SECUR

Safety Enhancement through Connected Users on the Road

Deliverable 4.1

Connected testing tools and environment specifications

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Deliverable	D4.1 Connected testing tools and environment specifications	
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UTAC

EXECUTIVE SUMMARY

Through its 2030 roadmap, the European New Car Assessment Programme (Euro NCAP) aims at encouraging, by a consumer approach, even more safety on the roads, in particular thanks to the use of new inter-vehicle communication solutions.

The aim of the SECUR project is to study the potential of communication to improve the safety of different road users. SECUR ensures technological neutrality in a complex and multi-faceted context. Coordinated by UTAC, the SECUR project outlines a coherent proposal for V2X testing and assessment protocols to Euro NCAP. To this end, an industrial consortium brings together about twenty international stakeholders, from the automotive and V2X ecosystem – automotive OEM, tier 1 suppliers, V2X-market-stakeholders, and automotive test systems providers.

The geographical scope of the SECUR Project is Europe. Considering that vehicle connectivity is relatively recent, offering a wide range of possibilities and benefits to all road users the following actors were considered as opponents: passenger cars, powered two-wheelers (PTWs), bicyclists and pedestrians. However, in this study the ego vehicle is always a passenger car.

The aim of this document is to provide specifications to the testing tools and environment necessary to perform connected tests in the SECUR project and later in the Euro NCAP testing context. Firstly, it gathers existing target solutions and requirements (e.g. detection, dynamic properties) and essential V2X properties and setup by target type. Secondly, a description of the connected testing environment. The different items of these requirements are the followings:

- Minimum communication range
- Technologies, messages & profiles supported by the connected platform
- Security layer capability (PKI)
- Positioning performances
- Testing interfaces (logging V2X data, V2X warmup)

Two platform designers were involved in SECUR as partner, AB Dynamics (ABD) and Humanetics. This explains the specific focus in this document on their existing platforms, car-sized platforms GST (ABD) and UFOpro (Humanetics) and on the VRU-sized platform Launchpad (ABD) and UFOnano (Humanetics).

It has been agreed by all partners that all the testing tools should be a modification of the existing platforms & targets. Indeed, the main objective of the testing tools provider is to add connectivity inside the existing platform, and thus, the connected platforms should comply with existing standards (e.g. ISO 19206-3, ISO 19206-4, ISO 19206-5) and Euro NCAP requirements.

In order to be representative of a real connected vehicle, the V2X hardware should be embedded inside the platform to keep a realistic distance between the vehicle under test (VUT) and the connected platform. Moreover, there is an important requirement on the position written inside the V2X messages to be representative of a real vehicle.

The connected testing tools should comply with all types of technologies studied in the SECUR project since all of them are defined as relevant by the WP2. In addition of this technology support, it is suggested to support communication profiles (e.g. C2C-CC Basic System Profile (BSP), C-ROAD System Profile) and since OEMs and Road Operators apply those to ensure same use case behaviour across European member states and across OEM as well as to ensure a good communication level, supporting these profiles is required.

Finally, a part of this document draws the guidelines and suggestions in terms of environment. Indeed, there are still open discussions on subject outside the SECUR project scope, the PKI and backend access. Indeed, in order to have trusted communication, V2X messages are signed using public key infrastructure (PKI) and today, it is not decided which entity will support this PKI (Euro NCAP or laboratories). Concerning V2N communication, there would be discussion needed to clarify how testing laboratories could make the connected platforms communicate with vehicles linked with a dedicated backend (usually supported by the OEM itself).

The following figure is a synthesis of the work performed by the WP4 during the project duration, with all the different testing capability for each V2X type of communication.

V2V

Passenger car connected target for the test:
- On-board connected target (preferable solution) | ✓ Available
  Off-board connected target | ✓ Available
  - ➢ Real non connected target on-track and use of a remote V2X system (direct communication) to send the V2X messages with the target live dynamic data)
- V2X simulation | ✓ Available
  - ➢ Digital twin solution with simulated dynamic and scenario data

Testing V2X acquisition – V2X messages log:
- Road-Side Unit (RSU) near to the test track | ✓ Available
- Log with the on-track connected module use for the test | ✓ Available
- V2X test data logging software | ✓ Available

V2I

If only V2X consider infrastructure during the test:
- Use of a V2X system to simulate a connected infrastructure with realistic parameters (e.g. internal treatment timing) (preferable solution) | ✓ Available
  - ➢ Simulation of the infrastructure possible without the need of real on-track infrastructure
- Use of real infrastructure for the test | Connected infrastructure available but not tested in Euro NCAP scenarios.

If other systems (e.g. camera) consider infrastructure during the test:
- Use of real infrastructure for the test | Connected infrastructure available but not tested in Euro NCAP scenarios.

