Cooperative Vehicle-Infrastructure Systems

D.CVIS.6.2	**Validation Plan**

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Abstract	This document describes the procedure for carrying out the validation task of CVIS. The validation task is driven by the high level objectives that are described in the CVIS Work Description (Annex I of the contract).

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Control sheet

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0.2	10/04/2007	Bart Driessen	Proper template. Added HLO.
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Abbreviations and Definitions

Abbreviation	Definition
ACI	Access Control Interface
AO	Assessment Objectives
CALM	Continuous Air interface for Long and Medium distance
CVIS	Cooperative Vehicle Infrastructure Systems
DSRC	Dedicated Short Range Communication
HLO	High Level Objectives as described in Annex I
HMI	Human Machine Interface
HOV	High Occupant Vehicle
NTVE	Non Technical Validation Element
OBU	On Board Unit
OEM	Original Equipment Manufacturer (Vehicle manufacturer)
RSE	Road side Equipment
SE	Systems Engineering
SP	Sub-Project
TSM	Test Site Manager
UML	Unified Modelling Language
VMP	Variable Message Panels
VMS	Variable Message Sign

Executive Summary

This document describes the CVIS project validation plan. The validation process in CVIS has three main objectives:

1. Verify that the CVIS technology and applications meet the functional and non-functional requirements as defined in WP2
2. Show that the CVIS framework is valid, meaning it enables and supports cooperative systems to the satisfaction of all stakeholders
3. Show that CVIS applications fulfil their promise concerning road efficiency, road safety and environmental impact

Based on the CVIS high level project objectives (HLO) that are described in the Work Description (Annex I), assessment objectives (AO) for each subproject will be derived. Different AOs may be associated with one HLO. These AOs may have a different description for each testing stage. Therefore, each subproject will have three sets of assessment objectives: a β-set, a γ-set and a test site set. Each assessment objective should have a clear link to an HLO.

Each AO will be defined by a label, a description, an indicator (identifying what will be measured), a criterion (defining when the validation test is successful), a test description, and (in case of test-bed tests) one or more use cases.

The validation procedure for tests to be carried out at the test sites is as follows. From all Use Cases, the test site manager (TSM) selects a set that will be executed at the test sites. All validation leaders will check whether they can implement their validation tests in the proposed experiments. If not, additional experiments will be defined in collaboration with the TSM.

For each experiment, detailed scripts will be derived by WP5, that show step by step how the experiment will be executed. The validation managers shall check whether their test set is properly implemented in the script. If not, the validation managers will propose adjustments of the experiment scripts.

After formal acceptance of the scripts, WP5 will execute the scripts at the test sites, and collect the data that is needed to derive the validation indicators.

For non technical validation issues, a structure is provided to be used by all SPs. Based on the proposed non technical validation elements (D.CVIS.6.1), all SPs select which non technical validation elements are applicable for the SP and will be validated in practice. The WP6 leader defines a validation procedure (test, inspection, interview etc.) for each non technical validation element to be validated.

1. Introduction

1.1. Intended audience.

This document describes the validation process of the CVIS project. It is intended to be a guide for the work package leaders of the subprojects (SP) who are responsible for implementing the validation process in their corresponding SPs. This document is the responsibility of the Core Architecture Group (CAG) and is produced by the Validation Manager. In this way a single methodology is proposed at IP level and should be implemented consistently at SP level.

1.2. Objective of the validation process.

It is important to understand that CVIS is a R&D project and not a product development or demonstration project. This means that the scope of validation in CVIS is more technical validation of prototype systems and applications, rather than assessment of impacts, costs and benefits etc. The validation process is based on accepted design methodologies such as the V-model methodology and the CONVERGE assessment guidelines, adapted as necessary to the specific needs within CVIS, because these methodologies are in general better suited for real product development and demonstration than for R&D projects.

The validation process in CVIS has three main objectives:

1. Verify that the CVIS technology and applications meet the functional and non-functional requirements as defined in WP2
2. Sshow that the CVIS framework is valid, meaning it enables and supports cooperative systems to the satisfaction of all stakeholders
3. Assess how far the CVIS applications fulfil their promise concerning road efficiency, road safety and environmental impact

The ideal outcome would be that the following statement can be confirmed by the end of the project:

*Cooperative vehicle-infrastructure applications are feasible and indeed improve road efficiency and road safety and decrease environmental damage significantly **AND** the CVIS framework does enable the realisation of those systems to the satisfaction of all stakeholders.*

1.3. Objectives of this document.

This document has the following objectives:

1. To describe the CVIS validation approach and process.
2. To specify the responsibilities and tasks of the actors and project entities (e.g. work packages) involved in the validation process. Note that this also includes certain activities beyond WP6 itself.
3. To supply common templates to by used by all WP6 SP leaders for their validation activities.

1.4. Structure of this document.

This document includes the following sections.

1. Introduction

Describes intended audience, objectives and use of this deliverable.

2. Overview of Validation Approach

This section describes the general approach to validation in the CVIS project, how the validation activities are to be organised within the development and test-site phases of work, and the relation between the various validation-related deliverables.

3. Assessment Objectives

This section defines how Assessment Objectives (AOs) should be described within the individual CVIS Sub-projects and how they relate to the CVIS High-level Objectives

4. Indicators

This section defines the format to be used for describing the assessment indicators to be measured for each Assessment Objective during the tests as part of CVIS validation.

5. Test Cases

This section defines how test cases should be formulated for the various tests to be performed at a CVIS test site.

6. Validation at Test Sites

Here the validation process to be carried out at each test site is illustrated and the procedure for defining which use cases will be executed and how (this is described in a "script").

7. Non-Technical Validation Plan

The accompanying deliverable D.CVIS.6.1, "Non-technical validation elements", identifies some issues for validation from each of the seven topics addressed in the Deployment Enablers (DEPN) sub-project. This section describes when and how non-technical validation elements should be incorporated in the validation process for each CVIS sub-project.

Annex 1. Copy of Project Objectives from Annex I

Annex 2. Copy of WP6 description from Annex I

2. Overview of Validation Approach

2.1. *Validation activities*

Below, the CVIS version of the development, test and validation V-model is shown.

