
**Intelligent transport systems —
Cooperative ITS — Test architecture**

*Systèmes intelligents de transport — SIT coopératifs —
Architecture d'essai*

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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Introduction

For conformance testing in C-ITS, ETSI developed a generic initial test architecture, published in Reference [6]. Considering the ITS station and communication architecture for C-ITS specified in ISO 21217 and implementations of ITS station units being compliant with the ITS-S station-internal management communications protocol (IICP) specified in ISO 24102-4, conformance testing can be simplified and related effort and cost can be reduced by applying the extended test architecture specified in this document. IICP enables remote access to all points of control and observation (PCO) of the implementation under test (IUT) without the need to implement IUT-specific upper tester applications and lower tester access.

Understanding of this document requires knowledge of:

- the ITS station and communication architecture specified in ISO 21217,
- the IICP specified in ISO 24102-4, and
- the related MX-SAP service primitive functions specified in ISO 24102-3.

Further knowledge of standards related to conformance testing with TTCN-3 is also recommended, for example:

- Reference [6] on the framework on C-ITS conformance testing, and
- Reference [7] on the TTCN-3 core language.

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Intelligent transport systems — Cooperative ITS — Test architecture

1 Scope

This document specifies an extension of the ETSI C-ITS test architecture for conformance testing of protocols and applications in ITS station units. It specifies usage of the ITS station-internal management communication protocol (IICP) for the purpose of connecting an ITS test system to an implementation under test (IUT) residing in a system under test (SUT).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 21217:2014, *Intelligent transport systems — Communications access for land mobiles (CALM) — Architecture*

ISO 24102-3, *Intelligent transport systems — Communications access for land mobiles (CALM) — ITS station management — Part 3: Service access points*

ISO 24102-4, *Intelligent transport systems — Communications access for land mobiles (CALM) — ITS station management — Part 4: Station-internal management communications*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp/>

3.1 implementation under test

IUT

part of a real system which is to be studied by testing

3.2 system under test

SUT

real system in which an *IUT* (3.1) resides

4 Abbreviated terms

CI	communication interface
IIC	ITS-S internal management communications
IICA	IIC agent

IICM	IIC manager
IICP	IIC protocol
ITS	intelligent transport systems
ITS-SCU	ITS station communication unit
ITS-SCU-ID	ITS-SCU identifier
PCO	point of control and observation
PDU	protocol data unit
TTCN-3	testing and test control notation version 3

5 Conventions

In this document, text presented in `Courier` font indicates ASN.1 codes.

6 Test system architecture

6.1 General

The general test system architecture is illustrated in [Figure 1](#). It shows how an implementation under test (IUT) contained in a system under test (SUT) is connected to the ITS test system via a lower layers link and an upper tester transport link and a configuration/notification link. These links allow accessing the points of control and observation (PCO) of the IUT.

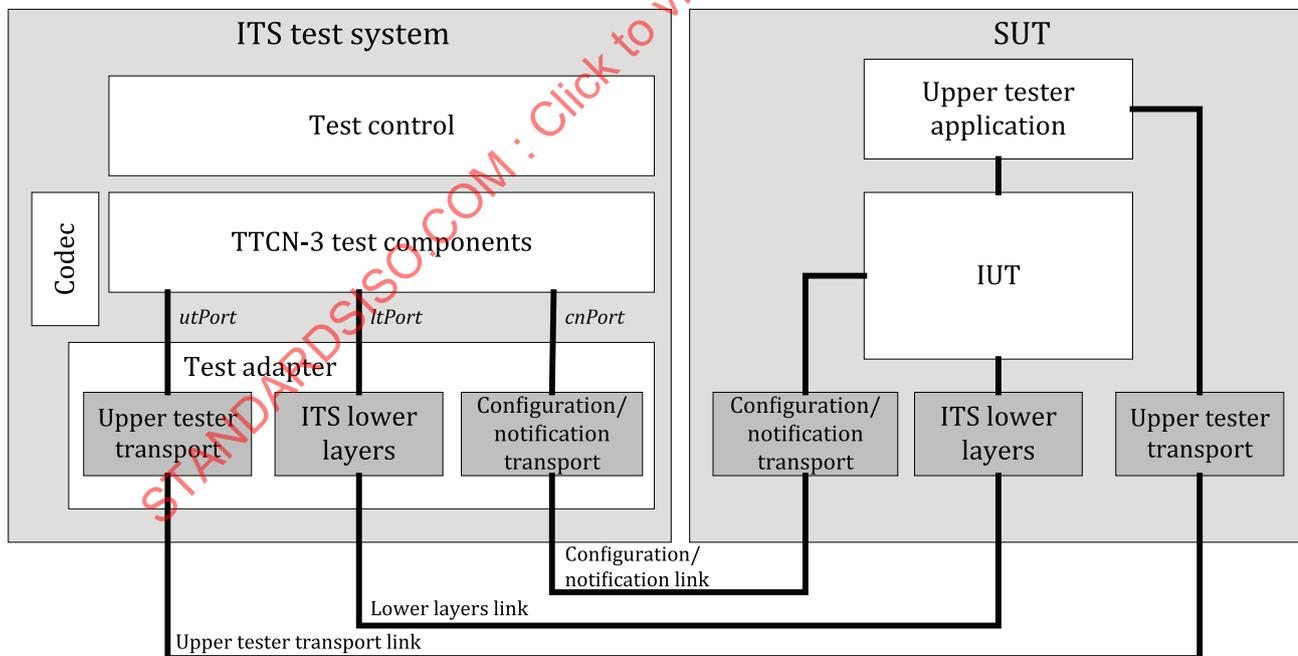


Figure 1 — General conformance test system architecture

The lower layers link may end up in the SUT at the block “ITS lower layers”, in case lower layers are used during testing, or directly at the lower interface of the IUT. The upper tester transport link ends up in the SUT at the block “upper tester transport”. This “upper tester transport” block together with the “upper tester application” block provides the test access to the upper interface of the IUT. The configuration

and event notification link is needed for testing of some IUTs, e.g. to set initial conditions and to retrieve status information, allowing remote access to the management/security SAPs in the SUT.

The links shown in [Figure 1](#) between the ITS test system and the SUT indicate connectivity between entities in the two systems and the physical implementation of these links is implementation dependent. For example, the three logical links shown may be implemented on a single physical communication medium such as a single Ethernet connection between the ITS test system and the SUT.

Following the ITS station and communication architecture specified in ISO 21217 (see [Figure 2](#)), an IUT can be a protocol or an ITS-S application process located in the

- ITS-S access layer (e.g. ITS-M5 specified in ISO 21215/ISO 21218),
- ITS-S networking and transport layer (e.g. FNTTP specified in ISO 29281-1),
- ITS-S facilities layer (e.g. the LDM specified in ISO 18750),
- ITS-S management entity, or
- ITS-S security entity.

