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Intelligent Transport Systems (ITS);
Testing;
Conformance test specification for
Decentralized Environmental Notification Messages (DENM);
Part 2: Test Suite Structure and Test Purposes (TSS&TP)

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Contents

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Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee Intelligent Transport System (ITS).

The present document is part 2 of a multi-part deliverable covering Conformance test specification for Decentralized Environmental Notification Messages (DENM) as identified below:

Part 1: "Test requirements and Protocol Implementation Conformance Statement (PICS) proforma";

Part 2: "Test Suite Structure and Test Purposes (TSS&TP)";

Part 3: "Abstract Test Suite (ATS) and Protocol Implementation eXtra Information for Testing (PIXIT)".

1 Scope

The present document provides the Test Suite Structure and Test Purposes (TSS&TP) for Decentralized Environmental Notification Messages (DENM) as defined in TS 102 637-3 [1] in compliance with the relevant requirements and in accordance with the relevant guidance given in ISO/IEC 9646-7 [6].

The ISO standard for the methodology of conformance testing (ISO/IEC 9646-1 [3] and ISO/IEC 9646-2 [4]) as well as the ETSI rules for conformance testing (ETS 300 406 [7]) are used as a basis for the test methodology.

2 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.

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

2.1 Normative references

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

[1] ETSI EN 302 637-3 (V1.2.0): "Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 3: Specifications of Decentralized Environmental Notification Basic Service".

[2] ETSI TS 102 869-1 (V1.2.1): "Intelligent Transport Systems (ITS); Testing; Conformance test specification for Decentralized Environmental Notification Messages (DENM); Part 1: Test requirements and Protocol Implementation Conformance Statement (PICS) proforma".

[3] ISO/IEC 9646-1 (1994): "Information technology -- Open Systems Interconnection -- Conformance testing methodology and framework -- Part 1: General concepts".

[4] ISO/IEC 9646-2 (1994): "Information technology -- Open Systems Interconnection -- Conformance testing methodology and framework -- Part 2: Abstract Test Suite specification".

[5] ISO/IEC 9646-6 (1994): "Information technology -- Open Systems Interconnection -- Conformance testing methodology and framework -- Part 6: Protocol profile test specification".

[6] ISO/IEC 9646-7 (1995): "Information technology -- Open Systems Interconnection -- Conformance testing methodology and framework -- Part 7: Implementation Conformance Statements".

[7] ETSI ETS 300 406 (1995): "Methods for testing and Specification (MTS); Protocol and profile conformance testing specifications; Standardization methodology".

2.2 Informative references

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 EG 202 798: "Intelligent Transport Systems (ITS); Testing; Framework for conformance and interoperability testing".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in TS 102 637-3 [1], ISO/IEC 9646-6 [5] and ISO/IEC 9646-7 [6] apply.

3.2 Abbreviations

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

BV	Valid Behaviour
CAN	Controller Area Network
CLT	Current Local Time
DE	Data Element
DEN	Decentralized Environmental Notification
DENM	Decentralized Environmental Notification Message
EVGN	Event Generation
ITS	Intelligent Transportation Systems
ITS-S	Intelligent Transport System - Station
IUT	Implementation Under Test
MSGF	Message Format
PDU	Protocol Data Unit
TP	Test Purposes
TSS	Test Suite Structure

4 Test Suite Structure (TSS)

4.1 Structure for DEN tests

Table 1 shows the DEN Test Suite Structure (TSS) including its subgroups defined for conformance testing.

Table 1: TSS for DEN

Root	Group	category
DEN	Message transmission	Valid behaviour
	--- Message format	Valid behaviour
	--- Event Generation	Valid behaviour
	--- Event Update	Valid behaviour
	--- Event Termination	Valid behaviour
	--- Message Repetition	Valid behaviour
	Message reception	Valid behaviour
	Keep-alive Forwarding	Valid behaviour

The test suite is structured as a tree with the root defined as DEN. The tree is of rank 2 with the first rank a Group, the second a category. The second rank is the standard ISO conformance test categories.

4.2 Test groups

The test suite has a total of three levels. The first level is the root. The second level separates the root into various functional areas. The third level is the standard ISO conformance test categories.

4.2.1 Root

The root identify the Decentralized environmental Notification Messages (DENM) given in TS 102 637-3 [1].

4.2.2 Groups

This level contains three functional areas identified as:

- Message transmission
- Message format
- Event Generation
- Event Update
- Event Termination
- Message Repetition
- Message reception
- Keep-alive Forwarding

4.2.3 Categories

This level contains the standard ISO conformance test categories limited to the valid behaviour.

5 Test Purposes (TP)

5.1 Introduction

5.1.1 TP definition conventions

The TP definition is built according to EG 202 798 [i.1].

5.1.2 TP Identifier naming conventions

The identifier of the TP is built according to table 2.

Table 2: TP naming convention

Identifier:	**TP/<root>/<gr>/<x>/<nn>**		
	<root> = root	DEN	
	<gr> = group	MSGF	Message transmission - Message format
		EVGN	Message transmission - Event Generation
		EVUP	Message transmission - Event Update
		EVTR	Message transmission - Event Termination
		EVRP	Message transmission - Message Repetition
		MSRV	Message reception
		KAFW	Keep-alive Forwarding
	<x> = type of testing	BV	Valid Behaviour tests
	<nn> = sequential number		01 to 99

5.1.3 Rules for the behaviour description

The description of the TP is built according to EG 202 798 [i.1].