V2VRU

VRU connected target for the test:
- On-board connected target (preferable solution) | × Not available
- Off-board connected target: | ✓ Available
  - ➢ Real non connected target on track and use of a remote V2X system (direct communication) to send the V2X messages with the target live dynamic data
- V2X simulation | ✓ Available
  - ➢ Digital twin solution with simulated dynamic and scenario data

Testing V2X acquisition – V2X messages log:
- Road-Side Unit (RSU) near to the test track | ✓ Available
- Log with the on-track connected module use for the test | ✓ Available
- V2X test data logging software | ✓ Available

V2N

Testing environment should be homogeneous between labs and representative of the current average network | × Network requirements still to be defined for testing

Road user network connected target for the test:
- On-board connected target (preferable solution) | ✓ Available
- Off-board connected target | ✓ Available
  - ➢ Real non connected target on track and use of a remote V2X system (indirect communication by the network) to send the V2X messages with the target live dynamic data
- V2X simulation | ✓ Available
  - ➢ Digital twin solution with simulated dynamic and scenario data

Testing V2X messages acquisition: V2X messages log with the connected target or the remote V2X system

Figure 1: Synthesis table of testing guidelines for each V2X types

REVISION HISTORY

Revision	Date	Description, updates and changes	Status
1.0	January 2022	Creation of the structure of the report	Draft
1.1	February 2022	Issuance of the first draft version of the document. Partners review.	Draft
2.0	January 2023	Issuance of the second version of the document. Partners review.	Draft
2.1	March 2023	Final version	Validated

ABBREVIATIONS

3GPP	3rd Generation Partnership Project
4G	4G is the fourth generation of broadband cellular network technology, succeeding 3G and preceding 5G
5G	In telecommunications, 5G is the fifth-generation technology standard for broadband cellular networks
ADAS	Advanced Driver Assistance Systems
AEB	Autonomous Emergency Breaking
ASIL	Automotive Safety Integrity Level
BC	Bicyclist
BLE	Bluetooth Low Energy
C2C-CC	Car 2 Car Communication Consortium
CAM	Cooperative Awareness Message
CBR	Channel Busy Ratio
CC	CauseCode
C-ITS	Cooperative Intelligent Transport Systems
CPM	Cooperative Perception Message These messages broadcast information on detected object to its surrounding.
D2VO	Datex-II Vehicle Obstruction
D2WRRC	Datex-II Weather Related Road Conditions
DENM	Decentralized Environmental Notification Message
ETSI	European Telecommunications Standards Institute
EU	European Union
GPS	Global Positioning System
HMI	Human Machine Interface
ITS-G5	Direct communication technology based on Wi-Fi. European name for WAVE or DSRC.
IVS	In-Vehicle Signage
KPH	Kilometers per hour
LOS	Line-of-sight
LTE	Long Term Evolution
MAPEM	MAP Extended Message
NLOS	Non-line-of-sight
PC	Passenger Car
PC5	Direct communication technology based on mobile network (3GPP). PC5 is one part of C-V2X/LTE-V2X that enable direct communication between objects.
PD	Pedestrian
PDR	Packet Delivery Ratio
PER	Packet Error Rate
PKI	Public Key Infrastructure
PTW	Powered Two-wheeler
RCS	Radar Cross Section
REL	Release
RHS	Road Hazard Signalling

SAS	Speed Assist Systems
SB	Steering Board
SPATEM	Signal Phase And Timing Extended Message
TTC	Time To Collision
UC	Use case
UK	United Kingdom
Uu	Radio interface in cellular communication between a user equipment (UE) and the cellular network base station.
V2I	Vehicle-To-Infrastructure
V2N	Vehicle-To-Network (Uu communication)
V2P	Vehicle-To-Pedestrian
V2V	Vehicle-To-Vehicle
V2VRU	Vehicle-To-Vulnerable Road User
V2X	Vehicle-To-Everything (i.e. vehicle to any type of other station)
VAM	VRU Awareness Message
VRU	Vulnerable Road User (motorcyclist, bicyclist and pedestrian)
WG	Working Group
WP	Work Package
WP1	SECUR Work Package n°1: Accidentology study
WP2	SECUR Work Package n°2: V2X technology study
WP3	SECUR Work Package n°3: Potential of V2X to improve ADAS performances and final use cases selection
WP4	SECUR Work Package n°4: Development of testing connected targets
WP5	SECUR Work Package n°5: Test and assessment procedures

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1. Introduction

The SECUR project aims to study the potential of connectivity, especially the V2X technology, in improving the safety of different road users. To this end, this project brings together diverse and complementary stakeholders: automotive OEM and tier 1 suppliers as well as V2X-market-stakeholders and automotive test systems providers.

This work package 4 is dedicated to the development of specifications for the tools to be connected and visible thanks to all types of technologies from WP2. During this WP4, in accordance with the providers, these specifications should focus on communication means, detection properties and the necessary robustness for testing.

The aim of this document is to provide specifications to the testing tools and environment necessary to perform connected tests in the SECUR project and later in the Euro NCAP testing context. Firstly, it gathers existing target solutions and requirements (e.g. detection, dynamic properties) and essential V2X properties and setup by target type. Secondly, a description of the connected testing environment is given.

According to the WP2, all communication types could be relevant for road safety. In addition, there is no consensus yet on a type of communication or a technology to use. The V2X market is still divided. Considered V2X communication: direct (V2V, V2VRU and V2I) and indirect (V2N, i.e., V2N2V, V2N2VRU, V2N2I, V2backend). Following this conclusion, it is necessary to be able to test all types of V2X relevant technologies and thus have solutions that can communicate through a relevant list of technologies (ITS-G5, PC5 Release 14 & 16, 4G & 5G Uu).