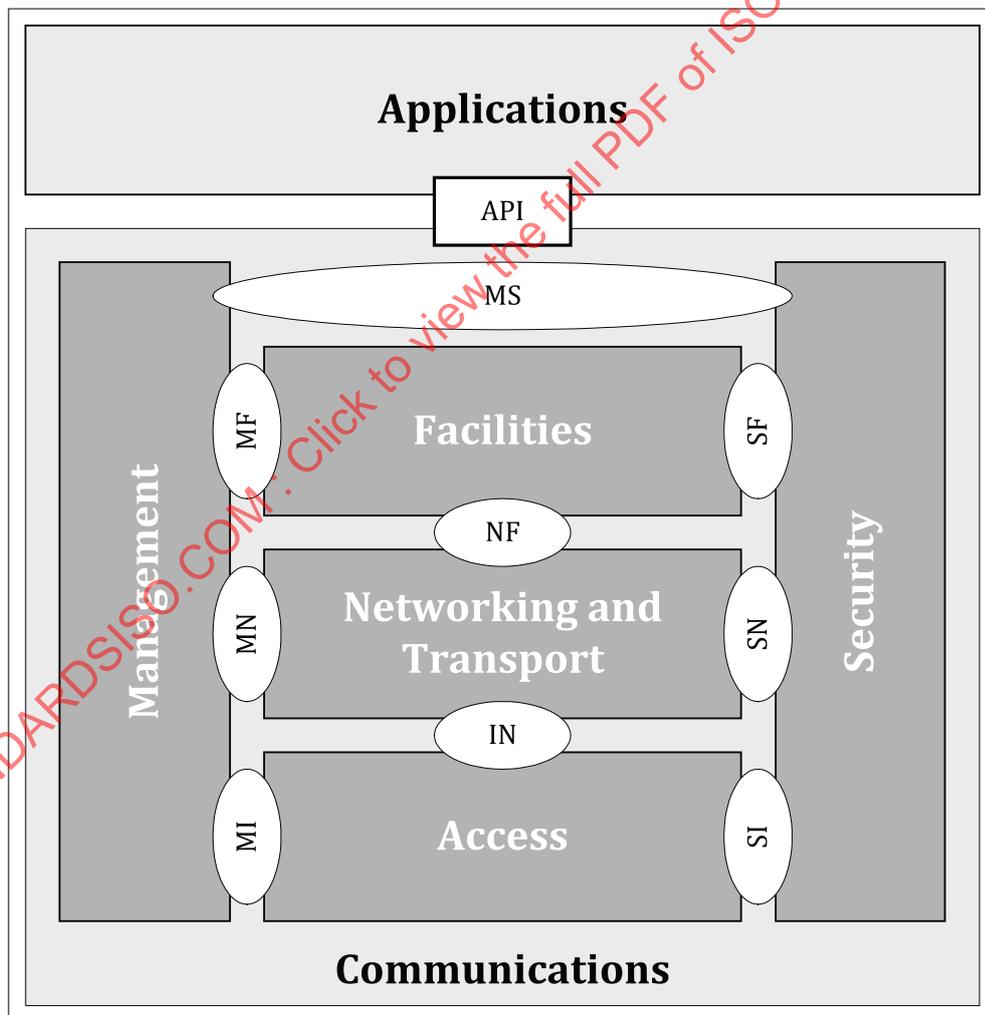


Figure 2 — ITS station architecture

An IUT may include functionalities in more than one architectural layer, for example, functionality in the:

- ITS-S access layer and the ITS-S networking and transport layer;

- ITS-S networking and transport layer and the ITS-S facilities layer;
- ITS-S facilities layer and the ITS-S applications entity;
- ITS-S access layer and the ITS-S networking and transport layer and the ITS-S facilities layer;
- ITS-S networking and transport layer and the ITS-S facilities layer and the ITS-S applications entity;
- ITS-S access layer and the ITS-S networking and transport layer and the ITS-S facilities layer and the ITS-S applications entity.

Additionally, an IUT may also include functionality in the ITS-S management entity and the ITS-S security entity.

Regardless of the functionalities under test, the IUT in principle has these three PCOs shown in [Figure 1](#).

The IUT may be accessed using the ITS station-internal management communications protocol (IICP) specified in ISO 24102-4, as illustrated in [6.2](#) and [6.3](#). [6.2](#) describes the general IICP test architecture, while [6.3](#) describes the extension of [6.2](#) needed in case the ITS-S access layer is used in the SUT. The general IICP reference architecture is illustrated in [6.4](#).

6.2 IICP test system architecture without test CI

When the IUT does not involve access layer functionality, and applying IICP, the three links in [Figure 1](#) are reduced to one physical link, e.g. an Ethernet cable with RJ45 connectors, as illustrated in [Figure 3](#). The ITS test system and the SUT, together, act as parts of a “virtual” ITS station unit (ITS-SU) where each of these two units constitutes an ITS station communication unit (ITS-SCU) as specified in ISO 21217. The ITS-SCU-ID (address of an ITS-SCU) of the ITS test system has the value 3 as specified in ISO 24102-4. The ITS-SCU-ID of the SUT for the purpose of conformance testing is within the valid range specified in ISO 24102-4.

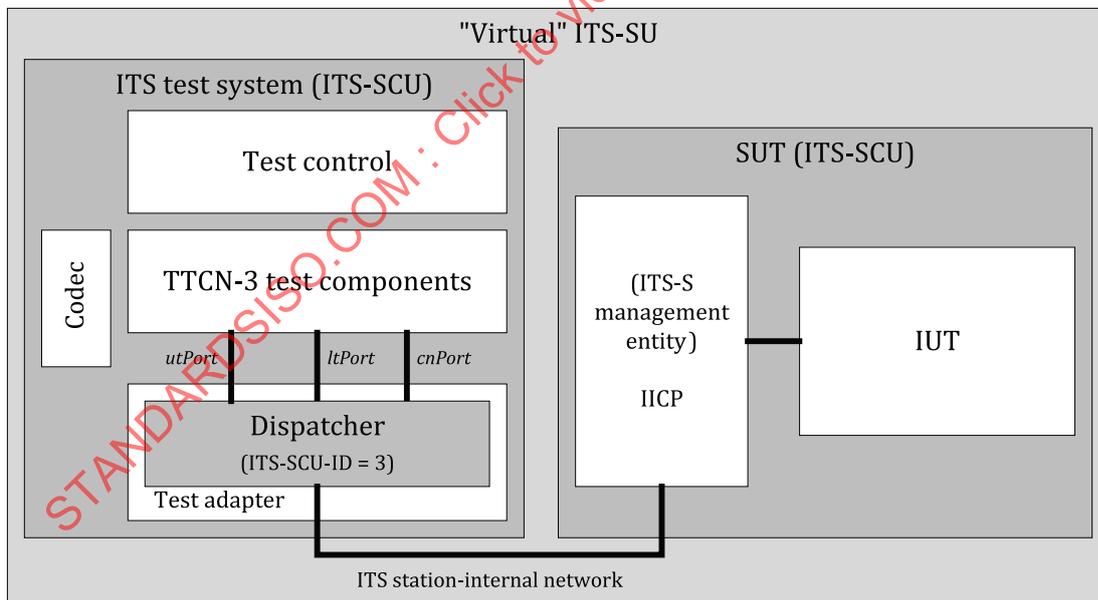


Figure 3 — IICP-based simple conformance test system architecture

The dispatcher in [Figure 3](#) needs to know the actually valid configuration of the ITS-SCU and the IUT in order to properly establish the three links between SUT and ITS test system. Details of the dispatcher are specified in [Clause 10](#).

6.3 IICP test system architecture with test CI

For some conformance tests (e.g. testing of an ITS-S access technology or using an ITS-S access technology as “lower layer” below an IUT), a separate test CI is used as illustrated in [Figure 4](#). This test CI constitutes a third ITS-SCU of the “virtual” test ITS-SU. The ITS-SCU-ID of the test CI has the value 4 as specified in ISO 24102-4.

