Seminar – 5th and 6th April 2018

Projet SCOOP
véhicules et routes connectés
connected vehicles and roads

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INTRODUCTION

Project SCOOP

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Connected vehicles and Cooperative ITS

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- Intelligent Transport System (ITS) : any use of information and communication technologies in the field of transport

- Cooperative : based on the exchange of information between vehicles and between vehicle and infrastructure. Also called V2X communication

- **NB : there are other types of connected vehicles beside V2X communications (multimedia platform of the car manufacturer, eCall, Pay As You Drive insurance…)**

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The 3 ways of cooperative ITS (C-ITS)

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- V2V : sensors embedded in the vehicles gather information and transmit them automatically to vehicles behind

- V2I : idem, but the information is received by the traffic management center of the road operator

- I2V : the road operator sends information which is displayed in vehicles driving near the site

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Stakes of C-ITS deployment

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- To enhance **road safety**
- To enhance **safety of road workers**
- To optimize **traffic information**
- To develop **new services**
- **To prepare the vehicles of tomorrow**

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C-ITS and automation

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- C-ITS are considered as a solution to make automated vehicles :
  - Cope with critical situations they could not cope with otherwise (ex. toll gate, road works)
  - Anticipate on sensor detection for better comfort of the driver (ex. end of queue)

- **To reach automation level 4 (no possibility to take over manually) will probably, C-ITS will probably be needed**

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ITS G5 technology

- A wifi technology adapted to high speed vehicles. Operating in the 5.9 GHz band
- Allowing V2X exchanges with **very low latency**, which is needed for road safety use cases (slippery road, end of queue)
- **No communication costs**
- Communication with infrastructure through Road Side Units
- **Mature** : standardized years ago, several Field Operational Tests including SCORE@F in France
- Can be hybridated with existing cellular networks (3G/4G) for latency non-critical services

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Project SCOOP

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- SCOOP (or SCOOP@F) is a pilot deployment of cooperative ITS
- Deployment : large-scale (3000 vehicles on 2000 km of roads), in real conditions, with real-life constraints
  - Vehicles sold to real customers => designed with CNIL and ANSSI
  - Constraints of serial production for car manufacturers
  - Every road operator does their own procurement
- Pilot : includes ex ante and ex post evaluation

IMPORTANT : the project does not involve any automation, messages are received by the driver

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Calendar of the project

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- Funded 50% by the European Commission, in two parts (2014-2015 and 2016-2018)

- **1st wave** (pilot deployment, 3000 vehicles) : 2014-2017
  - Priority services
  - ITS G5 communications

- **2nd wave** (proof of concept, a few vehicles) : 2016-2018
  - New services
  - Cellular / ITS G5 communications

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Project partners

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- **French Ministry of Transport** (Transport Infrastructure Directorate)
- **Local authorities**
  - Département de l'Isère
  - ITS Bretagne with Départements des Côtes d'Armor, du Finistère, d'Ille et Vilaine, Région Bretagne, Saint-Brieuc Agglomération)
- **TEN-T road operators** (3 DIRs, SANEF)
- **Car manufacturers** (PSA, Renault)
- **Universities and research centers** (Cerema, IFSTTAR, GIE RE PSA-Renault, Université de Reims Champagne-Ardenne, Institut Mines-Télécom).
- A **telecommunication** operator : Orange
- A provider of **trust services** : IDNomic
- **Spanish** partners (DGT, CTAG)
- **Portuguese** partners (DGAE)
- **Austrian** partners (ASFINAG)

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Five pilot sites

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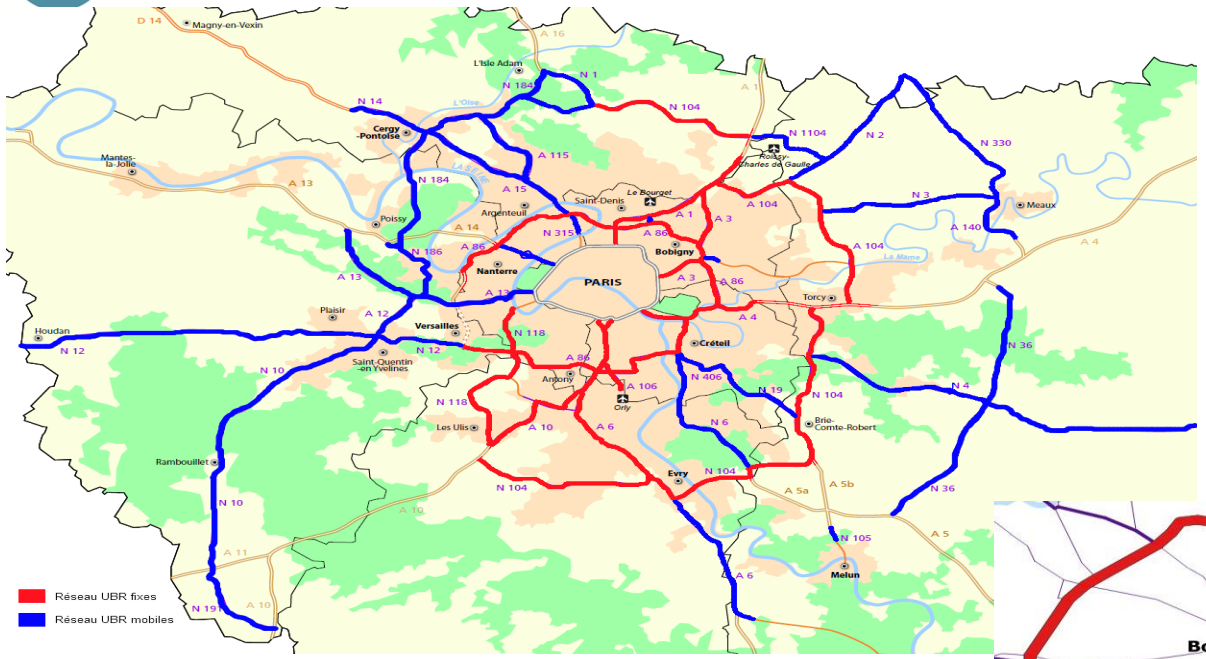
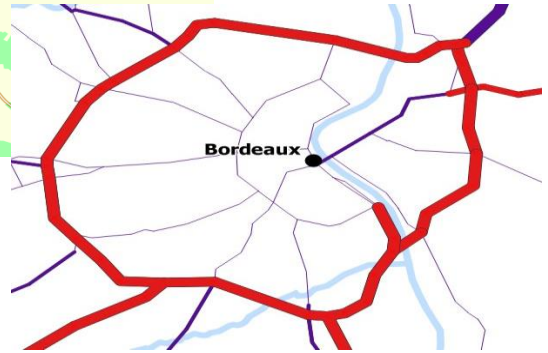
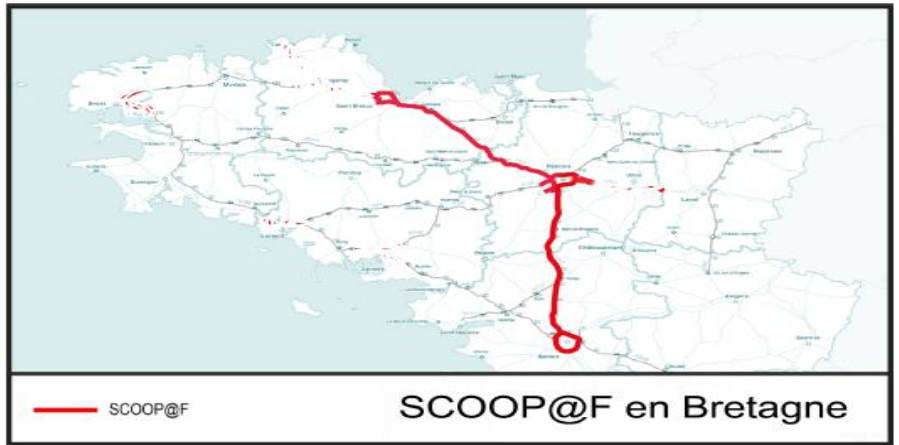
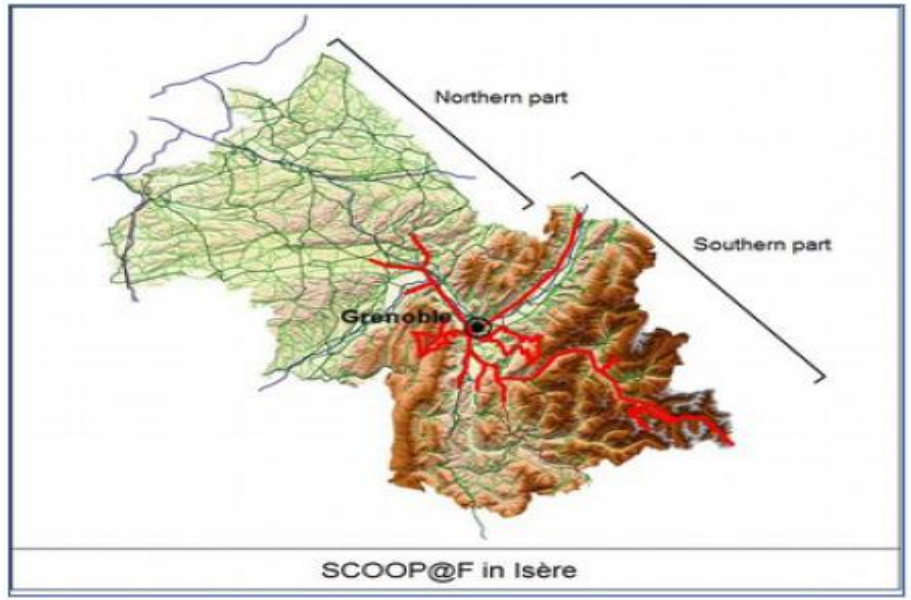