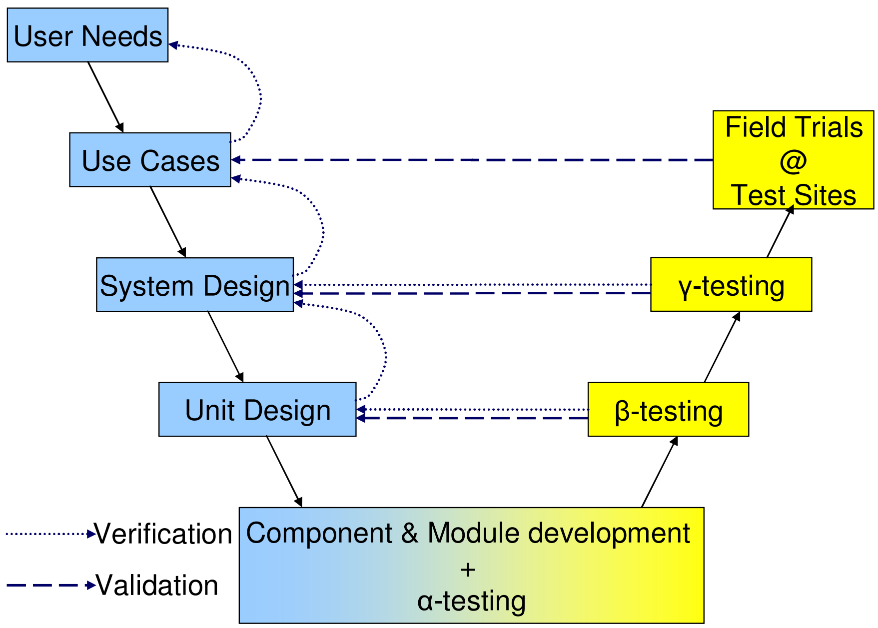

Figure 2-1 V-model for validation and verification.

User Needs and Use Cases are derived and described in WP2, the first development stage in CVIS. System architecture, system design and unit design are covered in WP3. Component and module development, including α-testing, are included in the implementation work-package, WP4. Field trials are covered in WP5 (for implementation) and WP6 (for validation). The testing of CVIS integrated equipment units, β-testing and γ-testing, comprises two main activities: verification and validation.

Verification tests are carried out to identify if *systems function correctly*. These cover integrity tests, stability tests, integration tests, etc. The main purpose of CVIS verification tests is to confirm if the components/modules developed in WP4 behave as specified in the system/unit specifications that are created in WP3.

Validation tests are carried out to identify whether the *systems perform as expected.* The tests are mainly focused on trying to confirm whether the project results meet the high level project objectives that are specified in Annex I of the CVIS proposal (see Annex 1 of this report).

The following definition of the test stages are used in Figure 2-1:

α-test

Test of an isolated system or subsystem, carried out to verify if the developed modules operate as defined in the functional specification. Dependencies with other modules (so called collaborators) shall be implemented using stubs. The outcome of the α-tests are α-tested modules that serve as the basis for the β-test.

α-tests are an activity of WP4.

β-test

Integrated tests in a simulated environment, using α-tested modules generated in the different sub projects. As far as possible real hardware components will be used to carry out the tests. Relevant dynamic traffic behaviour will be implemented using simulations (for example, for testing the FCD functionality, a travelling car connecting to RSE during its trip needs to be emulated).

β-verification tests are an activity of WP4. β-validation is the responsibility of WP6 (with support from WP4 for implementing and executing the tests).

γ-test

Integrated test in a controlled real-life environment, making use of β-tested modules generated in the different sub projects. Real components (such as vehicles) will be used to carry out the tests. The tests are carried out in test areas with an adequate technical infrastructure available (i.e. directly in the neighbourhood of participating research labs).

γ-verification is the responsibility of WP5, with support from WP4. γ-validation is the responsibility of WP6, with support from WP5 and WP4 (for implementing and executing the validation tests).

Field trial

Integrated test taking place at test sites, using γ-tested modules generated in the different sub projects.

Field trials are the responsibility of WP5. Validation at field trials is the responsibility of WP6, with support from WP5 and WP4 (implementing and executing the validation tests).

CVIS is a complex project, where many subprojects are progressing in parallel, but at the same time heavily depend on each others results. Especially for β-testing, γ-testing and field trials, this means that synchronisation of verification and validation activities is required. Figure 2-2 aims to clarify the relation between test results developed in the existing work packages.

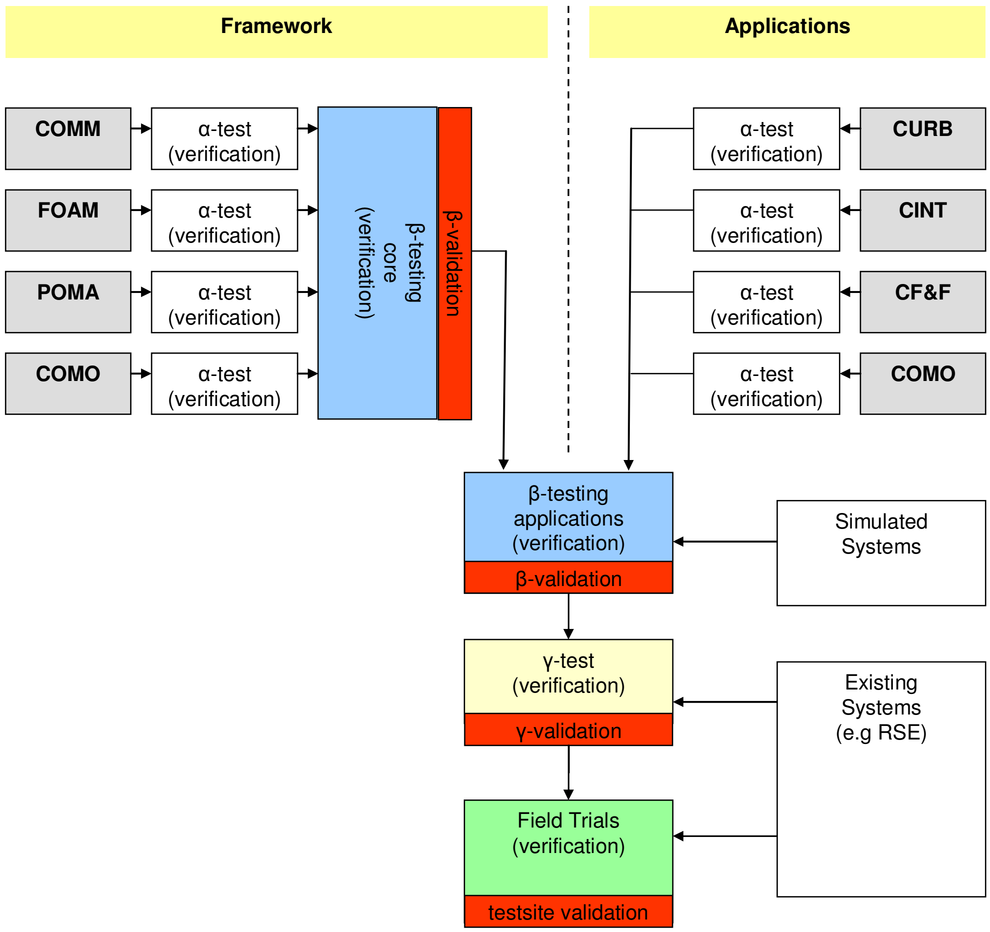

Figure 2-2 The process of creating, testing and using CVIS products

In Figure 2-2 the process of validation and verification is visualised.