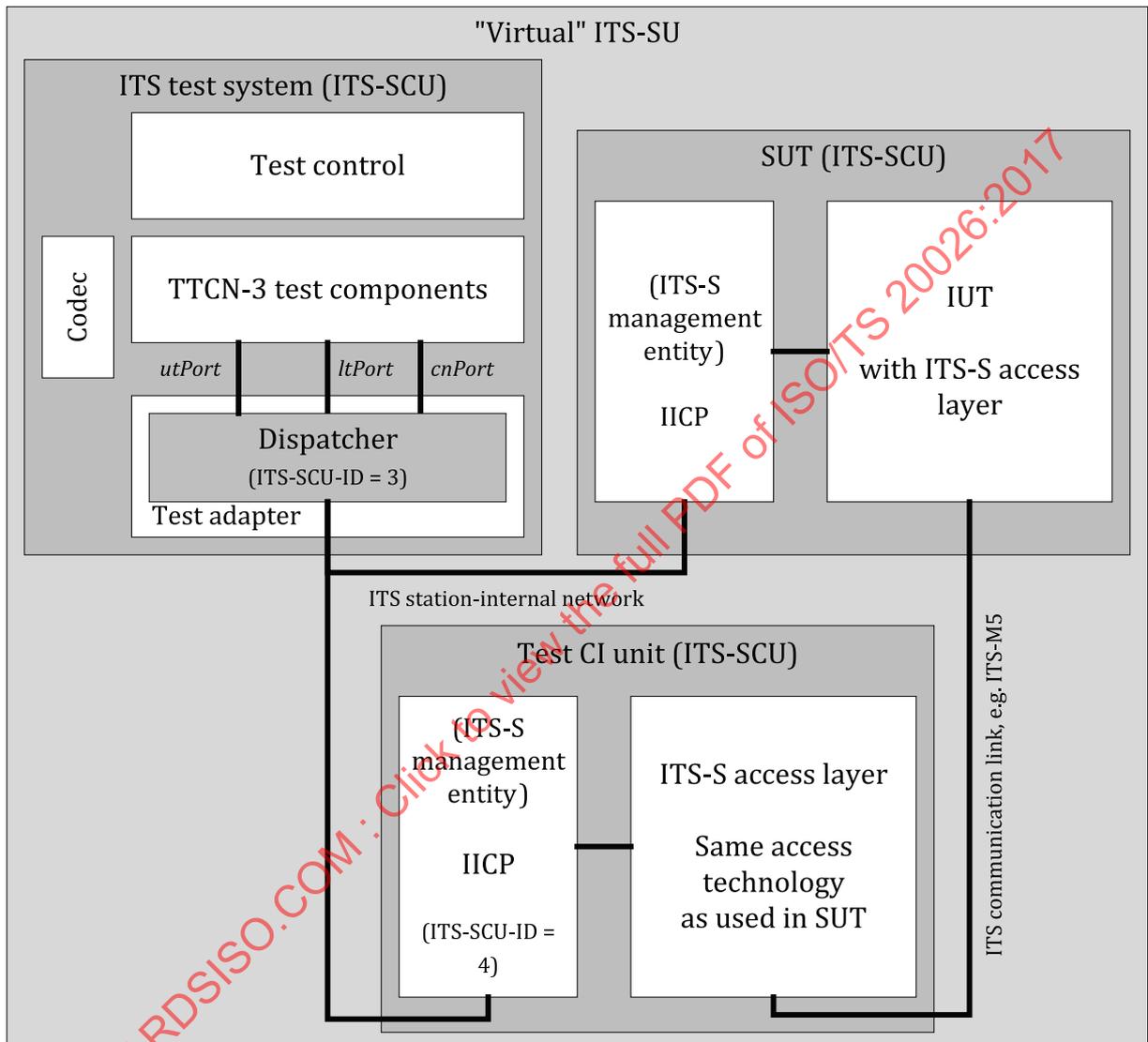


Figure 4 — IICP-based conformance test system architecture with test CI

The *ltPort* connects to the test CI using IICP. The test CI connects to the IUT using the respective ITS communication link. Thus, the test CI just performs a conversion between the ITS-S access layer stream and the ITS-ASDU of the IN-SAP (see ISO 21217:2014, Figure 12). The test CI is considered to be a “golden device” that does not introduce any errors that could lead to a wrong result in conformance testing.

The dispatcher in [Figure 4](#) needs to know the actual valid configuration in order to properly establish the three links between the SUT and ITS test system. By detecting ITS-SCU-ID=4, the dispatcher knows that a test CI is involved.

6.4 IICP reference architecture

The IICP reference architecture specified in ISO 24102-4 is illustrated in [Figure 5](#).

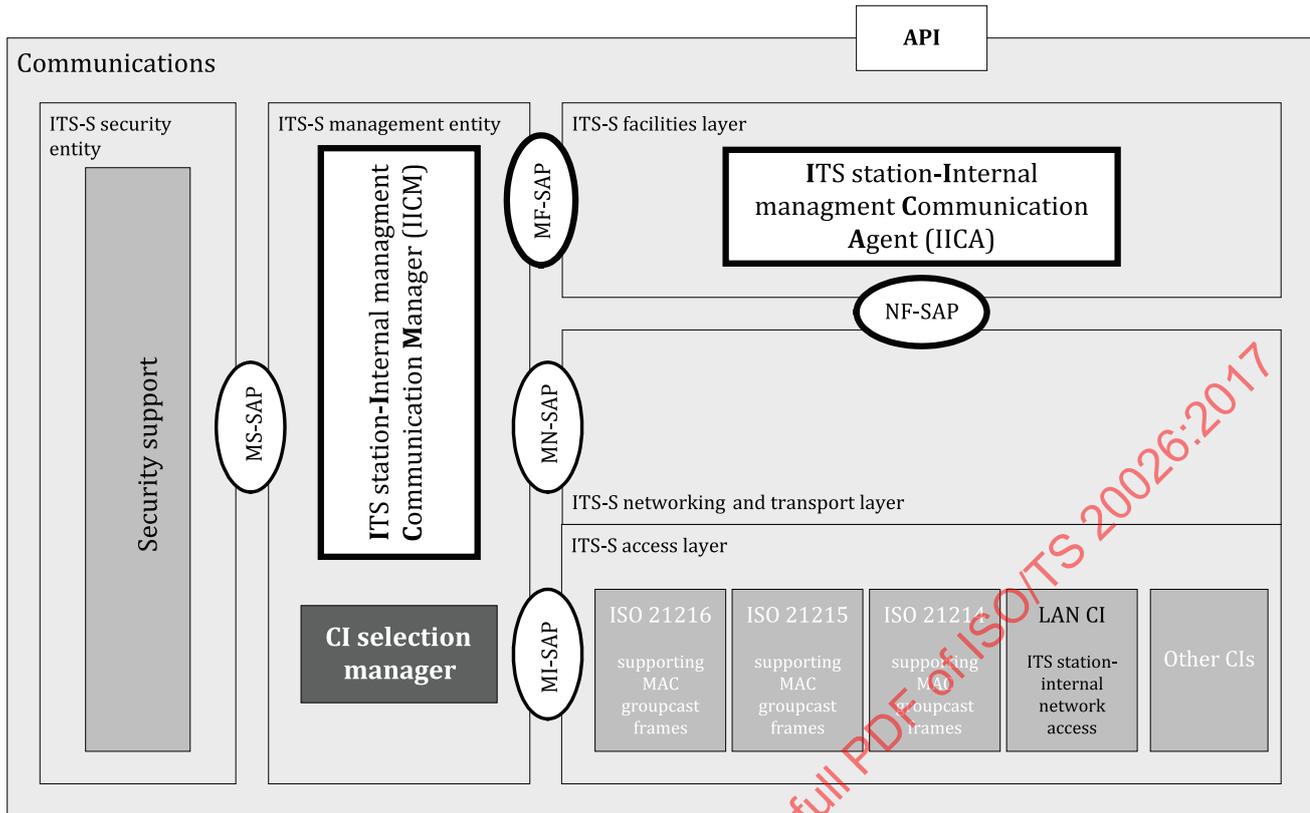


Figure 5 — IICP reference architecture

The IICP essentially is performed in the IICM presented in Figure 5. The IICA just performs forwarding of IICP PDUs between the MF-SAP and the NF-SAP. IICA uses a link between the SUT and the ITS test system, e.g. UDP/IP with dynamically assigned UDP port numbers or FNETP with the ITS port number PORT_IIC = 32764 specified in ISO 24102-4.

