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**Intelligent Transport Systems (ITS);**
**Architecture of conformance validation framework**

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# Contents

Intellectual Property Rights ..... 6
Foreword ..... 6
Modal verbs terminology ..... 6
Introduction ..... 6
1 Scope ..... 7
2 References ..... 7
2.1 Normative references ..... 7
2.2 Informative references ..... 7
3 Abbreviations ..... 8
4 Test platform overview ..... 9
4.1 Constraints and requirements ..... 9
4.2 General architecture ..... 9
5 Hardware equipment ..... 10
5.1 PC ..... 10
5.2 G5 adapter box ..... 11
6 Codecs ..... 11
6.1 Introduction ..... 11
6.2 Advanced details of implementation ..... 11
7 Test Adapter ..... 13
7.1 Introduction ..... 13
7.2 Lower Tester ..... 14
7.2.1 Overview ..... 14
7.2.2 Advanced details of implementation ..... 16
7.2.3 Extensibility of the test adapter ..... 18
7.2.4 Adapter Control primitives ..... 18
7.2.5 Adapter configuration parameters ..... 18
7.3 Platform Adapter ..... 20
7.4 Upper Tester ..... 20
**Annex A: Codecs Source Code ..... 22**
**Annex B: Test Adapter Source Code ..... 23**
**Annex C: Upper Tester Message Format ..... 24**
C.1 Introduction ..... 24
C.2 Common Upper Tester Primitives ..... 24
C.2.1 UtInitialize ..... 24
C.2.2 ChangePosition ..... 25
C.2.3 ChangePseudonym ..... 26
C.3 CAM Upper Tester Primitives ..... 26
C.3.1 ChangeCurvature ..... 26
C.3.2 ChangeSpeed ..... 27
C.3.3 SetAccelerationControlStatus ..... 27
C.3.4 SetExteriorLightsStatus ..... 29
C.3.5 ChangeHeading ..... 29
C.3.6 SetDriveDirection ..... 30
C.3.7 ChangeYawRate ..... 30
C.3.8 CamEventIndication ..... 31
C.3.9 SetStationType ..... 31
C.3.10 SetVehicleRole ..... 32
C.3.11 SetEmbarkationStatus ..... 32

C.3.12 SetPtActivation....33
C.3.13 SetDangerousGoods....33
C.3.14 SetLightBarSiren....34

C.4 DENM Upper Tester Primitives....35
C.4.1 GenerateDenmEvent....35
C.4.2 UpdateDenmEvent....37
C.4.3 TerminateDenmEvent....38
C.4.4 DenmEventIndication....38

C.5 GeoNetworking Upper Tester Primitives....39
C.5.1 GenerateGeoUnicast....39
C.5.2 GenerateGeoBroadcast....39
C.5.3 GenerateGeoAnycast....40
C.5.4 GenerateSHB....41
C.5.5 GenerateTSB....41
C.5.6 GnEventIndication....42

C.6 IPv6OverGeoNetworking Upper Tester Primitives....42
C.6.1 SendIPv6Message....42
C.6.2 GetInterfaceInfos....43
C.6.3 Gn6EventIndication....43

C.7 BTP Upper Tester Primitives....44
C.7.1 GenerateBtpA....44
C.7.2 GenerateBtpB....44
C.7.3 BtpEventIndication....45

C.8 MAP SPAT Upper Tester Primitives....45
C.8.1 UtMapSpatTrigger....45
C.8.2 UtMapEventInd....46
C.8.3 UtSpatEventInd....46

**Annex D: Example of Test Platform implementation....47**

**Annex E: Complete Test Adapter class diagram....52**

**Annex F: Bibliography....53**

History....54

# List of figures

Figure 1: General architecture ..... 10
Figure 2: Communication via G5 adaptation box ..... 11
Figure 3: Communication via Ethernet ..... 11
Figure 4: Codec class diagram ..... 13
Figure 5: Message sending sequence diagram ..... 15
Figure 6: Message reception sequence diagram ..... 15
Figure 7: Test Adapter class diagram ..... 16
Figure 8: Port initialization sequence diagram ..... 17
Figure 9: Upper Tester architecture ..... 21
Figure E.1: Test adapter complete class diagram ..... 52

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# Foreword

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

# Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

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# Introduction

In response to EC mandate M/453 [i.10], ETSI Technical Committee (TC) ITS has standardized base and test specifications for ITS protocols. In a next step a prototype TTCN-3 test system was built and validated. The present document describes the design and validation of the prototype TTCN-3 test system.

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

- Making available validated and standardized test specifications and thus enabling the application of reliable certification schemes.
- Executing conformance validation framework against real Implementations Under Test (IUTs) from industry and thus providing these companies a conformance assessment of their implementations. During the lifetime of this action, the conformance validation framework was as well provided at ITS Cooperative Mobility Services Interoperability events.
- Releasing all software as open source and thus allowing industry to build and run their own conformance validation framework.

# 1 Scope

The present document provides a description of the architecture of the ITS conformance 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 conformance validation framework.

The ITS conformance validation framework integrates the test suites ETSI TS 102 871-3 [i.4], ETSI TS 102 868-3 [i.5], ETSI TS 102 869-3 [i.6], ETSI TS 102 870-3 [i.7], ETSI TS 102 859-3 [i.8] and ETSI TS 103 191-3 [i.9].

# 2 References

## 2.1 Normative 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 reference document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at http://docbox.etsi.org/Reference.

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The following referenced documents are necessary for the application of the present document.

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## 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 reference 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 102 871-3 (V.1.3.1): "Intelligent Transport Systems (ITS); Testing; Conformance test specifications for GeoNetworking ITS-G5; Part 3: Abstract Test Suite (ATS) and Protocol Implementation eXtra Information for Testing (PIXIT)".

[i.5] ETSI TS 102 868-3 (V.1.3.1): "Intelligent Transport Systems (ITS); Testing; Conformance test specifications for Cooperative Awareness Basic Service (CA); Part 3: Abstract Test Suite (ATS) and Protocol Implementation eXtra Information for Testing (PIXIT)".

[i.6] ETSI TS 102 869-3 (V.1.4.1): "Intelligent Transport Systems (ITS); Testing; Conformance test specifications for Decentralized Environmental Notification Basic Service (DEN); Part 3: Abstract Test Suite (ATS) and Protocol Implementation eXtra Information for Testing (PIXIT)".

[i.7] ETSI TS 102 870-3 (V.1.1.1): "Intelligent Transport Systems (ITS); Testing; Conformance test specifications for Geonetworking Basic Transport Protocol (BTP); Part 3: Abstract Test Suite (ATS) and Protocol Implementation eXtra Information for Testing (PIXIT)".

[i.8] ETSI TS 102 859-3 (V.1.2.1): "Intelligent Transport Systems (ITS); Testing; Conformance test specifications for Transmission of IP packets over Geonetworking; Part 3: Abstract Test Suite (ATS) and Protocol Implementation eXtra Information for Testing (PIXIT)".

[i.9] ETSI TS 103 191-3 (V.1.1.1): "Intelligent Transport Systems (ITS); Testing; Conformance test specifications for Signal Phase And Timing (SPAT) and Map (MAP); Part 3: Abstract Test Suite (ATS) and Implementation eXtra Information for Testing (IXIT)".

[i.10] 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:

| | |
|---|---|
| AC | Adapter Control |
| ACC | Adaptive Cruise Control |
| API | Application Programming Interface |
| ASN | Abstract Syntax Notation |
| AT | Authorization Ticket |
| ATS | Abstract Test Suite |
| BTP | Basic Transport Protocol |
| BTP-A | Basic Transport Protocol - Type A |
| BTP-B | Basic Transport Protocol - Type B |
| CAM | Cooperative Awareness Message |
| CC | Cruise Control |
| DENM | Decentralized Environmental Notification Message |
| EC | European Commission |
| ETH | ETHernet |
| GN | GeoNetworking |
| HB | High Beam |
| IP | Internet Protocol |
| ITS | Intelligent Transportation Systems |
| ITS-S | Intelligent Transportation Systems - Station |
| IUT | Implementation Under Test |
| JDK | Java™ Development Kit |
| LB | Low Beam |
| LS | Location Service |
| LT | Left Turn |
| MAC | Media Access Control |
| MAP | MapData |
| MTC | Main Test Component |
| OS | Operating System |
| OSI | Open Systems Interconnection model |
| PC | Personal Computer |
| Pcap | Packet capture |
| PDU | Protocol Data Unit |
| PICS | Protocol Implementation Conformance Statement |
| RT | Right Turn |
| SHB | Single Hop Broadcast |
| SPAT | Signal Phase And Timing |
| SUT | System Under Test |
| TA | Test Adapter |
| TC | Test Cases |
| TCI | TTCN-3 Control Interface |
| TP | Test Purposes |

| | |
|---|---|
| TRI | TTCN-3 Runtime Interface |
| TSB | Topology Scoped Broadcast |
| TTCN-3 | Testing and Test Control Notation 3 |
| UDP | User Datagram Protocol |
| UT | Upper Tester |
| XP | Windows™ XP operating system |

# 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 equipments 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 (ETSI EG 201 015 [i.2]);
- to be independent of the platform used to implement the test system;
- 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 order to ensure independence of hardware platforms, all software pieces running on the test platform have been implemented using Java™ language, using generic and widely used libraries.

Test tool independence has been achieved by isolating the tool specific interfaces from core functionalities of the platform. Adapting the current platform to a different test tool would only require the implementation of a very simple piece of software mapping tool-specific functions to generic functions defined in this project.

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.

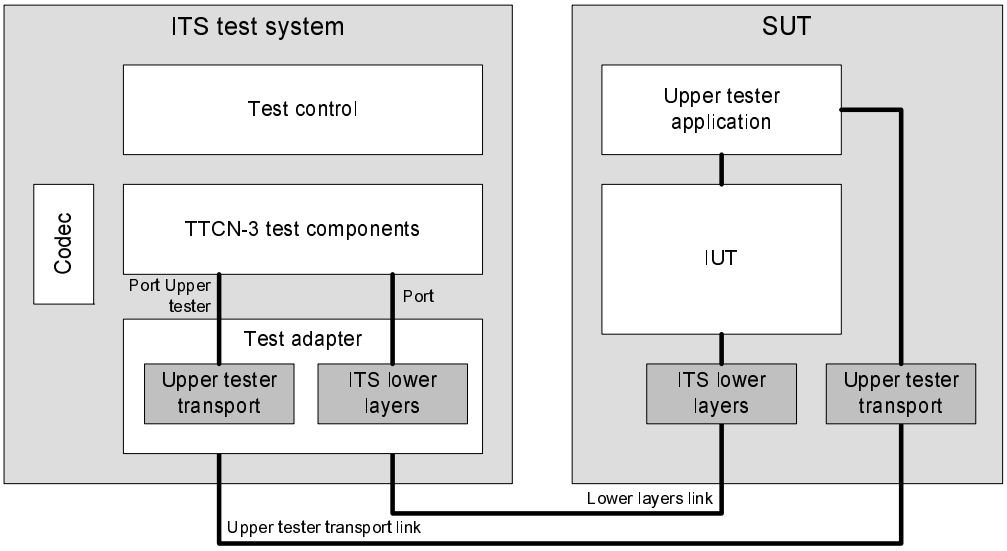



**Figure 1: General architecture**

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.

# 5 Hardware equipment

## 5.1 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 taken into account:

- 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) have 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 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 2 and in figure 3.

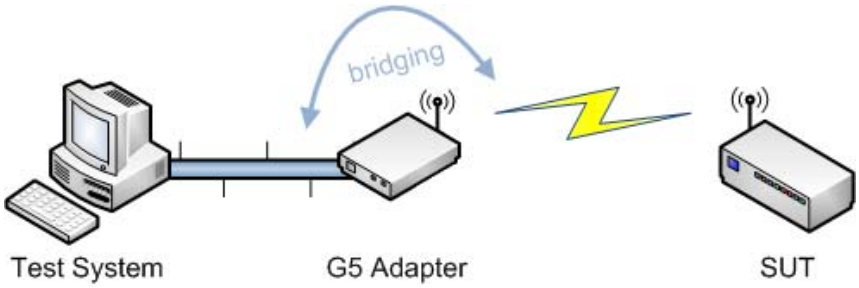



**Figure 2: Communication via G5 adaptation box**

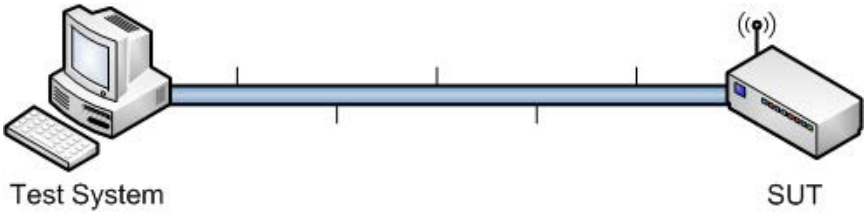



**Figure 3: Communication via Ethernet**

## 5.2 G5 adapter box

The ITS protocol stack makes use of G5 radio protocol in order to establish communication between ITS devices. To achieve G5 connectivity, a dedicated hardware equipment needs to be added to the test platform. The role of this adaptation box is to handle all radio-related tasks transparently and to act as a bridge for the test system.

Cohda Wireless™ MK2 has been chosen to fulfil this task. This device is fully IEEE 802.11p [i.3] compliant and provides as well an Ethernet interface so that it can be used as a transparent bridge between the test system and the SUT, as depicted in figure 2.

To transfer frames received on the Ethernet interface to the radio interface and vice versa, it is necessary to install and execute a small bridge application on the MK2. Only the frame featuring a specific ethertype (0x0707 by default) will be transferred from one interface to the other, so that only desired traffic will cross the bridge.

# 6 Codecs

## 6.1 Introduction

The codec entity is responsible for the encoding and decoding of TTCN-3 abstract values into bitstrings suitable to be sent to the System Under Test (SUT).

In order to simplify implementation and to ease the maintenance, coding and decoding tasks are handled by several codecs:

- One independent codec package per tested protocol;
- One codec package for TTCN-3 types that do not correspond to real protocol messages. It includes for example all auxiliary types used to carry information to/from Test Adapter, like the ones defined in TestSystem modules (CoapInd, CoapReq, etc.);
- One generic codec package available for handling default codec operation non related to any specific protocol. Theses codecs will be used if no protocol-specific codec exists for one type.

## 6.2 Advanced details of implementation

Figure 4 gives an overview of the relations between the different Java™ classes implementing the codecs. Connection with the tool-dependent classes is realized through the ITERquired interface and the associated factory class.

Each codec is responsible for correctly encoding and decoding one specific type and implements the ICodec interface.

Selection of correct codec for encoding or decoding a message at runtime is managed by the CodecFactory class, via the getCodec() method. This method will select the appropriate codec based on three parameters:

- the `type name`;
- the `encoding` as specified in TTCN-3 modules using "with encode" statements;
- the `type class` (record, union, etc.).

