.5.1   General approach

The separation of traffic is based upon 3 factors:

1) Test mode trigger messages should be routed over a separate BTP port. Hence, they should not interfere
    internally with basic services, even if the provided test mode is not supported.

2) Outgoing messages from the SUT should not interfere with other ITS-S as they are signed with certificates
    carrying a test mode ITS-AID. In succession this should force all ITS-S that are not in test mode, to drop these
    messages.

3) The alternative AA that is exclusively responsible for test mode certificates guarantees the possibility of strong
    regulation for issuing of test mode certificates.

4.5.2   Certificate chain

The certificate chain and its management follow the general model and processes of certificate chains for ITS station as
stated in ETSI TS 102 941 [i.1]. It applies the general ruleset and introduces the necessary AA and AT certificates on an
alternative branch. This branch is a result of the introduction of dedicated test ITS-AIDs which are derived from regular
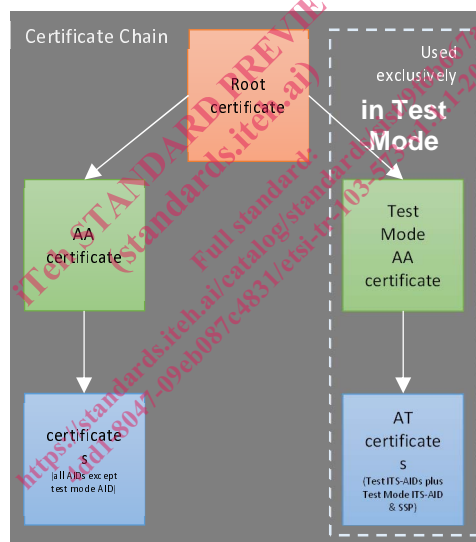ITS-AIDs. This means that every ITS-AID has a mirror Test ITS-AID.

**Figure 3: Illustration of separate certificate chains
for operational usage and test mode usage**

4.5.3   AA certificate properties

AA certificates should be conformant to certificate profiles for subordinate certification authority certificates as stated in
ETSI TS 103 097 [i.2]. In addition, the following restrictions should apply:

•   The `toBeSigned` component `CertificateId` should be set to the choice `name` contain a unique name
    associated to the certification authority and should not be set to the choice `none`.

•   The certificate should be the only one to contain the ITS-AID correspondent to test mode in its
    `certIssuePermissions` in addition to mirrored Test ITS-AIDs (all that are needed for testing; e.g.
    CAM, DENM).