IICP, in general, provides four different groups of functions as specified in ISO 24102-4:

- a) simulation of a communication SAP (IN-SAP, NF-SAP, FA-SAP) in a management SAP for upper and lower tester access;
- b) remote access to a management SAP (MX-SAP):
 - MA-SAP: for an IUT in the ITS-S applications entity;
 - MF-SAP: for an IUT in the ITS-S facilities layer;
 - MN-SAP: for an IUT in the ITS-S networking and transport layer;
 - MI-SAP: for an IUT in the ITS-S access layer;
 - MS-SAP: for an IUT in the ITS-S security entity;
- c) general commands to be executed in a remote ITS-S management entity;
- d) IICP-internal commands used to maintain IICP.

Two types of IICP messages to be exchanged between ITS-S management entities of ITS-SCUs are defined in ISO 24102-4, i.e. IIC-Request and IIC-Response. IICP messages are exchanged between the dispatcher in the test adapter and the ITS-S management entities in the SUT and the test CI via the station-internal network of the “virtual” ITS-SU constituted by the two or three ITS-SCUs, i.e. the ITS test system, the SUT and optionally, the test CI as illustrated in Figures 3 and 4.

Each IIC-Request containing a payload to be used for testing shall be acknowledged with an empty IIC-Response, thus IIC-Responses are not visible to the TTCN-3 test system, but are completely managed inside the dispatcher. The payloads of IIC-Requests are MX-SAP functions presented in [Table 4](#) (*utPort*), [Table 5](#) (*ltPort*) and [Table 6](#) (*cnPort*). These functions perform remote SAP access on MX-SAPs and remote requests to perform actions inside an ITS-S management entity. Only the payload part presenting the content of such a remote request is either produced in the TTCN-3 test system or consumed there. Thus, the dispatcher in the test adapter performs packing and unpacking of remote requests for the three TTCN-3 ports.

As in some tests, e.g. the testing of IICP, exchange of IIC-Requests and IIC-Responses may be part of the protocol to be tested, a capability is needed to distinguish between IIC-Requests and IIC-Responses used to exchange test information and IIC-Requests and IIC-Responses being part of the IUT behaviour. This distinction is done by means of the IICP address, ITS-SCU-ID contained in the SourceITS-SCU-ID and DestinationITS-SCU-ID fields of these messages. The unique address of the ITS test system ITS-SCU is ITS-SCU-ID = 3 as specified in ISO 24102-4. The unique address ITS-SCU-ID of the SUT is in the range of 8 through 66 534 and may be selected by different means, e.g. using the initialisation procedure of IICP specified in ISO 24102-4 or by static settings. In case IIC-Requests and IIC-Responses are part of the IUT protocol, then a second set of ITS-SCU-IDs is needed; one value to be used in the TTCN-3 test system and another value used in the SUT to serve the needs of the IUT.

7 IICP usage for conformance testing

7.1 General

The following subclauses specify details of IICP to perform conformance testing, e.g. by “simulation” of communication SAPs and by remote execution of management and security commands.

7.2 IUT in an ITS-S communications layer

7.2.1 ITS-S access layer

For an IUT in the ITS-S access layer, the IICP test architecture presented in [Figure 4](#) applies.

IN-SAP test access shall be performed as illustrated in [Figure 6](#) using the IICP command:

- SimIUTcmd:
 - upper tester access from ITS test system (*utPort*) to SUT (MI-SAP)
 - lower tester access from ITS test system (*ltPort*) to Test CI (MI-SAP)
- SimIUTreq:
 - upper tester access from SUT (MI-SAP) to ITS test system (*utPort*)
 - lower tester access from Test CI (MI-SAP) to ITS test system (*ltPort*)

specified in ISO 24102-4 with

- SimIUTcmd ::= INsapPrimitivesDown,
- SimIUTreq ::= INsapPrimitivesUp

specified in ISO 24102-3.

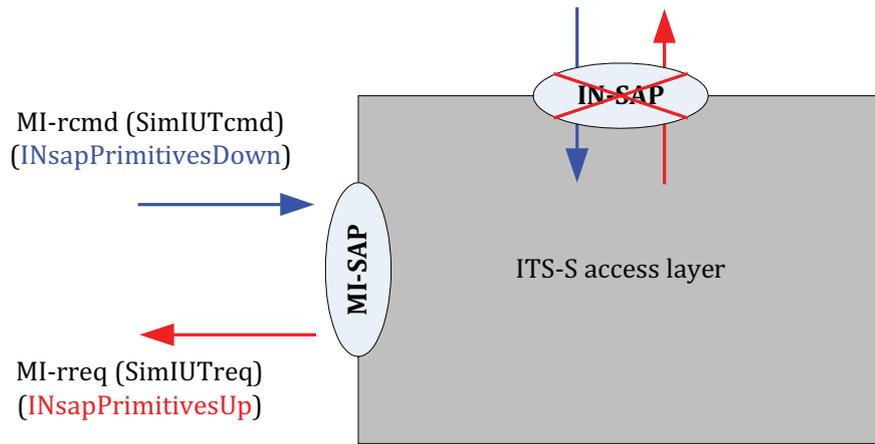


Figure 6 — IN-SAP simulation for IUT in ITS-S access layer

In addition to using these service primitives, the SUT shall be set to a test mode such that the IN-SAP is disabled and replaced by the simulated access via the MI-SAP. This setting shall be activated using IICP as specified in Annex A.

In order to perform settings in the IUT and to receive notifications of events from the IUT (*cnPort*), remote access to the MI-SAP specified in ISO 24102-4 shall be used:

- IICP MI-rcmd: sent from test adapter (*cnPort*) to perform an initial setting in the IUT;
- IICP MI-rreq: to receive a notification from the IUT that is forwarded from the test adapter to the *cnPort*;
- IICP MI-rget: sent from test adapter (*cnPort*) to retrieve an I-Parameter value from the IUT. The requested value is returned in a separate IIC-Request;
- IICP MI-rset: sent from test adapter (*cnPort*) to set an I-Parameter value in the IUT. The acknowledgement of the set command is returned in a separate IIC-Request.

7.2.2 ITS-S networking and transport layer

For an IUT in the ITS-S networking and transport layer, the lower layers link of Figure 1 may end up directly at the IUT such that no ITS lower layers block is to be considered (test architecture presented in Figure 3 applies) or at the ITS lower layers block (test architecture presented in Figure 4 applies). In case no ITS-S access layer is used (lower layers block), the IN-SAP shall be disabled using IICP as specified in Annex A and the access to the IN-SAP shall be performed as illustrated in Figure 7 using the IICP remote access to the MN-SAP:

- SimNLTcmd: lower tester access from ITS test system (*ltPort*) to SUT (MN-SAP)
- SimNLTreq: lower tester access from SUT (MN-SAP) to ITS test system (*ltPort*)

specified in ISO 24102-4 with

- SimNLTcmd ::= INsapPrimitivesUp,
- SimNLTreq ::= INsapPrimitivesDown

specified in ISO 24102-3.

NF-SAP test access shall be performed as illustrated in Figure 7 using the IICP command:

- SimNUTcmd: upper tester access from ITS Test System (*utPort*) to SUT (MN-SAP)

- SimNUTreq: upper tester access from SUT (MN-SAP) to ITS Test System (*utPort*)

specified in ISO 24102-4 with

- SimNUTcmd ::= NFsapPrimitivesDown,
- SimNUTreq ::= NFsapPrimitivesUp

specified in ISO 24102-3.

In addition to using these service primitives, the SUT shall be set to a test mode such that the NF-SAP is disabled and replaced by the simulated access via the MN-SAP. This setting shall be activated using IICP as specified in [Annex A](#).