The rules for selecting the correct codec are the following:

1) If a codec is registered for `type name` in the package corresponding to `encoding`, then select this codec and call encode() or decode() method;
2) Otherwise, if a codec is registered for `type class` in the package corresponding to `encoding`, then select this codec and call encode() or decode() method;
3) Otherwise, use codec corresponding to `type class` in `generic` package.

This design provides both flexibility and easy extensibility. For most protocols, the "generic" codec package will handle most of the encoding and decoding operations. Specific encoding processes can be handled case by case by adding minimal codecs and registering them in the CodecFactory.

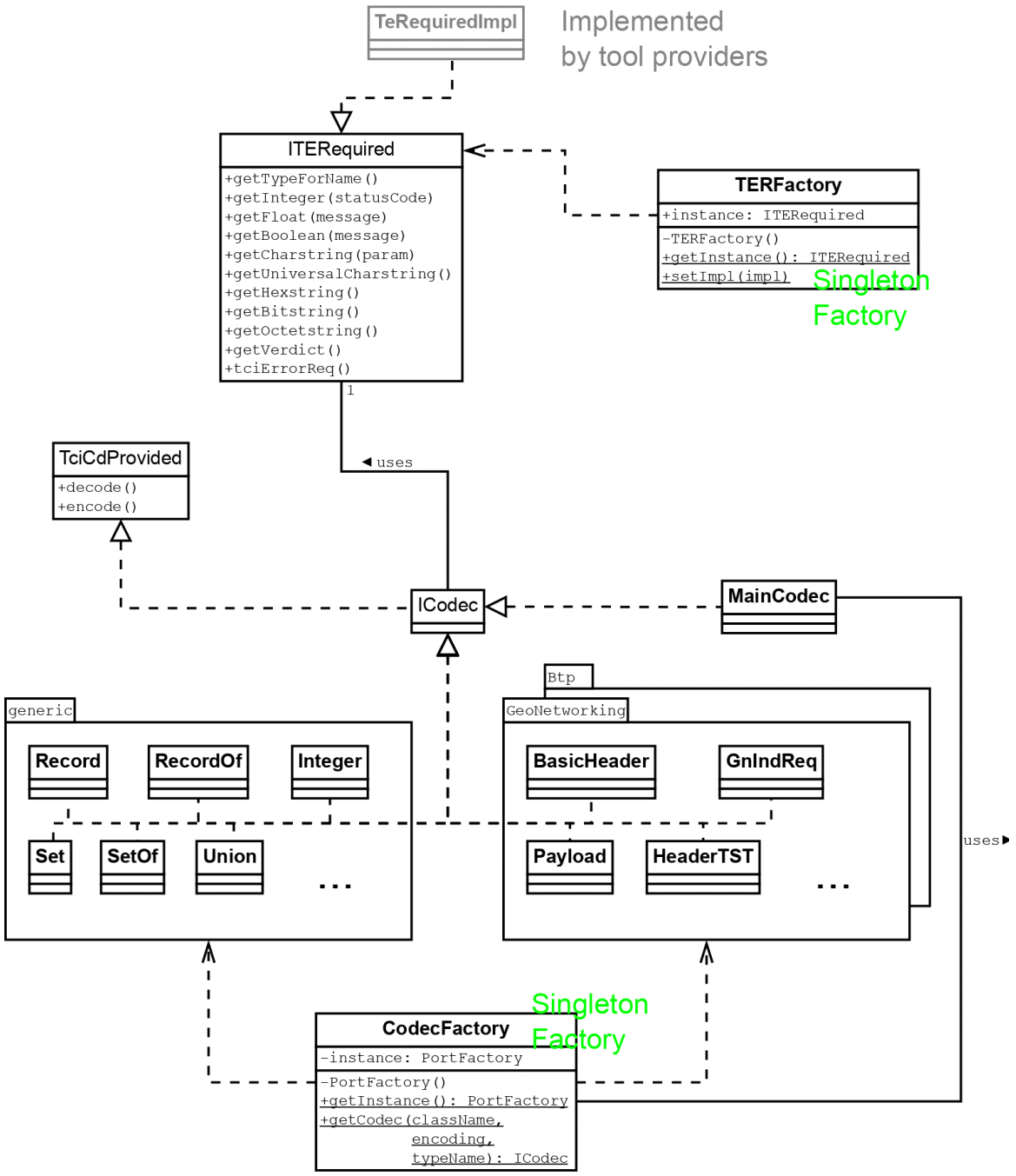



**Figure 4: Codec class diagram**

# 7 Test Adapter

## 7.1 Introduction

The test adapter conceptually splits into three parts:

- a lower test adapter;
- a TTCN-3 platform adapter implementing timers;
- an upper test adapter.

## 7.2 Lower Tester

### 7.2.1 Overview

TTCN-3 test suites are usually focusing on a single protocol layer and designed to be executed against real implementations (IUT). However, it is unusual to find standalone implementations as they are commonly integrated as an internal component of a physical device (SUT).

The purpose of a lower test adapter is to prepare and adapt the protocol messages used by TTCN-3 test suites so that they can be transmitted successfully to the SUT. One way to achieve this goal is for example to implement lower layers and encapsulate protocol messages accordingly. For instance, CAM and DENM messages need to be encapsulated in BTP datagrams, themselves encapsulated into GeoNetworking packets, and transmitted over G5 radio link. The higher up the IUT is located in the OSI stack, the more complex is the test adapter.

TTCN-3 test suites send and receive protocol messages via TTCN-3 communication ports. For each of these ports defined in the test suites, a corresponding port entity needs to be implemented in the test adapter using standardized TRI interface (ETSI ES 201 873-5 [i.1]). To provide maximum flexibility and allow for extensibility, the test adapter ports of the ITS test platform have been designed with the following constraints:

- For each port family, the lower stack can be configured using test adapter parameters (see annex D). As a consequence it is possible to dynamically define what will be the lower layers used to communicate with SUT, and how protocol messages will be encapsulated.
- All the instances of ports are independent.
- Behaviour of ports and lower layers can be dynamically modified by using predefined AC (Adapter Control) primitives directly sent from TTCN-3 script using dedicated port AcPort. For example, the AC primitive 'startBeaconing' requests the test adapter to start sending beacons.

The test adapter implementation mainly features `Port` and `Layer` objects. The relationship and interactions between these objects will be further detailed in clause 7.2.2, but it is important to notice the main differences between these objects, as misunderstanding their roles can lead to confusion:

- `Port` objects are the counterpart of TTCN-3 communication ports.
- `Layer` objects implement the minimal functionalities of a protocol layer and provide facilities for encapsulating or decapsulating packets.
- `Port` objects are configured with a lower stack composed of cascading `Layer` objects.
- For a same protocol layer, `Layer` objects usually implement more functionalities than `Port` objects.

Figures 5 and 6 show an example of interactions between these objects respectively when sending and receiving a message. The port described in this example is a CAM port configured with a BTP/GN/G5 lower stack.

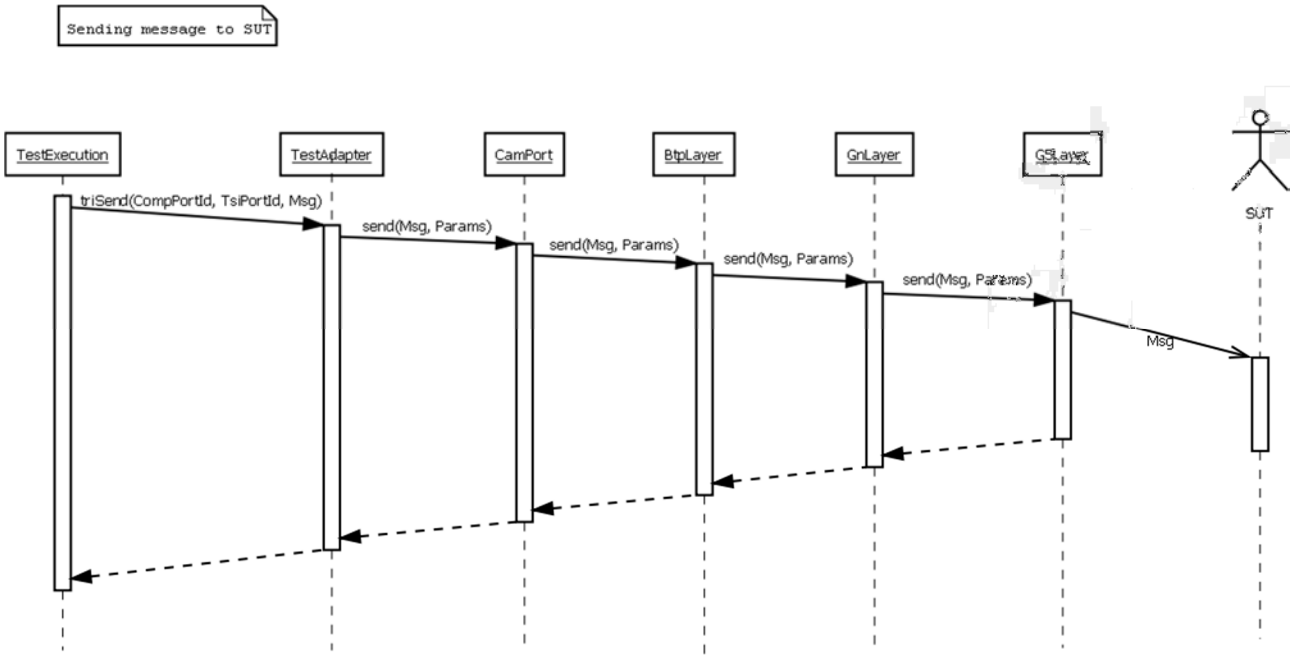



**Figure 5: Message sending sequence diagram**

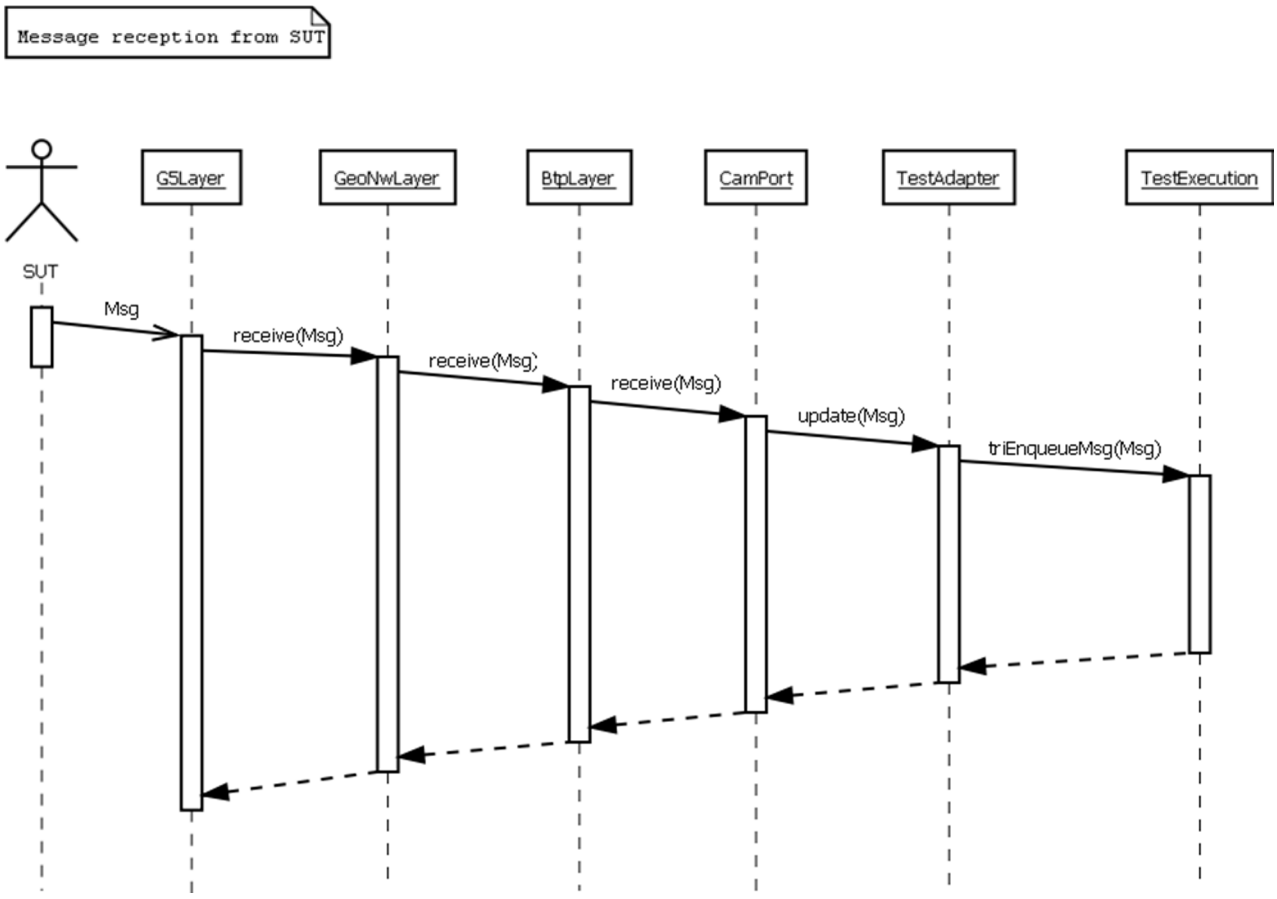



**Figure 6: Message reception sequence diagram**

### 7.2.2 Advanced details of implementation

Figure 7 presents the simplified class diagram of the test adapter. For better readability, auxiliary classes such as factories are not represented. The complete class diagram, also featuring design pattern indications, can be found in annex E.