The base standards are not using finite state machine concept. As consequence, the test purposes use a generic "Initial State" that corresponds to a state where the IUT is ready for starting the test execution. Furthermore, the IUT shall be left in this "Initial State", when the test is completed.

Being in the "Initial State", no pending actions, which could disturb the execution of following test purposes, are left in the IUT.

5.1.4 Sources of TP definitions

All TPs are specified according to EN 302 637-3 [1].

5.1.5 Mnemonics for PICS reference

To avoid an update of all TPs when the PICS document is changed, the following table introduce mnemonics name and the correspondence with the real PICS item number

Table 3: Mnemonics for PICS reference

Mnemonic	PICS item
PICS_KAF	A.2/5 [**Error! Reference source not found.**].

5.2 Test purposes for DEN

5.2.1 Message Transmission

5.2.1.1 Message Format

TP Id	TP/DEN/ MSGF/BV-01
Test objective	Check that protocolVersion is set to 1 and messageID is set to 1
Reference	EN 302 637-3 [1], clause B.1
PICS Selection	
Initial conditions	

with {
the IUT being in the "initial state"
}	

Expected behaviour	

ensure that {
when {
the IUT receives an AppDENM_Trigger request from the application layer
}
then {
the IUT sends a valid DENM
containing ITS PDU header
containing protocolVersion
indicating value 1
and containing messageID
indicating value 1
}	

TP Id	TP/DEN/ MSGF/BV-02
Test objective	Check that sent DENM contains at least one 'trace' DE
Reference	EN 302 637-3 [1], clause 6.1.3.2
PICS Selection	
Initial conditions	

with {
the IUT being in the "initial state"
}	

Expected behaviour	

ensure that {
when {
the IUT receives an AppDENM_Trigger request from the application layer
}
then {
the IUT sends a valid DENM
containing location container
containing at least one 'trace'
}	

5.2.1.2 Event Generation

TP Id	TP/DEN/EVGN/BV-01
Test objective	Check that DEN Basic Service generates a new DENM on reception of a valid AppDENM_Trigger request
Reference	EN 302 637-3 [1], clause 6.1.2.1
PICS Selection	
Initial conditions	

with {
the IUT being in the "initial state"
}	

Expected behaviour	

ensure that {
when {
the IUT receives an AppDENM_Trigger request from the application layer
}
then {
the IUT sends a valid DENM
}
}	

TP Id	TP/DEN/EVGN/BV-02
Test objective	Check that a new ActionID value is assigned for each generated DENM
Reference	EN 302 637-3 [1], clause 6.1.1
PICS Selection	
Initial conditions	

with {
the IUT being in the "initial state"
and the IUT having generated several events
}	

Expected behaviour	

ensure that {
when {
the IUT is requested to generate a new event
}
then {
the IUT sends a valid DENM
containing management container
containing actionID
indicating an unused value
}
}	

TP Id	TP/DEN/EVGN/BV-03
Test objective	Check that newly created ActionID contains the originator ITS-S ID
Reference	EN 302 637-3 [1], clause 6.1.1
PICS Selection	
Initial conditions	

with {
the IUT being in the "initial state"
}	

Expected behaviour	

ensure that {
when {
the IUT is requested to generate a new event
}
then {
the IUT sends a valid DENM
containing management container
containing actionID
containing originatorStationID
indicating its own StationID
}
}	

TP Id	TP/DEN/EVGN/BV-04
Test objective	Check that Cause and subcause values included in DENM as provided by application
Reference	EN 302 637-3 [1], clause 7.1.3
PICS Selection	
Initial conditions	

with {
the IUT being in the "initial state"
}	

Expected behaviour	

ensure that {
when {
the IUT receives an AppDENM_trigger request from the application layer
containing situation container
containing eventType
containing causeCode
indicating Value1
containing subCauseCode
indicating Value2
}
then {
the IUT sends a valid DENM
containing situation container
containing eventType
containing causeCode
indicating Value1
containing subCauseCode
indicating Value2
}
}	

TP Id	TP/DEN/EVGN/BV-05
Test objective	Check that referenceTime is set to the current time when generating a DENM for a new event
Reference	EN 302 637-3 [1], clause 8.1.1.2
PICS Selection	

Initial conditions

```
with {
    the IUT being in the "initial state"
    and the IUT having generated several events
}
```

Expected behaviour

```
ensure that {
    when {
        the IUT is requested to generate a new event
    }
    then {
        the IUT sends a valid DENM
            containing management container
                containing referenceTime                indicating CLT
    }
}
```

TP Id	TP/DEN/EVGN/BV-06
Test objective	Check that on startup, sequenceNumber is initialized with latest used value
Reference	EN 302 637-3 [1], clause 8.1.1.1
PICS Selection	

Initial conditions

```
with {
    the IUT being in the "initial state"
    and the IUT having generated several events
    and the IUT having generated its last DENM
        containing management container
            containing actionID
                containing sequenceNumber
                    indicating SEQ1
    and the IUT having been restarted
}
```

Expected behaviour

```
ensure that {
    when {
        the IUT is requested to generate a new event
    }
    then {
        the IUT sends a valid DENM
            containing management container
                containing actionID
                    containing sequenceNumber
                        indicating SEQ1 + 1
    }
}
```

TP Id	TP/DEN/EVGN/BV-07
Test objective	Check that sequenceNumber is incremented and set to an unused value each time an event is detected
Reference	EN 302 637-3 [1], clauses 6.1.1, 8.1.1.1
PICS Selection	