SCOOP@F en Ile-de-France

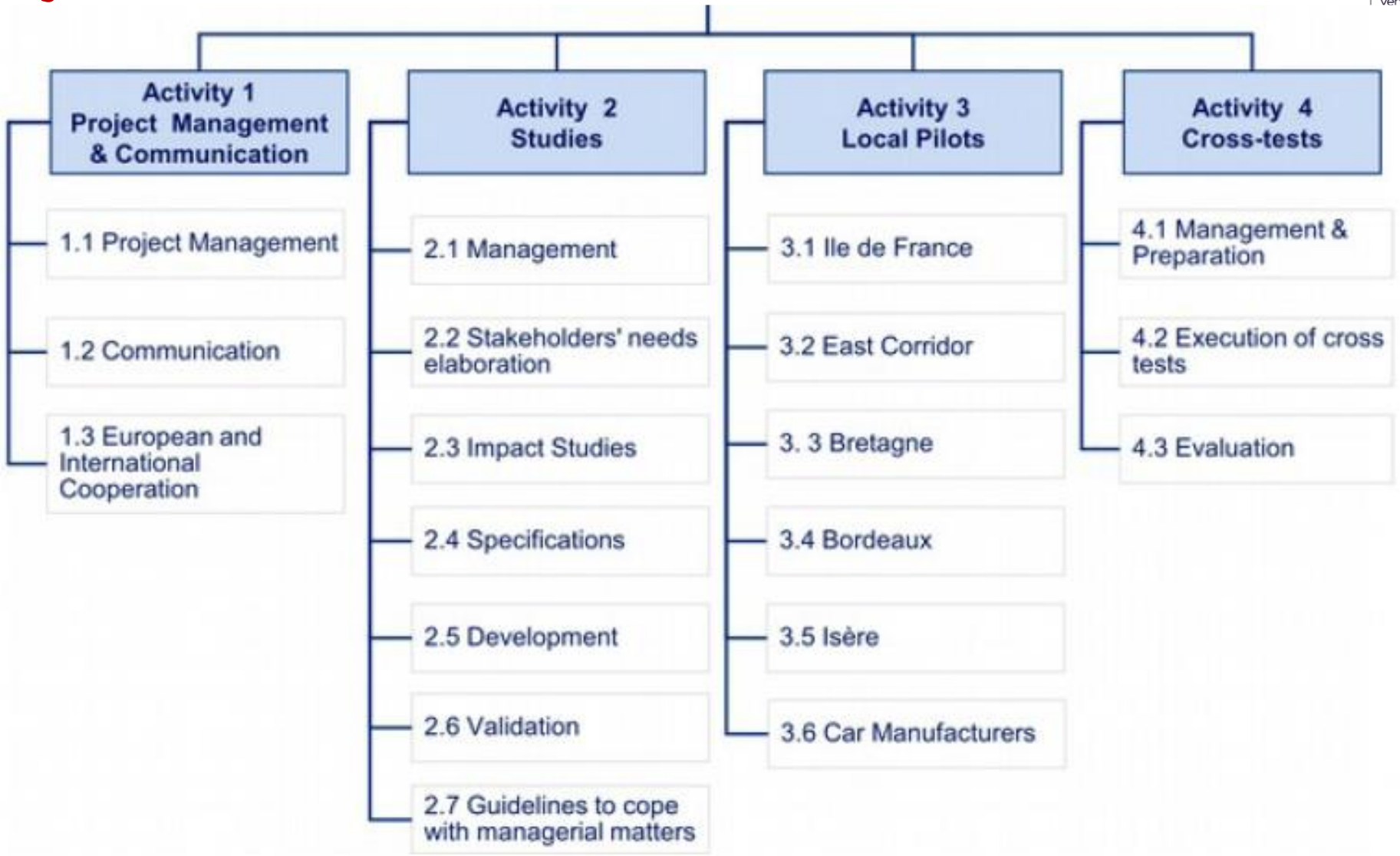


SCOOP@F à Bordeaux





Project structure



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System components

- **On board units (OBUs)**
  - PSA OBUs : new vehicles sold to private customers
  - Renault OBUs : new vehicles sold as company fleets
  - Road operator OBUs : retrofitted, with an RSU function

- **Road Side Units (RSUs),** to allow ITS G5 communications between vehicles and infrastructure

- The **SCOOP platform**, linking RSUs with the road operator's traffic management system