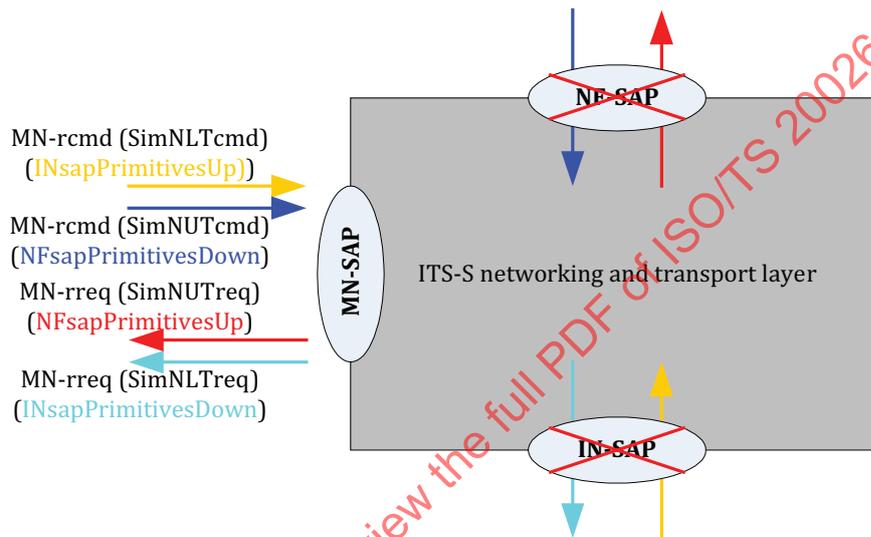


Figure 7 — IN-SAP and NF-SAP simulation for IUT in ITS-S networking and transport layer

In order to perform settings in the IUT and to receive notifications of events from the IUT, remote access to the MN-SAP specified in ISO 24102-4 shall be used:

- IICP MN-rcmd: sent from test adapter (*cnPort*) to perform an initial setting in the IUT;
- IICP MN-rreq: to receive a notification from the IUT that is forwarded from the test adapter to the *cnPort*.

7.2.3 ITS-S facilities layer

For an IUT in the ITS-S facilities layer, the lower layers link of [Figure 1](#) may end up directly at the IUT such that no ITS lower layers block is to be considered (test architecture presented in [Figure 3](#) applies) or at the ITS lower layers block (test architecture presented in [Figure 4](#) applies). In case no ITS-S networking and transport layer and no ITS-S access layer are used (lower layers block), the NF-SAP shall be disabled using IICP as specified in [Annex A](#) and the access to the NF-SAP shall be performed as illustrated in [Figure 8](#) using the IICP remote access to the MF-SAP:

- SimFLTcmd: lower tester access from ITS test system (*ltPort*) to SUT (MF-SAP)
- SimFLTTreq: lower tester access from SUT (MF-SAP) to ITS test system (*ltPort*)

specified in ISO 24102-4 with

- SimFLTcmd ::= NFsapPrimitivesUp,
- SimFLTTreq ::= NFsapPrimitivesDown

specified in ISO 24102-3.

FA-SAP test access shall be performed as illustrated in Figure 8 using the IICP command:

- SimFUTcmd: upper tester access from ITS test system (*utPort*) to SUT (MF-SAP)
- SimFUTreq: upper tester access from SUT (MF-SAP) to ITS test system (*utPort*)

specified in ISO 24102-4 with

- SimFUTcmd ::= FAsapPrimitivesDown,
- SimFUTreq ::= FAsapPrimitivesUp

specified in ISO 24102-3.

In addition to using these service primitives, the SUT shall be set to a test mode such that the FA-SAP is disabled and replaced by the simulated access via the MF-SAP. This setting shall be activated using IICP as specified in Annex A.

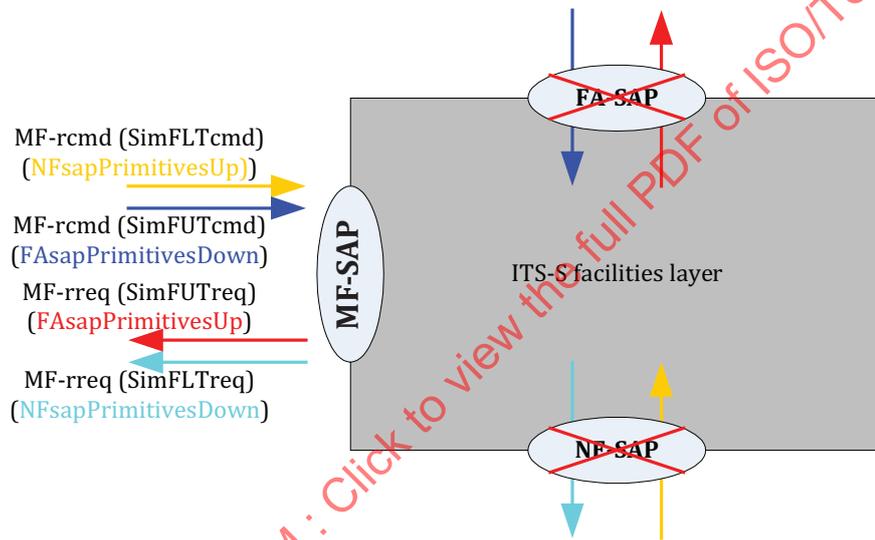


Figure 8 — NF-SAP and FA-SAP simulation for IUT in ITS-S facilities layer

In order to perform settings in the IUT and to receive notifications of events from the IUT, remote access to the MF-SAP specified in ISO 24102-4 shall be used:

- IICP MF-rcmd: sent from test adapter (*cnPort*) to perform an initial setting in the IUT;
- IICP MF-rreq: to receive a notification from the IUT that is forwarded from the test adapter to the *cnPort*.

7.3 IUT in the ITS-S management entity

This will be provided in a future edition of this document.

7.4 IUT in the ITS-S security entity

This will be provided in a future edition of this document.

8 Setting to test mode

Operating the SUT in test mode requires the following information:

- a) location of the IUT, which defines the interface(s) of the IUT for upper (/lower) tester access:
 - ITS-S access layer: upper tester access is via IN-SAP;
 - ITS-S networking and transport layer: upper/lower tester access is via NF-SAP;
 - ITS-S facilities layer: upper/lower tester access is via FA-SAP;
 - ITS-S management entity: upper/lower tester access is via MX-SAPs;
 - ITS-S security entity (not supported in this document);
 - ITS-S application entity (not supported in this document);
- b) lower tester access:
 - usage of lower layers (below the IUT).

NOTE 1 For simplicity, it is assumed that in case lower layers are used to test an IUT, a whole protocol stack below the IUT, including a communication interface is used for testing.

Upper tester access shall always be based on the IICP commands described in the present document. Hence, disregard whether the applicant implemented IICP as an operational protocol for ITS or not.

There may be IUTs which are architecturally located in more than one layer or entity. Either the various issues of the IUT then are tested separately or an appropriate overall test is performed. In any case, the tool to perform settings, as described below, shall be used by the dispatcher to describe the test configuration (upper access and lower access).

The test mode shall be automatically activated by the SUT upon detection of an ITS-SCU with ITS-SCU-ID=3. Test mode settings shall be provided to the SUT with the IICP command TestConfigIICP as specified in ISO 24102-4 and described below.

```
testConfigRq      MCMDREQ ::= {&refMcmd 255, &Mcmd TestConfigIICP}

TestConfigIICP ::= SEQUENCE {
  location      BIT STRING (SIZE(6)),
  reserved     BIT STRING (SIZE(2)) - set to '00'b
}

testConfigRes    MCMDRES ::= {&refMcmd 255, &Mcmd NULL}
```

The above specification of TestConfigIICP requires an update of ISO 24102-4.

Applying unaligned PER, TestConfigIICP is presented in a single octet as illustrated in [Table 1](#).

Table 1 — TestConfigIICP (location of IUT)

Bit position	Meaning
B7	'1'b: IUT is located in the ITS-S access layer. This implies B1 set to '1'b.
B6	'1'b: IUT is located in the ITS-S networking and transport layer.
B5	'1'b: IUT is located in the ITS-S facilities layer.
B4	'1'b: IUT is located in the ITS-S management entity.
B3	'1'b: IUT is located in the ITS-S security entity.