Initial conditions

```
with {
    the IUT being in the "initial state"
    and the IUT having generated several events
    and the IUT having generated its last DENM
        containing management container
            containing actionID
                containing sequenceNumber
                    indicating SEQ1
    and no active event being associated with sequenceNumber SEQ1 + 1
}
```

Expected behaviour

```
ensure that {
    when {
        the IUT is requested to generate a new event
    }
    then {
        the IUT sends a valid DENM
            containing management container
                containing actionID
                    containing sequenceNumber
                        indicating SEQ1 + 1
    }
}
```

TP Id	TP/DEN/EVGN/BV-08
Test objective	Check that sequenceNumber is incremented and set to an unused value each time an event is detected
Reference	EN 302 637-3 [1], clauses 6.1.1, 8.1.1.1
PICS Selection	

Initial conditions

```
with {
    the IUT being in the "initial state"
    and the IUT having generated several events
    and the IUT having generated its last DENM
        containing management container
            containing actionID
                containing sequenceNumber
                    indicating SEQ1
    and an active event being associated with sequenceNumber SEQ1 + 1
    and no active event being associated with sequenceNumber SEQ1 + 2
}
```

Expected behaviour

```
ensure that {
    when {
        the IUT is requested to generate a new event
    }
    then {
        the IUT sends a valid DENM
            containing management container
                containing actionID
                    containing sequenceNumber
                        indicating SEQ1 + 2
    }
}
```

TP Id	TP/DEN/EVGN/BV-09
Test objective	Check that the sequence number restarts from 0 when it reaches its range limit
Reference	EN 302 637-3 [1], clause 6.1.1
PICS Selection	
Initial conditions	

with {
the IUT being in the "initial state"
and the IUT having generated several events
and the IUT having generated its last DENM
containing management container
containing actionID
containing sequenceNumber
indicating 65535
and no active event being associated with sequenceNumber 0
}	

Expected behaviour	

ensure that {
when {
the IUT is requested to generate a new event
}
then {
the IUT sends a valid DENM
containing management container
containing actionID
containing sequenceNumber
indicating 0
}
}	

5.2.1.3 Event Update

TP Id	TP/DEN/EVUP/BV-01
Test objective	Check that DEN Basic Service generates an update DENM on reception of a valid AppDENM_update request
Reference	EN 302 637-3 [1], clause 6.1.2.2
PICS Selection	
Initial conditions	

with {
the IUT being in the "initial state"
and the IUT having generated an event
}	

Expected behaviour	

ensure that {
when {
the IUT receives an AppDENM_update request from the application layer
}
then {
the IUT sends a valid DENM
}
}	

TP Id	TP/DEN/EVUP/BV-02
Test objective	Check that the actionID is not changed by DENM update
Reference	EN 302 637-3 [1], clauses 6.1.2.2, 8.1.1.1
PICS Selection	

Initial conditions

```
with {
    the IUT being in the "initial state"
    and the IUT having generated an event
        containing management container
            containing actionID
                indicating ACTION_ID1
}
```

Expected behaviour

```
ensure that {
    when {
        the IUT receives an AppDENM_update request associated with ACTION_ID1 from the application layer
    }
    then {
        the IUT sends a valid DENM
            containing management container
                containing actionID
                    indicating ACTION_ID1
    }
}
```

TP Id	TP/DEN/EVUP/BV-03
Test objective	Check that referenceTime is updated and superior to previous value for each DENM update
Reference	EN 302 637-3 [1], clause 6.1.2.2
PICS Selection	

Initial conditions

```
with {
    the IUT being in the "initial state"
    and the IUT having generated an event
        containing management container
            containing actionID
                indicating ACTION_ID1
            containing referenceTime                indicating REFERENCETIME1
}
```

Expected behaviour

```
ensure that {
    when {
        the IUT receives an AppDENM_update request associated with ACTION_ID1 from the application layer
    }
    then {
        the IUT sends a valid DENM
            containing management container
                containing actionID
                    indicating ACTION_ID1
                and containing referenceTime                indicating REFERENCETIME2 > REFERENCETIME1
    }
}
```

TP Id	TP/DEN/EVUP/BV-04
Test objective	Check that DEN Basic Service does not send any update DENM if actionID is not in originator ITS-S message table
Reference	EN 302 637-3 [1], clause 8.1.2
PICS Selection	
Initial conditions	

with {
the IUT being in the "initial state"
and the IUT having generated an event
and the IUT not having sent event being associated with actionID ACTION_ID1
containing originatorStationID
indicating its own stationID
and containing sequenceNumber
indicating SEQ1
}	

Expected behaviour	

ensure that {
when {
the IUT is requested to update an event associated to actionID ACTION_ID1
}
then {
the IUT does not send any DENM for this event
}
}	

5.2.1.4 Event Termination

TP Id	TP/DEN/EVTR/BV-01
Test objective	Check that DEN Basic Service generates a cancellation DENM when application indicates the premature termination of an event for which it is the originator
Reference	EN 302 637-3 [1], clauses 6.1.2.4, 8.1.1.2
PICS Selection	
Initial conditions	

with {
the IUT being in the "initial state"
and the IUT having generated an event
containing management container
containing actionID
indicating ACTION_ID1
and containing validityDuration
indicating DURATION_1
}	

Expected behaviour	

ensure that {
when {
the IUT receives an *App*DENM_*termination* request associated to ACTION_ID1 from the application layer
}
then {
the IUT sends a valid DENM
containing management container
containing actionID
indicating ACTION_ID1
and containing isCancellation
indicating value TRUE
}
}	