- The **security system**, PKI-based

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System components

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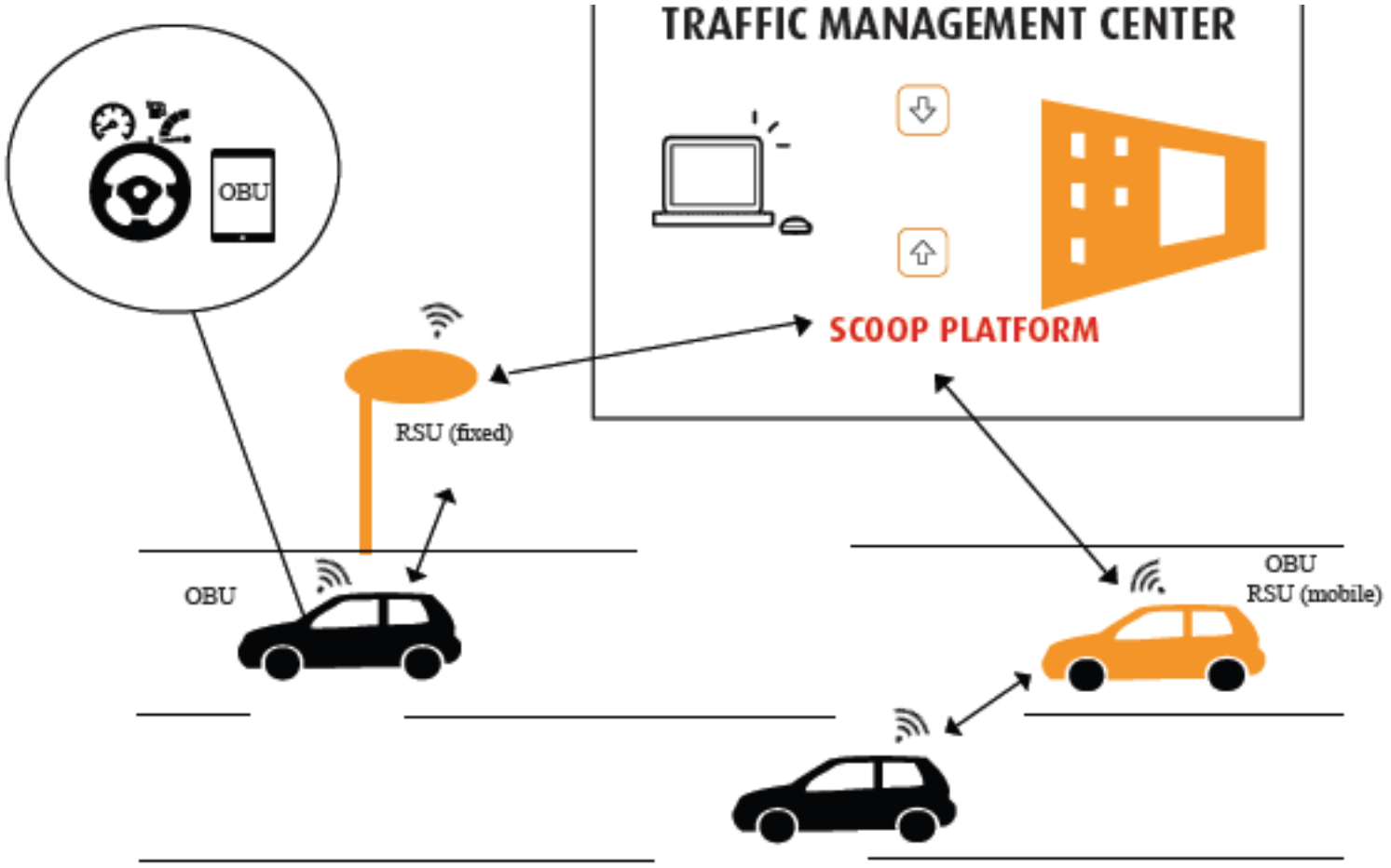

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SCOOP in Europe

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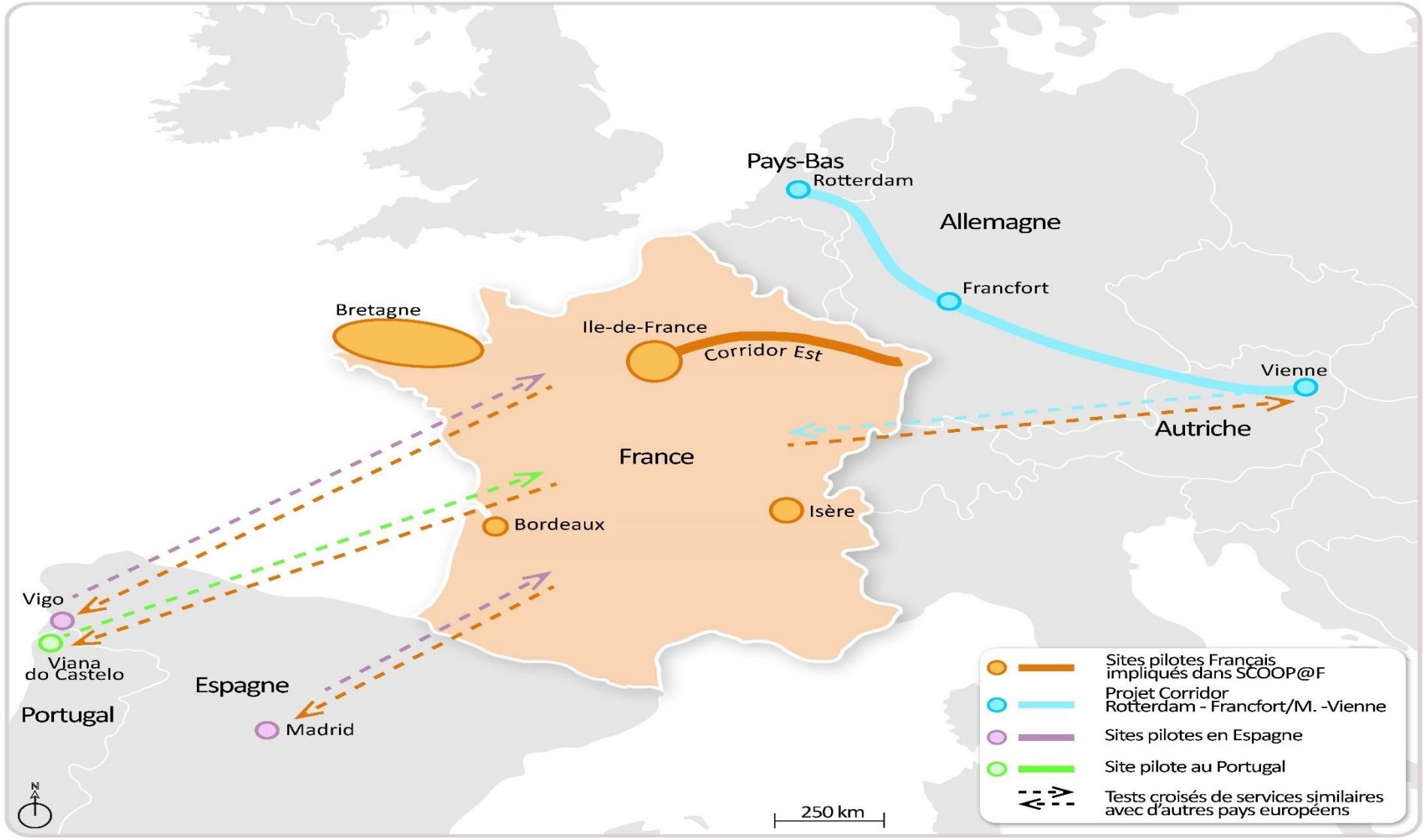

