



French C-ITS Deployment Coordination committee

UpperTester extension specification for SPATEM and MAPEM on-lab testing

2.4.2.1 **M** annexe 1

Activity 2: Studies

Sub Activity 2.4 > Specifications



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Quality rules

Reference to the version administration

Version number to be composed of 3 digits > vR.XY

- **R** corresponds to the release number: it is upgraded each time SC Studies validates the diffusion of a new release,

- **X** is the major version number: it is upgraded each time SC Studies validates the deliverable,

- **Y** is the minor version number: it is upgraded each time a contributor changes anything.

Once the deliverable is approved, its version number is upgraded from vR.XY to vR.(X+1)0

Once the deliverable is release, its version number is upgraded from vR.XY to v(R+1).00

As illustration:

0.03 > Work in progress version

0.10 > Del. Approved by SC Studies but not released

2.00 > Del. approved & released (in release 2)

2.05 > Del. Updated - in progress version

Requirements identification & traceability

In this document, the following verbal forms are used to indicate requirements: **Shall / Shall not**

Recommendations shall be indicated by the verbal forms: **Should / Should not**

Permissions shall be indicated by the verbal forms: **May / May not**

Possibility and capability shall be indicated by the verbal forms: **Can / Cannot**

Inevitability used to describe behaviour of systems beyond of the scope of this del. shall be indicated by: **Will / Will not**

Facts shall be indicated by the verbal forms: **Is / Is not**

In the table here below:

2.4.X.XX > is the number given to the deliverable (e.g. 2.4.4.8)

YYYY > for digit are given to identifying which component/entity the requirement is addressing (e.g. LTCA for long term certificate authority)

ZZZ > is the numeration of the requirement

W > is the number of the version of the requirement

ID	2.4.X.XX-YYYY-ZZZ (W)	
Component(s)	(e.g.) Vru-ITS-S, Vro-ITS-S, R-ITS-S, PKI	
Requirement	(e.g.) An ITS station SHALL be able to request and get a Long-Term Certificate (LTC) from the SCOOP Public Key Infrastructure (PKI).	
Acceptance	(e.g.) CA1: Vru-ITS-S sends a LTC request to the LTCA CA2: R-ITS-S relays the LTC request CA3: The LTCA verifies the request and sends a response CA4: The R-ITS-S relays the response CA5: The response is received by the Vru-ITS-S and is valid	
Additional information		

Acronyms & abbreviations

ASCII	American Standard Code for Information Interchange
CAM	Cooperative Awareness Message
CAN	Controller Area Network
C-ITS	Cooperative Intelligent Transport Systems
C-ITS DATEX	DATEX used in C-ITS
DENM	Decentralized Environmental Notification Message
DIASER	DIALOGue Standard des Équipements de Régulation de trafic
ETSI	European Telecommunications Standards Institute
GPS	Global Positioning System
HMI	Human-Machine Interface
IUT	Implementation Under Test
IVIM	Infrastructure to Vehicle Information Message
MAPEM	MAP (topology) Extended Message
R-ITS-S	Roadside ITS Station (RSU in the French Terminology)
SPATEM	Signal Phase and Timing Extended Message
TLM	Traffic Light Management
UPER	Unaligned Packet Encoding Rules
UT	UpperTester
V-ITS-S	Vehicle ITS Station

Table of Contents

Quality rules.....	3
Acronyms & abbreviations.....	5
List of figures.....	7
1. References.....	8
2. Background.....	8
3. Perimeter.....	9
4. SPATEM and MAPEM on-lab testing issues.....	9
5. UpperTester primitives definition for SPATEM and MAPEM on-lab test.....	10
5.1 UtMapemConfiguration.....	11
5.2 UtSetStatus.....	11
5.3 UtSetEventState.....	13
5.4 UtSetTiming.....	15
5.5 UtSetSpeeds.....	17
5.6 UtSetManeuverAssistList.....	18

List of figures

Figure 1: On-lab testing architecture.....	8
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1. References