TP Id	TP/DEN/EVTR/BV-02
Test objective	Check that DEN Basic Service generates a negation DENM when application indicates the premature termination of an event for which it is not the originator
Reference	EN 302 637-3 [1], clause 6.1.2.4
PICS Selection	

Initial conditions

```
with {
    the IUT being in the "initial state"
    and the IUT having received an event
        containing management container
            containing actionID
                indicating ACTION_ID1
                    containing originatorStationID
                        indicating stationID different from its own stationID

}
```

Expected behaviour

```
ensure that {
    when {
        the IUT receives an AppDENM_termination request associated to ACTION_ID1 from the application layer
    }
    then {
        the IUT sends a valid DENM
            containing management container
                containing actionID
                    indicating ACTION_ID1

                and containing isNegation
                    indicating value TRUE
    }
}
```

TP Id	TP/DEN/EVTR/BV-03
Test objective	Check that referenceTime is set to the latest value received for this event in negation DENM
Reference	EN 302 637-3 [1], clauses 6.1.2.4, 8.1.1.2
PICS Selection	

Initial conditions

```
with {
    the IUT being in the "initial state"
    and the IUT having received an event
        containing management container
            containing actionID
                indicating ACTION_ID1
                    containing originatorStationID
                        indicating stationID different from its own stationID
            and containing referenceTime
                indicating REFERENCETIME1
    and the IUT having received an event
        containing management container
            containing actionID
                indicating ACTION_ID1
            and containing referenceTime
                indicating REFERENCETIME2 > REFERENCETIME1
}
```

Expected behaviour

```
ensure that {
    when {
        the IUT receives an AppDENM_termination request associated to ACTION_ID1 from the application layer
    }
    then {
        the IUT sends a valid DENM
            containing management container
                containing actionID
                    indicating ACTION_ID1
                and containing referenceTime
                    indicating value REFERENCETIME2
                and containing isNegation
                    indicating value TRUE
    }
}
```

TP Id	TP/DEN/EVTR/BV-04
Test objective	Check that situation container and location container are not present in cancellation DENM
Reference	EN 302 637-3 [1], clause 7.1
PICS Selection	

Initial conditions

```
with {
    the IUT being in the "initial state"
    and the IUT having generated an event
        containing management container
            containing actionID
                indicating ACTION_ID1

}
```

Expected behaviour

```
ensure that {
    when {
        the IUT receives an AppDENM_termination request associated to ACTION_ID1 from the application layer
    }
    then {
        the IUT sends a valid DENM
            containing management container
                containing actionID
                    indicating ACTION_ID1
                and containing isCancellation
                    indicating value TRUE
            and not containing situation container
            and not containing location container
    }
}
```

TP Id	TP/DEN/EVTR/BV-05
Test objective	Check that situation container and location container are not present in negation DENM
Reference	EN 302 637-3 [1], clause 7.1
PICS Selection	

Initial conditions

```
with {
    the IUT being in the "initial state"
    and the IUT having received an event
        containing management container
            containing actionID
                indicating ACTION_ID1
                    containing originatorStationID
                        indicating stationID different from its own stationID

}
```

Expected behaviour

```
ensure that {
    when {
        the IUT receives an AppDENM_termination request associated to ACTION_ID1 from the application layer
    }
    then {
        the IUT sends a valid DENM
            containing management container
                containing actionID
                    indicating ACTION_ID1

                and containing isNegation
                    indicating value TRUE
            and not containing situation container
            and not containing location container
    }
}
```

TP Id	TP/DEN/EVTR/BV-06
Test objective	Check that DEN Basic Service does not send any termination DENM if actionID is not in originator ITS-S message table or receiver ITS-S message table
Reference	EN 302 637-3 [1], clauses 8.1.2
PICS Selection	

Initial conditions

```
with {
    the IUT being in the "initial state"
    and the IUT having generated several events
    and the IUT not having send event being associated with ACTION_ID1
        containing originatorStationID
            indicating its own stationID
        and containing sequenceNumber
            indicating SEQ1
}
```

Expected behaviour

```
ensure that {
    when {
        the IUT is requested to terminate an event associated to ACTION_ID1
            containing originatorStationID
                indicating its own stationID
            and containing sequenceNumber
                indicating SEQ1
    }
    then {
        the IUT does not send any termination DENM for this event
    }
}
```

NOTE: Event associated to ACTION_ID1 cannot be present in receiver ITS-S message table as its stationID is IUT's stationID (see TP/DEN/EVTR/BV-07)

TP Id	TP/DEN/EVTR/BV-07
Test objective	Check that DEN Basic Service does not send any termination DENM if actionID is not in originator ITS-S message table or receiver ITS-S message table
Reference	EN 302 637-3 [1], clauses 8.1.2
PICS Selection	

Initial conditions

```
with {
    the IUT being in the "initial state"
    and the IUT having received several events
    and the IUT not having received event being associated with ACTION_ID1
        containing originatorStationID
            indicating STATION_ID1 different from its own stationID
        and containing sequenceNumber
            indicating SEQ1
}
```

Expected behaviour

```
ensure that {
    when {
        the IUT is requested to terminate an event associated to ACTION_ID1
            containing originatorStationID
                indicating STATION_ID1
            and containing sequenceNumber
                indicating SEQ1
    }
    then {
        the IUT does not send send any termination DENM for this event
    }
}
```

NOTE: Event associated to ACTION_ID1 cannot be present in originator ITS-S message table as its stationID is not IUT's stationID (see TP/DEN/EVTR/BV-06)