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Questions / answers

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Seminar programme

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April 5

- 11h-12h30 Specification and testing
  - Specification
  - Testing
  - Working together
- 12h30-13h30 Lunch / presentation of the vehicles
- 13h30-14h15 Security and Privacy
  - Security
  - Privacy by design

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Seminar programme

- 14h20-15h15 An operational system
  - Road operator infrastructure
  - Vehicles are available !
- 15h15-15h45 Break / presentation of the vehicles
- 15h45-16h55 Ex ante evaluation, business model
  - Health
  - Organisational
  - Business model
- 17h-18h Ex post evaluation
  - Road safety
  - Traffic
  - Socio-economic

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Seminar programme

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- Gala dinner : 19h30 at the Paris Wine Museum

Located in the 16th arrondissement of Paris, the Paris Wine Museum presents a collection of more than 2000 items on the culture of the vine and the wine.

This exhibition was fitted out in the old quarries of limestone of Passy who date the 15th century and who were used for the construction of Paris.

Travel time : 55 minutes from IFSTTAR

MUSEE DU VIN PARIS
5 Square Charles Dickens, 75016 Paris

METRO
Ligne 6 : Passy

RER
RER C: Champ de Mars - Tour Eiffel

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Seminar programme

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April 6

- 9h-10h Towards new services
  - Hybrid architecture
  - C-Roads France and InterCor
  - C-The-Difference
- 10h-11h European harmonization
  - Cross-tests
  - The C-Roads Platform

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Seminar programme

- 11h-12h Round table « Deployment strategies, link with automation »

With : Renault, PSA, DGITM, Commission européenne, Région Ile-de-France

- 12h Conclusion by Elisabeth Borne

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Questions / answers

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SPECIFICATIONS AND TESTING

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Services and specifications

Marie-Christine ESPOSITO
(French Ministry of Transport)
SCOOP@F Technical project manager

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Summary

- Scope of activity 2 within SCOOP@F project
- 1st step: definition of services
- 2nd step: specifications
- 3rd step: development and validation
- Following steps

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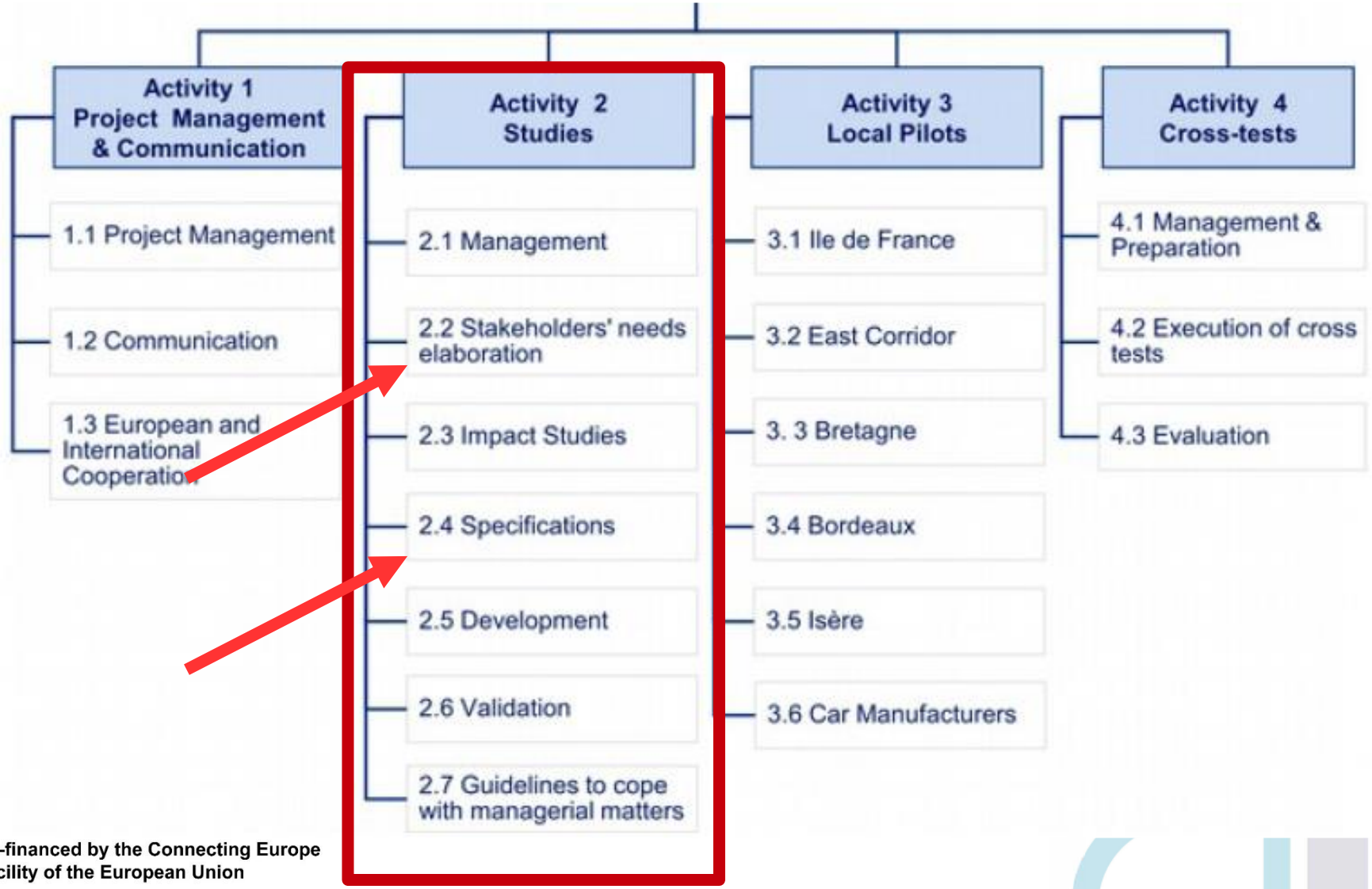
Activity 2 : studies



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First step: definition of services

- SCOOP@F Wave 1 process:
  - Definition of services declined in use-cases at a macro-level
  - Focus on road safety
  - Prioritisation of use-cases that were ready to be deployed (standards ready), especially day 1 services
  - Link with action b and action c priority use-cases

→ Difficulty to define properly the use-cases, each partner had a different understanding of it while deploying it

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First step: definition of services

- SCOOP@F Wave 2 & new projects (C-Roads France and French partners of InterCor) process:
  - Definition of services declined in use-cases at a micro-level, technologically agnostic
  - Focusing on the objective of the use-case taking into account each stakeholder involved
  - One message exchanged between different parties = one use-case

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First step: definition of services