For β-testing the CVIS technology or application sub-projects, verification as well as validation activities will be carried out. The verification activities (blue) focus on proving that the produced systems are stable, and compliant with the functional requirements. The validation activities (red) are tests that investigate whether the CVIS high level objectives (HLO) are met. β-testing will be carried out at the β-test site locations (i.e. the testbeds).

For γ-testing the same procedure holds. Verification activities (yellow), aiming to prove the system is stable and complies with the functional specification will be concluded with a validation process (red) aiming to show the subprojects conform to the HLO.

At field trial sites, a number of different applications will be demonstrated (green). The field trials will be concluded with a validation phase (red), again aiming to show if and to what extent the CVIS HLO are met.

2.2. Relation between deliverables

In Figure 2.3 below, the IP and SP level deliverables are shown that have a relation with the validation and verification process.

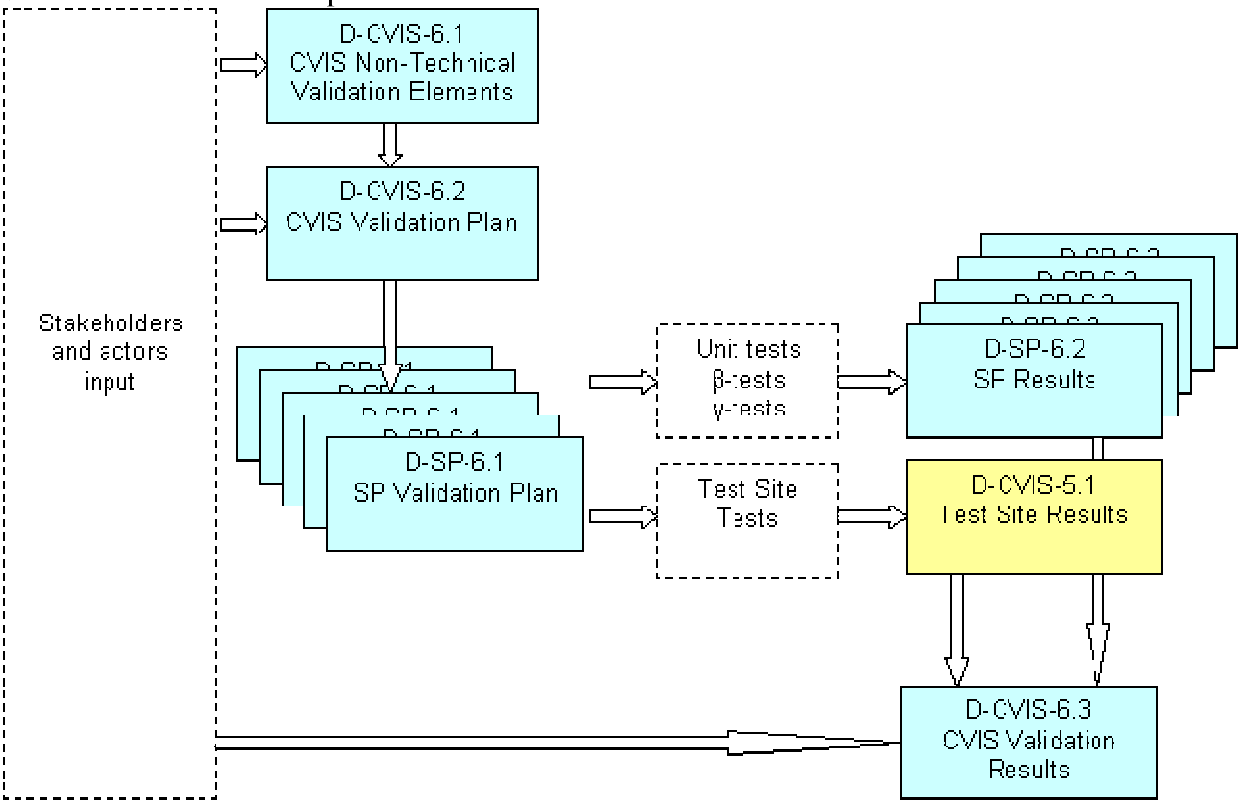

Figure 2-3 Relation between deliverables.

At IP level, D.CVIS.6.1 proposes a list of and methodology to approach the non-technical validation elements. This document, D.CVIS.6.2, comprises the validation approach adopted by the CAG that should be applied in the different sub-projects. Based on this document, the WP6 leaders of all subprojects will generate a detailed subproject validation plan (D.SP.6.1). β-validation and γ-validation will produce results to be documented for each subproject (D.SP.6.2). Test sites will deliver their test results at IP level (D.CVIS.5.1). All validation results will be aggregated to generate the final consolidated CVIS validation deliverable (D.CVIS.6.3).

3. Assessment objectives

3.1. Procedure

The CVIS HLO (defined in the CVIS work description), are listed in Annex 1 of this document. Based on these HLO, assessment objectives for each subproject will be derived. These assessment objectives will have a different formulation for each testing stage. Therefore, each subproject will have three sets of assessment objectives: a β-set, a γ-set and a test site set. For each assessment objective, a clear link to the HLO will exist. This scheme is illustrated below.

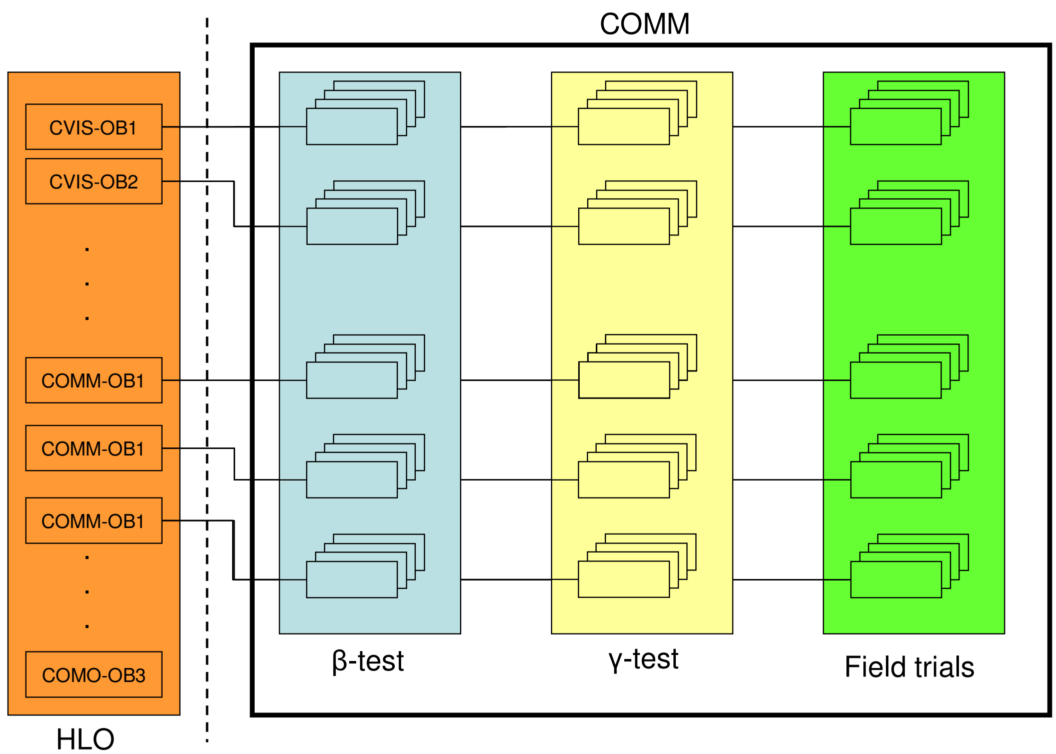

Figure 3-1 From high level objective to assessment objective.