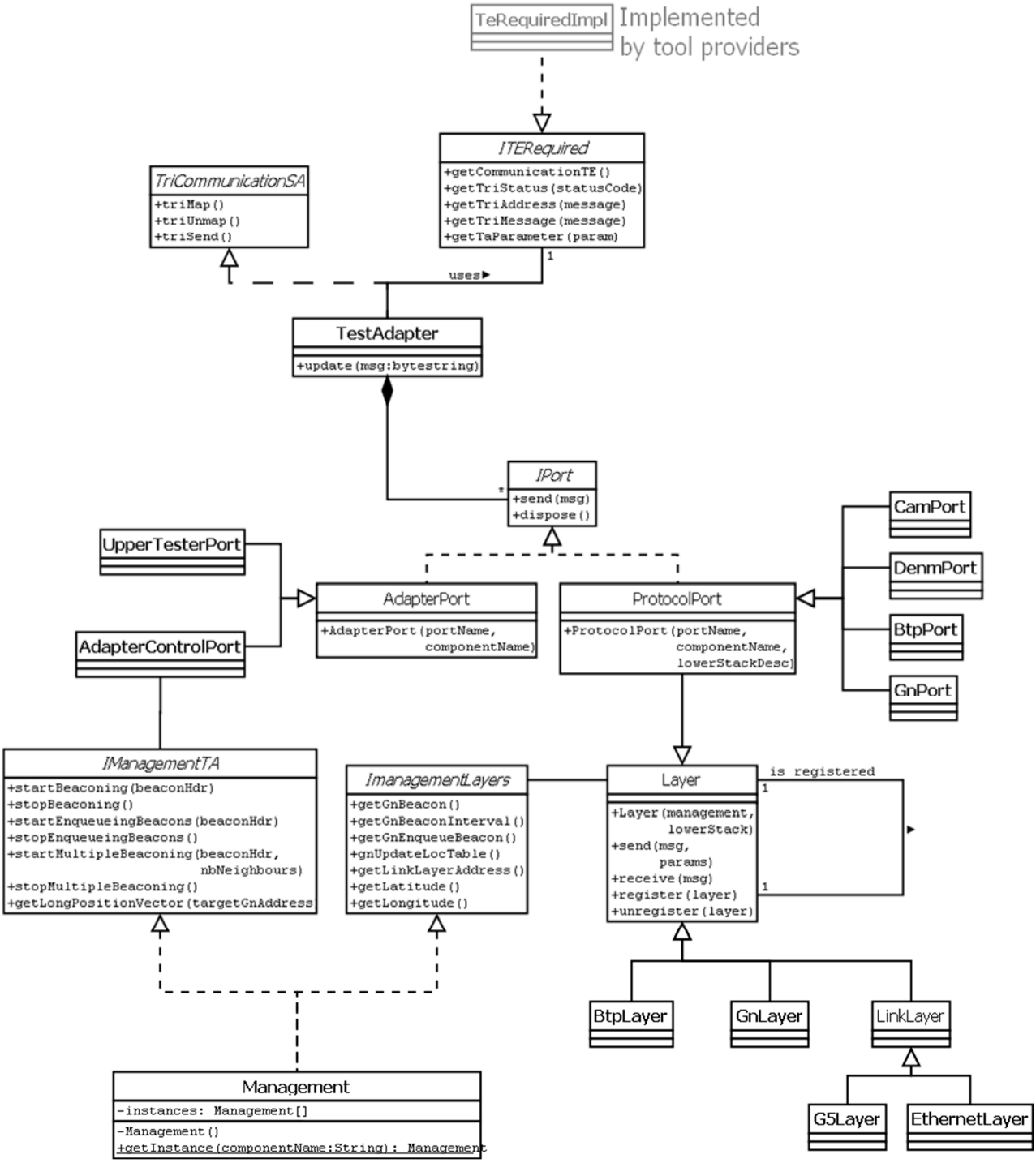



**Figure 7: Test Adapter class diagram**

The main class of this implementation is the `TestAdapter` class. It implements the standardized interface `TriCommunicationSA` and uses the `ITERequired` interface implemented by test tool providers. These interfaces are part of the TRI API defined in ETSI ES 201 873-5 [i.1]. All other classes of this implementation are completely TRI-agnostic. The main purpose of the `TestAdapter` class is to instantiate and manage the different ports.

There are two different kinds of ports:

- Protocol ports realizing communication between TTCN-3 and SUT.
- Adapter ports which are used for test adapter configuration and upper tester communication.

Upon protocol port initialization, lower layers are instantiated in cascade and chained as depicted in figure 8, based on lower stack description. Figure 8 also illustrates the usage of "Factory" design patterns for instantiating `Layer` and `Port` objects. Each `Layer` is responsible for encapsulating and decapsulating packets and transmitting result to lower and upper layer using `send()`/`receive()` methods.

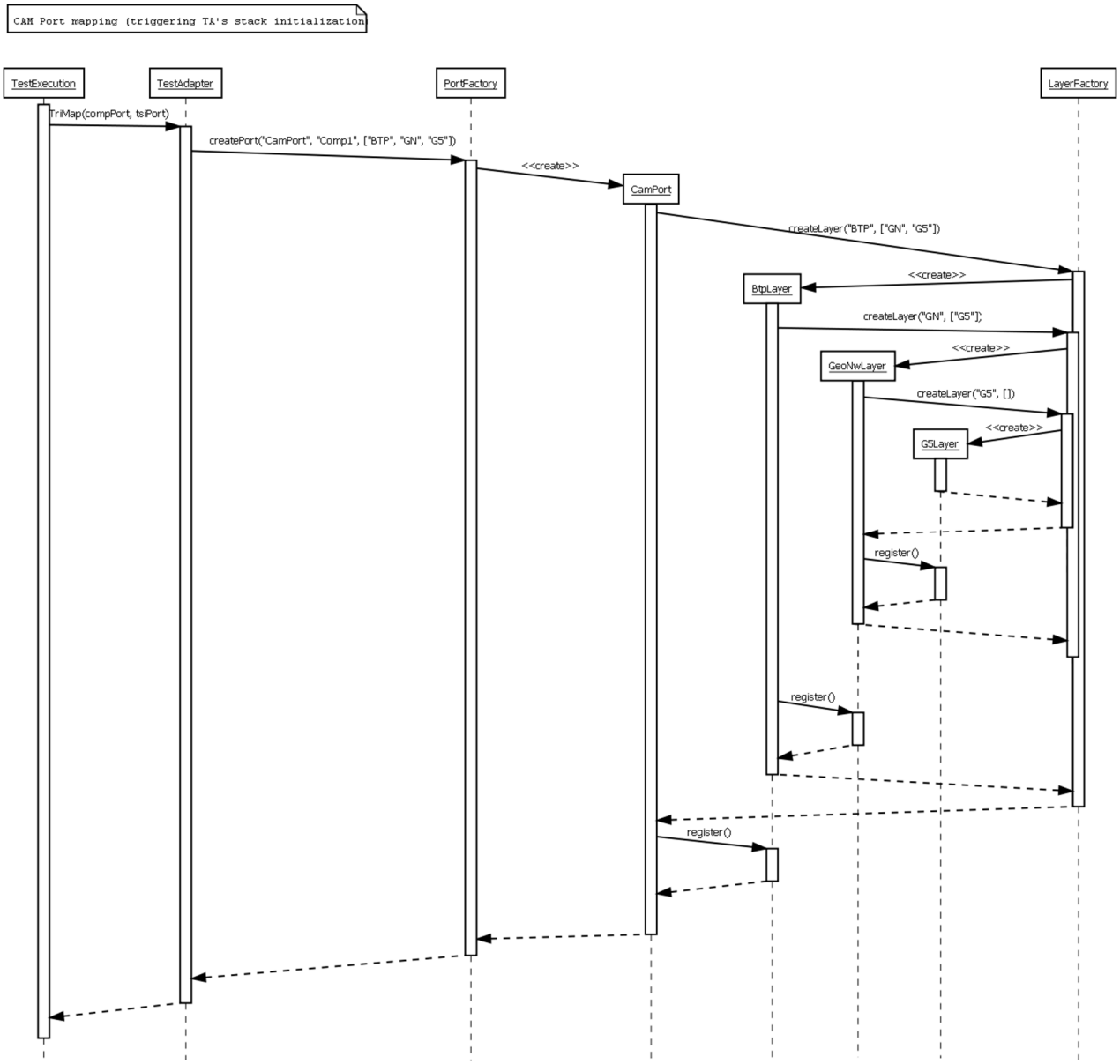



**Figure 8: Port initialization sequence diagram**

Currently the following layers have been implemented:

- GnLayer: basic functionalities of GeoNetworking layer, including beaconing.
- BtpLayer.
- EthernetLayer. It is important to note that this class requires the usage of the external library JnetPcap for capturing and injecting Ethernet frames.
- G5Layer.

The Management class, implementing IManagementTA and IManagementLayers interfaces is used for handling the dynamic configuration of Layer objects. It is directly linked to the AdapterControlPort and implements the AC primitives defined in the TTCN-3 test suites. It is important to notice that this class is implemented using a "Multiton or Multiple Singleton" design pattern: one single instance of this class can be instantiated per TTCN-3 component.

### 7.2.3 Extensibility of the test adapter

The test adapter can be extended in several ways. The first option is to add new protocol layers by adding new classes inheriting from the Layer class. These new layers have then to be assigned a short name and registered in the LayerFactory.

It is also possible to define new protocol ports. To do so, it is necessary to implement new classes inheriting from the ProtocolPort class. These new ports have then to be assigned a short name and registered in the ProtocolPortFactory.

Furthermore, it is also possible to extend AC primitives. This requires to enrich IManagementLayers and IManagementTA interfaces and to implement new functionalities in the Management class.

### 7.2.4 Adapter Control primitives

The following adapter control primitives are used to control the dynamic configuration of the various layers:

**Table 1: Adapter Control primitives**

| Adapter Control Primitive | Description |
|---|---|
| startBeaconing | Requests Test Adapter to start sending periodic beacons for the current component |
| stopBeaconing | Requests Test Adapter to stop sending periodic beacons for the current component |
| startEnqueueingBeacons | Requests Test Adapter to start enqueueing beacon messages on the current component GN port |
| stopEnqueueingBeacons | Requests Test Adapter to stop enqueueing beacon messages on the current component GN port |
| startMultipleBeaconing | Requests Test Adapter to start simulating neighbour presence by sending multiple periodic beacons for the current component |
| stopMultipleBeaconing | Requests Test Adapter to stop simulating neighbour presence |
| getLongPositionVector | Gets the long position vector of a neighbour given its GN_Address |

### 7.2.5 Adapter configuration parameters

The test adapter provides several parameters to configure and adapt its behaviour. Some of those parameters are generic and apply globally to the complete test adapter, and some are specific to a particular protocol (i.e. those are mainly parameters used by Port object).

**Table 2: Generic test adapter configuration parameters**

| Parameter name | Description | Example |
|---|---|---|
| UpperTesterSettings | IUT's Upper Tester module IP address and port, to which Test System UT primitives will be sent. <address>:<port> | 192.168.56.129:1501 |
| TsLatitude | Latitude of the Test System | 7 000 |
| TsLongitude | Longitude of the Test System | 520 000 |
| TsSecuredMode | Indicates whether ITS security is enabled or disabled. "true" or "false" For more If set to 'true' then the test adapter will process all security actions internally. If set to false then the test adapter | false |
| LocalEthernetMAC | Link layer address of the physical interface to be used to communicate with IUT | 005056C00008 |
| IutEthernetTypeValue | Ethertype value used by IUT | 0x8947 |

**Table 3: GeoNetworking test adapter configuration parameters**

| Parameter name | Description | Example |
|---|---|---|
| geoNetworkingPort | Configuration of GnPort's lower layers <layer1>/<layer2>/.../<layerN> | ETH |
| LinkLayer_MTC | Link layer address of simulated ITS-S MTC | BABEBABE0000 |
| LinkLayer_NodeA | Link layer address of simulated ITS-S NodeA | BABEBABE0001 |
| LinkLayer_NodeB | Link layer address of simulated ITS-S NodeB | BABEBABE0002 |
| LinkLayer_NodeC | Link layer address of simulated ITS-S NodeC | BABEBABE0003 |
| LinkLayer_NodeD | Link layer address of simulated ITS-S NodeD | BABEBABE0004 |
| LinkLayer_NodeE | Link layer address of simulated ITS-S NodeE | BABEBABE0005 |
| LinkLayer_NodeF | Link layer address of simulated ITS-S NodeF | BABEBABE0006 |
| TsBeaconInterval | Beaconing interval to be used by GnPort | 1 000 |

**Table 4: BTP test adapter configuration parameters**

| Parameter name | Description | Example |
|---|---|---|
| btpPort | Configuration of BtpPort's lower layers <layer1>/<layer2>/.../<layerN> | GN/ETH |

**Table 5: CAM test adapter configuration parameters**

| Parameter name | Description | Example |
|---|---|---|
| camPort | Configuration of CamPort's lower layers <layer1>/<layer2>/.../<layerN> | BTP/GN/ETH |

**Table 6: DENM test adapter configuration parameters**

| Parameter name | Description | Example |
|---|---|---|
| denmPort | Configuration of DenmPort's lower layers <layer1>/<layer2>/.../<layerN> | BTP/GN/ETH |

**Table 7: GN6 test adapter configuration parameters**

| Parameter name | Description | Example |
|---|---|---|
| ipv6OverGeoNetworkingPort | Configuration of Gn6Port's lower layers <layer1>/<layer2>/.../<layerN> | Debug |
| Gn6RemoteAdapterIp | IP address of the GN6 remote adapter | 192.168.56.11 |
| Gn6RemoteAdapterPort | Listening port of the remote GN6 adapter | 42 000 |

**Table 8: Security test adapter configuration parameters**

| Parameter | Description | Example |
|---|---|---|
| `TsSecuredMode` | Indicates that test adapter performs all security tasks internally (see notes 1 and 2) | `false` |
| `TsSecuredPath` | Secured root path to access certificate files | `"data/certificates"` |
| `TsSecuredConfiId` | Vendor specific configuration identifier. This should be actually a name of the subfolder inside the TsSecuredPath, containing the IUT certificates or digests, e.g. "data/certificates/vendorA" | `vendorA` |

NOTE 1: The parameter TsSecuredMode==true indicates that all security tasks are performed by the test adapter. This includes that the test adapter will decapsulate the received secured message and pass the payload to the upper layer as well as to encapsulate the toBeSent message
The parameter TsSecuredMode==false indicates that the test adapter passes the received secured message to the upper layer. The test adapter does not perform any security tasks on the toBeSentMessage.

NOTE 2: There are three possible ways of executing the tests:
- Running CAM/DENM/GN tests with IUT in secured mode: TsSecuredMode set to TRUE and PICS_GN_SECURITY set to FALSE
- Running CAM/DENM/GN tests with IUT in non-secured mode: TsSecuredMode set to FALSE and PICS_GN_SECURITY set to FALSE
- Running Security tests with IUT in secured mode: TsSecuredMode set to FALSE and PICS_GN_SECURITY set to TRUE

## 7.3 Platform Adapter

All TTCN-3 commercial tools provide generic Platform Adapter implementations for managing TTCN-3 timers. These implementations are well tested and usually accurate enough for most usages. In the case of ITS protocols, e.g. DENM re-broadcasting, GN beacon interval, etc., the protocol timer value is in the order of magnitude of hundreds of milliseconds. This order of magnitude can be handled well with the built in test system timers. As a consequence, no specific development is required for this component.

## 7.4 Upper Tester

The upper tester is used to interact with the upper interface of the implementation under test (IUT). It is typically implemented as an upper tester module executing in the test adapter and as a small module executing on the SUT and acts as an upper layer for the IUT, as shown in figure 9. It is particularly useful for:

- Triggering events in SUT.
- Triggering messages.
- Checking that payload are transmitted correctly to upper layers.

The communication between the two upper tester modules is performed in accordance with the upper tester message format described in annex C.

As it interacts with potentially proprietary APIs, it is usually the responsibility of IUT vendors to implement module located within SUT.