Document reference	Name
[DR1]	ETSI TR 103 099 V1.4.1 (2017-03)
[DR2]	ETSI TS 102 868-2 V1.5.1 (2020-04)
[DR3]	ETSI TS 102 869-2 V1.6.1 (2020-04)
[DR4]	ETSI TS 102 871-2 V1.4.1 (2017-05)
[DR5]	ETSI TS 103 191-2 V1.2.1 (2017-03)
[DR6]	2.6.1.5_M-ETSI_Testlab_IVIM_MAPEM_SPATEM_v0.01
[DR7]	NF P 99-071 Mai 2020
[DR8]	12-UpperTester-TriggeringConditions-SCOOP-v.6.0(1).docx
[DR9]	2.4.1.2_M_Master_I2V_V4.100

2. Background

In order to make on-lab C-ITS protocols testing, ETSI developed some tests and an architecture to emulate the C-ITS equipment environment. We have two parts: the implementation under test (IUT, i.e. the equipment to test) and the Tester. Since generation of C-ITS messages and environment acquisition is ad-hoc to each equipment, ETSI specified a middleware implemented by the C-ITS equipment providers to ~~generate messages and~~ emulate the environment. This middleware is called UpperTester (UT). This UT is connected to the Tester using Ethernet, and is used to communicate with the Tester using primitives specified by ETSI which can be found in [DR1].

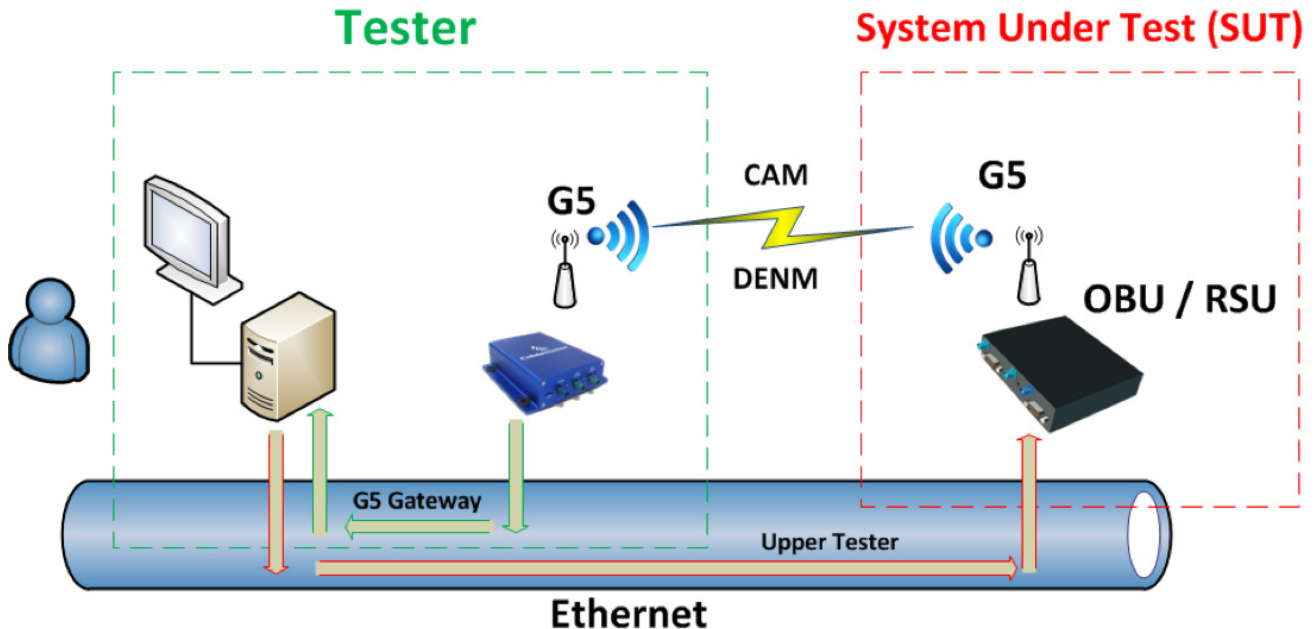


Figure 1: On-lab testing architecture

For example, in V-ITS-S CAM on-lab tests, the Tester can emulate that the tested equipment changes its position in CAM on reception of the UT primitive telling the V-ITS-S to move. We can also check that V-ITS-S updates its exterior lights status on reception of the UT primitive telling the V-ITS-S to update its exterior lights status.

An other example of UT primitive usage is with DENM on-lab tests. We can use UT primitives to tell the IUT to generate DENM, or check that IUT does not consider as valid the cancellation of an unknown DENM.