Note that the figure only represents the assessment objectives for one SP (in this case COMM). Also note that the color scheme used for β-test, γ-test and test bed-tests are consistent with the colours used in Figure 2-2. The schedule will apply for all SPs, as shown in the figure below:

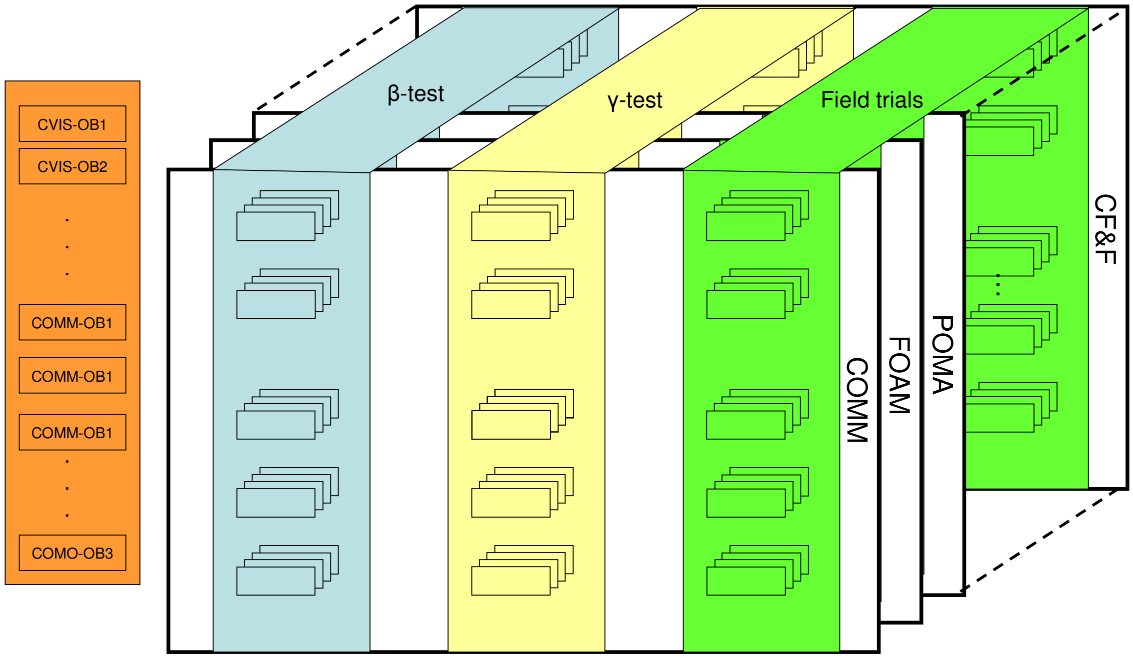

Figure 3-2 Assessment objectives for all CVIS SPs.

3.2. Naming convention

The naming convention of assessment objectives to be adopted by each SP will be:

AO_SP_HLO.i_s , where:

- AO is a literal, identifying that we are talking about Assessment Objectives,
- SP is to be replaced by the initials of one of the subprojects COMM, FOAM, POMA, COMO, CURB, CINT, CF&F, CAG, or DEPN
- i is a sequence number
- s represents the test state, being either b (for β-test), g (for γ-test) of t (for test site-test).

SP only needs to be specified if the SP differs from the SP that is mentioned in the HLO part.

Examples:

AO_COMM_CVIS-OB1.1_b	First β-test assessment objective of the SP COMM that is related with high level objective

	CVIS-OB1.
AO_COMM_COMM-OB3.4_g	Fourth γ-test assessment objective of the SP COMM that is related with the high level objective COMM-OB3.

4. Indicators

For each assessment objective, the SPs shall define a set of measurable indicators that will be used for checking whether the assessment objective is successfully achieved (or not). Criteria for success will be defined using the indicators. Typically a criterion will be a threshold value. Assessment objective, indicator and criterion for success are closely related.

An example of an Assessment Objective – Indicator – Criterion set is shown below:

ID	**Description**	**Indicator**	**Criterion**
AO_COMM_CVIS-OB1.4_b	Bandwidth for IR communication at distance of 200m.	Communication bandwidth realised.	Bandwidth > 2 Mbps

Note: an official request is submitted to change the description and criterion of this indicator.

5. Test Cases

The test defined in paragraph 4 is not complete if the test case (the way the test should be carried out) is not described. Therefore, for each test, assessment objective, a small text paragraph will be produced to identify how the test is carried out.

The demonstrations that will be implemented at the test sites will be based on the use cases that were derived in WP2. Those validation tests that will be executed at the test site (thus having the extension _t), should contain a reference to the use case(s) that is(are) selected for execution during this test site validation test (see also section 6)

An example of a test case description is given below.

ID	Test case
AO_COMM_CVIS-OB1.4_b	A sequence of xxx data packets of format yyy and size zzz are sent via IR communication channel to a receiver that is located 200m away. The receiver sends the packets back to the original sender. The time for this roundtrip communication is measured and used for calculating the average communication bandwidth.

Or, in case of a test site test:

ID	Test case	Use Cases
AO_CINT_CINT-OB3.4_t	A vehicle enters the road driving in the wrong way. The vehicle is identified as a ghost driver (either by other vehicles or by the infrastructure). CVIS (i.e. either the traffic management centre, or the individual cars) warns downstream vehicles that a ghost driver is approaching. As a result, the downstream vehicle tries to find an alternative route in order to avoid being in the vicinity of the ghost driver. If an alternative route is available, this alternative route is displayed to the driver.	CV-UC-SP3.2-0017 CV-UC-SP3.2-0021 CV-UC-SP3.2-0025 CV-UC-SP3.2-0027

6. Validation at Test Sites

The demonstrations that will be held at the test sites will serve two major purposes:

- To validate the CVIS project results in a realistic setting.
- To create awareness amongst professionals and the general public about the potential impacts and benefits of CVIS technologies and applications.

The workflow of the experiments carried out at each test site is shown below.