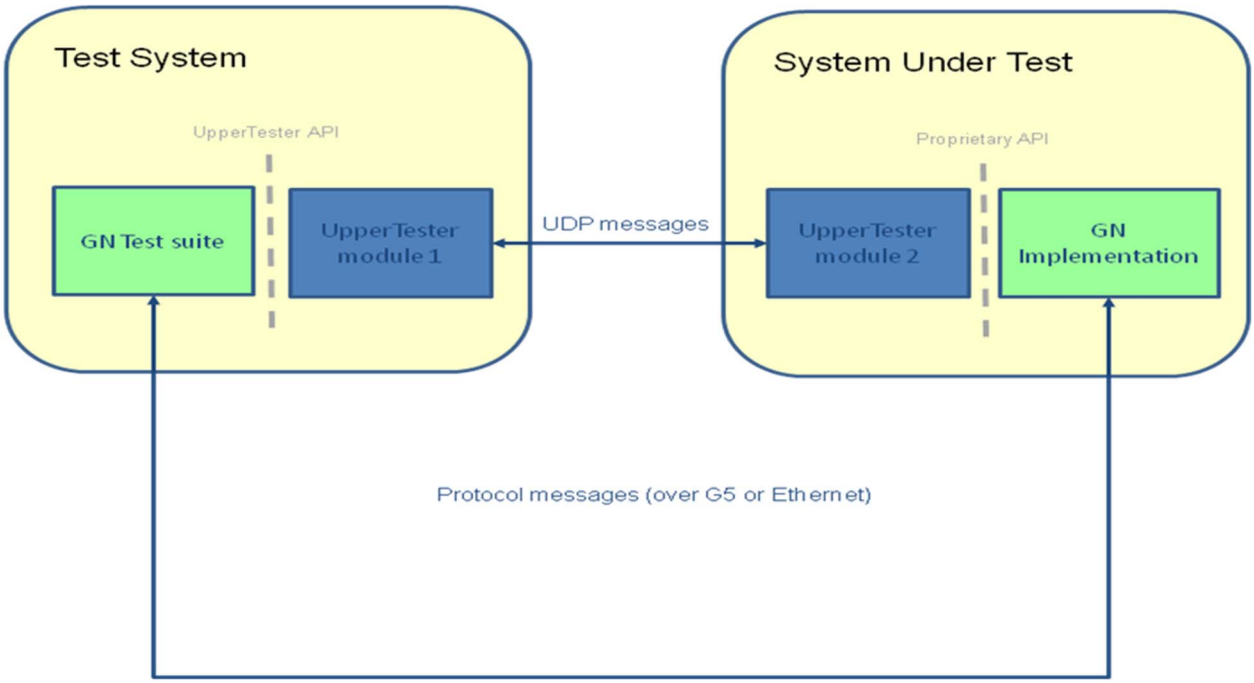



**Figure 9: Upper Tester architecture**

This upper tester module implements the upper tester message based API described in annex C.

# Annex A:
# Codecs Source Code

The applicable software tag of the codec source code is:
http://forge.etsi.org/websvn/listing.php?repname=ITS.ITS&path=/releases/TR103099/v1.3.1

# Annex B:
# Test Adapter Source Code

The applicable software tag of the test adapter source code is:
http://forge.etsi.org/websvn/listing.php?repname=ITS.ITS&path=/releases/TR103099/v1.3.1

# Annex C:
# Upper Tester Message Format

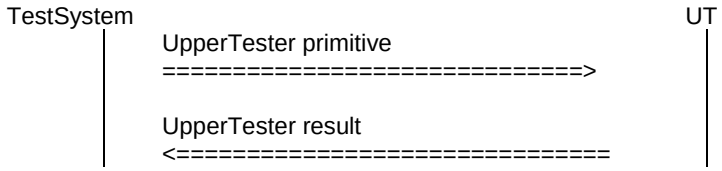
## C.1 Introduction

The messages defined in the present annex are exchanged between the Test System and Upper Tester using a UDP connection.

All integer values are encoded in big-endian byte order (most significant byte first).

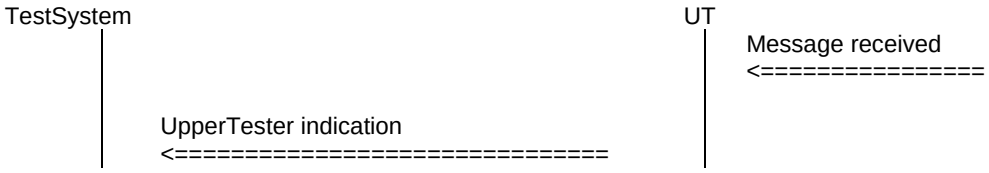
Two different message exchanges can occur.

- The first communication exchange is initiated by the test system and consists in a request - response exchange as described below. The UpperTester result message is specific to each primitive and may be used to indicate the success of the request or to report some values.



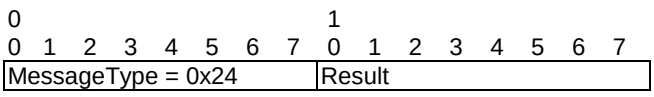

In this case the UDP destination port of the response is identical to the UDP source port of the corresponding request. When receiving UtInitialize primitive from Test System, the UDP source port of this request is saved as 'defaultUTPort' and used for unsolicited indications.

- The second communication exchange is initiated by the Upper Tester. It consists in unsolicited indications sent each time a packet is transmitted to upper layers, as described below. The Test System never replies to such messages (one way communication)




In this case, the UDP destination port of the indication is set to the 'defaultUTPort', which corresponds to the UDP source port of the UTInitialize request.

Format of UtResult:




| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0x24 |
| Result | 1 byte | 0x00: Failure<br>0x01: Success |

## C.2 Common Upper Tester Primitives

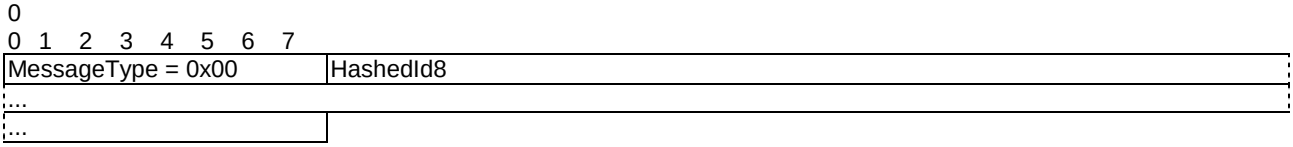
### C.2.1 UtInitialize

NOTE: The notation "TS ➔ UT" and "UT ➔ TS" is used in this clause and all sub-sequent clauses, and signifies "from TS to UT" and "from UT to TS".

This message is used to request initialization of IUT implementation. This means that at least:

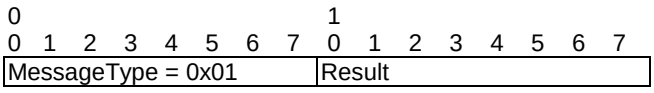
- Location Table, Forwarding buffers, LS buffer, list of collected certificates should be cleared; and
- the Sequence Number and the GN address should be reset to initially configured values.

Request (UtInitialize TS ➔ UT):




| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0x00 |
| HashedId8 | 8 bytes | In case PICS_GN_SECURITY is set to TRUE, then HashedId8 indicates the AT certificate digest to be used by the IUT.<br>In case PICS_GN_SECURITY is set to FALSE, then HashedId8 is set to 0, which indicates to the IUT that testing of the security protocol is disabled. |

Response (UtInitializeResult UT ➔ TS):

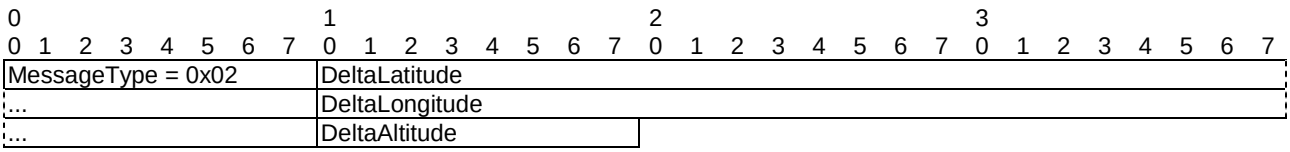



| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0x01 |
| Result | 1 byte | 0x00: Failure<br>0x01: Success |

## C.2.2 ChangePosition

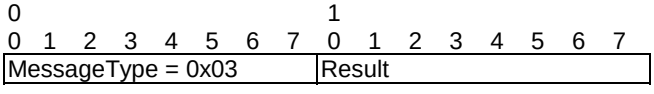
This message is used to change the position of the ITS station. The latitude, longitude and altitude parameters are relative to the current position of IUT. They are NOT absolute position.

Request (UtChangePosition TS ➔ UT):




| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0x02 |
| DeltaLatitude | 4 bytes | Latitude offset (multiples of 0,1 microdegree) |
| DeltaLongitude | 4 bytes | Longitude offset (multiples of 0,1 microdegree) |
| DeltaElevation | 1 byte | Altitude offset (meter) |

Response (UtChangePositionResult UT ➔ TS):

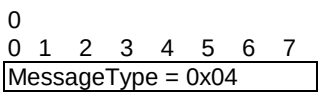


| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0x03 |
| Result | 1 byte | 0x00: Failure<br>0x01: Success |

## C.2.3 ChangePseudonym

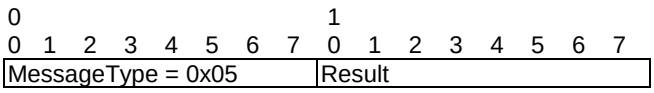
This message is used to change the pseudonym of the ITS-S.

Request (UtChangePseudonym TS ➔ UT):




| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0x04 |

Response (UtChangePseudonymResult UT ➔ TS):



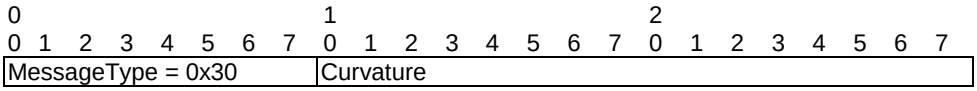

| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0x05 |
| Result | 1 byte | 0x00: Failure<br>0x01: Success |

# C.3 CAM Upper Tester Primitives

## C.3.1 ChangeCurvature

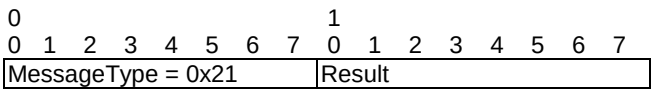
This message is used to set the curvature of the ITS station. The curvature parameter is relative to the current curvature value. It is NOT an absolute value.

Request (UtCamTrigger_changeCurvature TS ➔ UT):




| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0x30 |
| Curvature | 2 bytes | Signed integer. Curvature offset from -30 000 to 30 001 |

Response (UtCamTriggerResult UT ➔ TS):



| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0x21 |
| Result | 1 byte | 0x00: Failure<br>0x01: Success |

## C.3.2 ChangeSpeed

This message is used to change the speed of the ITS station. The vehicle speed is increased by the value of 'SpeedVariation' field.

For instance, if the current speed of the ITS station is 10 m/s and received SpeedVariation is +300, then the new vehicle speed will be 10 + 0,01 × 300 = 13 m/s.

Request (UtCamTrigger_changeSpeed TS ➔ UT):

| 0 | | | | | | | | 1 | | | | | | | | 2 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| MessageType = 0x31 | | | | | | | | SpeedVariation | | | | | | | | | | | | | | | |

| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0x31 |
| SpeedVariation | 2 bytes | Signed integer. Speed variation in units of cm/s |

Response (UtCamTriggerResult UT ➔ TS):

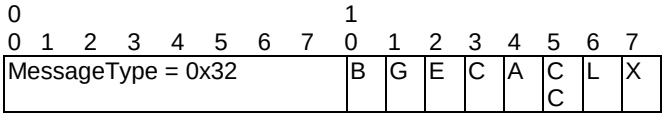
| 0 | | | | | | | | 1 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| MessageType = 0x21 | | | | | | | | Result | | | | | | | |

| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0x21 |
| Result | 1 byte | 0x00: Failure<br>0x01: Success |

## C.3.3 SetAccelerationControlStatus

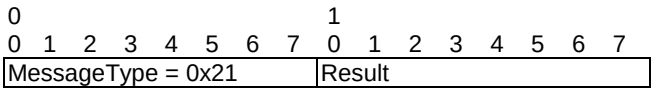
This message is used to set acceleration control status of the ITS station.

Request (UtCamTrigger_setAccelerationControlStatus TS ➔ UT):




| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0x32 |
| B | 1 bit | 0: brake pedal inactive<br>1: brake pedal active |
| G | 1 bit | 0: gas pedal inactive<br>1: gas pedal active |
| E | 1 bit | 0: emergency brake inactive<br>1: emergency brake active |
| C | 1 bit | 0: collision warning inactive<br>1: collision warning active |
| A | 1 bit | 0: ACC inactive<br>1: ACC active |
| CC | 1 bit | 0: cruise control inactive<br>1: cruise control active |
| L | 1 bit | 0: speed limiter inactive<br>1: speed limiter active |
| X | 1 bit | Reserved |

Response (UtCamTriggerResult UT ➔ TS):




| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0x21 |
| Result | 1 byte | 0x00: Failure<br>0x01: Success |

## C.3.4 SetExteriorLightsStatus

This message is used to set exterior lights status of the ITS station.

Request (UtCamTrigger_setExteriorLightsStatus TS ➔ UT):

| 0 | | | | | | | | 1 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| MessageType = 0x33 | | | | | | | | LB | HB | LT | RT | D | R | F | P |

| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0x33 |
| LB | 1 bit | 0: low beam headlights off<br>1: low beam headlights on |
| HB | 1 bit | 0: high beam off<br>1: high beam headlights on |
| LT | 1 bit | 0: left turn signal off<br>1: left turn signal on |
| RT | 1 bit | 0: right turn signal off<br>1: right turn signal on |
| D | 1 bit | 0: daytime running lights off<br>1: daytime running lights on |
| R | 1 bit | 0: reverse light off<br>1: reverse lights on |
| F | 1 bit | 0: fog light off<br>1: fog light on |
| P | 1 bit | 0: parking lights off<br>1: parking lights on |

Response (UtCamTriggerResult UT ➔ TS):

| 0 | | | | | | | | 1 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| MessageType = 0x21 | | | | | | | | Result | | | | | | | |

| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0x32 |
| Result | 1 byte | 0x00: Failure<br>0x01: Success |

## C.3.5 ChangeHeading

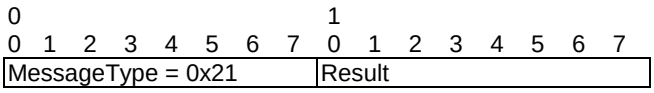
This message is used to change the heading of the ITS station. The heading parameter is relative to the current heading value. It is NOT an absolute value.

Request (UtCamTrigger_changeHeading TS ➔ UT):

| 0 | | | | | | | | 1 | | | | | | | | 2 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| MessageType = 0x34 | | | | | | | | Heading | | | | | | | | | | | | | | | |

| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0x34 |
| Heading | 2 bytes | Heading offset. Integer value from 0 to 3 600 |

Response (UtCamTriggerResult UT ➔ TS):

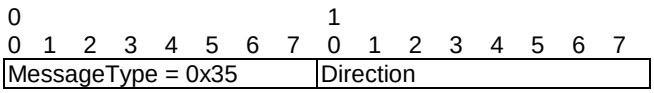



| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0x21 |
| Result | 1 byte | 0x00: Failure<br>0x01: Success |

## C.3.6 SetDriveDirection

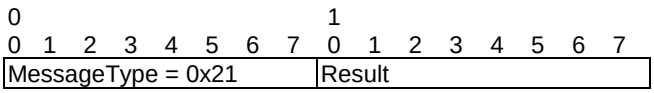
This message is used to change the direction of the ITS station.