ETSI made on-lab tests for many protocols (not an exhaustive list):

- CAM [DR2],
- DENM [DR3],
- GeoNetworking [DR4],
- IVIM [DR5],
- MAPEM and SPATEM [DR5]

But in [DR6], we saw that for IVIM and MAPEM / SPATEM protocols, ETSI on-lab tests are limited. That's why IVIM are tested with the C-ITS DATEX interface, but MAPEM and SPATEM need to be tested using the UT, because there is no equivalent with the C-ITS DATEX interface.

Since ETSI **may** add some primitives to their UT, if new values of MessageType collide with some of these extensions, the ETSI MessageType and associated primitives **must be** used and so, this document will be updated in order to be compliant with the ETSI standard.

3. Perimeter

Since this document specify SPATEM and MAPEM UT extension, only R-ITS-S have to consider it. [DR8] is a specification of an extension of the UT in order to simulate the automatic triggering conditions for V-ITS-S, and therefore, **should not** be taken in account in this specification.

4. SPATEM and MAPEM on-lab testing issues

The configuration of the R-ITS-S MAPEM is made manually in different way from a provider to another, and need to be remade between every scenarios. When MAPEM configuration is made with an HMI, there is no way to be precise and so, it's difficult to check MAPEM validity.

For the SPATEM configuration, R-ITS-S communicates with the traffic light management (TLM) using DIASER protocol. R-ITS-S asks the TLM how is the traffic light settings, and then only the traffic light status to generate SPATEM. And so, between each scenario, we need to manually reboot the R-ITS-S, which can take around one minute.

Another issue, is that DIASER is a French protocol, specifying only requests and responses that can be used, but everyone can make how they want to collect the data they need to fill the SPATEM.

In this document, we propose to add some UT primitives in order to configure MAPEM and to emulate TLM. The Tester will emulate the TLM, and send traffic light status to the UT, as it is done for CAM on-lab tests with GPS and CAN bus emulation.

5. UpperTester primitives definition for SPATEM and MAPEM on-lab test

In order to use the second solution, following UT primitives need to be used:

- UtInitialize [DR1] – used to remove SPATEM / MAPEM data,
- UtInitializeResult [DR1] – used by the IUT to acknowledge the success of the UtInitialize request,
- UtMapemConfiguration section 5.1 – used to configure MAPEM data,
- UtSetStatus section 5.2 – used to set intersection status
- UtSetEventState section 5.4 – used to set phase and states
- UtSetTiming 5.4 – used to set timings
- UtSetSpeeds 5.5 – used to set advisory speeds
- UtSetManeuverAssistList 5.6 – used to set maneuver assists
- UtMapemSpatemTriggerResult [DR1] – used to acknowledge the success of the UtMapemConfiguration or SPATEM requests.

Some other new UT primitives **may** be define later.

Note: the definition of TLM simulation by the UT is out of scope of this document.

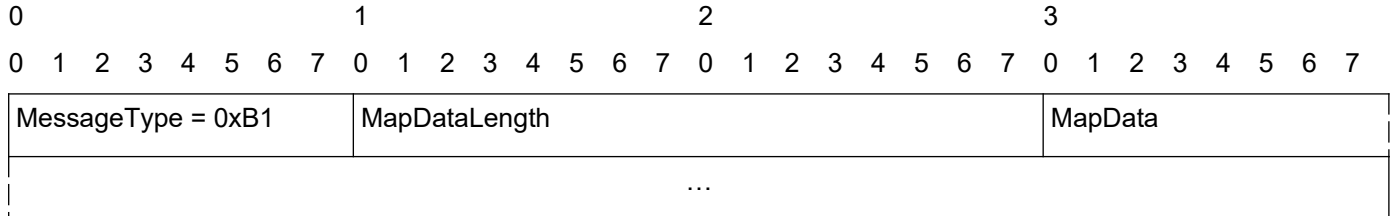
ID	2.4.2.1_M_Annexe_1-UtInitializeReception-001 (1)
Component(s)	R-ITS-S
Requirement	On reception of an UtInitialize primitive, R-ITS-S shall remove all data about MAPEM and SPATEM.
Acceptance	
Additional information	On reception of an UtInitialize primitive, R-ITS-S also reset other data like SequenceNumber etc. On reception of an UtInitialize primitive, R-ITS-S shall stop emitting MAPEM and SPATEM since all data about them are reset.