Moreover, according to the WP3, all types of road users were relevant in the use cases development process. Thus, it is important for the WP4 to supply specifications for solutions capable to represent all types of road user: passenger cars, PTW, bicyclist and pedestrian.

Two platform designers were involved in SECUR as partners, AB Dynamics (ABD) and Humanetics. As such, the specific focus in this document on their existing platforms, car-sized platforms GST (ABD) and UFOpro (Humanetics) and on the VRU-sized platform Launchpad (ABD) and UFOnano (Humanetics).

2. Connected target specifications

This section gathers all the information concerning the V2X properties that need to be included in the existing platforms to be able to perform connected testing.

These V2X modules should permit to have connected testing tools that could communicate with multiple technologies while being waterproof, able to survive a crash and present similar performance of real vehicles.

Finally, during this WP4, it has been agreed by all partners that all the testing tools should be modifications of existing platforms and targets. Indeed, the main objective of the testing tools providers is to add connectivity inside existing platform, and thus, the connected platforms should comply with existing standards (e.g. ISO 19206-3, ISO 19206-4, ISO 19206-5)) & Euro NCAP requirements.

It has been decided that the connectivity implementation should be a modification of an existing model thanks to the Annex A that gathers all existing platforms characteristics provided by the platform providers (AB Dynamics & Humanetics). Indeed, it is not recommended by the project to create a new platform from scratch for the only purpose to bring connectivity into it. Thus, all the already existing requirements on dynamic & detection properties are maintained for the connected platforms.

Finally, it is required to not modify the existing detection properties such as the radar cross section (RCS) and so, all the V2X hardware should be integrated inside the platforms in order to not alter the existing platforms specifications and also ensure the waterproofness and crashability according to ISO19206-3 of the connected targets.

2.1 Connected target specifications

This section is providing all the requirements that the connected platforms should fulfil in order to perform V2X testing on car use-cases defined in previous Work Packages.

2.1.1 V2X Properties

Table 1 – V2X Properties required for the platforms

Item	***Requirement***
Minimum communication range	Comply with the relevant access layer for the technologies implemented *For example, ETSI 302 663 for ITS-G5*
Antenna characteristics	Comparable to passenger car roof mounting, e.g. dipole antenna with vertical polarization mounted on passenger car roof height. Comparable antenna directivity to all participants involved in the scenario.
Supported technologies	Should support all the relevant technologies deployed on the market *Today in Europe:* *Direct communication: ITSG5* *Note: If/When LTE-V2X PC5 (direct communication) is deployed/operational in Europe, the target shall be adapted to handle this technology. Same for BLE 5.0.* *Indirect communication: 2G, 4G, 5G Uu link*
Supported messages	Should support all the standardized ETSI messages deployed on the market *For example, today at least:* *Rx: ETSI CAM/DENM* *Tx: ETSI CAM/DENM and in addition ETSI SPATEM/MAPEM for RSU* *On SECUR roadmap for 2029:* *Rx/Tx: Collective Perception Message ETSI CPM* *Rx/Tx: Impact reduction container (IRC) in ETSI DENM*
Supported profiles	Multiple working groups are working on the standardization of communication profiles. It is important that connected platforms comply with them in order to communicate with Vehicles Under Test *For example, today used by vehicles and infrastructure*: *C2C-CC Basic System Profile 1.6.3* [1] *C-ROAD System Profile 2.0* [2]
PKI compliance	Supported (cf. 2.2.2)
Disabling PKI capability	Supported
Positioning accuracy (Sent in messages)	Representative of a vehicle positioning, typically lane level accurate, including confidence values, as specified in message standards and profiles. Accuracy corresponding to the safety use cases for the tests. *For example:1) Additive white Gaussian noise is applied to the location data to increase the standard deviation of the*

	distribution by a user defined amount (0.5m standard deviation by default) *Note that the standard deviation is increased by 0.5m, the k=2 standard deviations value would then be 1.0m* *2) To capture time domain correlation of real GNSS data, a first order stochastic difference equation is used to generate additive noise. Default equation constants are chosen so that the noise has an expected standard deviation of 0.5 metres and time constant of autocorrelation of 10 seconds.*
Message transmission and reception	Supported
Interaction with platform dynamic data	Supported
Log of V2X messages capability (PCAPs) For example: *Positioning/ CauseCode - Subcausecode*	Supported
Digital twin/simulation interface	Supported
V2X Warmup (V2X communication measurement)	Supported For example: *Chanel Busy Ratio* *Packet Error Rate* *Cellular network availability*

2.2 SECUR TARGET SETUPS FOR EACH TYPE OF OPPONENT

2.2.1 PASSENGER CAR

According to the Annex A, the solution of implementing V2X hardware inside the storage space of existing platform is possible. Thus, the idea of having a connectivity solution on board the platform is possible and highly recommended for project in order to be in the situation of a real connected vehicle. The specifications will permit to help platform providers to make sure all V2X criteria are fulfilled by the implemented hardware.

During the project, this implementation has been done in order to perform tests. The V2X hardware (YoGoKo YBOX) was implemented inside the platform (ABD GST) as requested by the WP4.