Request (UtCamTrigger_setDriveDirection TS ➔ UT):




| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0x35 |
| Direction | 1 byte | 0x00: Forward<br>0x01: Backward<br>0x02: Unavailable |

Response (UtCamTriggerResult UT ➔ TS):

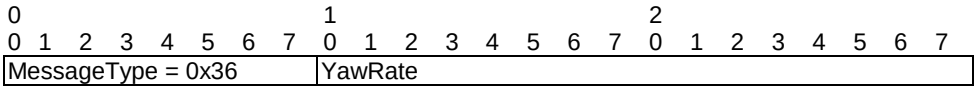



| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0x21 |
| Result | 1 byte | 0x00: Failure<br>0x01: Success |

## C.3.7 ChangeYawRate

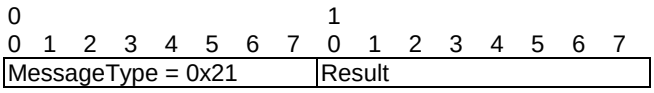
This message is used to change the yaw rate of the ITS station. The yaw rate parameter is relative to the current yaw rate value. It is NOT an absolute value.

Request (UtCamTrigger_changeYawRate TS ➔ UT):




| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0x36 |
| YawRate | 2 bytes | Yaw rate offset. Signed integer from -32 767 to -32 767 |

Response (UtCamTriggerResult UT ➔ TS):

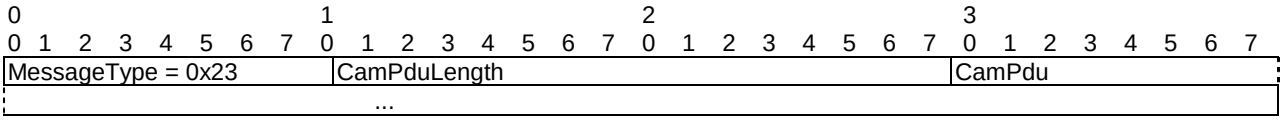



| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0x21 |
| Result | 1 byte | 0x00: Failure<br>0x01: Success |

## C.3.8 CamEventIndication

This message is used to indicate reception of CAM information by IUT.

Indication (UtCamEventInd UT ➔ TS):

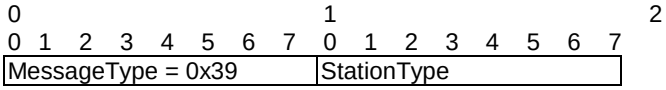



| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0x23 |
| CamPduLength | 2 bytes | Length of 'CamPdu' field |
| CamPdu | Variable | Received CAM |

## C.3.9 SetStationType

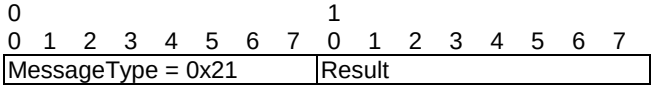
This message is used to change the type of the ITS station.

Request (UtCamTrigger_setStationType TS ➔ UT):




| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0x39 |
| StationType | 1 byte | Unsigned char range from 0 to 15<br>unknown(0),<br>pedestrian(1),<br>cyclist(2),<br>moped(3),<br>motorcycle(4),<br>passengerCar(5),<br>bus(6),<br>lightTruck(7),<br>heavyTruck(8),<br>trailer(9),<br>specialVehicles(10),<br>tram(11),<br>roadSideUnit(15) |

Response (UtCamTriggerResult UT ➔ TS):



| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0x21 |
| Result | 1 byte | 0x00: Failure<br>0x01: Success |

## C.3.10 SetVehicleRole

This message is used to change the vehicle role of the ITS station.

Request (UtCamTrigger_setVehicleRole TS ➔ UT):

| 0 | | | | | | | | 1 | | | | | | | | 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | |
| MessageType = 0x3a | | | | | | | | VehiculeRole | | | | | | | | |

| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0x3a |
| VehiculeRole | 1 byte | Unsigned char range from 0 to 7<br>default(0),<br>publicTransport(1),<br>specialTransport(2),<br>dangerousGoods(3),<br>roadWork(4),<br>rescue(5),<br>emergency(6),<br>safetyCar(7) |

Response (UtCamTriggerResult UT ➔ TS):

| 0 | | | | | | | | 1 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| MessageType = 0x21 | | | | | | | | Result | | | | | | | |

| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0x21 |
| Result | 1 byte | 0x00: Failure<br>0x01: Success |

## C.3.11 SetEmbarkationStatus

This message is used to indicate whether the passenger embarkation is ongoing.

Request (UtCamTrigger_setEmbarkationStatus TS ➔ UT):

| 0 | | | | | | | | 1 | | | | | | | | 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | |
| MessageType = 0x3b | | | | | | | | EmbarkationStatus | | | | | | | | |

| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0x3b |
| EmbarkationStatus | 1 byte | Unsigned char. Value is 0 for false and value is 255 for true |

Response (UtCamTriggerResult UT ➔ TS):

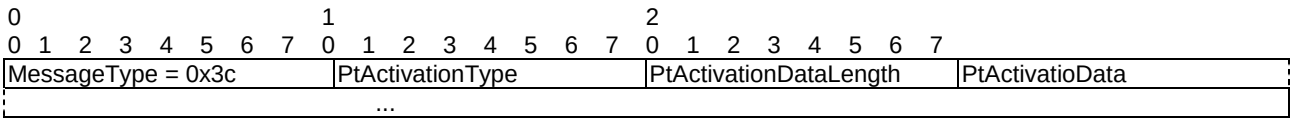
| 0 | | | | | | | | 1 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| MessageType = 0x21 | | | | | | | | Result | | | | | | | |

| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0x21 |
| Result | 1 byte | 0x00: Failure<br>0x01: Success |

## C.3.12 SetPtActivation

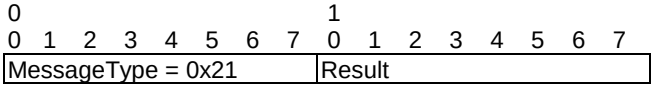
This message is used to control traffic lights, barriers, etc.

Request (UtCamTrigger_setPtActivation TS ➔ UT):




| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0x3c |
| PtActivationType | 1 byte | Unsigned char range from 0 to 255 |
| PtActivationDataLength | 1 byte | Unsigned char range from 0 to 20 |
| PtActivatioData | Variable | Unsigned char range from 0 bytes to 20 bytes |

Response (UtCamTriggerResult UT ➔ TS):

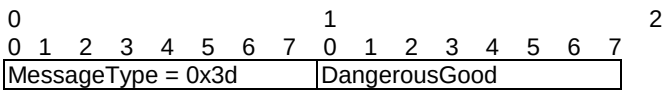



| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0x21 |
| Result | 1 byte | 0x00: Failure<br>0x01: Success |

## C.3.13 SetDangerousGoods

This message is used to set the dangerous good property of the ITS station.

Request (UtCamTrigger_setDangerousGoods TS ➔ UT):



| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0x3d |
| DangerousGood | 1 byte | Unsigned char range from 0 to 19<br>explosives1(0),<br>explosives2(1),<br>explosives3(2),<br>explosives4(3),<br>explosives5(4),<br>explosives6(5),<br>flammableGases(6),<br>nonFlammableGases(7),<br>toxicGases(8),<br>flammableLiquids(9),<br>flammableSolids(10),<br>substancesLiableToSpontaneousCombustion(11),<br>substancesEmittingFlammableGasesUponContactWithWater(12),<br>oxidizingSubstances(13),<br>organicPeroxides(14),<br>toxicSubstances(15),<br>infectiousSubstances(16),<br>radioactiveMaterial(17),<br>corrosiveSubstances(18),<br>miscellaneousDangerousSubstances(19) |

Response (UtCamTriggerResult UT ➔ TS):

| 0 | | | | | | | | 1 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| MessageType = 0x21 | | | | | | | | Result | | | | | | | |

| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0x21 |
| Result | 1 byte | 0x00: Failure<br>0x01: Success |

## C.3.14 SetLightBarSiren

This message is used to set light and siren bar status of the ITS station.

Request (UtCamTrigger_setLightBarSiren TS ➔ UT):

| 0 | | | | | | | | 1 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| MessageType = 0x3f | | | | | | | | LB | S | | | | | | |

| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0x3f |
| LB | 1 bit | 0: Light bar is not activated<br>1: Light bar is activated |
| S | 1 bit | 0: Siren is off<br>1: Siren is on |

Response (UtCamTriggerResult UT ➔ TS):

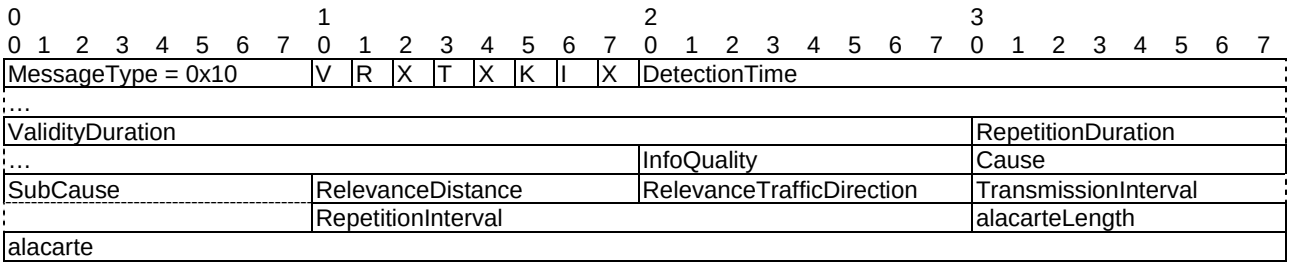
| 0 | | | | | | | | 1 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| MessageType = 0x21 | | | | | | | | Result | | | | | | | |

# C.4 DENM Upper Tester Primitives

## C.4.1 GenerateDenmEvent

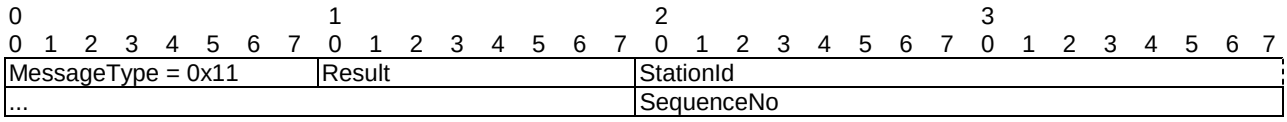
This message is used to create a new DENM event.

Request (UtDenmTrigger TS ➔ UT):




| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0x10 |
| V | 1 bit | 0: validityDuration to be ignored<br>1: validityDuration to be used |
| R | 1 bit | 0: RepetitionDuration to be ignored<br>1: RepetitionDuration to be used |
| X | 1 bit | reserved |
| T | 1 bit | 0: RelevanceTrafficDirection to be ignored<br>1: RelevanceTrafficDirection to be used |
| X | 1 bit | reserved |
| K | 1 bit | 0: TransmissionInterval to be ignored<br>1: TransmissionInterval to be used |
| I | 1 bit | 0: RepetitionInterval to be ignored<br>1: RepetitionInterval to be used |
| X | 1 bit | reserved |
| DetectionTime | 6 bytes | Unsigned integer. From 0 to 3 153 600 000 000 |
| ValidityDuration | 3 bytes | Unsigned integer. From 0 s to 86 400 s |
| RepetitionDuration | 3 bytes | Unsigned integer. From 0 s to 86 400 s |
| InfoQuality | 1 byte | 0x00: Unavailable<br>0x01: Lowest<br>…<br>0x07: Highest |
| Cause | 1 byte | Event cause ID |
| Subcause | 1 byte | Event sub-cause ID |
| RelevanceDistance | 1 byte | 0x00: less than 50 m<br>0x01: less than 100 m<br>0x02: less than 200 m<br>0x03: less than 500 m<br>0x04: less than 1 000 m<br>0x05: less than 5 km<br>0x06: less than 10 km<br>0x07: greater than 10 km |
| RelevanceTrafficDirection | 1 byte | 0x00: unavailable<br>0x01: upstream traffic<br>0x02: downstream traffic<br>0x03: all traffic directions |
| TransmissionInterval | 2 bytes | From 1 ms to 10 000 ms |
| RepetitionInterval | 2 bytes | From 1 ms to 10 000 ms |
| alacarteLength | 1 byte | Length of 'Alacarte container' field<br>Value 0 means no Alacarte container included. |
| alacarte | n bytes | Alacarte container |

Response (UtDenmTriggerResult UT ➔ TS):

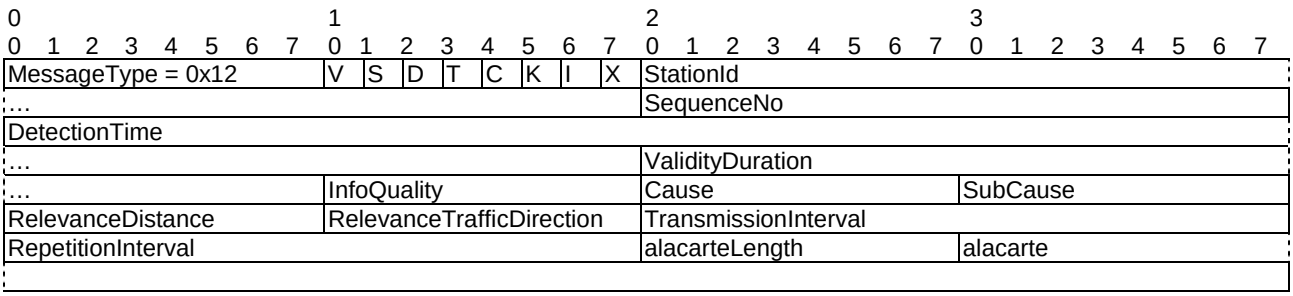



| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0x11 |
| Result | 1 byte | Operation result |
| StationId | 4 bytes | Station ID |
| SequenceNo | 2 bytes | Event sequence number |

## C.4.2 UpdateDenmEvent

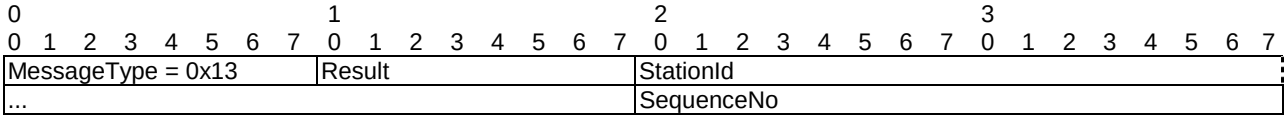
This message is used to update expiration time of an existing DENM event.