ID	2.4.2.1_M_Annexe_1-UtInitializeReception-002 (1)
Component(s)	R-ITS-S
Requirement	When R-ITS-S has reset its data, it sends an UtInitializeResult primitive to the same IP address and port used by the Tester to send the UtInitialize primitive in order to indicate whether the reset was made successfully.
Acceptance	
Additional information	

ID	2.4.2.1_M_Annexe_1-UtPrimitiveReception-001 (1)
Component(s)	R-ITS-S
Requirement	When R-ITS-S receives other primitives defined in the present document than UtInitialize, it sends an UtMapemSpatemTriggerResult primitive to the same IP address and port that the Tester used to send the primitive. The answer will be used to indicate whether the primitive has been successfully treated.
Acceptance	
Additional information	

5.1 UtMapemConfiguration

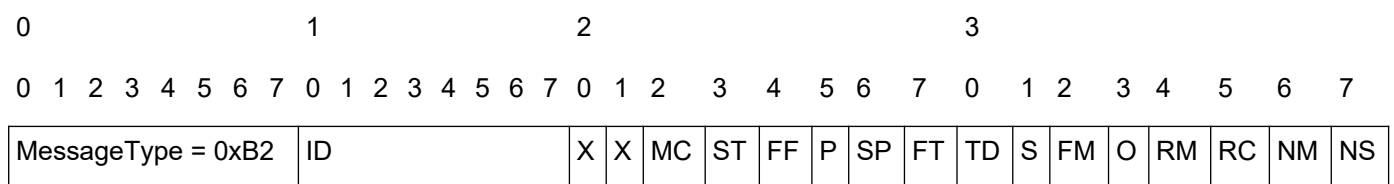
For MAPEM configuration, we use the UtMapemConfiguration primitive.



Name	Length	Value
MessageType	1 byte	0xB1
MapDataLength	2 bytes	Length of MapData field
MapData	MapDataLength byte(s)	UPER encoded of the MapData to be inserted in the MAPEM

ID	2.4.2.1_M_Annexe_1-UtMapemConfigurationReception-001 (2)
Component(s)	R-ITS-S
Requirement	On reception of UtMapemConfiguration primitive, R-ITS-S decodes the MapData and sends MAPEM containing an ItsPduHeader set with R-ITS-S data and MapData with the decoded MapData.
Acceptance	
Additional information	<ol style="list-style-type: none"> 1. R-ITS-S shall not send MAPEM before sending the UtMapemSpatemTriggerResult. 2. <u>R-ITS-S shall manage the created MAPEM in order to be compliant with [DR9] (e.g. timestamps).</u>

5.2 UtSetStatus



Name	Length	Value
MessageType	1 byte	0xB2
ID	1 byte	ID of the intersection to fill the status
X	1 bit	Reserved
MC	1 bit	0: manual control is disabled 1: manual control is enabled

Name	Length	Value
ST	1 bit	0: stop time is not active 1: stop time is activate
FF	1 bit	0: no hardware failure detected 1: hardware failure detected
P	1 bit	0: preempt is not active 1: preempt is active
SP	1 bit	0: signal priority is not active 1: signal priority is active
FT	1 bit	0: fixed time operation is not active 1: fixed time operation is active
TD	1 bit	0: traffic dependent operation is not active 1: traffic dependent operation is active
S	1 bit	0: standby is not active 1: standby is active
FM	1 bit	0: controller has no problem or failure in operation 1: controller has a problem or a failure in operation
O	1 bit	0: controller is switched on 1: controller is switched off
RM	1 bit	0: no Map revision with content changes 1: Map revision with content changes
RC	1 bit	0: no Map changes in assigned or active lane 1: Map changes in assigned or active lane
NM	1 bit	0: MAP avialable 1: MAP not avialable
NS	1 bit	0: SPAT available 1: SPAT not available

ID	2.4.2.1_M_Annexe_1-UtSetStatusReception-001 (1)
Component(s)	R-ITS-S
Requirement	On reception of an UtSetStatus primitive, R-ITS-S shall fill the status of the intersection with the id ID.
Acceptance	
Additional information	If the R-ITS-S can not fill all SPATEM data (e.g. no event state is filled), the R-ITS-S shall not consider as a setting failure. An example of setting resulting to a failure is when id is an unknown ID.