The following figure shows the different interaction between objects on tracks during these tests:

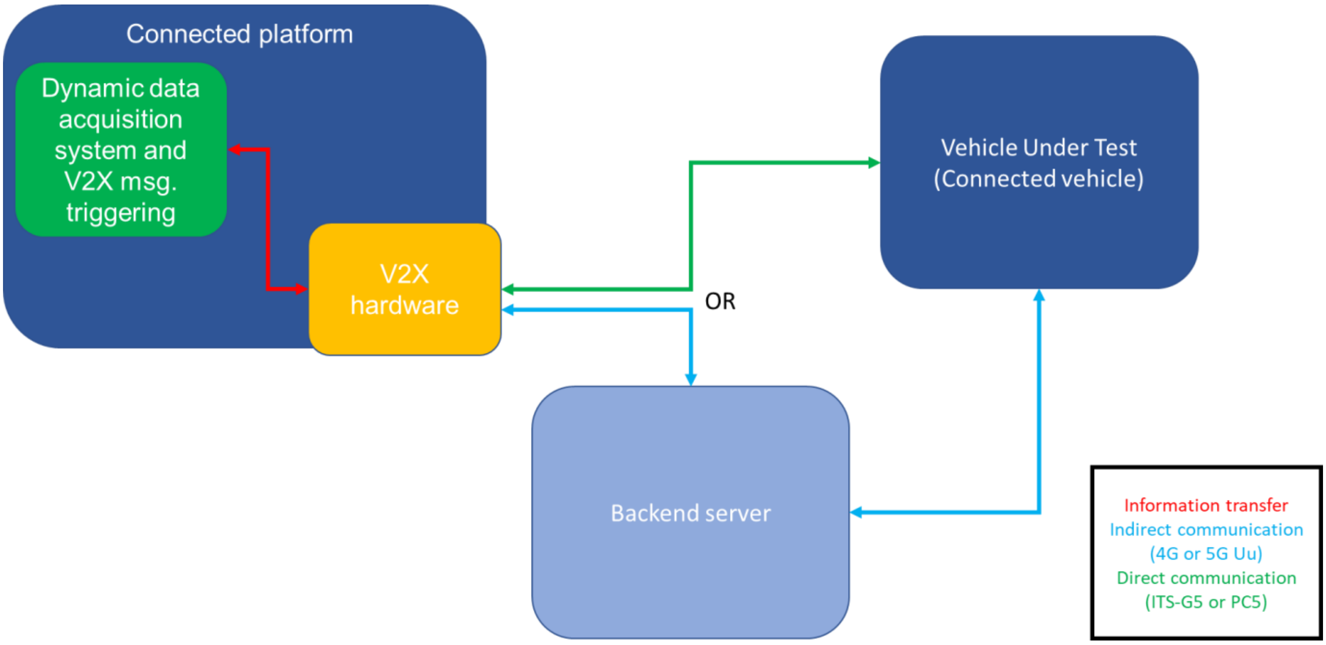

Figure 2: On-board solution model

2.2.2 PTW, Bicyclist & Pedestrian

In this section of the document, testing solutions will be presented to permit the tests of PTW, Bicyclist and Pedestrian use cases.

According to the Annex A, the solution of implementing V2X hardware inside the storage space of existing platforms is not possible due to limited space. Indeed, the V2X hardware available during the project was too large.

However, during the project, testing on VRU was necessary in the WP3 and WP5 scope. These solutions have been found in order to be able to support these tests.
As mentioned in the Introduction, for detection alteration purpose, it is required to have the V2X hardware integrated inside the platforms for the final products.

The first solution used during the project was to keep the V2X hardware outside of the platform and put it next to the track (in SECUR case it was inside the testing truck where the testing team was managing the tests). A wireless link between the platform and the laptops inside the truck already existed. Thanks to this link, real time dynamic data was retrieved and implemented inside messages sent out by the V2X hardware, in order to have relevant positioning information from the CAM messages. Through this link, the testing team retrieved the RTK position of the PTW platform at 100 Hz and then implemented all this dynamic data inside the message that will be sent out from the V2X module on the side of the track. The downside of this solution is that the distance between the V2X antenna of the testing setup and V2X antenna of the Vehicle under tests are not representative of a real case scenario. However, the latency inducted by the communication between the platform and the V2X hardware (red link on Figure 2) is dependent on radio network and implementation this can vary - typically 3-5ms per hop on the radio network, though radio interference can cause jitter.

The following figure shows the different interactions between objects on tracks during these tests with this off-board solution (since the V2X module is outside the testing material on track):