Request (UtDenmUpdate TS ➔ UT):




| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0x12 |
| V | 1 bit | 0: validityDuration to be ignored<br>1: validityDuration to be used |
| S | 1 bit | 0: InfoQuality, CauseCode and SubCauseCode to be ignored<br>1: InfoQuality, CauseCode and SubCauseCode to be used |
| D | 1 bit | 0: relevanceDistance to be ignored<br>1: relevanceDistance to be used |
| T | 1 bit | 0: RelevanceTrafficDirection to be ignored<br>1: RelevanceTrafficDirection to be used |
| C | 1 bit | 0: TrafficClass to be ignored<br>1: TrafficClass to be used |
| K | 1 bit | 0: TransmissionInterval to be ignored<br>1: TransmissionInterval to be used |
| I | 1 bit | 0: RepetitionInterval to be ignored<br>1: RepetitionInterval to be used |
| X | 1 bit | reserved |
| StationId | 4 bytes | Original event's station ID |
| SequenceNo | 2 bytes | Original event's sequence number |
| DetectionTime | 6 bytes | Unsigned integer. From 0 to 3 153 600 000 000 |
| ValidityDuration | 3 bytes | Unsigned integer. From 0 s to 86 400 s |
| InfoQuality | 1 byte | 0x00: Unavailable<br>0x01: Lowest<br>…<br>0x07: Highest |
| Cause | 1 byte | Event cause ID |
| Subcause | 1 byte | Event sub-cause ID |
| RelevanceDistance | 1 byte | 0x00: less than 50 m<br>0x01: less than 100 m<br>0x02: less than 200 m<br>0x03: less than 500 m<br>0x04: less than 1 000 m<br>0x05: less than 5 km<br>0x06: less than 10 km<br>0x07: greater than 10 km |
| RelevanceTrafficDirection | 1 byte | 0x00: all traffic directions<br>0x01: upstream traffic<br>0x02: downstream traffic<br>0x03: oppositeTraffic |
| TransmissionInterval | 2 bytes | From 1 ms to 10 000 ms |
| RepetitionInterval | 2 bytes | From 1 ms to 10 000 ms |
| alacarteLength | 1 byte | Length of 'Alacarte container' field<br>Value 0 means no Alacarte container included. |
| alacarte | n bytes | Alacarte container |

Response (UtDenmUpdateResult UT ➔ TS):

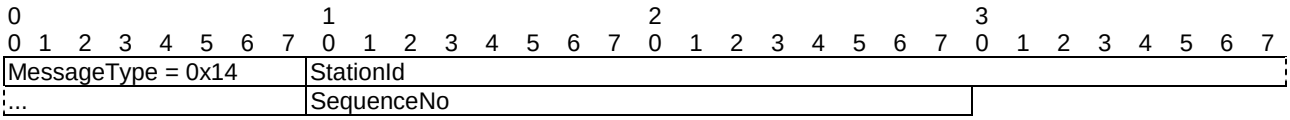



| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0x13 |
| Result | 1 byte | Operation result |
| StationId | 4 bytes | Station ID |
| SequenceNo | 2 bytes | Event sequence number |

## C.4.3 TerminateDenmEvent

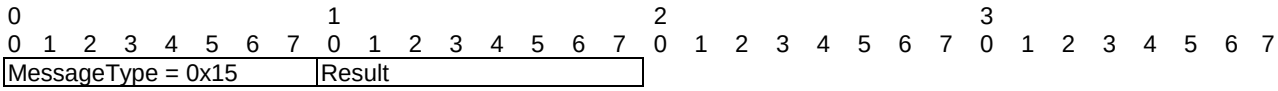
This message is used to terminate an existing DENM event.

Request (UtDenmTermination TS ➔ UT):




| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0x14 |
| StationId | 4 bytes | Original Station ID |
| SequenceNo | 2 bytes | Event sequence number |

Response (UtDenmTerminationResult UT ➔ TS):

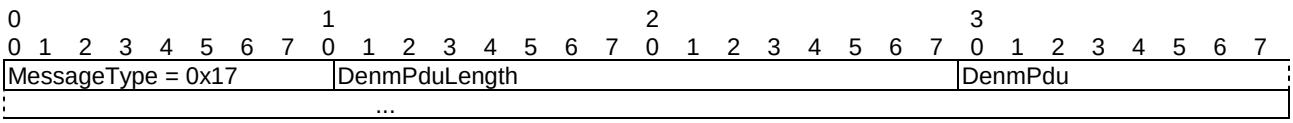



| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0x15 |
| Result | 1 byte | 0x00: Failure<br>0x01: Success |

## C.4.4 DenmEventIndication

This message is used to indicate reception of DENM information by IUT.

Indication (UtDenmEventInd UT ➔ TS):



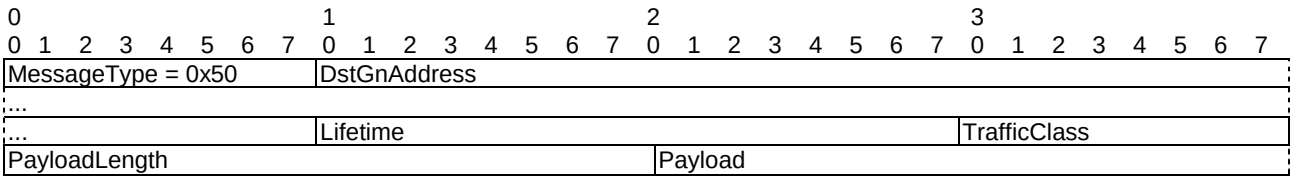

| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0x17 |
| DenmPduLength | 2 bytes | Length of 'DenmPdu' field |
| DenmPdu | Variable | Received DENM |

# C.5 GeoNetworking Upper Tester Primitives

## C.5.1 GenerateGeoUnicast

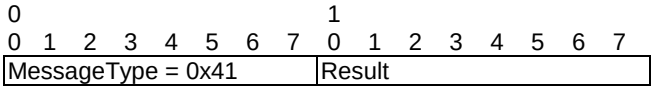
This message is used to trigger a GeoUnicast message.

Request (UtGnTrigger_geoUnicast TS ➔ UT):




| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0x50 |
| DstGnAddr | 8 bytes | Destination GN Address |
| Lifetime | 2 bytes | Packet lifetime in milliseconds |
| TrafficClass | 1 byte | Packet traffic class |
| PayloadLength | 2 bytes | Length of 'Payload' field |
| Payload | Variable | Packet's final payload |

Response (UtGnTriggerResult UT ➔ TS):

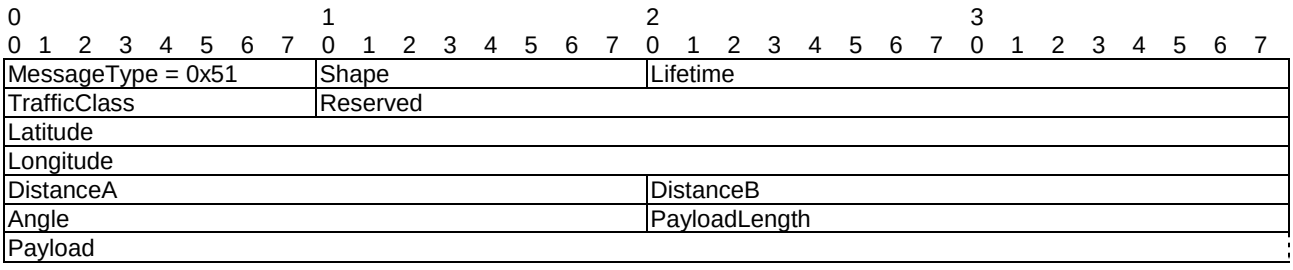



| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0x41 |
| Result | 1 byte | 0x00: Failure<br>0x01: Success |

## C.5.2 GenerateGeoBroadcast

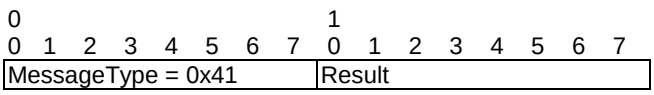
This message is used to trigger a GeoBroadcast message.

Request (UtGnTrigger_geoBroadcast TS ➔ UT):



| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0x51 |
| Shape | 1 byte | 0: Circle<br>1: Rectangle<br>2: Ellipse |
| Lifetime | 2 bytes | Packet lifetime in milliseconds |
| TrafficClass | 1 byte | Packet traffic class |
| Reserved | 3 bytes | Reserved |
| Latitude | 4 bytes | Destination area latitude (1/10 degrees) |
| Longitude | 4 bytes | Destination area longitude (1/10 degrees) |
| DistanceA | 2 bytes | Destination area distance A |
| DistanceB | 2 bytes | Destination area distance B |
| Angle | 2 bytes | Destination area angle |
| PayloadLength | 2 bytes | Length of 'Payload' field |
| Payload | Variable | Packet's final payload |

Response (UtGnTriggerResult UT ➔ TS):

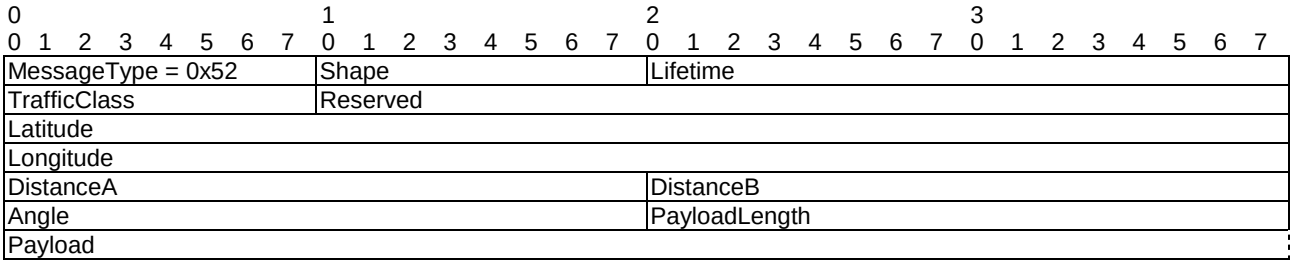



| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0x41 |
| Result | 1 byte | 0x00: Failure<br>0x01: Success |

## C.5.3 GenerateGeoAnycast

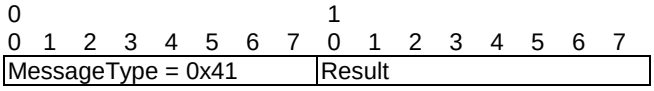
This message is used to trigger a GeoAnycast message.

Request (UtGnTrigger_geoAnycast TS ➔ UT):




| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0x52 |
| Shape | 1 byte | 0: Circle<br>1: Rectangle<br>2: Ellipse |
| Lifetime | 2 bytes | Packet lifetime in milliseconds |
| TrafficClass | 1 byte | Packet traffic class |
| Reserved | 3 bytes | Reserved |
| Latitude | 4 bytes | Destination area latitude (1/10 degrees) |
| Longitude | 4 bytes | Destination area longitude (1/10 degrees) |
| DistanceA | 2 bytes | Destination area distance A |
| DistanceB | 2 bytes | Destination area distance B |
| Angle | 2 bytes | Destination area angle |
| PayloadLength | 2 bytes | Length of 'Payload' field |
| Payload | Variable | Packet's final payload |

Response (UtGnTriggerResult UT ➔ TS):

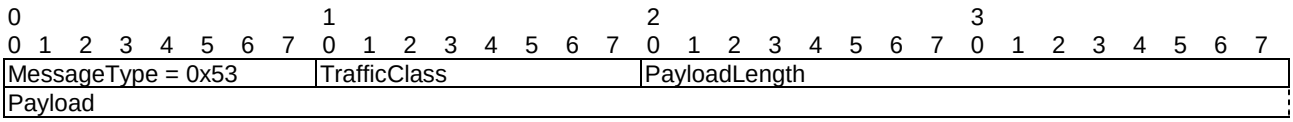



| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0x41 |
| Result | 1 byte | 0x00: Failure<br>0x01: Success |

## C.5.4 GenerateSHB

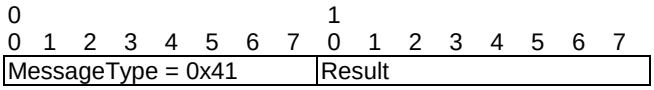
This message is used to trigger a SHB message.

Request (UtGnTrigger_shb TS ➔ UT):




| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0x53 |
| TrafficClass | 1 byte | Packet traffic class |
| PayloadLength | 2 bytes | Length of 'Payload' field |
| Payload | Variable | Packet's final payload |

Response (UtGnTriggerResult UT ➔ TS):

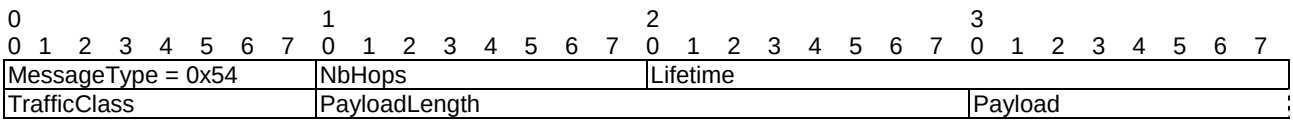



| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0x41 |
| Result | 1 byte | 0x00: Failure<br>0x01: Success |

## C.5.5 GenerateTSB

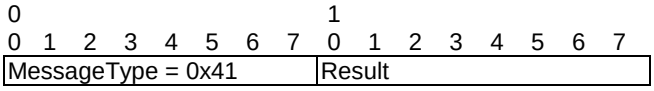
This message is used to trigger a TSB message.

Request (UtGnTrigger_tsb TS ➔ UT):




| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0x54 |
| NbHops | 1 byte | Number of hops |
| Lifetime | 2 bytes | Packet lifetime in milliseconds |
| TrafficClass | 1 byte | Packet traffic class |
| PayloadLength | 2 bytes | Length of 'Payload' field |
| Payload | Variable | Packet's final payload |

Response (UtGnTriggerResult UT ➔ TS):

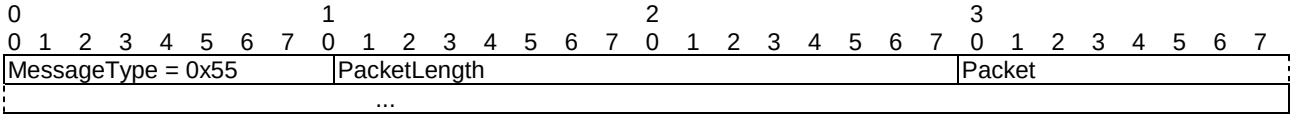



| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0x41 |
| Result | 1 byte | 0x00: Failure<br>0x01: Success |

## C.5.6 GnEventIndication

This message is used to check whether payload contained in GeoNetworking PDU has been transmitted to upper layer (CAM/DENM/IPv6).