ID	2.4.2.1_M_Annexe_1-SPATEMSending-001 (1)
Component(s)	R-ITS-S
Requirement	R-ITS-S shall wait to have all necessary (i.e. at least one of each primitive of this document) data before sending SPATEM.
Acceptance	
Additional information	

5.3 UtSetEventState

0	1	2	3
0 1 2 3 4 5 6 7	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 = 0xB3	SignalGroupID	NMovementPhaseState	MovementPhaseState1
...			

Name	Length	Value
MessageType	1 byte	0xB3
SignalGroupID	1 byte	SignalGroupID where states are set
NMovementPhaseState	1 byte	Number of MovementPhaseState
MovementPhaseStateX	1 byte	Unsigned byte range from 0 to 9 unavailable (0), dark (1), stop-Then-Proceed (2), stop-And-Remain (3), pre-Movement (4), permissive-Movement-Allowed (5), protected-Movement-Allowed (6), permissive-clearance (7), protected-clearance (8), caution-Conflicting-Traffic (9)

Note: from the J2735 standard, these different values mean

0. This state is used for unknown or error
1. The signal head is dark (unlit)
2. Often called 'flashing red' in US

Driver Action:

Stop vehicle at stop line.

Do not proceed unless it is safe.

Note that the right to proceed either right or left when it is safe may be contained in the lane description to handle what is called a 'right on red'

3. e.g. called 'red light' in US

Driver Action:

Stop vehicle at stop line.

Do not proceed.

Note that the right to proceed either right or left when it is safe may be contained in the lane description to handle what is called a 'right on red'

4. Not used in the US, red+yellow partly in EU

Driver Action:

Stop vehicle.

Prepare to proceed (pending green)

(Prepare for transition to green/go)

5. Often called 'permissive green' in US

Driver Action:

Proceed with caution,

must yield to all conflicting traffic

Conflicting traffic may be present in the intersection conflict area

6. Often called 'protected green' in US

Driver Action:

Proceed, tossing caution to the wind, in indicated (allowed) direction.

7. Often called 'permissive yellow' in US

Driver Action:

Prepare to stop.

Proceed if unable to stop,

Clear Intersection.

Conflicting traffic may be present in the intersection conflict area

8. Often called 'protected yellow' in US

Driver Action:

Prepare to stop.

Proceed if unable to stop,

in indicated direction (to connected lane)

Clear Intersection.

9. Often called 'flashing yellow' in US

Often used for extended periods of time

Driver Action:

Proceed with caution,

Conflicting traffic may be present in the intersection conflict area

ID	2.4.2.1_M_Annexe_1-UtSetEventStateReception-001 (1)
Component(s)	R-ITS-S
Requirement	On reception of an UtSetEventState primitive, R-ITS-S shall fill the movement phase and state of the signal group with the id SignalGroupID.
Acceptance	
Additional information	If the R-ITS-S can not fill all SPATEM data, the R-ITS-S shall not consider as a setting failure. An example of setting resulting to a failure is when id is an unknown ID.

5.4 UtSetTiming

0	1	2	3
0 1 2 3 4 5 6 7	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 = 0xB4	SignalGroupID	NTiming	X X S M E L C N
StartTime1		MinEndTime1	
MaxEndTime1		LikelyTime1	
Confidence1	NextTime1		...

Name	Length	Value
MessageType	1 byte	0xB4
SignalGroupID	1 byte	SignalGroupID where timings are set
NTiming	1 byte	Number of timing set
X	1 bit	Reserved
S	1 bit	0: StartTimeX to be ignored 1: StartTimeX to be used
M	1 bit	0: MinEndTimeX to be ignored 1: MinEndTimeX to be used
E	1 bit	0: MaxEndTimeX to be ignored 1: MaxEndTimeX to be used
L	1 bit	0: LikelyTimeX to be ignored 1: LikelyTimeX to be used
C	1 bit	0: ConfidenceX to be ignored

Name	Length	Value
		1: ConfidenceX to be used
N	1 bit	0: NextTimeX to be ignored 1: NextTimeX to be used
StartTimeX	2 bytes	From 0 to 3 600 36001: unknown or undefined value Unit: 0.1 s Value of the StartTime of SignalGroupID X
MinEndTimeX	2 bytes	From 0 to 3 601 36001: unknown or undefined value Unit: 0.1 s Value of the MinEndTimeX of SignalGroupID X
MaxEndTimeX	2 bytes	From 0 to 3 600 36001: unknown or undefined value Unit: 0.1 s Value of the MaxEndTimeX of SignalGroupID X
LikelyTimeX	2 bytes	From 0 to 3 600 36001: unknown or undefined value Unit: 0.1 s Value of the LikelyTimeX of SignalGroupID X
ConfidenceX	1 byte	Unsigned byte from 0 to 15 0. 21 % 1. 36 % 2. 47 % 3. 56 % 4. 62 % 5. 68 % 6. 73 % 7. 77 % 8. 81 % 9. 85 % 10. 88 %