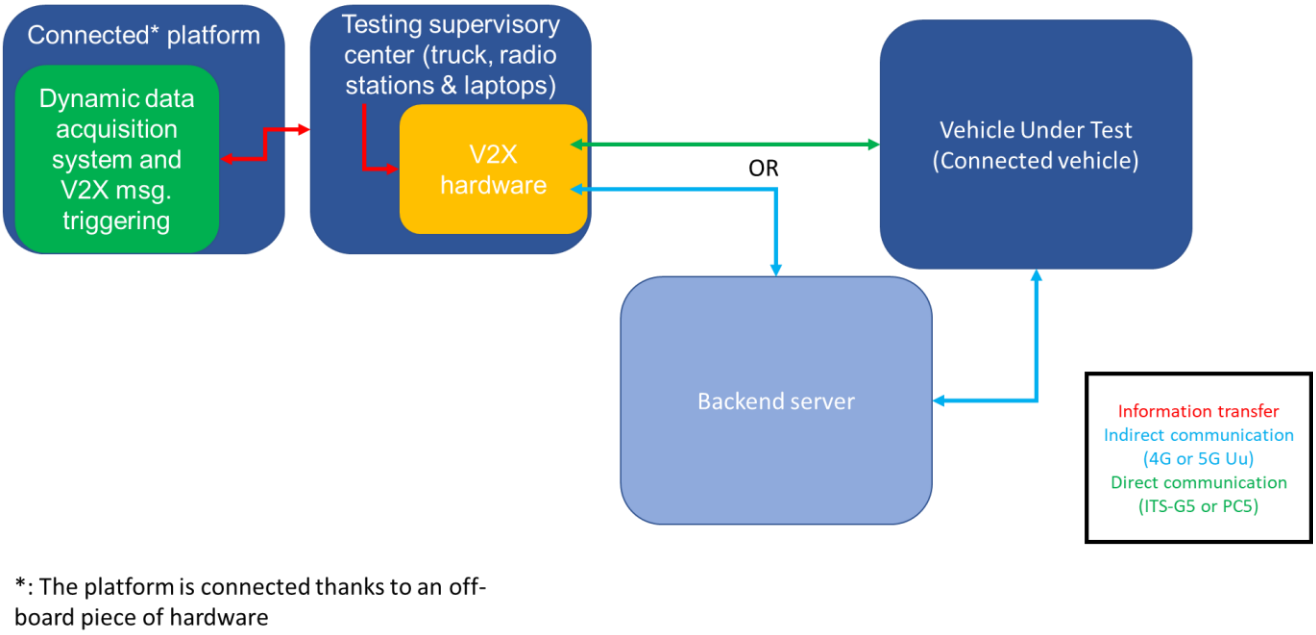

Figure 3: Off-board solution model (solution 1)

The second solution used during this type of tests is different, it presents benefits and downsides comparing to the previous solution presented. Indeed, in that case, the testing team implemented an independent V2X solution on the platform. Multiple propositions have been submitted, i.e., all the hardware will be stored inside a backpack on the dummy and the hardware will be mounted at the feet of the dummy. The chosen decision has been the usage of a small V2X device (Autotalks ZooZ) mounted on the handlebar of the dummy in order to minimize the RCS impact of altering the shape of the target. This solution permits to have a representative distance between V2X antennas; however, the messages are based on the positioning accuracy of the device since there is no link between the RTK acquisition system of the platform and the V2X hardware. Moreover, with this solution, the testing teams needs to be careful with the autonomy of the V2X hardware since everything is working thanks to battery supply.

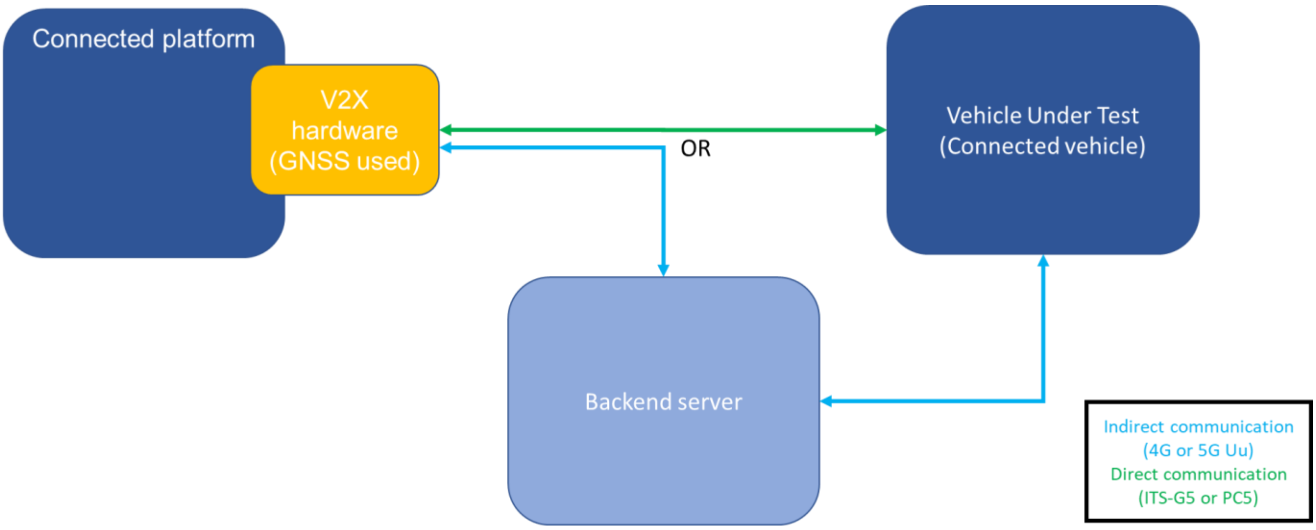

Figure 4: On-board but non-integrated model (solution 2)

3. Connected testing environment

3.1 Local hazard testing

According to WP3, V2X for local hazards (Euro NCAP Safe driving rating scheme) is relevant and should be tested. This section of the document is dedicated to the testing tools capable to provide tests protocols and assessment for local hazards. Moreover, it is planned to test vehicles on both their sending and receiving capability. Local hazards provide valuable information to the VUT (receiving side) but it is important for the VUT to be able to provide information to others (sending side).