Indication (UtGnEventInd UT ➔ TS):



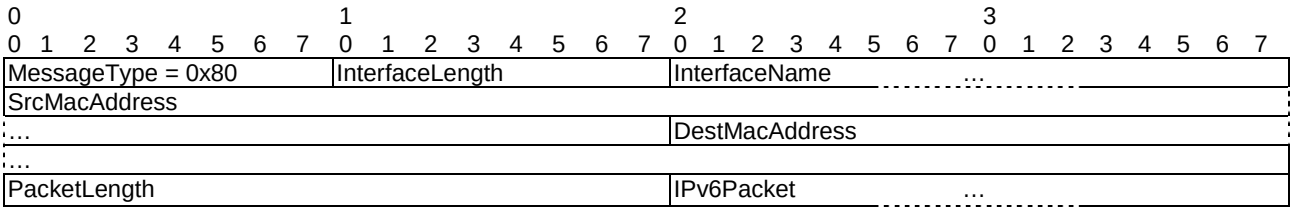

| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0x17 |
| PacketLength | 2 bytes | Length of 'Packet' field |
| Packet | Variable | Packet's final payload |

# C.6 IPv6OverGeoNetworking Upper Tester Primitives

## C.6.1 SendIPv6Message

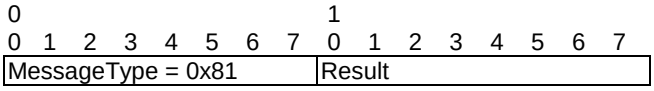
This message is used to trigger the sending of an IPv6 message on a specified network interface.

Request (UtGn6Trigger TS ➔ UT):




| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0x80 |
| InterfaceLength | 1 byte | Length of "InterfaceName" field |
| InterfaceName | InterfaceLength × 1 byte | Name of the interface on which to send the IPv6 packet |
| SrcMacAddress | 6 bytes | Source MAC address |
| DestMacAddress | 6 bytes | Destination MAC address |
| PacketLength | 2 bytes | Length of the "IPv6Packet" field |
| IPv6Packet | Variable | IPv6 packet to be sent |

Response (UtGn6TriggerResult UT ➔ TS):

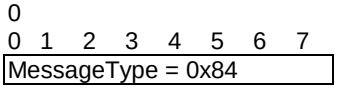



| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0x81 |
| Result | 1 byte | 0x00: Failure<br>0x01: Success |

## C.6.2 GetInterfaceInfos

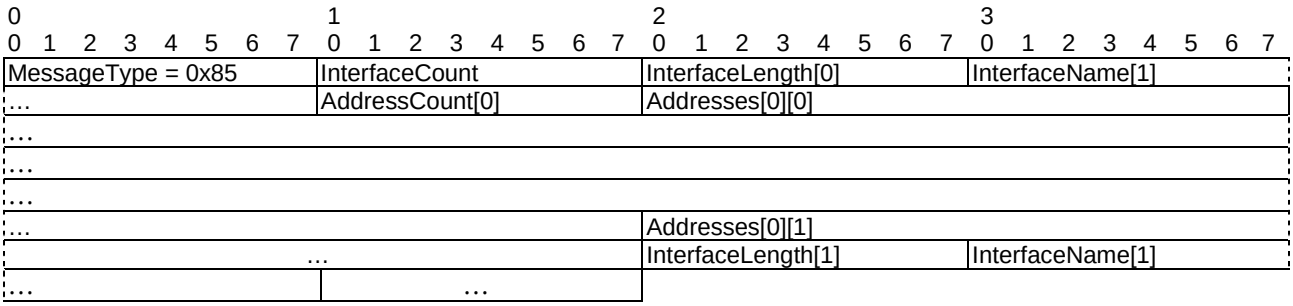
This message is used by the Test System to retrieve the configuration of network interfaces on IUT.

Request (UtGn6GetInterfaceInfo TS ➔ UT):




| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0x84 |

Response (UtGn6GetInterfaceInfoResult UT ➔ TS):

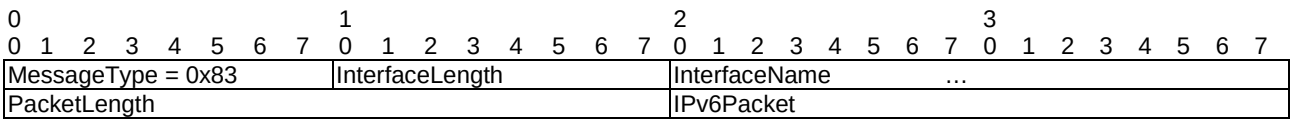



| Name | | Length | Value |
|---|---|---|---|
| MessageType | | 1 byte | 0x85 |
| InterfaceCount | | 1 byte | Number of interface descriptors |
| Interface Descriptor | InterfaceLength | 1 byte | Length of "InterfaceName" field |
| | InterfaceName | InterfaceLength × 1 byte | Name of the interface |
| | AddressCount | 1 byte | Number of configured IPv6 address on the interface |
| | Addresses | AddressCount × 16 bytes | IPv6 addresses configured on interface |

## C.6.3 Gn6EventIndication

This message is used to check whether payload contained in GeoNetworking PDU has been transmitted to upper layer (CAM/DENM/IPv6).

Indication (UtGnEventInd UT ➔ TS):



| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0x83 |
| InterfaceLength | 1 byte | Length of "InterfaceName" field |
| InterfaceName | InterfaceLength × 1 byte | Name of the interface on the IPv6 packet has been received |
| PacketLength | 2 bytes | Length of ' IPv6Packet' field |
| IPv6Packet | Variable | Received IPv6 packet |

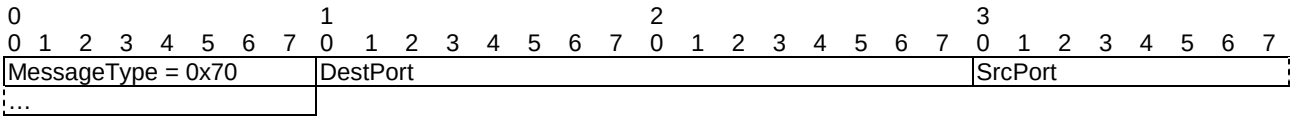
NOTE: Gn6 primitives are not yet supported by the ITS test suite.

# C.7 BTP Upper Tester Primitives

## C.7.1 GenerateBtpA

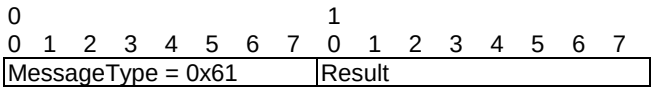
This message is used to trigger a BTP-A message.

Request (UtBtpTrigger_A TS ➔ UT):




| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0x70 |
| DestPort | 2 bytes | Destination port |
| SrcPort | 2 bytes | Source port |

Response (UtBtpTriggerResult UT ➔ TS):

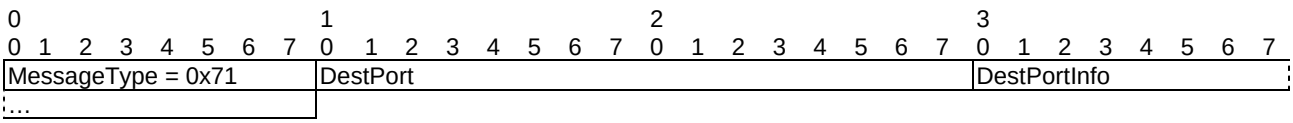



| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0x61 |
| Result | 1 byte | 0x00: Failure<br>0x01: Success |

## C.7.2 GenerateBtpB

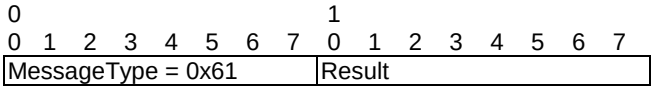
This message is used to trigger a BTP-B message.

Request (UtBtpTrigger_B TS ➔ UT):




| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0x71 |
| DestPort | 2 bytes | Destination port |
| DestPortInfo | 2 bytes | Destination port info |

Response (UtBtpTriggerResult UT ➔ TS):

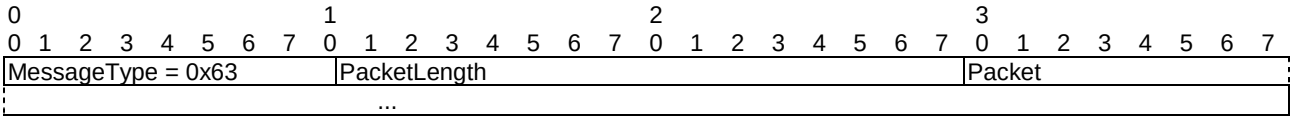



| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0x61 |
| Result | 1 byte | 0x00: Failure<br>0x01: Success |

## C.7.3 BtpEventIndication

This message is used to check whether payload contained in BTP PDU has been transmitted to upper layer.

Indication (UtBtpEventInd UT ➔ TS):



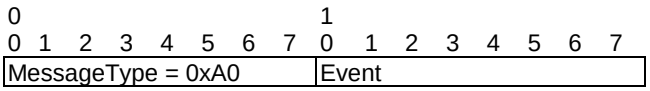

| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0x63 |
| PacketLength | 2 bytes | Length of 'Packet' field |
| Packet | Variable | Packet's final payload |

# C.8 MAP SPAT Upper Tester Primitives

## C.8.1 UtMapSpatTrigger

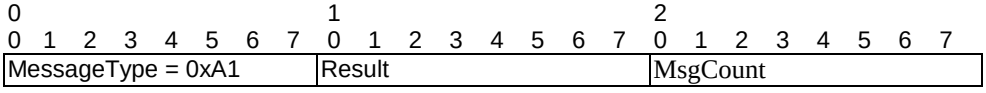
This message is used to trigger a specific event.

Request (UtMapSpatTrigger TS ➔ UT):




| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0xA0 |
| Event | 1 byte | 0 Generate a SPAT message<br>1 Generate a MAP message with new content<br>2 Force MAP repetition < 10 s<br>3 Force MAP repetition > 10 s |

Response (UtMapSpatTriggerResult UT ➔ TS):

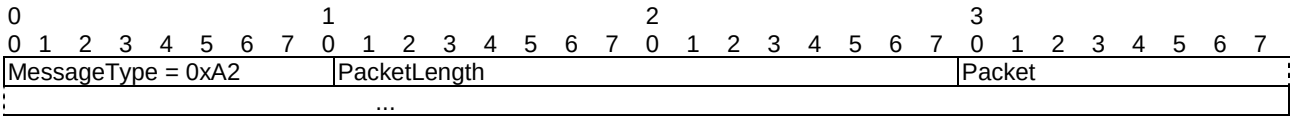


| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0xA1 |
| Result | 1 byte | 0x00: Failure<br>0x01: Success |
| MsgCount | 1 byte | Value of the MsgCount of the generated event<br>0 when not applicable |

## C.8.2 UtMapEventInd

This message is used to indicate reception of MAP information by IUT.

Indication (UtMapEventInd UT ➔ TS):

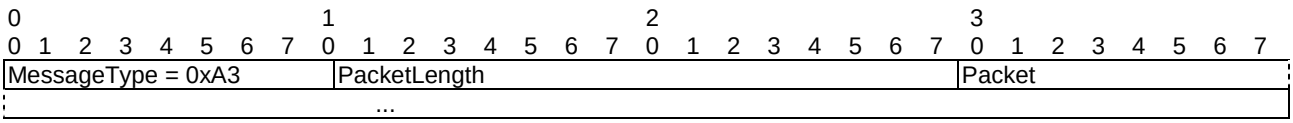



| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0xA2 |
| PacketLength | 2 bytes | Length of 'MapPdu' field |
| Packet | Variable | Received MAP |

## C.8.3 UtSpatEventInd

This message is used to indicate reception of SPaT information by IUT.

Indication (UtSpatEventInd UT ➔ TS):




| Name | Length | Value |
|---|---|---|
| MessageType | 1 byte | 0xA3 |
| PacketLength | 2 bytes | Length of 'SpatPdu' field |
| Packet | Variable | Received SPaT |

# Annex D:
# Example of Test Platform implementation

The test platform used by ETSI STF424 for validating ITS conformance test suites has been developed using the following tools and components:

- Standard PC equipped with two Ethernet network cards (It is possible to use the same single network card for both tasks, but it is less practical and gives less flexibility).
  One network card (Mac address: 00-A0-24-AD-56-FF) is used to communicate with G5 device.
  The second one (Mac address: 00-50-56-C0-00-08) is used to establish upper tester link with SUT and is configured with IP address 192.168.56.1/24.

- Windows™ XP Professional operating system (32 bits)
  No special requirement concerning operating system. Theoretically, the platform can be used on Linux based operating systems, as it is OS independent.

- Testing Technologies TTworkbench Basic v13 with ASN.1 plugins
  ASN.1 plugins are necessary for CAM and DENM codecs. Any other TTCN-3 test tool would be suitable with minimum adaptation as the test platform is tool independent.

- Java™ JDK 1.6.0-24
  All the software used in the test platform have been developed using Java™ language.

NOTE: "Java™ is the trade name of a product supplied by Oracle. This information is given for the convenience of users of the present document and does not constitute an endorsement by ETSI of the product named. Equivalent products may be used if they can be shown to lead to the same results."

- JnetPcap 1.3.0
  This library is used for capturing and injecting raw Ethernet packets. It is a direct dependency of EthernetLayer module. For easy setup the `jnetpcap.dll` file has to be installed in `C:\Windows\System32\` folder and the jnetpcap.jar has to be installed in `C:\Windows\Sun\Java\lib\ext\` folder or equivalent. By doing this, no specific setting will be required to include JnetPcap library when building Test Adapter.

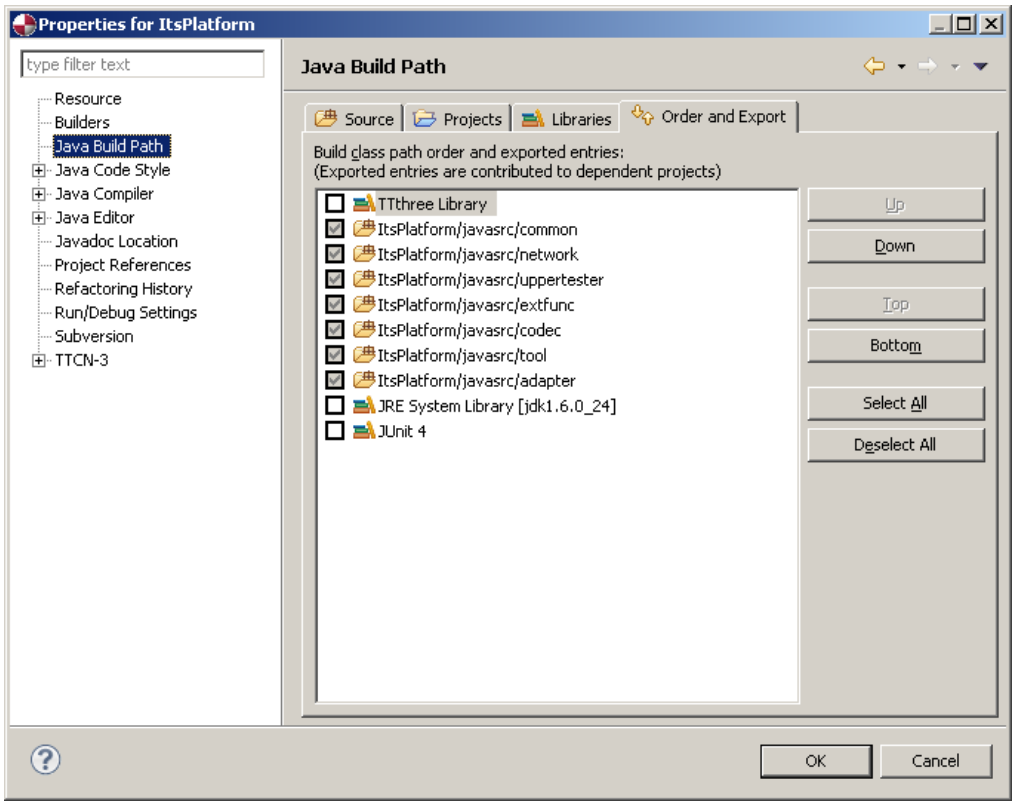
- Cohda Wireless™ MK2
  This device provides G5 connectivity to the test platform. This device features a G5 radio interface used to communicate with SUT and Ethernet interface that is connect to the test platform PC in order to transfer G5 packets to be sent and received via the radio interface.