- The template for description has been developed within InterCor, and is commonly agreed by the 4 countries involved (NL, UK, FR, Flanders)

- It's also mostly used by the C-Roads Platform

Use case introduction	
Summary	Here we provide a summary of the use cases (one or two lines)
Background	Here we describe the motivation/rationale of the use case
Objective	Here we describe the intended outcome of the use case
Desired behavior	Here we describe the behavior of the system and the intended behavior of users
Expected benefits	Here we described the added value and actor benefits
Use case description	
Situation	Here we describe one or more situations relevant to the use case
Logic of transmission	Here we describe the transmission logic (I2V, V2V, V2I, V2I2V… + broadcast / unicast / multicast)
Actors and relations	Here we list all relevant actors and their relation/interaction to the system and their role in the use case (incl. sender and receiver). The actors are: vehicle driver, road operator, service provider, end user, vulnerable road user and other. In particular : Sender and End-receiver.
Scenario	Here we describe the story of the use case based on a sequence of situations (e.g. initial and after), events and actions. With illustration. Sender and End-received should be addressed, in stakeholder neutral manner.
Use case implementation	
Implementation outlook	Here we provide a functional description of a typical implementation of the use cases
Functional architecture	Here we provide a high-level architecture (as in act2.1b) to illustrate the main components, interfaces, data flows and display principles.
Display / alert principle	Here we describe triggering conditions and what is displayed to the user when.
Functional and non-functional requirements	
Sources of information	Here we describe the necessary data
Standards	Here we list relevant standards
Constraints / dependencies	Here we describe constraints and dependencies that are requirements (if any) related to e.g. business, security, telecommunications, privacy, legal, human behavior, etc.

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First step: definition of services

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- Categories of services
  - A – Probe vehicle data
  - B – Road works warning
  - C – Signage applications
  - D – Hazardous location notifications
  - E – Traffic information and smart routing
  - F – Parking, park & ride, multimodality
  - G – Intersections
  - H – Traffic management
  - I – Vulnerable users
  - J – Logistics

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First step: definition of services

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- Categories of services
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SCOOP wave 1

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First step: definition of services

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- Categories of services
  - A – Probe vehicle data
  - B – Road works warning (enhanced) SCOOP wave 2
  - C – Signage applications
  - D – Hazardous location notifications (WWD)
  - E – Traffic information and smart routing
  - F – Parking, park & ride, multimodality
  - G – Intersections
  - H – Traffic management
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First step: definition of services

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- List of use-cases SCOOP wave 1/2
  - A – Probe vehicle data
    - **A1** – Traffic data collection
    - **A2** – Probe vehicle data on detected events
    - **A3** – Probe vehicle data on declared events
  - B – Road works warning
    - **B1** – Alert planned road works (RWW)
    - **B2a** – Alert operator vehicle approaching
    - **B2b** – Alert operator vehicle in intervention
    - **B2c** – Alert operator vehicle in patrol
    - **B3a** – Winter maintenance – Salting in process
    - **B3b** – Winter maintenance – Snow removal in process
    - **B3c** – Winter maintenance – Alert vehicle moving
  - C – Signage applications
    - **C3** – In-vehicle signage (embedded VMS)
  - D– Hazardous location notifications
    - **D1** – Alert temporary slippery road
    - **D2a** – Alert animal on the road
    - **D2b** – Alert people on the road
    - **D3** – Alert obstacle on the road
    - **D4** – Alert stationary vehicle / breakdown
    - **D5** – Alert accident area
    - **D6** – Alert reduced visibility
    - **D7** – Alert wrong way driving
    - **D8** – Alert blockage of a road
    - **D10** – Alert emergency brake
    - **D11** – Alert end of queue
  - E - Traffic information and smart routing
    - **E6** -Alert extreme weather conditions

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Second step : specifications

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- After sharing the definitions of services:
  - Elaboration the detailed functional description of the use-cases within the architecture (not technologically agnostic there)
  - Precise study of the available standards to technically define the use-cases and then the common specifications of all partners
  - Specifications of the different components

- Nearly 30 deliverables of specifications were needed!
  - Necessity to share between the partners
  - Shows the lacks in the standards

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Second step : specifications

- 2.4.1 category – common specifications

2.4.1	Common set of functional and technical specifications for SCOOP
2.4.1_Bis	List of standards applicable for specifications and development
2.4.1_Annexe	Renewal of pseudonym certificates and upload of Logs (T-Logs and U-Logs)
2.4.1_Annexe	Appendix 1 - Renewal Of Pesudonym Certificates
2.4.1_Annexe	Appendix 2 - CAMI-Specification
2.4.1_Annexe	Appendix 3 - ITS-Container
2.4.1.2	Specifications of DENM fields
2.4.1.3	Catalogue of data to collect - Tlog
2.4.1.3	Catalogue Of Data Tlog To Collect
2.4.1.3	Specification of ASN.1 code for CM's Tlog
2.4.1.3	Specification of ASN.1 code for RO's Tlog
2.4.1.3	Catalogue Of Data Ulog To Collect
2.4.1.3	Specification of ASN.1 code for Ulog
2.4.1.3	Catalogue Of Data Tlog for Security To Collect
2.4.1.3	Specification of ASN.1 code for security Tlog
2.4.1.3_Bis	Technical specification for encoding data
2.4.1.4	Specifications of Datex II v2.3 messages in conjunction with CAMs and DENMs
2.4.1.4	Specification of DATEX II messages in conjunction with CAMs and DENMs
2.4.1.4	Appendix 1: DENM Structure and Datex II translation
2.4.1.4	Appendix 2: Simplification of Datex II Classes emitted by SAGT
2.4.1.5	Technical architecture for Road Operators' components
2.4.1.6	IPv6 Addressing over G5

Specification of communication profiles and content of CAM, CAM-I and DENM messages

Specification of logs and their collection

Specification of Datex II messages in conjunction with CAM and DENM

Specification of technical architecture

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Second step : specifications

- 2.4.2 and 2.4.3 categories – specifications of individual components
- 2.4.4 category – specifications of security elements

Specification of RSU and OBU for road operators

Specification of car manufacturers OBU

Specification of SCOOP platform

Specification of security elements

2.4.2.1	Functional and technical specifications of RSU
2.4.2.2	Functional and technical specifications of OBU for road operators
2.4.2.2_Bis	Specifications of Software for Road operators OBU
2.4.2.2_Ter	Specifications of Software for Road operators OBU
2.4.2.3_P	Functional and technical specifications of OBU for car manufacturer PSA
2.4.2.3_R	Functional and technical specifications of OBU for car manufacturer Renault
2.4.3.2	Detailed functional specifications of SCOOP platform
2.4.4.1	Analysis of safety objectives
2.4.4.2	Scoop@f risk analysis for safety
2.4.4.2_bis	Risk Analysis Safety Info Note
2.4.4.3	Comparison between the risk analysis performed by Solucom (del. 2.4.4.2) and the risk analysis proposed in ETSI standard TR 102 893 (TVRA)
2.4.4.4	State of the art of public key infrastructures for cooperative ITS
2.4.4.5	PKI System Requirement Specifications
2.4.4.6	PKI architecture and technical specifications
2.4.4.6_Bis	Use case scenarios with security data
2.4.4.6_App	Appendix_ASN.1
2.4.4.7	Strategies for changing pseudonyms and sizing the PKI traffic
2.4.4.8	SCOOP Security System: Integration Guide
2.4.4.9	Certification policy