5.2.1.5 Message repetition

TP Id	TP/DEN/EVRP/BV-01
Test objective	Check that DEN Basic Service repeats DENM transmission according to transmissionInterval parameter provided by application
Reference	EN 302 637-3 [1], clause 6.1.2.3
PICS Selection	
Initial conditions	

with {
the IUT being in the "initial state"
and the IUT having generated an event
containing management container
containing actionID
indicating ACTION_ID1
and containing validityDuration
indicating DURATION_1
and containing transmissionInterval
indicating INTERVAL_1
}	

Expected behaviour	

ensure that {
when {
the IUT is alerted of expiration of the time associated with INTERVAL_1
}
then {
the IUT repeats the transmission of the valid DENM associated with ACTION_ID1
}
}	

TP Id	TP/DEN/EVRP/BV-02
Test objective	Check that the repeated DENM is always the most up-to-date message
Reference	EN 302 637-3 [1], clause 6.1.2.3
PICS Selection	
Initial conditions	

with {
the IUT being in the "initial state"
and the IUT having generated an event
containing management container
containing actionID
indicating ACTION_ID1
and containing validityDuration
indicating DURATION_1
and containing transmissionInterval
indicating INTERVAL_1
and the IUT having generated an update of the event associated with ACTION_ID1 modifying partly the event
}	

Expected behaviour	

ensure that {
when {
the IUT is alerted of expiration of the time associated with INTERVAL_1
}
then {
the IUT repeats the transmission of the most up-to-date valid DENM associated with ACTION_ID1
}
}	

TP Id	TP/DEN/EVRP/BV-03
Test objective	Check that DEN Basic Service stops retransmitting DENM after event's validityDuration expiration
Reference	EN 302 637-3 [1], clauses 6.1.2.4, 8.1.2
PICS Selection	

Initial conditions

```
with {
    the IUT being in the "initial state"
    and the IUT having generated an event
        containing management container
            containing actionID
                indicating ACTION_ID1
            and containing validityDuration
                indicating DURATION_1
            and containing transmissionInterval
                indicating INTERVAL_1
    and the IUT having repeated (one or more) the transmission of the valid DENM associated with ACTION_ID1
}
```

Expected behaviour

```
ensure that {
    when {
        the IUT is alerted of expiration of the time associated with DURATION_1
    }
    then {
        the IUT stops the retransmission of the most up-to-date valid DENM associated with ACTION_ID1
    }
}
```

TP Id	TP/DEN/EVRP/BV-04
Test objective	Check that DEN Basic Service stops retransmitting DENM after event's repetitionDuration expiration
Reference	EN 302 637-3 [1], clause 8.1.2
PICS Selection	

Initial conditions

```
with {
    the IUT being in the "initial state"
    and the IUT having received an AppDENM_trigger request from application layer
        containing repetitionDuration
            indicating DURATION_2
    and the IUT having generated an event
        containing management container
            containing actionID
                indicating ACTION_ID1
            and containing validityDuration
                indicating DURATION_1 > DURATION_2
            and containing transmissionInterval
                indicating INTERVAL_1
    and the IUT having repeated (one or more) the transmission of the valid DENM associated with ACTION_ID1
}
```

Expected behaviour

```
ensure that {
    when {
        the IUT is alerted of expiration of the time associated with DURATION_2
    }
    then {
        the IUT stops the retransmission of the most up-to-date valid DENM associated with ACTION_ID1
    }
}
```

TP Id	TP/DEN/EVRP/BV-05
Test objective	Check that DEN Basic Service does not repeat transmission of DENM if transmissionInterval is not provided by application
Reference	EN 302 637-3 [1], clause 8.1.2
PICS Selection	

Initial conditions

```
with {
    the IUT being in the "initial state"
    and the IUT having received an AppDENM_trigger request from application layer
        not containing transmissionInterval
    and the IUT having generated an event
        containing management container
            containing actionID
                indicating ACTION_ID1
            and containing validityDuration
                indicating DURATION_1
}
```

Expected behaviour

```
ensure that {
    when {
        the IUT has detected that transmissionInterval is not provided for the event associated with ACTION_ID1
    }
    then {
        the IUT does not repeat the transmission of the valid DENM associated with ACTION_ID1
    }
}
```

TP Id	TP/DEN/EVRP/BV-06
Test objective	Check that DEN Basic Service does not repeat transmission of DENM if repetitionDuration is not provided by application
Reference	EN 302 637-3 [1], clause 6.1.2.3
PICS Selection	

Initial conditions

```
with {
    the IUT being in the "initial state"
    and the IUT having received an AppDENM_trigger request from application layer
        not containing repetitionDuration
    and the IUT having generated an event
        containing management container
            containing actionID
                indicating ACTION_ID1
            and containing validityDuration
                indicating DURATION_1
            and containing transmissionInterval
                indicating INTERVAL_1
}
```

Expected behaviour

```
ensure that {
    when {
        the IUT has detected that repetitionDuration is not provided for the event associated with ACTION_ID1
    }
    then {
        the IUT does not repeat the transmission of the valid DENM associated with ACTION_ID1
    }
}
```

TP Id	TP/DEN/EVRP/BV-07
Test objective	Check that DEN Basic Service does not repeat transmission of DENM if *detectionTime* is not provided by application
Reference	EN 302 637-3 [1], clause 6.1.2.3
PICS Selection	