NOTE: "Cohda Wireless™ is the trade name of a product supplied by Cohda Wireless Pty Ltd. This information is given for the convenience of users of the present document and does not constitute an endorsement by ETSI of the product named. Equivalent products may be used if they can be shown to lead to the same results."

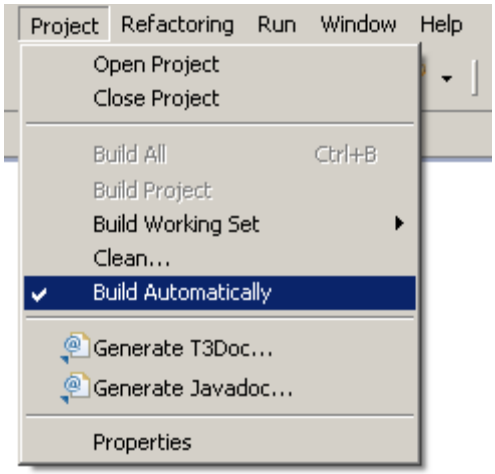
Before running successfully any test, a certain number of settings have to be verified in TTworkbench:

- Project has to be set for using Java™ JDK 1.6.0 as indicating in the following picture. Please note that JnetPcap should automatically appear in the library list:

- Test Adapter and Codecs source folders have to be declared in project's Java™ Build Path:

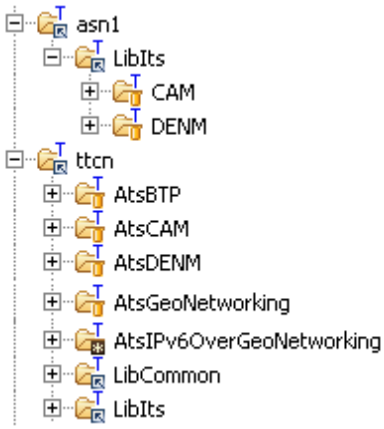



- Test Adapter and Codecs will then be automatically compiled if "Build automatically" option is set:



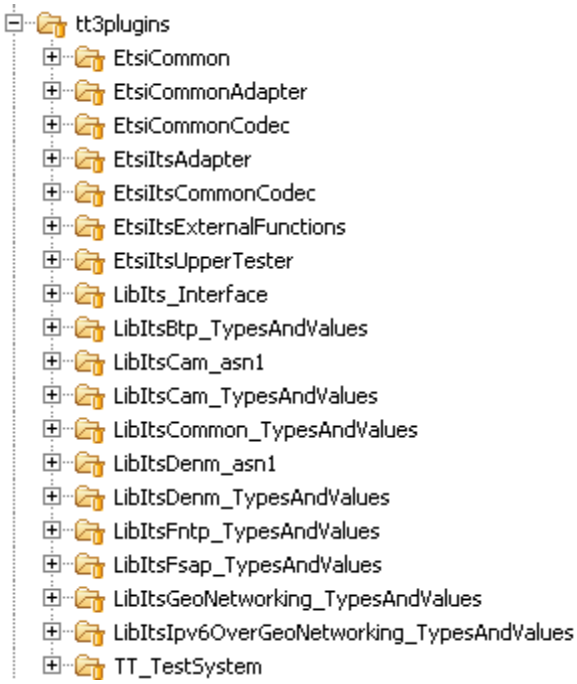

- Alternatively, Test Adapter and Codecs precompiled libraries have to be referenced as external libraries.

- TTCN-3 test suites and ASN.1 definitions have to be copied to the project and declared as TTCN-3 source folders:




- The test suites need to be compiled using the "Rebuild All" button:

- TT3 plugins have to be configured using the provided xml files:



- Test adapter parameters have to be adjusted in `taconfig.xml` file:

```
<parameter id="taParams">
      <parameter id="DEBUG_ENABLED" value="ALL"/>
      <parameter id="camPort" value="BTP/GN/ETH"/>
      <parameter id="denmPort" value="BTP/GN/ETH"/>
      <parameter id="btpPort" value="GN/ETH"/>
      <parameter id="geoNetworkingPort" value="ETH"/>
      <parameter id="ipv6OverGeoNetworkingPort" value="Debug"/>
      <parameter id="CamUpperTester" value="Operator"/>
      <parameter id="CamUpperTesterSettings" value=""/>
      <parameter id="DenmUpperTester" value="Operator"/>
      <parameter id="DenmUpperTesterSettings" value=""/>
      <parameter id="BtpUpperTester" value="Operator"/>
      <parameter id="BtpUpperTesterSettings" value=""/>
      <parameter id="GnUpperTester" value="Generic"/>
      <parameter id="GnUpperTesterSettings"
            value="NwtaTrigger:192.168.56.10:1600:1601"/>
      <parameter id="LocalEthernetMAC" value="00A024AD56FF"/>
      <parameter id="IutEthernetTypeValue" value="0x0707"/>
      <parameter id="LinkLayer_MTC" value="BABEBABE0000"/>
      <parameter id="LinkLayer_NodeA" value="BABEBABE0001"/>
      <parameter id="LinkLayer_NodeB" value="BABEBABE0002"/>
      <parameter id="LinkLayer_NodeC" value="BABEBABE0003"/>
      <parameter id="LinkLayer_NodeD" value="BABEBABE0004"/>
      <parameter id="Gn6RemoteAdapterIp" value="192.168.56.10"/>
      <parameter id="Gn6RemoteAdapterPort" value="42000"/>
</parameter>
```

Table D.1 summarizes the authorized values for these parameters.

**Table D.1: Test Adapter Parameters**

| Parameter | Description | Allowed values |
|---|---|---|
| `DEBUG_ENABLED` | Indicates whether Codecs and Test Adapter produce debugging logs | ALL, NONE, OFF |
| `camPort` | Defines the lower stack of CamPort | Any combination of valid layer identifier separated by "/" symbol:<br>• ETH<br>• BTP<br>• GN<br>• UdpIp<br>• Debug (pseudo layer that dumps packet to console)<br>• Loopback (pseudo layer that reinjects the packets) |
| `denmPort` | Defines the lower stack of CamPort | |
| `btpPort` | Defines the lower stack of CamPort | |
| `geoNetworkingPort` | Defines the lower stack of CamPort | |
| `ipv6OverGeoNetworkingPort` | Defines the lower stack of CamPort | |
| `CamUpperTester`<br>`DenmUpperTester`<br>`BtpUpperTester`<br>`GnUpperTester` | Selects the type of Upper tester to be used for each test suite | Operator, Yes, Generic |
| `CamUpperTesterSettings`<br>`DenmUpperTesterSettings`<br>`BtpUpperTesterSettings`<br>`GnUpperTesterSettings` | Defines Upper Tester specific settings like remote IP addresses, UDP ports, etc. | Upper tester specific |
| `LocalEthernetMAC` | MAC Address of the Ethernet card used to communicate with G5 equipment | Hexstring representation of Mac Address without separator |
| `IutEthernetTypeValue` | Ethertype value to be used for sending and capturing packets | Integer 0 to 65 635. Should be 0x0707 |
| `LinkLayer_MTC`<br>`LinkLayer_NodeA`<br>`LinkLayer_NodeB`<br>`LinkLayer_NodeC`<br>`LinkLayer_NodeD` | MAC addresses used by simulated ITS nodes | Hexstring representation of Mac Address without separator |
| `Gn6RemoteAdapterIp` | IP Address of GN6 Remote Adapter | Standard IP address notation |
| `Gn6RemoteAdapterPort` | UDP port of GN6 Remote Adapter | Integer 0 to 65 635. |

# Annex E:
# Complete Test Adapter class diagram

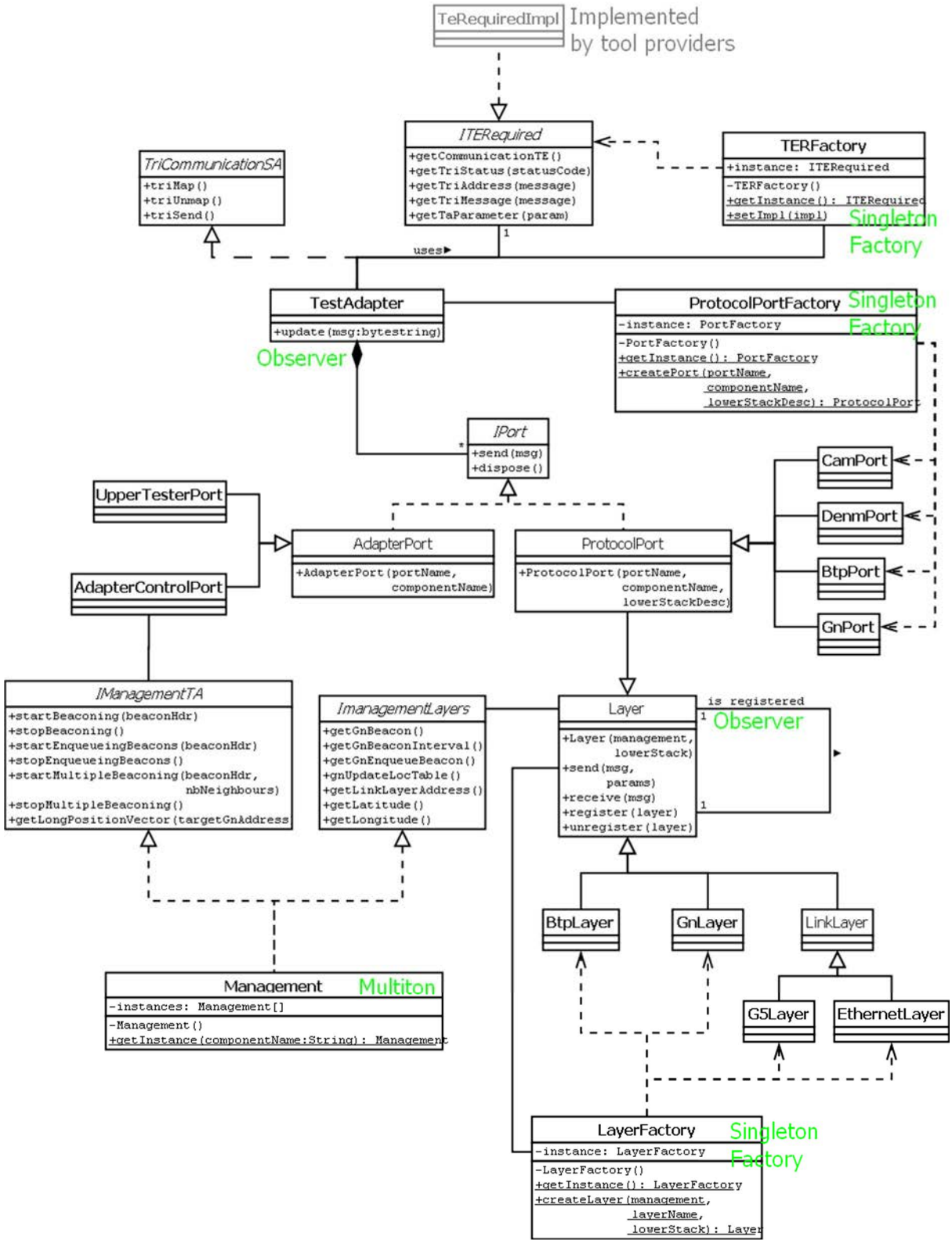



**Figure E.1: Test adapter complete class diagram**

# Annex F: Bibliography

This annex lists all test specifications which were integrated with the Conformance Validation Framework:

- ETSI TS 102 868-1 (V1.2.1): "Intelligent Transport Systems (ITS); Testing; Conformance test specification for Co-operative Awareness Messages (CAM); Part 1: Test requirements and Protocol Implementation Conformance Statement (PICS) proforma".
- ETSI TS 102 868-2 (V1.2.1): "Intelligent Transport Systems (ITS); Testing; Conformance test specification for Co-operative Awareness Messages (CAM); Part 2: Test Suite Structure and Test Purposes (TSS&TP)".
- ETSI TS 102 869-1 (V.1.2.1): "Intelligent Transport Systems (ITS); Testing; Conformance test specification for Of Decentralized Environmental Notification basic Service (DENM); Part 1: Test requirements and Protocol Implementation Conformance Statement (PICS) proforma".
- ETSI TS 102 869-2 (V.1.3.1): "Intelligent Transport Systems (ITS); Testing; Conformance test specification for Of Decentralized Environmental Notification basic Service (DENM); Part 2: Test Suite Structure and Test Purposes (TSS&TP)".
- ETSI TS 102 870-1 (V.1.3.1): "Intelligent Transport Systems (ITS); Testing; Conformance test specifications for Geonetworking Basic Transport Protocol (BTP); Part 1: Test requirements and Protocol Implementation Conformance Statement (PICS) proforma".
- ETSI TS 102 870-2 (V.1.1.1): "Intelligent Transport Systems (ITS); Testing; Conformance test specifications for Geonetworking Basic Transport Protocol (BTP); Part 2: Test Suite Structure and Test Purposes (TSS&TP)".
- ETSI TS 102 859-1 (V.1.2.1): "Intelligent Transport Systems (ITS); Testing; Conformance test specifications for Transmission of IP packets over GeoNetworking; Part 1: Test requirements and Protocol Implementation Conformance Statement (PICS) proforma".
- ETSI TS 102 859-2 (V.1.2.1): "Intelligent Transport Systems (ITS); Testing; Conformance test specifications for Transmission of IP packets over GeoNetworking; Part 2: Test Suite Structure and Test Purposes (TSS&TP)".
- ETSI EG 202 798 (V1.1.1): "Intelligent Transport Systems (ITS); Testing; Framework for conformance and interoperability testing".
- JNetPcap library: "http://jnetpcap.com/".
- ETSI ES 201 873-1 (V4.5.1): "Methods for Testing and Specification (MTS); The Testing and Test Control Notation version 3; Part 1: TTCN-3 Core Language".
- ETSI ES 201 873-6 (V4.5.1): "Methods for Testing and Specification (MTS); The Testing and Test Control Notation version 3; Part 6: TTCN-3 Control Interface (TCI)".

# History

| Document history | | |
|---|---|---|
| V1.1.1 | November 2012 | Publication |
| V1.2.1 | May 2014 | Publication |
| V1.3.1 | July 2015 | Publication |
| | | |
| | | |