A local hazard is a situation, an event, or a state towards in which a vehicle is driving. The aim of local hazard is to provide information to the driver for a safe and comfortable drive. V2X brings data on the road state to the driver, so they could adapt their behaviour in consequence. A local hazard can be very diversified.

All the different methods of testing for local hazards are detailed below.

Note: All the methods must send CAM messages as this is necessary for local Hazards

3.1.1 Dedicated V2X hardware on track

The first solution would be to have a Roadside Unit (RSU), installed next to the tracks by the testing providers. It could be installed on a pole or deploy it only during V2X testing. This kind of hardware is durable in outside conditions (rain, hot temperature, cold temperature), and thus will be a relevant way to test local hazards. Moreover, all type of DENMs can be sent out, received and stored by this type of hardware.

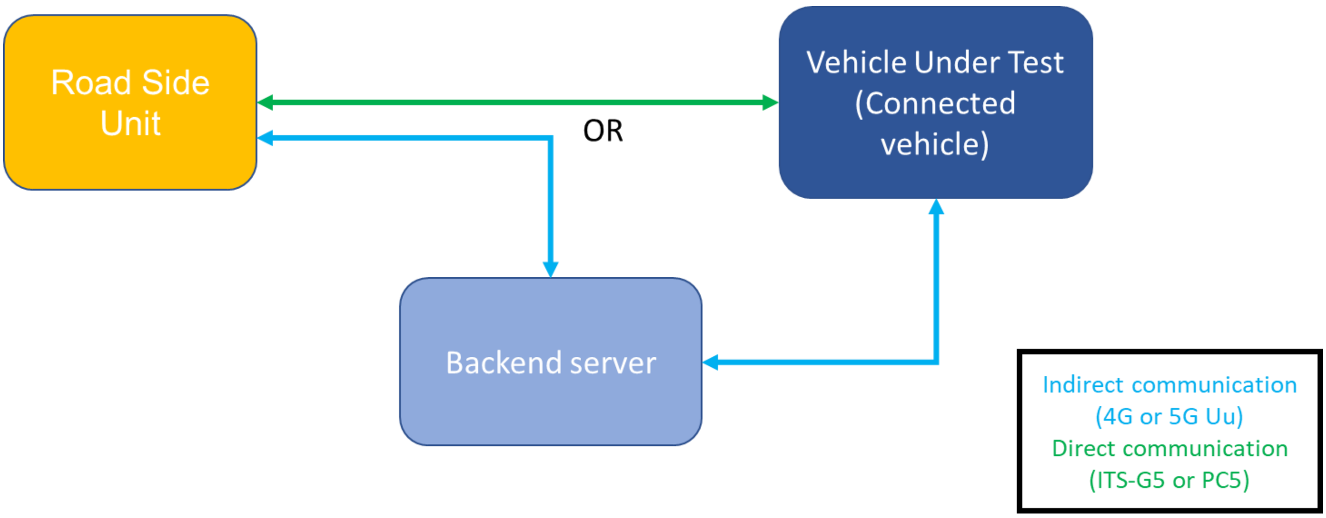

Figure 5: Communication between a RSU & VUT

3.1.2 Connected platforms

As explained in 1.1.1, it is required to be able to send out Decentralized Environment Notification Messages (DENM) from connected platforms. Moreover, local hazard messages are essentially transmitted thanks to DENM messages and thus will be capable to operate like a station that send local hazards information. The figure 1 is applicable on this test setup.

3.1.3 Digital twin

The last solution would be to use a digital twin to simulate one or multiple vehicles on the tracks that send out DENMs messages. It has been done during the SECUR project for traffic jam hazard. The connectivity between the digital twin and the Vehicle under test should meet the same requirements as defined in 1.1.1 to be able to communicate by using the same technology, profile and messages.