Initial conditions

```
with {
    the IUT being in the "initial state"
    and the IUT having received an AppDENM_trigger request from application layer
        not containing detectionTime
    and the IUT having generated an event
        containing management container
            containing actionID
                indicating ACTION_ID1
            and containing validityDuration
                indicating DURATION_1
            and containing transmissionInterval
                indicating INTERVAL_1
}
```

Expected behaviour

```
ensure that {
    when {
        the IUT has detected that detectionTime is not provided for the event associated with ACTION_ID1
    }
    then {
        the IUT does not repeat the transmission of the valid DENM associated with ACTION_ID1
    }
}
```

5.2.2 Message Reception

TP Id	TP/DEN/MSRV/BV-01
Test objective	Check that receiver ITS-S transmits DENM to application if it concerns an unknown ActionID and if it is not a termination DENM
Reference	EN 302 637-3 [1], clauses 8.3.2
PICS Selection	

Initial conditions

```
with {
    the IUT being in the "initial state"
    and the IUT not having send DENM
        containing management container
            containing actionID
                indicating ACTION_ID1
    and the IUT not having received DENM
        containing management container
            containing actionID
                indicating ACTION_ID1
}
```

Expected behaviour

```
ensure that {
    when {
        the IUT receives a DENM that is not a termination
            containing management container
                containing actionID
                    indicating ACTION_ID1
    }
    then {
        the IUT transmits the DENM content to upper layer
    }
}
```

TP Id	TP/DEN/MSRV/BV-02
Test objective	Check that receiver ITS-S transmits DENM to application if it concerns a known ActionID and referenceTime is greater than highest value received for this ActionID
Reference	EN 302 637-3 [1], clauses 8.3.2
PICS Selection	

Initial conditions

```
with {
    the IUT being in the "initial state"
    and the IUT having received DENM
        containing management container
            containing actionID
                indicating ACTION_ID1
            and containing referenceTime
                indicating REFERENCETIME_1
}
```

Expected behaviour

```
ensure that {
    when {
        the IUT receives a DENM
            containing management container
                containing actionID
                    indicating ACTION_ID1
                and containing referenceTime
                    indicating REFERENCETIME_2 greater than REFERENCETIME_1
    }
    then {
        the IUT transmits the DENM content to upper layer
    }
}
```

TP Id	TP/DEN/MSRV/BV-03
Test objective	Check that receiver ITS-S discards termination DENM if it concerns an unknown ActionID
Reference	EN 302 637-3 [1], clauses 8.3.2
PICS Selection	

Initial conditions

```
with {
    the IUT being in the "initial state"
    and the IUT having sent several events
    and the IUT not having send DENM
        containing actionID
            indicating ACTION_ID1
}
```

Expected behaviour

```
ensure that {
    when {
        the IUT receives a termination DENM
            containing actionID
                indicating ACTION_ID1
    }
    then {
        the IUT discards the DENM
        and the IUT does not forward the DENM content to upper layer
    }
}
```

TP Id	TP/DEN/MSRV/BV-04
Test objective	Check that receiver ITS-S discards termination DENM if it concerns an unknown ActionID
Reference	EN 302 637-3 [1], clauses 8.3.2
PICS Selection	

Initial conditions

```
with {
    the IUT being in the "initial state"
    and the IUT having received several events
    and the IUT not having received DENM
        containing actionID
            indicating ACTION_ID1
}
```

Expected behaviour

```
ensure that {
    when {
        the IUT receives a termination DENM
            containing actionID
                indicating ACTION_ID1
    }
    then {
        the IUT discards the DENM
        and the IUT does not forward the DENM content to upper layer
    }
}
```

TP Id	TP/DEN/MSRV/BV-05
Test objective	Check that receiver ITS-S discards DENM if referenceTime is lower than highest value received for this ActionID
Reference	EN 302 637-3 [1], clauses 8.3.2
PICS Selection	

Initial conditions

```
with {
    the IUT being in the "initial state"
    and the IUT having received DENM
        containing management container
            containing actionID
                indicating ACTION_ID1
            and containing referenceTime
                indicating REFERENCETIME_1
}
```

Expected behaviour

```
ensure that {
    when {
        the IUT receives a DENM
            containing management container
                containing actionID
                    indicating ACTION_ID1
                and containing referenceTime
                    indicating REFERENCETIME_2 lower than REFERENCETIME_1
    }
    then {
        the IUT discards the DENM
        and the IUT does not forward the DENM content to upper layer
    }
}
```

TP Id	TP/DEN/MSRV/BV-06
Test objective	Check that receiver ITS-S discards DENM if referenceTime is equal to highest received value and detectionTime is not more recent
Reference	EN 302 637-3 [1], clauses 8.3.2
PICS Selection	

Initial conditions

```
with {
    the IUT being in the "initial state"
    and the IUT having received DENM
        containing management container
            containing actionID
                indicating ACTION_ID1
            and containing referenceTime          indicating REFERENCETIME_1
            and containing detectionTime
                indicating TIME_1
}
```

Expected behaviour

```
ensure that {
    when {
        the IUT receives a DENM
            containing management container
                containing actionID
                    indicating ACTION_ID1
                and containing referenceTime          indicating REFERENCETIME_1
                and containing detectionTime
                    indicating TIME_2 not more recent than TIME_1
    }
    then {
        the IUT discards the DENM
        and the IUT does not forward the DENM content to upper layer
    }
}
```

TP Id	TP/DEN/MSRV/BV-07
Test objective	Check that receiver ITS-S transmits DENM to application if it concerns a known ActionID and referenceTime is equal to highest received value and detectionTime is more recent
Reference	EN 302 637-3 [1], clauses 8.3.2
PICS Selection	