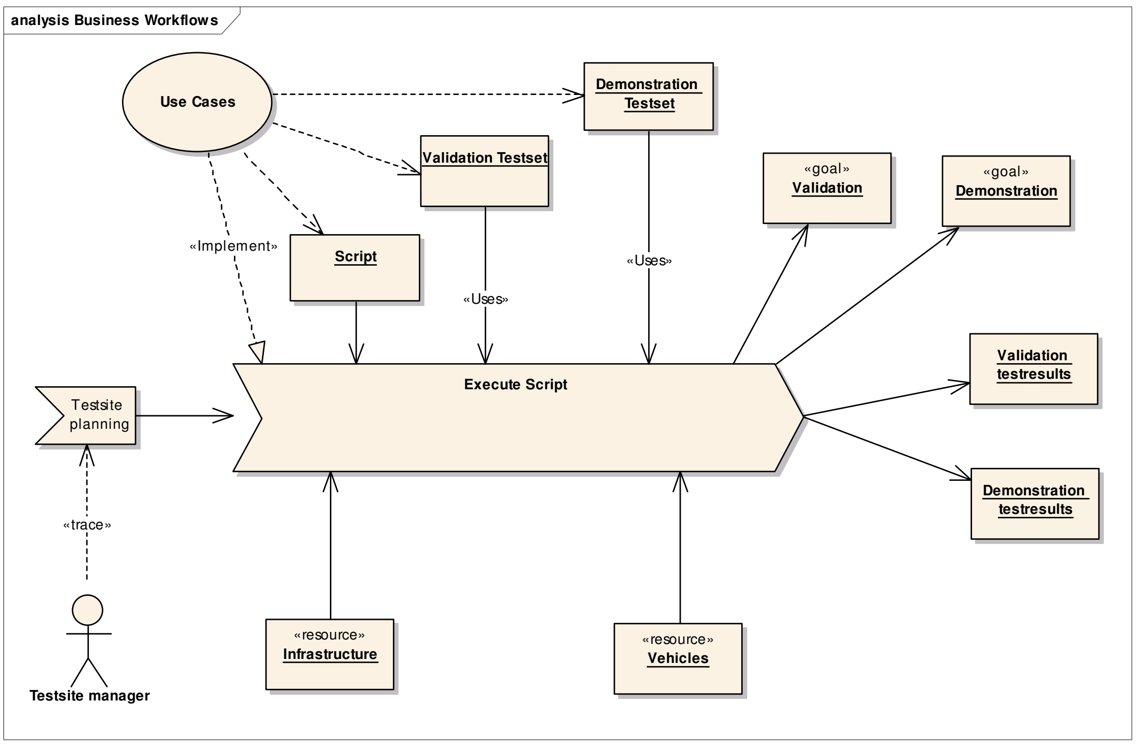

Figure 6-1Workflow of experiments at test sites.

From all Use Cases, the Test Site Manager (TSM) selects a set that will be executed and validated at the respective test site. Here, this set of Use Cases will be referred to as the Experiments. Each validation leader will check whether they can implement their validation tests in the proposed Experiments. If not, additional Experiments will be defined in collaboration with the TSM.

For each Experiment, detailed scripts will be derived by WP5, showing step by step how the Experiment will be executed. The validation managers shall check whether their test set is properly implemented in the script. If not, the validation manager proposes adjustments of the Experiment scripts.

After formal acceptance of the scripts, WP5 will execute the scripts at the test sites, and collect the data that is needed to derive the validation indicators.

7. Non-Technical Validation Plan

In D.CVIS.6.1 Non-Technical Validation Elements a compilation of non-technical validation issues has been identified from a deployment perspective and from the viewpoint of various stakeholders in the CVIS community. This section deals with how to ensure that those issues raised will be properly addressed within CVIS.

By their nature non-technical validation elements (NTVE) may not be directly related to performance criteria, and the corresponding criteria not straightforward to quantify. Consider for example the non-technical validation element "*End users' trust that CVIS positioning data are accurate and precise*", formulated from the perspective of safe, secure and fault-tolerant design. Quantifying 'end user trust' in an objective way is not straightforward. Even more, different SPs may have different interpretations of 'trust', in which case each should choose the appropriate assessment technique for its own circumstances. It is important in that case that the various approaches be harmonised via the CAG so that common conclusions can be drawn from the validation across the different CVIS sub-projects.

Non-technical validation elements listed in D.CVIS.6.1 may also conflict with each other, due to the different stakeholders' interests, and as such reflect real life conflicts of interest. Trade-offs should accordingly be made by the subprojects involved. In each sub-project the set of NTVEs that will actually be assessed should be identified, as it is likely that only a sub-set of the full list would be both appropriate and practicable.

During validation it should be clear and traceable in the documentation of the respective subprojects - be it meeting notes, architecture diagrams or any other (formal) document - how the relevant NTVEs have been addressed, and whether this is sufficient according to the validation criteria. In difficult cases it would be sufficient if a traceable, understandable rationale could be found in the subproject's documentation, proving that the NTVE has indeed been addressed.

The various NTVE categories are aligned along the topics treated by the CVIS DEPN sub-project and have been marked as such:

T2 – Openness and interoperability

T3 – Safe, secure and fault-tolerant design

T4 – Utility, usability and user acceptance

T5 – Costs, benefits and business models

T6 – Risk and liability

T7 – CVIS and policy

T8 – Deployment maps

Each SP will make a selection out of the list of NTVEs that are most related to this SP. Note that it is not the intention to strive to completeness. Only the most important NTVEs will be addressed, and only those that can realistically be assessed within the means available. This will be clearly outlined in the various SP validation plans (D.SP.6.2).

Templates

Each SP will create a list of applicable NTVEs. The naming convention to be followed is as follows:

NTVE_SP_Ti_j, where:

- NTVE is a literal
- SP is one of the subprojects COMM, FOAM, POMA, COMO, CURB, CINT, CF&F, CAG, or DEPN
- T is a literal (referring to "DEPN ***T***opic")
- i is the number of the DEPN Topic,
- j is the sequence letter of the NTVE as listed in D.CVIS.6.1.