Table 1 (continued)

Bit position	Meaning
B2	'1'b: IUT is located in the ITS-S application entity.
B1	Reserved for future use.
B0	Reserved for future use.

NOTE 2 Details of enabling test mode operation in an implementation are not standardized.

Combinations of values of the bits B7, B6, B5, B4, B3 and B2 presented in [Table 1](#) are valid values as specified in [Table 2](#).

Table 2 — Valid TestConfigIICP values (B2 through B7)

B7	B6	B5	B4	B3	B2	Comment
'1'b	'0'b	'0'b	'0'b	'0'b	'0'b	IUT is implemented in the ITS-S access layer only.
'0'b	'1'b	'0'b	'0'b	'0'b	'0'b	IUT is implemented in the ITS-S networking and transport layer only.
'0'b	'0'b	'1'b	'0'b	'0'b	'0'b	IUT is implemented in the ITS-S facilities layer only.
'0'b	'0'b	'0'b	'0'b	'0'b	'1'b	IUT is implemented in the ITS-S applications entity only.
'1'b	'1'b	'0'b	'0'b	'0'b	'0'b	IUT is implemented in the ITS-S access layer and the ITS-S networking and transport layer.
'0'b	'1'b	'1'b	'0'b	'0'b	'0'b	IUT is implemented in the ITS-S networking and transport layer and in the ITS-S facilities layer.
'0'b	'0'b	'1'b	'0'b	'0'b	'1'b	IUT is implemented in the ITS-S facilities layer and the ITS-S applications entity.
'1'b	'1'b	'1'b	'0'b	'0'b	'0'b	IUT is implemented in the ITS-S access layer and the ITS-S networking and transport layer and in the ITS-S facilities layer.
'0'b	'1'b	'1'b	'0'b	'0'b	'1'b	IUT is implemented in the ITS-S networking and transport layer and in the ITS-S facilities layer and in the ITS-S applications entity.
'1'b	'1'b	'1'b	'0'b	'0'b	'1'b	IUT is implemented in the ITS-S access layer and the ITS-S networking and transport layer and in the ITS-S facilities layer and in the ITS-S applications entity.
'0'b	'0'b	'0'b	'1'b	'0'b	'0'b	IUT is implemented in the ITS-S management entity.
'0'b	'0'b	'0'b	'0'b	'1'b	'0'b	IUT is implemented in the ITS-S security entity.
'0'b	'0'b	'1'b	'1'b	'0'b	'0'b	IUT is implemented in the ITS-S management entity and uses the ITS-S facilities layer. An example is FSAP specified in Reference [4].
'0'b	'1'b	'1'b	'1'b	'0'b	'0'b	IUT is implemented in the ITS-S management entity and uses the ITS-S facilities layer and the ITS-S networking and transport layer. An example is FSAP specified in Reference [4] combined with FNTF, specified in ISO 29281-1[5], however, this is not based on a standardized requirement.
'1'b	'1'b	'1'b	'1'b	'0'b	'0'b	IUT is implemented in the ITS-S management entity and uses the ITS-S facilities layer, the ITS-S networking and transport layer and the ITS-S access layer. An example is FSAP specified in Reference [4] combined with FNTF specified in ISO 29281-1[5] and a 5,9 GHz 802.11 radio specified in ISO 21215[1], however, this is not based on a standard and thus, the test suite might not directly support it. To be discussed.

[Table 3](#) shows how *utPort*, *ltPort* and *cfPort* illustrated in [Figure 3](#) are connected to the IUT for the valid values presented in [Table 1](#).

Table 3 — TestConfigIICP access to IUT

B7	B6	B5	B4	B3	B2	Upper tester	Lower tester	Configuration/ notification
						(IICP reqRef)		
'1'b	'0'b	'0'b	'0'b	'0'b	'0'b	SimIUTcmd (248), SimIUTreq (249)	Not applicable	MI-Command-request (5) MI-Request-request (6) MI-Get-request (7) MI-Set-request (8)
'0'b	'1'b	'0'b	'0'b	'0'b	'0'b	SimNUTcmd (246), SimNUTreq (247)	SimNLTcmd (254), SimNLTreq (255)	MN-Command-request (3) MN-Request-request (4)
'0'b	'0'b	'1'b	'0'b	'0'b	'0'b	SimFUTcmd (244), SimFUTreq (245)	SimFLTcmd (252), SimFLTreq (253)	MF-Command-request (1) MF-Request-request (2)
'0'b	'0'b	'0'b	'0'b	'0'b	'1'b	SimAUTcmd (242), SimAUTreq (243)	SimALTCmd (250), SimALTreq (251)	MA-Command-request (10) MA-Request-request (11)
'1'b	'1'b	'0'b	'0'b	'0'b	'0'b	SimNUTcmd (246), SimNUTreq (247)	Not applicable	MN-Command-request (3) MN-Request-request (4) MI-Command-request (5) MI-Request-request (6) MI-Get-request (7) MI-Set-request (8)
'0'b	'1'b	'1'b	'0'b	'0'b	'0'b	SimFUTcmd (244), SimFUTreq (245)	SimNLTcmd (254), SimNLTreq (255)	MF-Command-request (1) MF-Request-request (2) MN-Command-request (3) MN-Request-request (4)
'0'b	'0'b	'1'b	'0'b	'0'b	'1'b	SimAUTcmd (242), SimAUTreq (243)	SimFLTcmd (252), SimFLTreq (253)	MF-Command-request (1) MF-Request-request (2) MA-Command-request (10) MA-Request-request (11)
'1'b	'1'b	'1'b	'0'b	'0'b	'0'b	SimFUTcmd (244), SimFUTreq (245)	Not applicable	MF-Command-request (1) MF-Request-request (2) MN-Command-request (3) MN-Request-request (4) MI-Command-request (5) MI-Request-request (6) MI-Get-request (7) MI-Set-request (8)
'0'b	'1'b	'1'b	'0'b	'0'b	'1'b	SimAUTcmd (242), SimAUTreq (243)	SimNLTcmd (254), SimNLTreq (255)	MF-Command-request (1) MF-Request-request (2) MN-Command-request (3) MN-Request-request (4) MA-Command-request (10) MA-Request-request (11)

Table 3 (continued)

B7	B6	B5	B4	B3	B2	Upper tester	Lower tester	Configuration/ notification
(IICP reqRef)								
'1'b	'1'b	'1'b	'0'b	'0'b	'1'b	SimAUTcmd (242), SimAUTreq (243)	Not applicable	MF-Command-request (1) MF-Request-request (2) MN-Command-request (3) MN-Request-request (4) MI-Command-request (5) MI-Request-request (6) MI-Get-request (7) MI-Set-request (8) MA-Command-request (10) MA-Request-request (11)
'0'b	'0'b	'0'b	'1'b	'0'b	'0'b	To be defined in a later edition of this document.		
'0'b	'0'b	'0'b	'0'b	'1'b	'0'b	To be defined in a later edition of this document.		
'0'b	'0'b	'1'b	'1'b	'0'b	'0'b	SimFUTcmd (244), SimFUTreq (245) and/or SimAUTcmd (242), SimAUTreq /243)	SimFLTcmd (252), SimFLTreq (253)	—
'0'b	'1'b	'1'b	'1'b	'0'b	'0'b	SimFUTcmd (244), SimFUTreq (245) and/or SimAUTcmd (242), SimAUTreq /243)	SimNLTcmd (254), SimNLTre req (255)	—
'1'b	'1'b	'1'b	'1'b	'0'b	'0'b	SimFUTcmd (244), SimFUTreq (245) and/or SimAUTcmd (242), SimAUTreq /243)	Not applicable	—
Other bit settings						To be defined in a later edition of this document.		