Initial conditions

```
with {
    the IUT being in the "initial state"
    and the IUT having received DENM
        containing management container
            containing actionID
                indicating ACTION_ID1
            and containing referenceTime          indicating REFERENCETIME_1
            and containing detectionTime
                indicating TIME_1
}
```

Expected behaviour

```
ensure that {
    when {
        the IUT receives a DENM
            containing management container
                containing actionID
                    indicating ACTION_ID1
                and containing referenceTime
                    indicating REFERENCETIME_1
                and containing detectionTime
                    indicating TIME_2 more recent than TIME_1
    }
    then {
        the IUT transmits the DENM content to upper layer
    }
}
```

5.2.3 Keep-Alive Forwarding

TP Id	TP/DEN/KAFW/BV-01
Test objective	Check that forwarder ITS-S forwards DENM if no DENM with same ActionId has been received during forwarding delay
Reference	EN 302 637-3 [1], clause 8.2.2
PICS Selection	PICS_KAF
Initial conditions	

with {
the IUT being in the "initial state"
and the IUT having received a DENM
containing actionID
indicating ACTION_ID1
and containing transmissionInterval
indicating TRANS_INTERVAL1
and containing validityDuration
indicating value more than 3 times greater than TRANS_INTERVAL1
and the IUT having starting timer T_Forwarding for this DENM
and the IUT not having received further DENM
containing actionID
indicating ACTION_ID1
}	

Expected behaviour	

ensure that {
when {
the timer T_Forwarding expires
}
then {
the IUT reconstructs and sends the DENM associated to ACTION_ID1
}
}	

TP Id	TP/DEN/KAFW/BV-02
Test objective	Check that forwarder ITS-S forwards DENM if no DENM with same ActionId and referenceTime greater or equal to the last received DENM has been received during forwarding delay
Reference	EN 302 637-3 [1], clause 8.2.2
PICS Selection	PICS_KAF

Initial conditions

```
with {
    the IUT being in the "initial state"
    and the IUT having received a DENM
        containing actionID
            indicating ACTION_ID1
        and containing transmissionInterval
            indicating TRANS_INTERVAL1
        and containing referenceTime          indicating REFERENCETIME_1
        and containing validityDuration
            indicating value more than 3 times greater than TRANS_INTERVAL1
    and the IUT having starting timer T_Forwarding for this DENM
    and the IUT having received DENM
        containing actionID
            indicating ACTION_ID1
        and containing referenceTime          indicating value REFERENCETIME_2 < REFERENCETIME_1
    and the IUT not having received further DENM
        containing actionID
            indicating ACTION_ID1
        and containing referenceTime          indicating value REFERENCETIME_3 > REFERENCETIME_1
}
```

Expected behaviour

```
ensure that {
    when {
        the timer T_Forwarding expires
    }
    then {
        the IUT reconstructs and sends the DENM associated to ACTION_ID1
    }
}
```

TP Id	TP/DEN/KAFW/BV-03
Test objective	Check that forwarding delay is set to min(2 × transmissionInterval + rnd(0, 150 ms), validityDuration)
Reference	EN 302 637-3 [1], clause 8.2.1.4
PICS Selection	PICS_KAF

Initial conditions

```
with {
    the IUT being in the "initial state"
    and the IUT having received a DENM
        containing actionID
            indicating ACTION_ID1
        and containing transmissionInterval
            indicating TRANS_INTERVAL1
        and containing validityDuration
            indicating value DURATION_1 more than 3 times greater than TRANS_INTERVAL1
}
```

Expected behaviour

```
ensure that {
    when {
        the timer T_Forwarding expires
    }
    then {
        the IUT reconstructs and sends the DENM associated to ACTION_ID1 at a point of time corresponding to
        min ( 2*transmissionInterval + rnd (0, 150 ms ), validityDuration )
    }
}
```

TP Id	TP/DEN/KAFW/BV-04
Test objective	Check that Forwarder ITS-S replaces the ITS PDU header of forwarded DENMs
Reference	EN 302 637-3 [1], clause 8.2.1.6
PICS Selection	PICS_KAF

Initial conditions

```
with {
    the IUT being in the "initial state"
    and the IUT having received a DENM
        containing actionID
            indicating ACTION_ID1
        and containing transmissionInterval
            indicating TRANS_INTERVAL1
        and containing validityDuration
            indicating value more than 3 times greater than TRANS_INTERVAL1
    and the IUT having starting timer T_Forwarding for this DENM
    and the IUT not having received further DENM
        containing actionID
            indicating ACTION_ID1
}
```

Expected behaviour

```
ensure that {
    when {
        the timer T_Forwarding expires
    }
    then {
        the IUT reconstructs and sends the DENM associated to ACTION_ID1
            containing ITS PDU header
                containing StationID
                    indicating its own stationID
    }
}
```

TP Id	TP/DEN/KAFW/BV-05
Test objective	Check that forwarder ITS-S does not change actionID
Reference	EN 302 637-3 [1], clause 8.2.1.1
PICS Selection	PICS_KAF

Initial conditions

```
with {
    the IUT being in the "initial state"
    and the IUT having received a DENM
        containing actionID
            indicating ACTION_ID1
        and containing transmissionInterval
            indicating TRANS_INTERVAL1
        and containing validityDuration
            indicating value more than 3 times greater than TRANS_INTERVAL1
    and the IUT having starting timer T_Forwarding for this DENM
    and the IUT not having received further DENM
        containing actionID
            indicating ACTION_ID1
}
```