For each entry, a description about the validation procedure will be created according to the following template and example content:

	Relevance and procedure				Rationale	Criterion
Name/ID of the NTVE	*A description about the procedure that is used to validate this element*				*A short description showing in what way this NTVE is relevant for this SP*	*As sharp as possible criterion pointing out when the testing procedure is successful. In many cases this will not be possible for NTVE's*
NTVE_CAG_T2_a	**x**				**NTVE touches upon the CVIS HLA, the systems lifecycle maintenance, openness and interoperability in the broadest sense**	**No hard criterion possible; general awareness must have been created in all SP's, traceable as dissimination actions and explicit architectural design choices**
	R	P	T	W		
NTVE_CAG_T2_b	**-**					
	R	P	T	W		
NTVE_CAG_T2_c	**-**					
	R	P	T	W		
[et cetera]						

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R = Requirements test
P = Project documentation review
T = Test and/or simulation
W = Structured walkthrough
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Annex 1 Copy of Project Objectives from Annex I

Objective #	Project Objective	Targets	Criteria for validation
CVIS-OB1	Demonstrate the full interoperability of CVIS on-board units (OBU) across vehicles from different suppliers, and between vehicles and roadside equipment of different suppliers.	100% interoperability across 3 different makes of vehicle and 4 different test site implementations	Cross-interoperability trials will be carried out between different makes of equipped vehicle, and between different vehicles and equipped infrastructure at test sites. A common test suite of communication types and content will be designed for this trial. Success will be judged according to how well these communications succeed.
CVIS-OB2	Development of generic open source interfaces and modules for the cooperative exchange of data between vehicles and infrastructure (V2I).	80% of drivers, operating system elements and application software are under open-source licence	Verify by inspection the proportion of software that is under open-source licence
CVIS-OB3	Create open reference platform with pluggable communication interfaces with IPv6 mobile routeing capability	20 CVIS units are delivered to application developers and test site managers, that can work with all intended communication interfaces, and deliver mobile IPv6 routeing capacity.	Verify by inspection that an open-design developer's kit is available, and also a specified number of CVIS reference platform units suitable for both vehicle and roadside deployment; and that a helpdesk is operational.
CVIS-OB4	Show that CVIS equipment and services are accepted by the general public as future customers, and that the different applications are perceived by users as providing positive value.	75% of sample of end users have a positive or neutral attitude to the acceptance and benefits of CVIS on-board equipment and applications	Selected panels of users will receive a demonstration of CVIS equipment and will experience both real-life and realistic but simulated CVIS services, both at test-sites and other project expositions. They will make a personal evaluation of the utility, usability of the equipment and services, and will rate their willingness to acquire and pay for these.
CVIS-OB5	Show that a majority of end users of CVIS systems are willing to allow the use of data collected from their vehicle and journey, as input to cooperative monitoring services.	Over 50% acceptance of a sample of end users for release of floating vehicle and journey destination data	Selected panels of users will be asked to assess their willingness to provide data gathered from their journeys to a CVIS service provider, and to specify any conditions that must be applied to protect their privacy, and any benefits that must be provided in return.
CVIS-OB6	Show that users are willing and likely to adopt cooperative driving and travel behaviour in order to realise benefits themselves.	Over 50% driver acceptance to adopt recommendations for speed, route etc. provided by traffic centre	A panel of drivers will be asked to drive CVIS-equipped vehicles at test sites, as well as to use simulators, and their behaviour will be recorded. They will also be asked during an in-depth interview to describe their expected behaviour when using fully-developed CVIS in-vehicle equipment and services.

Objective #	Project Objective	Targets	Criteria for validation
COMM-OB1	Demonstrate that CVIS communication will cover a range of performance from today's short-range communication speeds up to broadband speed, and communication distance will be substantially increased, and CVIS will also enable vehicle-to-vehicle communications.	CVIS reference platform will check the following capabilities: - DSRC: 250kbps at 8m (roadside to vehicle) - cellular: 384 kbps (roadside-vehicle) - IR: 2Mbps at 200m (roadside-vehicle, vehicle-vehicle) - CALM M5: 54 Mbps at 80m or 6Mbps at 500m (all modes)	CVIS reference platform units will be trialled using two test vehicles and one roadside test unit, for CALM M5 and Infra-red communications.
COMM-OB2	Demonstrate that CVIS communications equipment is able to roam across multiple available wireless carriers (heterogeneous or vertical handover).	For suite of test applications, the reference platform will maintain a session as 4 different media are activated (for: cellular, WAVE (CALM M5), CEN DSRC and infra-red),	The prototype CVIS communications testbed will be trialled in both laboratory and real-life environments, to verify that a continuous connection can be maintained across cellular, WAVE, CEN DSRC and infra-red bearers.
COMM-OB3	Demonstrate that CVIS networking equipment is able to maintain a continuous IP connection, and with sufficient data throughput for CVIS application requirements, from a moving vehicle (homogeneous or horizontal handover).	For a single reference application, a mobile test unit, passing at least 3 roadside units, the session will be maintained; to be repeated for WAVE (CALM M5) and Infra-Red bearers.	The CVIS prototype testbed will be tested in the laboratory, on a test track and in a real-life environment, to verify that a continuous IP network connection can be maintained from a moving vehicle and to a number of roadside units, while maintaining sufficient bandwidth and with acceptable latency; verify that the testbed meets defined Quality of Service (QoS) parameters..

Objective #	Project Objective	Targets	Criteria for validation
FOAM-OB1	Demonstrate that new CVIS applications and services can be developed, deployed and provisioned on an open end-to-end framework and run-time environment	100 % successful tests between 3 test sites on this core FOAM functionality	Demonstrate for FOAM test suite of applications, that interoperability is ensured between CVIS test sites allowing to interchange applications and services between service centres, control centres and in-vehicle or roadside equipment
FOAM-OB2	Demonstrate that external service and application providers can deploy new applications and services on CVIS infrastrucure	75% satisfaction rating by at least 5 external service providers that FOAM does provide ease of use for public availability of specifications and availability of development tools	Demonstrate through evaluation of test suite of new applications & services to be solicited through a "service submission contest", and tested using one or more reference implementations on CVIS test sites.
FOAM-OB3	Demonstrate that in-vehicle and roadside units can be	100 % successful remote management tests	Trial FOAM remote management test suite for 2 reference

	remotely managed		applications, demonstrate that both in-vehicle and roadside units can be remotely managed.
FOAM-OB4	Demonstrate the secure operation of CVIS infrastructure	100 % successful security tests	Trial FOAM security test suite of 2 reference applications, to show resilience to tampering and other potential vulnerabilities.

Objective #	Project Objective	Targets	Criteria for validation
POMA-OB-1	To provide an open API (applications programmer interface) for positioning and map services that will run on the CVIS reference platform, and that will: - integrate different positioning techniques (GNSS, road-side beacons, inertial); - provide overall quality of service and integrity indicators on resulting positions - provide new techniques for infrastructure based positioning.	CVIS positioning module can achieve better than 1m accuracy in critical locations, and better than 3m accuracy in general; at least 80% of POMA service software is under open-source licence (target performance will be revised once the application requirements are defined by the application SPs (following Month 6)	Demonstration of the CVIS positioning solution and comparison with technologies commonly available at the time of the demonstration. CVIS positioning solution must demonstrate a clear added-value. The demonstration results must show that the CVIS solution meets the application positioning requirements identified at the beginning of the project.
POMA-OB-2	CVIS mapping tools shall: - include new map content enhancing locally the standard map specification. - support distribution and integration of map updates and related content. - support the sharing of geo-referenced data across CVIS entities.	During driving at normal speed in a trial road network, new local map content will be automatically transferred; full functionality will be demonstrated for one vehicle passing three roadside units offering local map service: map is downloaded and made available through POMA API to other vehicle services.	Demonstration of CVIS applications integrating the mapping tools. The mapping solutions must be able to cope with the highly dynamic CVIS environment. CVIS mapping solutions must demonstrate a clear innovation compared to map solutions implemented at the vehicle or centre level at the time of the demonstration.