9 Message types and formats

9.1 Unaligned PER

The binary format of messages exchanged between the ITS test system and SUT based on the IICP shall be retrieved from the ASN.1 modules in ISO 24102-4, ISO 24102-3 and related modules from which imports are performed. Unaligned PER encoding shall be applied.

9.2 utPort

Table 4 shows IICP request PDUs which can be selected for upper test access. The choice is performed by the value of the ASN.1 component `reqRef` of the ASN.1 type `PduRequest`.

Table 4 — IICP request PDUs for upper tester access

PduRequest.reqRef	PduRequest.iicpReq	Location of IUT	Direction
242 = 0xF2	SimAUTcmd	ITS-S application entity	From ITS test system to SUT
243 = 0xF3	SimAUTreq		From SUT to ITS test system
244 = 0xF4	SimFUTcmd	ITS-S facilities layer	From ITS test system to SUT
245 = 0xF5	SimFUTreq		From SUT to ITS test system
246 = 0xF6	SimNUTcmd	ITS-S networking and transport layer	From ITS test system to SUT
247 = 0xF7	SimNUTreq		From SUT to ITS test system
248 = 0xF8	SimIUTcmd	ITS-S access layer	From ITS test system to SUT
249 = 0xF9	SimIUTreq		From SUT to ITS test system

The binary format of IIC-Requests, for example, of an IUT residing in the ITS-S networking and transport layer (FNTP specified in ISO 29281-1[5]) is illustrated in B.2 and B.3 (see Annex B).

9.3 ItPort

Table 5 shows IICP request PDUs which can be selected for lower tester access. The choice is performed by value of the ASN.1 component reqRef of the ASN.1 type PduRequest.

Table 5 — IICP request PDUs for lower tester access

PduRequest.reqRef	PduRequest.iicpReq	Location of IUT	Direction
250 = 0xF2	SimALTCmd	ITS-S application entity	From ITS test system to SUT
251 = 0xF3	SimALTreq		From SUT to ITS test system
252 = 0xF4	SimFLTcmd	ITS-S facilities layer	From ITS test system to SUT
253 = 0xF5	SimFLTreq		From SUT to ITS test system
254 = 0xF6	SimNLTCmd	ITS-S networking and transport layer	From ITS test system to SUT
255 = 0xF7	SimNLTreq		From SUT to ITS test system
248 = 0xF8	SimIUTCmd	ITS-S access layer	From ITS test system to test CI
249 = 0xF9	SimIUTreq		From Test CI to ITS test system

The binary format of IIC-Requests, for example, of an IUT residing in the ITS-S networking and transport layer (FNTP specified in ISO 29281-1[5]) is illustrated in B.4 and B.5 (see Annex B).

9.4 cnPort

Table 6 shows IICP request PDUs which can be selected for remote management SAP access. The choice is performed by the value of the ASN.1 component reqRef of the ASN.1 type PduRequest.

Table 6 — IICP request PDUs for management SAP access

PduRequest.reqRef	PduRequest.iicpReq	Location of IUT	Direction
10 = 0x0A	MA-Command-request	ITS-S application entity	From ITS test system to SUT
11 = 0x0B	MA-Request-request		From SUT to ITS test system
1 = 0x01	MF-Command-request	ITS-S facilities layer	From ITS test system to SUT
2 = 0x02	MF-Request-request		From SUT to ITS test system
3 = 0x03	MN-Command-request	ITS-S networking and transport layer	From ITS test system to SUT
4 = 0x04	MN-Request-request		From SUT to ITS test system

Table 6 (continued)

PduRequest.reqRef	PduRequest.iicpReq	Location of IUT	Direction
5 = 0x05	MI-Command-request	ITS-S access layer	From ITS test system to SUT
6 = 0x06	MI-Request-request		From SUT to ITS test system
7 = 0x07	MI-Get-request		From ITS test system to SUT
8 = 0x08	MI-Set-request		From ITS test system to SUT
9 = 0x09	McCmdRq	ITS-S management entity	Bidirectional

The IICP request PDU “McCmdRq” may select different management functions. McCmd is identified by the value of the ASN.1 component mCmdRef of the ASN.1 type McCmdRq as illustrated in [Table 7](#).

Table 7 — IICP request PDUs for remote management entity access

McCmdRq.mCmdRef	McCmdRq.mCmd	Description (from ISO 24102-4)
0 = 0x00	pingReq	Octet string with random data to be replied.
1 = 0x01	vCIinfoRq	Request to all ITS-SCUs containing a router, to report about existing VCIs.
2 = 0x02	vCIupdateRq	Information on change of VCI information to be stored in VCI list.
3 = 0x03	getParam24102Rq	Retrieves the value of a management parameter Param24102 specified in ISO 24102-1.
4 = 0x04	setparam24102Rq	Sets the value of a management parameter Param24102 specified in ISO 24102-1.
255 = 0xFF	testConfigRq	Sets test configuration as specified in Clause 5 .

9.5 IICP management

The only IICP request PDU used for IICP management purposes, i.e. not for test purposes, is the ITS-SCUalive command of which the binary presentation is shown in [Table 8](#). This message shall be managed by the dispatcher without harming the conformance test process.

Table 8 — IICP management request

Octet #	Attribute/Field	Hex presentation	Description
	IIC-Request ::= SEQUENCE {		
0 to 1	sourceITS-scuId ::= INTEGER(0..65535)	0x0000 .. 0xFFFF	SourceITS-SCU-ID = 8 .. 65534
2 to 3	destinationITS-scuId ::= INTEGER(0..65535)	0x0000 .. 0xFFFF	DestinationITS-SCU-ID = 3
4 to 5	pduCounter ::= INTEGER(0..65535)	even value	0, 2, ... 65534
	pduRequest ::= SEQUENCE {		
6	pduRef ::= INTEGER(0..255)	0x00	indicating PduRequest
7	iicpPDU = PduRequest ::= SEQUENCE {	0x04	Length of this CLASS object
8	reqRef ::= INTEGER(0..255)	0x00	0: ITS-SCUalive
9	iicpReq = ITS-SCUalive ::= SEQUENCE {	0x02	Length of this CLASS object
10	message ::= INTEGER(0..255)		0x00: alive 0x01: delete 0xFF: new
11	its-scuType ::= INTEGER(0..255)		0x01: host 0x02: router 0x03: ITS test system 0xFF: any

Table 8 (continued)

Octet #	Attribute/Field	Hex presentation	Description
	} -- iicpReq		
	} -- iicpPDU		
	} -- pduRequest		
12 to 13	secRq ::= OCTET STRING [SIZE(0..65535)]	0x0000	not used
	} -- IIC-Request		

This request PDU is acknowledged with the IICP response PDU presented in [Table 9](#).

Table 9 — IICP management response

Octet #	Attribute/Field	Hex presentation	Description
	IIC-Response ::= SEQUENCE {		
0 to 1	sourceITS-scuId ::= INTEGER(0..65535)	0x0000 .. 0xFFFF	SourceITS-SCU-ID = 8 .. 65534
2 to 3	destinationITS-scuId ::= INTEGER(0..65535)	0x0000 .. 0xFFFF	DestinationITS-SCU-ID = 3
4 to 5	pduCounter ::= INTEGER(0..65535)	request value plus one	1, 3, ... 65535
	pduResponse ::= SEQUENCE {		
6	pduRef ::= INTEGER(0..255)	0x01	indicating PduResponse
7	iicpPDU = PduResponse ::= SEQUENCE {	0x04	Length of this CLASS object
8	reqRef ::= INTEGER(0..255)	0x00	0: ITS-SCUalive
9	iicpReq = ITS-SCUalive ::= SEQUENCE {	0x02	Length of this CLASS object
10	message ::= INTEGER(0..255)		0x00: alive 0x01: delete 0xFF: new
11	its-scuType ::= INTEGER(0..255)		0x01: host 0x02: router 0x03: ITS test system 0xFF: any
	} -- iicpReq		
	} -- iicpPDU		
12	errorStatus ::= INTEGER(0..255)		0x00: success 0x01: pduUnknwon 0x02: duplicateITS-scuId 0x03: invalidAliveMessage 0x04: invalidITSscuType 0xFF: unspecifiedFailure
	} -- pduResponse		
13 to 14	secRs ::= OCTET STRING [SIZE(0..65535)]	0x0000	not used
	} -- IIC-Response		

10 Dispatcher

The dispatcher is presented in [Figures 3](#) and [4](#). The dispatcher performs filtering, multiplexing and demultiplexing of IICP messages and maintains the IICP as specified in ISO 24102-4.