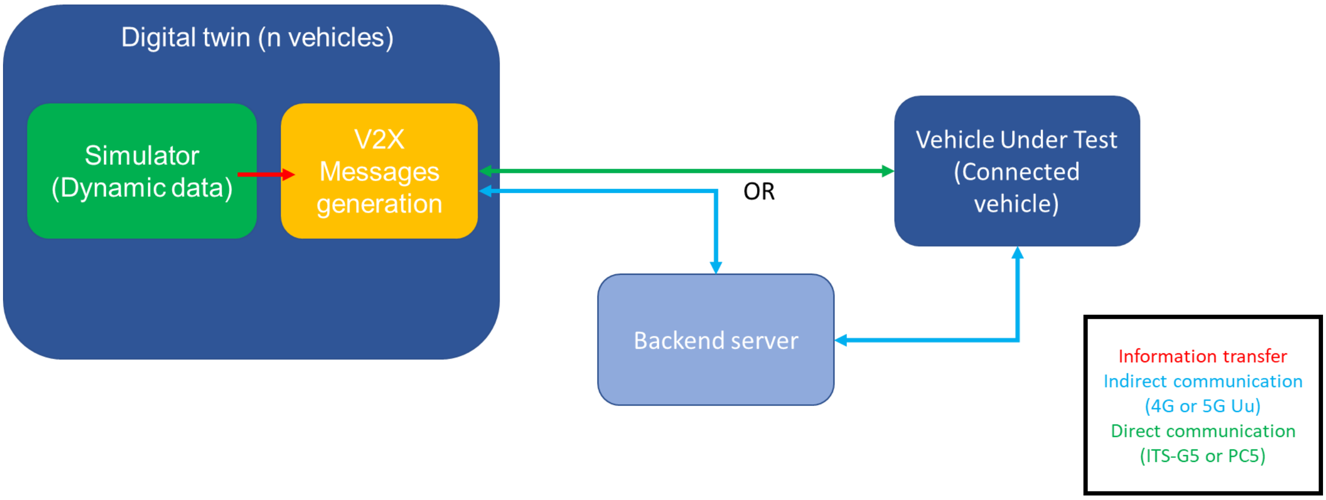

Figure 6: Digital twin model

3.2 Testing environment connectivity properties

In this section, all the necessary aspects outside of the testing tools will be covered. Indeed, the performances of connected service and systems are highly dependent of their environment. Other parameters are also important to consider as how crowded the area is, the implementation of the cellular network on the testing track and the securing mechanism (PKI) implemented on V2X messages. In order to provide the same quality of testing through testing laboratories (reproducibility) and also through the test itself (repeatability), it is important to look at metrics before and during tests.

3.2.1 Performances

The different values in the following table are based on the knowledge of different experts from the project. No dedicated study has been performed to validate these values during the project.

Table 2 - Relevant environment metrics for direct communication

Direct communication	
Channel Busy Ratio (CBR) [%]	<40%* *: permits to ensure that the V2X properties of the vehicles are not altered by Congestion Control Mechanisms.
Packet Delivery Ratio (PDR) [%]	>90% in a range of 300m in LOS conditions

The indirect communication relevant environment metrics should be investigated more in the future. The agency in charge of regulating telecommunications in France (ARCEP: Autorité de Régulation des Communications Électroniques, des Postes et de la Distribution de la Presse) measures the performances of the network following multiple tests (cf. [3]) on the four major French network providers (Bouygues Telecom, Orange, SFR & Free). This gives a global French picture of the performances on the year. Globally, the upload speed is around at least 10 Mbits/s and download speed around at least 50 Mbits/s in France (15 largest cities, cities between 10 000 & 400 000 people, cities with less than 10 000 and 100 most visited sites).

3.2.2 Security

In this section all guidelines regarding security of communication are listed.

Today, direct communication (V2V, V2I, V2VRU) is secured thanks to authorized Public Key Infrastructure (PKI) systems to provide security certificates (in EU SCMS[1] called authorization tickets). Moreover, this direct communication security layer is taken in account by design. The European Certificate Trust List (ECTL) supports to manage valid authorization tickets and revocation lists. ECTL is a today's example of these security solutions.

However, for indirect communication (V2N), this type of solution is not democratized and agreed by all stakeholders. A solution should be developed in the upcoming years.

SECUR guidelines concerning this aspect stated that the vehicles should be tested with a non-proprietary PKI activated, for ensuring having a secure communication between tools and vehicles but also to be more representative of real-life performances since security layers increase latency in messages. If it is not possible for testing to use the production PKI platform because OEMs can't provide access to the testing tools to this trust list, Euro NCAP or laboratories could create their own PKI dedicated for testing. In that case, the vehicle under test will thus have to register to it before testing.

Finally, the second point that needs additional work by OEMs and laboratories during tests is concerning indirect communication tests. In order to have a communication between the connected platform and the VUT, a backend should make the link between these two objects by receiving the messages and sending it to the relevant vehicle.

[1] European Security Certification Management System according to EU COM C-ITS Point of Contact ECTL - Documentation (europa.eu), https://cpoc.jrc.ec.europa.eu/Documentation.html

CONCLUSION

The deliverable D4.1 is the unique report of the WP4 which focuses on the specifications concerning the testing tools and environment necessary to conduct V2X tests. It contains all the guidelines and requirements defined by the WP4 on the different testing tools: platforms, targets, and testing environment.

Firstly, it has been ruled that the connectivity of the platforms and targets shouldn't change their properties in order to keep the material already used in ADAS testing still relevant in the future. That is why in the platform specifications the ISO 19206-3, ISO 19206-4 and ISO 19206-5 ("Test devise for target vehicles, vulnerable road users and other objects, for assessment of active safety functions") are called in order to respect these existing requirements.

Besides, in SECUR, all types of opponents are studied: passenger car, bicyclist and pedestrian, and all types of technologies are studied: ITS-G5, PC5, 5G/4G Uu & BLE. In that wide scope, it has been critical for the WP4 to give requirements on the different technologies' implementation on each different tools necessary for passenger car & VRU use cases. That is why in this document, there are detection, dynamic and V2X criteria for the car-sized platforms (e.g. GST & UFOpro) and VRU-sized platforms (Launchpad and UFOnano). As said before, the dynamic and detection requirements remain identical as the one expected today by the Euro NCAP.

Concerning the V2X aspects, multiple requirements have been highlighted. To begin, in order to be representative of a real connected vehicle, the connectivity hardware should be embedded inside the platform to keep a realistic distance with the VUT. Moreover, there is an important requirement on the position written inside the V2X messages to be representative of a real vehicle. And so, the position should be either retrieved by a technology precise enough (e.g., GNSS antenna) or use the positioning technology already used in platform (e.g. RTK) with a "degraded mode" to match the precision of a real vehicle.