Objective #	Project Objective	Targets	Criteria for validation
CURB-OB-1	By having the knowledge of individual vehicle trip characteristics and destination, and being able to give trip advice to vehicles on an individual basis, show considerable advances in: - the creation and real time selection of traffic management scenarios, the implementation of the selected scenario throughout the urban road network, and the dissemination of information to drivers.	The sub project will show that – the margin of error in short term urban traffic flow prediction will be reduced by 50%; drivers will receive information of incidents affecting the efficiency of the urban road network in 50% of the time it would take a non-cooperative urban traffic management system to convey this information.	Comparative validation of the effectiveness of the use of individual vehicle trip data and the dissemination of traffic management information to individual vehicles, in comparison with a situation where only historic trip data and limited flow information are available and communication with vehicles is limited to collective roadside message signs.
CURB-OB-2	By having the knowledge of individual vehicle trip characteristics and destination, and being able to give trip advice to vehicles on an individual basis, show considerable advances in – - the determination of momentary disturbances in traffic flow and highly responsive local area rerouting, building on state-of-the-art traffic flow theory and experience.	The sub project will show that – - local area rerouting provides time savings for drivers and a more balanced use of road network sections around an incident within 5 minutes of the first occurrence, and without a detrimental effect on the overall network efficiency.	Comparative validation of the effectiveness of the use of individual vehicle trip data and the dissemination of traffic management information to individual vehicles in sub areas of the network, in comparison with a situation where an urban traffic management system has only historic trip data and limited flow information, and communication with vehicles is limited to collective roadside message signs.
CURB-OB-3	By having the knowledge of individual vehicle trip characteristics and destination, and being able to give trip advice to vehicles on an individual basis, show considerable advances in – - supporting the drivers with intersection control and traffic state related information; - improving road efficiency by creating virtual green waves through speed recommendations (speed profiles) for the drivers and data exchange with neighbouring intersections.	The sub project will show that – - the driver of an equipped vehicle can receive a traffic signal status prediction well before he/she reaches the dilemma zone in 99 % of trips, as well as a speed recommendation for the green wave in the next network link in 90 % of relevant cases. - the traffic control system creates more effective green waves which gives at least 5 % less aggregated travel time for all vehicles (equipped and non-equipped).	Direct measurement of system performance in equipped vehicles, as defined by individual journey time savings, driver satisfaction with improved information, reduced overall traffic network delay, smoother traffic flows and positive driver acceptance of speed recommendations.. Note: the green wave efficiency (travel time criterion) can probably not be validated at a very low rate of equipped vehicles in a test site. In this case, a model simulation must be used.

Objective #	Project Objective	Targets	Criteria for validation
CURB-OB-4	By having the knowledge of individual vehicle trip characteristics and destination, and being able to give trip advice to vehicles on an individual basis, show considerable advances in – - the safe management of the dynamic allocation of road space to priority public transport vehicles and selected other road users.	The sub project will show that – - in appropriate locations, the travel time for participating (selected) vehicles will decrease, while the travel time for public transport will not increase in at least 95 % of trips.	Comparative validation of the effectiveness of the use of individual vehicle trip data and the dissemination of traffic management information to individual vehicles, in comparison with a situation where the use of the public transport lane is normally closed for other vehicles.
CURB-OB-5	Show that the innovations allow a realistic transition phase by supporting roadside interoperability with legacy equipment, and by allowing an increasing penetration rate of innovative vehicle equipment.	The sub project will show that – - all applications are active on new and legacy equipment; - sensible results are produced at low penetration rates.	Demonstration by reference implementations of all four applications on equipment of different type and manufacture. Validating (the effects of) mixed operation with equipped and non-equipped vehicles at different penetration rates by a model simulation.

Objective #	Project Objective	Targets	Criteria for validation
CINT-OB-1	Development of a toolkit for vehicle-Infrastructure cooperation suitable for inter-urban highways, within the high level CVIS architecture.	Toolkit exists, is documented and is supported by an available on-line helpdesk	Verify by inspection that a toolkit of core software modules are available for deploying the EDA and CTA applications in a new test or deployment site.
CINT-OB-2	Show that CVIS technologies enable Enhanced Driver Awareness (EDA) to deliver more accurate and timely driver information, directly to the driver at any time	Driver of equipped vehicle is informed within 5 seconds, and at any location in the test stretch, of: real-time traffic and safety information, for example - - change in a variable speed limit; and - presence of a wrong-way driver approaching	Demonstration of functionality and assessment of reliability of CVIS technologies as implemented in reference EDA applications (proposed, t.b.c.) for - Speed alert and - Wrong-way driver
CINT-OB-3	Show that CVIS technologies enable Cooperative Traveller's Assistance (CTA) to help drivers to avoid getting caught up in downstream congestion incidents	From time of detection, drivers are advised within the vehicle and within 15 seconds of a major congestion incident, and within a further 15 seconds they receive a routeing recommendation	Demonstration of functionality and assessment of reliability of CVIS technologies as implemented in reference CTA applications for individualised route guidance recommendations; Simulation and survey of trial users' acceptance and evaluation of the improved information, and behavioural reaction