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Second step : specifications

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- Production of deliverables : scoping, structuring, production, proofreading, approval
- Validation of each step of the production of the deliverables :
  - Only during a Steering Committee for Studies (once a month)
  - Approval only after a complete review process involving all partners

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Third step : development and validation

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- After the specifications, the developments started along with the validation process (for each stage of development)
- Those provided feedbacks on the initial specifications (more than 300 questions needed to be resolved)

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Third step : development and validation

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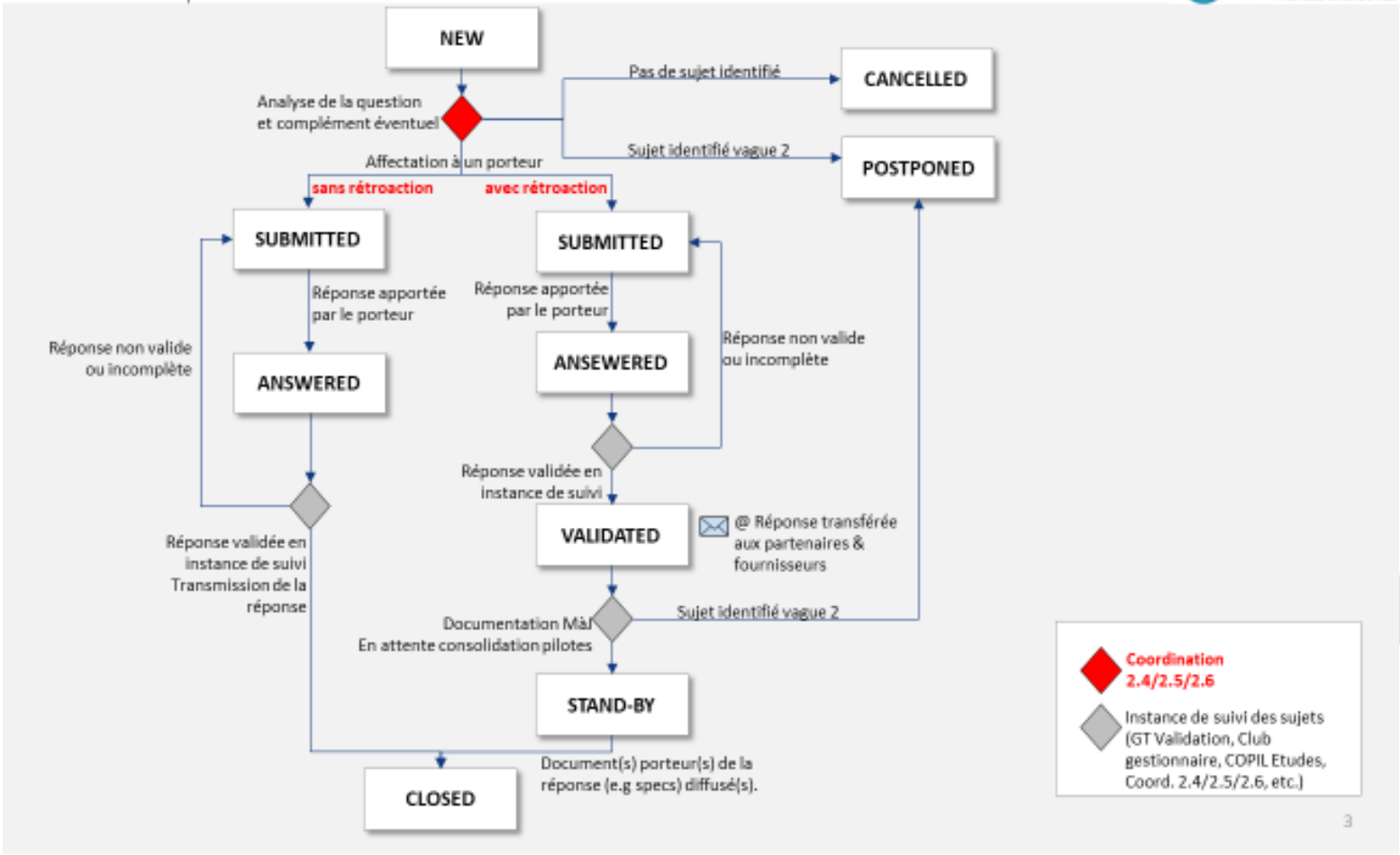
Talan | Diagramme des états des QR avec et sans rétroactions



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ID	Date	Titre	SPEC	Author (Company)	Question	Stakeholder (Company)	Feedback	ADM	Retroaction	Impact DEV	GO DEV	Status
57	29/03/2016	PKI		YGK	Il n'est pas indiqué dans la spécification NACS quelle clé publique est utilisée pour le chiffrement ECIES des requêtes NACS SAReq. Est-ce que cette clé est fixée dans la configuration de l'UTIC ? Est-ce le cas également pour les clés publiques des serveurs PKI ?	H Labiod (TPT)	**Pre-requis : réponse à la question ID123** Le véhicule génère une paire de clés éphémère, valable uniquement pour la session en cours. La clé privée éphémère est combinée avec la clé publique du certificat de la RSU pour générer le secret partagé de ECIES. Donc il faut la clé privée éphémère du véhicule et la clé publique du certificat reçu de la part de la RSU. Pour la requête d'un LTC, l'ITSS chiffre sa requête à destination du LTCA. Il utilise une clé privée éphémère (valable que pour cette requête) + la clé publique de chiffrement du LTCA (présente dans le certificat du LTCA) Pour la requête d'un PC, l'ITSS chiffre sa requête à destination du PCA. Il utilise une clé privée éphémère (valable que pour cette requête) + la clé publique de chiffrement du PCA (présente dans le certificat du PCA). A noter, qu'il existe dans la requête d'un PC une partie chiffrée à destination du LTCA (de la même façon que pour la requête LTC). Donc les seules clés "fixées" coté ITSS dans le cadre du chiffrement des requêtes PKI sont les clés publiques de chiffrement présentes dans les certificats PCA & LTCA		No			6-Closed
74	27/04/2016			Valeo	Concernant la traduction DATEX II => DENM il est spécifié que le stationId et le referenceTime sont récupérés du message DATEX II. Selon nous, ce point soulève certaines questions: · Est-ce cohérent d'envoyer un DENM avec un stationId (celui de la plateforme) différent de celui utilisé dans la signature (stationId local) ? · Quels impacts sur le mécanisme détection de collision de stationId ? (ce mécanisme permet à une station de changer de stationId si elle se rend compte qu'une autre station utilise le même stationId) · Quels impacts sur la LDM ? Comme plusieurs stations risquent d'envoyer un DENM avec le stationId de la plateforme, la LDM ne pourra pas différencier les DENM envoyés des DENM reçus avec ce stationId. Est-il envisageable de garder le fonctionnement actuel des stack ITS en les laissant remplir les paramètres DENM stationId et referenceTime ?	Loïc Blaive (CEREMA)	Le station ID reste celui de l'UBR ; par contre, pour émettre son message, l'UBR construira l'action ID à l'aide du station ID de la PF et le numéro incrémental créé par la PF ; tel que cela est décrit dans le livrable 2414. « The platform creates the "situationRecordCreationReference" attribute by concatenating the following information: • its "stationID" (32-bit integer in hexadecimal format left padded with 0), • followed by an incremental number (16-bit integer in hexadecimal format left padded with 0), • followed by a sequence number in each situation starting from 1 (0 is allocated for the situation itself) (4-bits integer in hexadecimal format left padded with 0). There is no need for a separation character between the different concatenated elements due to the fix format. The RSU that receives this message recovers the incremental number and the "stationID" from the platform (considered as the "originatingStationID") to fill in the "actionID" attribute of the DENM to transmit. »		Yes			6-Closed