The filter task shall ensure that IICP messages that are not intended for testing are completely managed inside the dispatcher, i.e. are never forwarded to the TTCN-3 test components.

The multiplexing and de-multiplexing tasks shall ensure that

- the test payload of IICP messages from the SUT or the test CI intended for testing is forwarded to the appropriate test port of the TTCN-3 test components, and
- messages coming from the test ports of the TTCN-3 test components are correctly installed as payload in IICP messages and forwarded to the appropriate entity, i.e. either the SUT or the test CI.

The maintenance task shall manage the IICP ITS-SCUalive message as specified in ISO 24102-4.

NOTE Typically, the dispatcher is implemented with Java¹⁾, running on the same Windows²⁾ PC on which the TTCN-3 test tool is executed.

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1) Java is the trademark of a product supplied by Oracle Corporation. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of the product named. Equivalent products may be used if they can be shown to lead to the same results.

2) Windows is the trademark of a product supplied by Microsoft. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of the product named. Equivalent products may be used if they can be shown to lead to the same results.

Annex A (normative)

IICP conformance test

This annex deals with the special considerations needed for testing of IICP, i.e. having IICP as IUT.

As the IICP is a protocol inside the ITS-S management entity without specified interfaces except the MF-SAP interface towards the communications protocol stack, testing of the IICP partly requires an IICP test application which logically resides inside the ITS-S management entity of the SUT.

Access to the upper test application residing in the ITS-S management entity of the SUT uses the following extension of IICP:

```

testIicpRq          MCMREQ:={&refMcmd 254, &Mcmd TestIicp}

-- the below definition of TestIicp using CLASS is a redefinition
and requires an update of ISO 24102-4:2013
IICPtestRef:=INTEGER{
  c-msRcmd      (1),
  c-maRcmd      (2),
  c-mfRcmd      (3),
  c-mnRcmd      (4),
  c-miRcmd      (5)
} (0..255)

IICPTR:=CLASS{
  &cmdRef      IICPtestRef UNIQUE
  &cmd
}

TestIicp:=SEQUENCE{
  commandRef   IICPTR.&cmdRef({IicpTestCmds}),
  command      IICPTR.&cmd({IicpTestCmds}{@commandRef}),

IicpTestCmds IICPTR:={msRcmd | maRcmd | mfRcmd | mnRcmd | miRcmd, ...}

-- request to send MS-Command-request to ITS Test System
msRcmd IICPTR:={&cmdRef c-msRcmd, &cmd MSrcmd}
-- request to send MA-Command-request to ITS Test System
maRcmd IICPTR:={&cmdRef c-maRcmd, &cmd MArcmd}
-- request to send MF-Command-request to ITS Test System
mfRcmd IICPTR:={&cmdRef c-mfRcmd, &cmd MFrcmd}
-- request to send MN-Command-request to ITS Test System
mnRcmd IICPTR:={&cmdRef c-mnRcmd, &cmd MNrcmd}
-- request to send MI-Command-request to ITS Test System
miRcmd IICPTR:={&cmdRef c-miRcmd, &cmd MIrcmd}

MSrcmd:=SEQUENCE{
  destination  ITS-scuId,
  cmd          MS-Command-request
}
MArcmd:=SEQUENCE{
  destination  ITS-scuId,
  cmd          MA-Command-request
}
MFrcmd:=SEQUENCE{
  destination  ITS-scuId,
  cmd          MF-Command-request
}
MNrcmd:=SEQUENCE{
  destination  ITS-scuId,
  cmd          MN-Command-request
}

```

```
MIrcmd ::= SEQUENCE {
    destination ITS-scuId,
    cmd MI-Command-request
}

-- acknowledgement back to the ITS test system
testIicpRs MCMDRES ::= {&refMcmd 254, &Mcmd NULL}
```

In order to test a MX-Command-request sent by the ITS test system to the SUT, den SAP standard ISO 24102-3 specifies a service primitive function (EchoTest) available in all MX-SAPs:

```
-- Test COMMAND (ping) from ITS Test System to SUT
testMF MFSAP-CR ::= {&mxref c-testMF, &MXParam EchoTest}
testMN MNSAP-CR ::= {&mxref c-testMN, &MXParam EchoTest}
testMI MISAP-CR ::= {&mxref c-testMI, &MXParam EchoTest}
testMS MSSAP-CR ::= {&mxref c-testMS, &MXParam EchoTest}
testMA MASAP-CR ::= {&mxref c-testMA, &MXParam EchoTest}
```

```
EchoTest ::= OCTET STRING (SIZE(0..255))
```

These MX-Command-requests are confirmed first as part of the test procedure with an empty MX-Command-confirm acknowledgement (ASN.1 type NULL):

```
-- Acknowledged of COMMAND with a NULL command
testMFConf MFSAP-CC ::= {&mxref c-testMF, &MXParam NullType}
testMNConf MNSAP-CC ::= {&mxref c-testMN, &MXParam NullType}
testMSConf MSSAP-CC ::= {&mxref c-testMS, &MXParam NullType}
testMAConf MASAP-CC ::= {&mxref c-testMA, &MXParam NullType}
```

Every layer and entity confirms the received MX-Command-request in a unique way using an MX-Request-reply, reporting the type of layer/entity and the content contained in the EchoTest:

```
-- Test REQUEST replies from IUT
testMFecho MFSAP-RR ::= {&mxref c-testMFecho, &MXParam TestMFecho}
testMNecho MNSAP-RR ::= {&mxref c-testMNecho, &MXParam TestMNecho}
testMIecho MISAP-RR ::= {&mxref c-testMIecho, &MXParam TestMIecho}
testMSecho MSSAP-RR ::= {&mxref c-testMSecho, &MXParam TestMSecho}
testMAecho MASAP-RR ::= {&mxref c-testMAecho, &MXParam TestMAecho}

TestMFecho ::= SEQUENCE {
    sap INTEGER {f (70)} (0..255), -- indicating MF-SAP
    info EchoTest
}

TestMNecho ::= SEQUENCE {
    sap INTEGER {n (78)} (0..255), -- indicating MN-SAP
    info EchoTest
}

TestMIecho ::= SEQUENCE {
    sap INTEGER {i (73)} (0..255), -- indicating MI-SAP
    info EchoTest
}

TestMSecho ::= SEQUENCE {
    sap INTEGER {s (83)} (0..255), -- indicating MS-SAP
    info EchoTest
}

TestMAecho ::= SEQUENCE {
    sap INTEGER {a (65)} (0..255), -- indicating MA-SAP
    info EchoTest
}
```

These MX-Request-requests are confirmed with an empty MX-Request-confirm acknowledgement (ASN.1 type NULL):

```
-- Acknowledgement of REQUEST with a NULL command
testMFechoConf  MFSAP-RC:={&mxref c-testMFecho, &MXParam NullType}
testMNechoConf  MNSAP-RC:={&mxref c-testMNecho, &MXParam NullType}
testMSechoConf  MSSAP-RC:={&mxref c-testMSecho, &MXParam NullType}
testMAechoConf  MASAP-RC:={&mxref c-testMAecho, &MXParam NullType}
```

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