Objective #	Project Objective	Targets	Criteria for validation
CF&F-OB-1	Show that the project has advanced the state-of-the-art regarding Cooperative dynamic management of dangerous goods transport - dangerous goods vehicle route guidance, based on locally defined preferences (today: paper maps with allowed routes) - monitoring of dangerous goods including hand-over of the monitoring task between authorities in different regions / countries as the vehicle crosses regional and national borders (today: some trials / pilots with local monitoring) - dynamic individual influence of local authorities on dangerous goods routing and guidance, including re-routing of individual dangerous goods vehicles after incidents or changed local conditions (today: navigation + RDS/TMC broadcast)	100% success of trial of off-board route guidance for a truck carrying simulated dangerous goods; at least 75% user satisfaction reported by vehicle driver Successful trial of handover of dangerous goods truck from region "A" to region "B" Successful transmission of a dynamic geo-fence to dangerous goods hauliers and of relay to vehicles performing the transport.	Demonstration of off-board route guidance (with the regionally defined allowed road network for dangerous goods in the off-board database) in a real customer truck. Review of application benefits with a real dangerous goods driver. Demonstration of trucks equipped with CVIS HW and the CF&F applications, reporting their position and goods content to regional authority "A" (for dangerous goods monitoring), crossing a defined regional border and being handed over to a regional authority "B". Both monitoring systems "A" and "B" reside in the test site "virtual traffic management centre". Review of application benefits with local authority traffic management officials. Demonstration (in a real customer truck) of off-board route guidance and dynamic changes in the route, "pushed" to individual vehicles by the regional authorities by marking a specific road and temporary "forbidden" e.g. due to a fire. Review of application benefits with a real dangerous goods driver and local authority traffic management officials.
CF&F-OB-2	Show that the project has advanced the state-of-the-art regarding dynamic scheduling of loading bays and highway resting areas; booking, physical access monitoring and control (today: local road signs, manual physical access by key to barrier/gate)	3 major logistics/forwarder actors in EU has applied dynamic scheduling and booking of loading bays in one of their respective terminals and 1 consignee with inner city location has the same capabilities.	Demonstrate the booking of a loading bay and a highway resting place from a truck, receipt of acknowledge, authorisation/authentication and automatic physical access through short-range communication. Review of application benefits with a real truck driver and a city traffic management official.
CF&F-OB-3	Show that the project has advanced the state-of-the-art regarding dynamic geo-fencing policies regulating sensitive area access (today: road signs and manual enforcement of traffic regulations by police patrols)	Successful demonstration of dynamic geo-fencing and remote diagnostics; at least 75% satisfaction reported by test drivers and city traffic officials..	Demonstrate a vehicle equipped with CVIS unit and software reporting diagnostics status and driving style when driving in a specific area, bounded by a "geo-fence". Demonstrate the granting / denying of access to certain physical area through the back-office analysis of historic driving style and vehicle diagnostics status. Review of application benefits with a city traffic management official.
CF&F-OB-4	CVIS technology interoperability	Successful interoperability trials using vehicles of	Demonstrate the CVIS technology interoperability by equipping two

		at least 2 major HGV manufacturers.	vehicles with different HW setups (e.g. one OEM CVIS computer and one “CVIS suitcase”) and performing the demonstration for Objectives CF&F-OB-1 - CF&F-OB-3

Objective #	Project Objective	Targets	Criteria for validation
COMO-OB-1	Show that the project has advanced the state-of-the-art regarding standardized interfaces to in-vehicle and infrastructure sensor technology and detection methods. Intelligent use of the in-vehicle sensor data for distributed data processing. Integration of new and existing approaches and processing algorithms using the CVIS In-Car Gateway. Supply of the sensor data within the COMO framework for the data processing.	- 5 CVIS cars will be equipped and are available for test. - 5 CVIS infrastructure units for the urban areas will be equipped. - 5 CIVI infrastructure units for the interurban areas will be equipped.	Feasibility study which sensor data can be made available and how they can be used within COMO algorithms. Implementation and demonstration of pre-processing methods and algorithms into CVIS test site environment, that provides the Gateway. Demonstration of in-vehicle data processing using the supplied sensor data.
COMO-OB-2	Show that the project has advanced the state-of-the-art regarding a standardized communication interface between vehicles and infrastructure, between vehicles and between infrastructures. Today only approaches exist where vehicles exchange some raw data among each other – there is no interaction between vehicles and roadside infrastructure. Exchange of pre-processed sensor data and provision of these data within the COMO framework. Data processing inside the COMO framework using various COMO applications that are depending on the requirements of the service applications CURB, CINT and CF&F.	Demonstration that the data communication will be successful in at least 95 % of the cases. Demonstration that the transmitted data will be interpreted correctly in at least 95% of the cases.	Implementation of the communication interfaces and demonstration of active data exchange between vehicles and the infrastructure. Demonstration of data processing using the exchanged sensor and pre-processed data and generation of application specific input. Generation of application specific input based on the COMO data fusion algorithms. Distribution of application specific input to other CVIS applications.

Objective #	Project Objective	Targets	Criteria for validation
COMO-OB-3	Show that COMO will interact with the CVIS CURB, CINT, CF&F sub-project on different levels: Information (e.g. local traffic volume, OD, travel times, jam information, weather condition) gathered and processed by a COMO Car-Infrastructure-Cluster will be integrated in a Service Centre environment in order to support the CURB application. A cluster of COMO-Cars and COMO-Infrastructures Units are cooperating in order to collect and process data describing the traffic situation (e.g. travel time, OD, Jams) and the environmental situation (e.g. weather) in a dedicated number of segments in an area. The processed information will be distributed locally. COMO services are offering a lane fine picture of the traffic situation at intersection equipped with CURB traffic lights. COMO will use the POMA positioning information.	Demonstration of a traffic-monitoring interaction with 3 cars and 2 infrastructure units. Increasing of the covered urban network segments by with situation based 100% compared with stationary detectors. Increasing of the covered interurban network by 200% compared with situation based on stationary detectors. Decreasing of the processing time by 50% compared with a centre based data processing. Increasing of the data and information correctness by 50% (compared with the reference situation).	Demonstration of the processes that are needed to transmit aggregated and evaluated data from vehicles and infrastructure units to a central service centre in a COMO and CURB test site. Several CVIS units located in a network section are collecting and processing sensor data in order to create a COMO traffic state picture for a CURB application. Also the information transport from one infrastructure unit to another via vehicles can be demonstrated. One infrastructure unit cooperates with several vehicles collecting information to gather a picture of the local intersection situation, which will be used by CURB for intelligent traffic signalling.

Annex 2 Copy of WP6 description from Annex I

IP Level	SP Level
Objectives	
1. To define the validation plan at IP-level 2. To identify (critical) scenarios to be tested in the field trials 3. To prepare suitable validation tools, including support for processing the site results and tools to analyse and present the validation results at IP-level 4. To consolidate the validation results of the sub-projects.	1. To develop the apply the validation plan at sub-project level 2. To identify (critical) scenarios to be tested in the field trials 3. To prepare suitable validation tools, including support for processing the site results and tools to analyse and present the validation results at sub-project level 4. To develop a test suite 5. To evaluate the results of the field trials.
Description of work	
1. Develop a common methodology and common templates for the validation work within the IP 2. Develop common assessment objectives 3. Filter and consolidate assessment objectives from sub-projects 4. Develop common indicators, success criteria, measurement methods 5. Filter and consolidate indicators, success criteria, measurement methods from sub-projects 6. Finalise the CVIS validation plan 7. To support WP3 for the second workshop on architecture and specifications – incorporating the validation results	1. Elaborate assessment objectives 2. Elaborate indicators, success criteria, measurement methods 3. Finalise the SP Validation Plan 4. Develop a test suite based on the sub-project architecture and specifications 5. To support WP3 for the second workshop on architecture and specifications – incorporating the validation results
Deliverables	
• D.CVIS.6.1 - CVIS Non-technical validation elements • D.CVIS.6.2 - CVIS Validation plan • D.CVIS.6.2 - CVIS Validation results	• D.SP.6.1 - SP Validation plan • D.SP.6.2 - SP Validation results
Milestones	
• M.CVIS.10 – Validation plan complete –	• M.SP.4 – SP Validation results – M44

M18 • M.CVIS.18 – Validation results – M46 • M.CVIS.19 – Validation workshop – M46	