Name	Length	Value
		11. 91 % 12. 94 % 13. 96 % 14. 98 % 15. 100 %
NextTimeX	2 bytes	From 0 to 3 600 36001: unknown or undefined value Unit: 0.1 s Value of the NextTimeX of SignalGroupID X

ID	2.4.2.1_M_Annexe_1-UtSetTimingReception-001 (1)
Component(s)	R-ITS-S
Requirement	On reception of an UtSetTiming primitive, R-ITS-S shall fill the timing of the signal group with the id SignalGroupID.
Acceptance	
Additional information	If the R-ITS-S can not fill all SPATEM data, the R-ITS-S shall not consider as a setting failure. An example of setting resulting to a failure is when id is an unknown ID.

5.5 UtSetSpeeds

0	1	2	3
0 1 2 3 4 5 6 7	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 = 0xB5	SignalGroupID	NSpeed	Type1
SpeedAdvisory1	...		

Name	Length	Value
MessageType	1 byte	0xB5
SignalGroupID	1 byte	SignalGroupID where advisory speed is set
NSpeed	1 byte	Number of advisory speed set
TypeX	1 byte	Unsigned byte from 0 to 3 none (0), greenwave (1) ecoDrive (2) transit (3)

Name	Length	Value
SpeedAdvisoryX	1 byte	Unsigned byte from 0 to 500 500: speed advisory Unit: 0.1 m/s

ID	2.4.2.1_M_Annexe_1-UtSetSpeedsReception-001 (1)
Component(s)	R-ITS-S
Requirement	On reception of an UtSetSpeeds primitive, R-ITS-S shall fill the speed advisory of the signal group with the id SignalGroupID.
Acceptance	
Additional information	If the R-ITS-S can not fill all SPATEM data, the R-ITS-S shall not consider as a setting failure. An example of setting resulting to a failure is when id is an unknown ID.

5.6 UtSetManeuverAssistList

0	1	2	3
0 1 2 3 4 5 6 7	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 = 0xB6	SignalGroupID	NManeuver	X X X X Q A W P
ConnectionID1	QueueLength1		AvailableStorageLength1
...	WaitOnStop1	PedBicycleDetect1	...

Name	Length	Value
MessageType	1 byte	0xB6
SignalGroupID	1 byte	SignalGroupID where maneuver assist are set
NManeuver	1 byte	Number of maneuver assist set
X	1 bit	Reserved
Q	1 bit	0: QueueLengthX to be ignored 1: QueueLengthX to be used
A	1 bit	0: AvailableSotrageLengthX to be ignored 1: AvailableSotrageLengthX to be used
W	1 bit	0: WaitOnStopX to be ignored 1: WaitOnStopX to be used
P	1 bit	0: PedBicycleDetectX to be ignored

Name	Length	Value
		1: PedBicycleDetectX to be used
ConnectionIDX	1 byte	Unsigned byte from 0 to 255
QueueLengthX	2 bytes	Unsigned integer from 0 to 10 000 Unit: meter 0: unknown length 10 000: length \geq 10 000 m
AvailableStorageLengthX	2 bytes	Unsigned integer from 0 to 10 000 Unit: meter 0: unknown length 10 000: length \geq 10 000 m
WaitOnStopX	1 byte	0x00: true 0xFF: false
PedBicycleDetectX	1 byte	0x00: true 0xFF: false

ID	2.4.2.1_M_Annexe_1-UtSetManeuverAssistListReception-001 (1)
Component(s)	R-ITS-S
Requirement	On reception of an UtSetManeuverAssistList primitive, R-ITS-S shall fill the maneuver assist list of the signal group with the id SignalGroupID.
Acceptance	
Additional information	If the R-ITS-S can not fill all SPATEM data, the R-ITS-S shall not consider as a setting failure. An example of setting resulting to a failure is when id is an unknown ID.