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Following steps

- The specifications for wave 1 are now consolidated - release 3 soon to be published
- Specifications for wave 2 have started and soon to be released (1st release for wave 2) – 12 working groups started at the same time
- Next step: feedback to standardisation organisations, harmonisation with the C-Roads platform (on-going)

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Thanks !

marie-christine.esposito@developpement-durable.gouv.fr

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Testing in SCOOP

Hacène Fouchal

Université de Reims Champagne-Ardenne

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Main objectives

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- Validation of all components in order to ensure:
  - Interoperability among partners equipments (*and foreign ones*)

Conformance to basic communication standards

Conformance to security rules

  - Compliance with local contracts
    - **Integration of local requirements**
  - Compliance with national requirements

- Components are : OBU, RSU, Sccop@F Platform, PKI, Log manager

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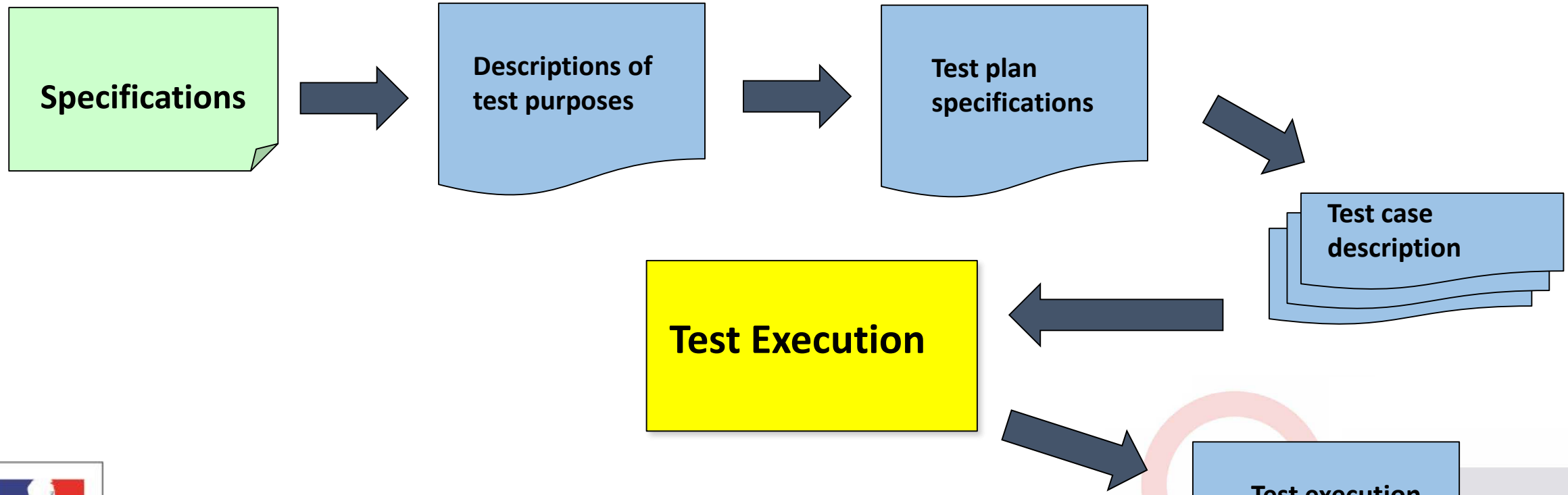
Testing overview



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Testing overview

- What aspects do we test?
  - **Communication parts (radio issues as well as high level protocols)**
  - **Functional parts (local features as destination areas, HMIs, ..)**
  - **Hardware parts (processor performances, temperature resistance..)**

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Functional testing

- Functional Testing is of high complexity
  - **More than 500 functions on OBU/RSU**
  - **Message receiving**
  - **DENM sending generated by a DATEX message**
  - **Settings updates**
  - **Network connections**
  - **System monitoring**
  - **OBU: Display management, Cartography management**
  - **RSU: HMI management**

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Testing levels

- Three main testing levels:
  - Laboratory test
  - Test-track test
  - Open road test

- After approval of all steps -> **equipment ready for deployment**

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Laboratory test

- *Most of them have been run at Université de Reims*

- Tests are run either on OBUs and RSUs
- A very long step (2015—Up to now)
  - Mainly, compliance to communication protocols standards

  - Test cases have been updated
  - **SCOOP has provided inputs to nearly 10 test cases**

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Test Track test

- *Most of them have been run on Satory Track, IFSTTAR Versailles.*

- They have provided analysis on radio coverage
- They allowed to test first HMI displays of events in almost real conditions with low speeds
- They have allowed billateral tests OBU-RSU ; OBU1-OBU2, ….

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Open road test

- *They have been run on many sites (Bordeaux, Saint Brieuc, Ile-de-France, Reims, …)*

- They have allowed to check the project results in real environments
- They have produced important log files to be used in early evaluation analysis

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Lab Test example: Triggering conditions

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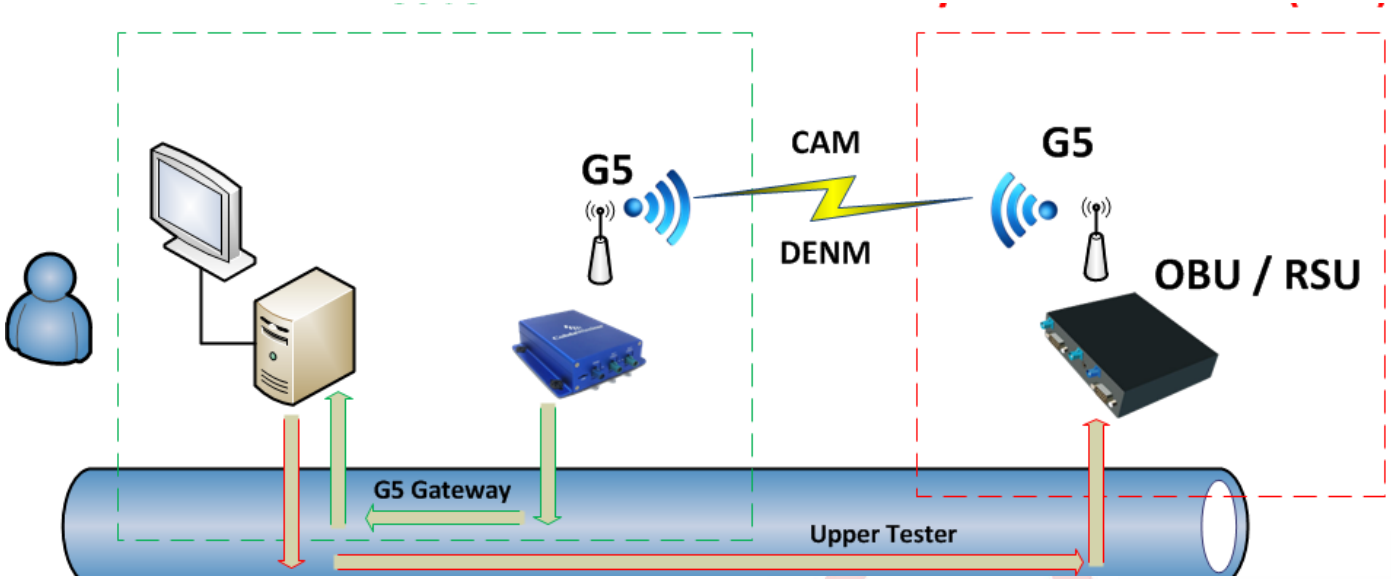
The tester triggers appropriate conditions on the equipment, for example:
-Warnings on
-Opened doors
We observe the generation of an event:
Stationary Vehicle