Besides, as mentioned, the platform should comply with all types of technology studied in the SECUR project since all of them are defined as relevant by the WP2. However, as mentioned in Table 2, it is important to keep the requirements flexible on that item since V2X technologies are evolving constantly and the platform needs to be easily tuneable. In addition of these technologies supported, it is necessary to support communication profiles (e.g. C2C-CC BSP, C-Roads etc.). Indeed, since OEMs are requiring them for their systems, having the capability to support these profiles is also needed for the connected platforms.

Moreover, in the report, there is a section dedicated to the alternative solution proposed by ABD, YoGoKo and Autotalks in order to perform PTW testing. Indeed, as mentioned previously, it is required to have the V2X hardware embedded inside the platform, but it wasn't possible within the SECUR project. Two solutions have been used and worked during the project with however, downside compared to the guidelines of the WP4 in PTW testing. One of the solutions consists of implementing V2X hardware on the platform without being inside of it. The second solution is to bring the connectivity outside of the system "target/platform", i.e., on the side of the test field.

Finally, a part of this document draws the guidelines and suggestions about connected testing environment. Indeed, there are still open discussions on subjects outside the SECUR project scope, e.g., the PKI and backend access. Indeed, in order to have trusted communication, V2X messages are signed using PKI and today, it is not decided which entity will support this PKI (Euro NCAP or laboratories). Concerning, the V2N communication, there would be discussions needed to clarify how testing laboratories could make the connected platforms communicate with vehicles that is linked with a dedicated backend (usually supported by the OEM itself).

ACKNOWLEDGEMENTS

The SECUR Project consortium would like to acknowledge for their support and work all the Partners and Third Parties involved:

Partners

Contributors

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TABLE OF ILLUSTRATIONS

ANNEXES

A – Existing platforms characteristics

A.1. UFOpro (Black Series) from Humanetics

a- Detection

Dimensions (Length-width) [mm]	2950 x 1690
Height [mm]	98
Colour	Grey
Radar Cross Section	According to Euro NCAP requirements

b- Dynamic Properties (with target)

Speed [km/h]	100
Maximum Acceleration [g]	0.2
Deceleration [g]	0.61

c- Scalability

Additional storage in the platform	Yes

A.2. GST (120) and Soft Car 360 from AB Dynamics

a- Detection

Dimensions (Length-width) [mm]	3160 x 1680
Height [mm]	100
Colour	Grey
Radar Cross Section	According to Euro NCAP requirements

b- Dynamic Properties (with target)

Speed [km/h]	120
Maximum Acceleration [g]	0.28
Deceleration [g]	0.8 (with ABS)

c- Scalability

Additional storage in the platform	Yes

A.3. GST (100) FROM AB DYNAMICS

a- Detection

Dimensions (Length-width) [mm]	2950 x 1680
Height [mm]	100
Colour	Grey
Radar Cross Section	According to Euro NCAP requirements

b- Dynamic Properties (with target)

Speed [km/h]	100
Maximum Acceleration [g]	0.2
Deceleration [g]	0.8 (with ABS)

c- Scalability

Additional storage in the platform	Yes

A.4. UFONANO FROM HUMANETICS

a- Detection

Dimensions (Length-width) [mm]	700 x 800
Height [mm]	65
Colour	Grey
Radar Cross Section	ISO 19206-2 ISO 19206-4 Depending on target Euro NCAP approved target carrier

b- Dynamic Properties (with target)

Speed [km/h]	20
Maximum Acceleration [g]	0.2
Deceleration [g]	0.2

c- Scalability

Additional storage in the platform	No

A.5. LAUNCHPAD (80) FROM AB DYNAMICS

a- Detection

Dimensions (Length-width) [mm]	1045 x 960
Height [mm]	80
Colour	Grey
Radar Cross Section	ISO 19206-2 ISO 19206-4 ISO 19206-5 Depending on target Euro NCAP approved target carrier

b- Dynamic Properties (with target)

Speed [km/h]	80
Maximum Acceleration [g]	0.3
Deceleration [g]	0.6

c- Scalability

Additional storage in the platform	No

A.6. LAUNCHPAD (60) FROM AB DYNAMICS

a- Detection

Dimensions (Length-width) [mm]	917 x 875
Height [mm]	65
Colour	Grey
Radar Cross Section	ISO 19206-2 ISO 19206-4 ISO 19206-5 Depending on target Euro NCAP approved target carrier

b- Dynamic Properties (with target)

Speed [km/h]	60
Maximum Acceleration [g]	0.3
Deceleration [g]	0.6

c- Scalability

Additional storage in the platform	No

A.7. UFOMICRO FROM HUMANETICS

a- **Detection**

Dimensions (Length-width) [mm]	1050 x 980
Height [mm]	70
Colour	Grey
Radar Cross Section	ISO 19206-2 ISO 19206-4 ISO 19206-5 Depending on target Euro NCAP approved target carrier

b- **Dynamic Properties (with target)**

Speed [km/h]	80
Maximum Acceleration [g]	0.41
Deceleration [g]	0.61

c- **Scalability**

Additional storage in the platform	No