Expected behaviour

```
ensure that {
    when {
        the timer T_Forwarding expires
    }
    then {
        the IUT reconstructs and sends the DENM
            containing management container
                containing actionID
                    indicating ACTION_ID1
    }
}
```

TP Id	TP/DEN/KAFW/BV-06
Test objective	Check that forwarder ITS-S does not change referenceTime
Reference	EN 302 637-3 [1], clause 8.2.1.2
PICS Selection	PICS_KAF

Initial conditions

```
with {
    the IUT being in the "initial state"
    and the IUT having received a DENM
        containing actionID
            indicating ACTION_ID1
        and containing transmissionInterval
            indicating TRANS_INTERVAL1
        and containing validityDuration
            indicating value DURATION_1 more than 3 times greater than TRANS_INTERVAL1
        and containing referenceTime          indicating REFERENCETIME_1
    and the IUT having starting timer T_Forwarding for this DENM
    and the IUT not having received further DENM
        containing actionID
            indicating ACTION_ID1
}
```

Expected behaviour

```
ensure that {
    when {
        the timer T_Forwarding expires
    }
    then {
        the IUT reconstructs and sends the DENM associated to ACTION_ID1
            containing management container
                containing referenceTime                indicating REFERENCETIME_1
    }
}
```

TP Id	TP/DEN/KAFW/BV-07
Test objective	Check that forwarder ITS-S does not change isNegation
Reference	EN 302 637-3 [1], clause 8.2.1.3
PICS Selection	PICS_KAF

Initial conditions

```
with {
    the IUT being in the "initial state"
    and the IUT having received a DENM
        containing actionID
            indicating ACTION_ID1
        and containing transmissionInterval
            indicating TRANS_INTERVAL1
        and containing validityDuration
            indicating value DURATION_1 more than 3 times greater than TRANS_INTERVAL1      and containing
isNegation
            indicating ISNEGATION_1
    and the IUT having starting timer T_Forwarding for this DENM
    and the IUT not having received further DENM
        containing actionID
            indicating ACTION_ID1
}
```

Expected behaviour

```
ensure that {
    when {
        the timer T_Forwarding expires
    }
    then {
        the IUT reconstructs and sends the DENM associated to ACTION_ID1
            containing management container
                containing isNegation
                    indicating ISNEGATION_1
    }
}
```

TP Id	TP/DEN/KAFW/BV-08
Test objective	Check that Forwarder ITS-S does not modify management, situation, location and alacarte containers when forwarding a DENM
Reference	EN 302 637-3 [1], clause 8.2.1.6
PICS Selection	PICS_KAF

Initial conditions

```
with {
    the IUT being in the "initial state"
    and the IUT having received a DENM
        containing management container
            indicating MANAGEMENTCONTAINER_1
        and containing situation container
            indicating SITUATION_1
        and containing location container
            indicating LOCATION_1
        and containing alacarte container
            indicating ALACARTE_1
    and the IUT having starting timer T_Forwarding for this DENM
    and the IUT not having received further DENM
        containing actionID
            indicating ACTION_ID1
}
```

Expected behaviour

```
ensure that {
    when {
        the timer T_Forwarding expires
    }
    then {
        the IUT reconstructs and sends the DENM associated to ACTION_ID1
            containing management container
                indicating MANACEMENTCONTAINER_1
            and containing situation container
                indicating SITUATION_1
            and containing location container
                indicating LOCATION_1
            and containing alacarte container
                indicating ALACARTE_1
    }
}
```

TP Id	TP/DEN/KAFW/BV-09
Test objective	Check that forwarder ITS-S stops forwarding DENM after validity expiration
Reference	EN 302 637-3 [1], clause 8.2.2
PICS Selection	

Initial conditions

```
with {
    the IUT being in the "initial state"
    and the IUT having received an event
        containing management container
            containing actionID
                indicating ACTION_ID1
            and containing validityDuration
                indicating DURATION_1
    and the IUT having starting timer T_Forwarding for this DENM
    and the IUT not having received further DENM
        containing actionID
            indicating ACTION_ID1
}
```

Expected behaviour

```
ensure that {
    when {
        the IUT is alerted of expiration of the time associated with DURATION_1
    }
    then {
        the IUT stops to reconstruct and to send the DENM associated with ACTION_ID1
    }
}
```

TP Id	TP/DEN/KAFW/BV-10
Test objective	Check that forwarder ITS-S stops forwarding DENM if it is outside relevance area
Reference	EN 302 637-3 [1], clause 8.2.2
PICS Selection	

Initial conditions

```
with {
    the IUT being in the "initial state"
    and the IUT having received an event
        containing management container
            containing actionID
                indicating ACTION_ID1
    and the IUT having starting timer T_Forwarding for this DENM
    and the IUT not having received further DENM
        containing actionID
            indicating ACTION_ID1
}
```

Expected behaviour

```
ensure that {
    when {
        the IUT is alerted that its position is now outside of the relevance area associated with ACTION_ID1
    }
    then {
        the IUT stops to reconstruct and to send the DENM associated with ACTION_ID1
    }
}
```

Annex A (informative): Bibliography

ETSI TS 102 637-1: "Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 1: Functional Requirements".

ETSI TS 102 637-2 (V1.2.1): "Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 2: Specification of Cooperative Awareness Basic Service".

ETSI TS 102 637-4: "Intelligent Transport Systems (ITS); Vehicular Communications; Basic set of applications; Part 4: Operational Requirements".

History

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