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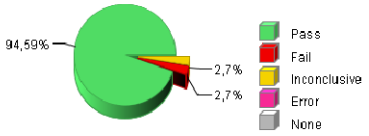
Test report

Test Report

provided by TTworkbench Professional 1.1.20.201510201509l

Report Number	1
Report Date	
Company Name	
Test Lab	URCA
System Under Test (SUT)	
Release	

Number of Test Cases	37
Pass	35
Fail	1
Inconclusive	1
Error	0
None	0

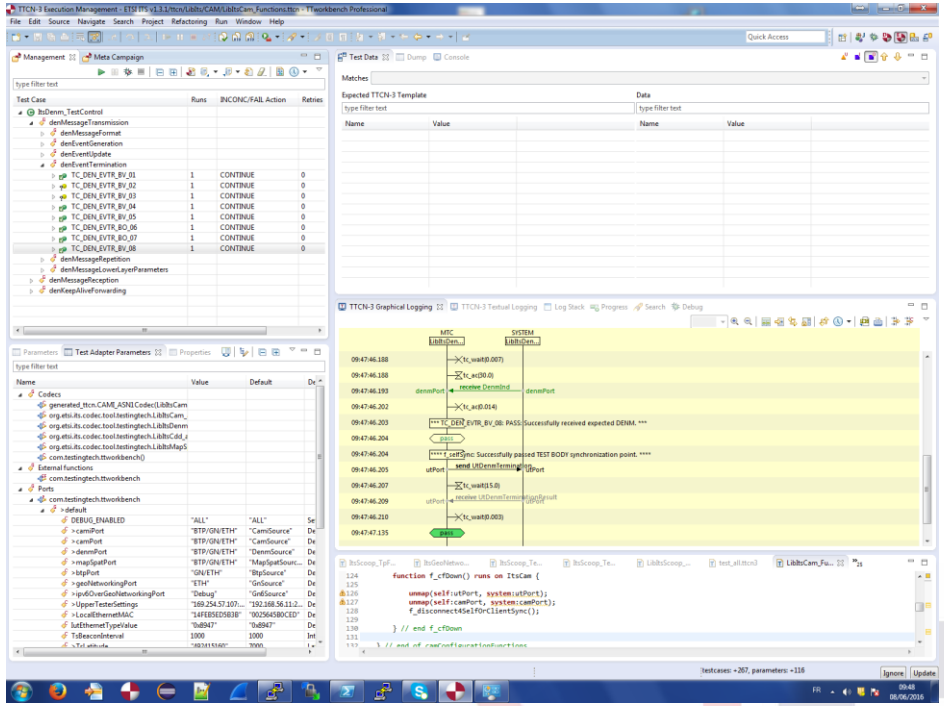


Campaign Configuration

Campaign Name	ItsDenm_TestControl
Campaign File	ItsDenm_TestControl.clf

Test Adapter

Class	com.testingtech.ttcn.tri.PluginTestAdapter
File Name	



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Unitary testing

Tests	Lab	Test track	Open roads
Compliance to standard communication tests	x		
Functional application tests	x		
Logs generation tests	x	x	
Security tests	x		
PKI access tests	x		
Performance testing	x		
Radio coverage		x	
Messages contents	x	x	
SCOOP platform Tests	x		

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Bilateral testing

Components	Tests	Lab	Test tracks	Open roads
OBUu-RSU	**Tests of requests from an ITS Station to the PKI via RSU**	x	x	
OBUu-RSU	**Uploaded logs tests from ITS Station via RSU**	x	x	
OBU-RSU	**Mitigation tests**	x	x	
OBU-RSU and OBU-OBU	**Radio coverage**		x	
OBUro-PF	**DatexII exchanges**	x		

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Collective testing

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Tests	Lab	Test tracks	Open roads
Interoperability messages tests between ITS Station with security	x		
Forward test at a geonet layer level	x	x	
Use cases A (including security and log management)			x
Use cases B (including security and log management)			x
Use cases D (including security and log management)			x
Mitigation (at a toll station) tests			x
Latency tests		x	

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SCOOP@F testing tools

- Extension of ETSI TTCN testing cases
- Specific software able to communicate (sending or receiving) with all SCOOP@F equipments able to emulate
  - PKI server ; Log server ; another station ; a SCOOP Platform

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Testing tasks

- Task effort provides only by Université de Reims:
  - Test specification : 30HM (2015)
  - Test developement : 30HM (2016-2017)
  - Test management : 15HM (2015-2018)
  - Test debbuging : 15HM (2015-2018)
  - Test analysis : 10 HM (2015-2018)

- **Nearly 100 HM for Testing**

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Lessons learned

- A validation step in C-ITS is very usefull
- But it is time consuming.
- And requires a wide set of skills:
  - Networking, Embedded systems, Programming, Formal testing, computer security
- Laboratory tests give a precise view of provider products compared to the ETSI plugtest: **SCOOP is the unique project where Lab test are handled (as done by the ETSI standard institute)**

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Lessons learned

- Need to coordinate a convenient planning with all partners for testing
- Need to separate debugging sessions from validation sessions
- To carry out these tests for this system type is a project itself
- A step by step development/testing of a prototype could be appreciated

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Lessons learned

- Need to have an upper tester on equipments
- Need to have Technical logs for deep analysis
- Providers are required to participate during test periods in order to react to dysfunctionning of their equipments
- Road operators may take profit to improve their knowledge on their system

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Questions/answers

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Working together

D. DUPPERAY

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12 actors and 9 suppliers

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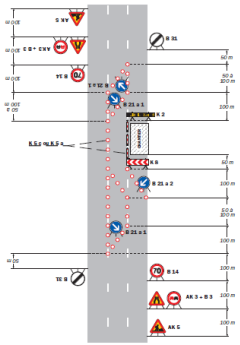
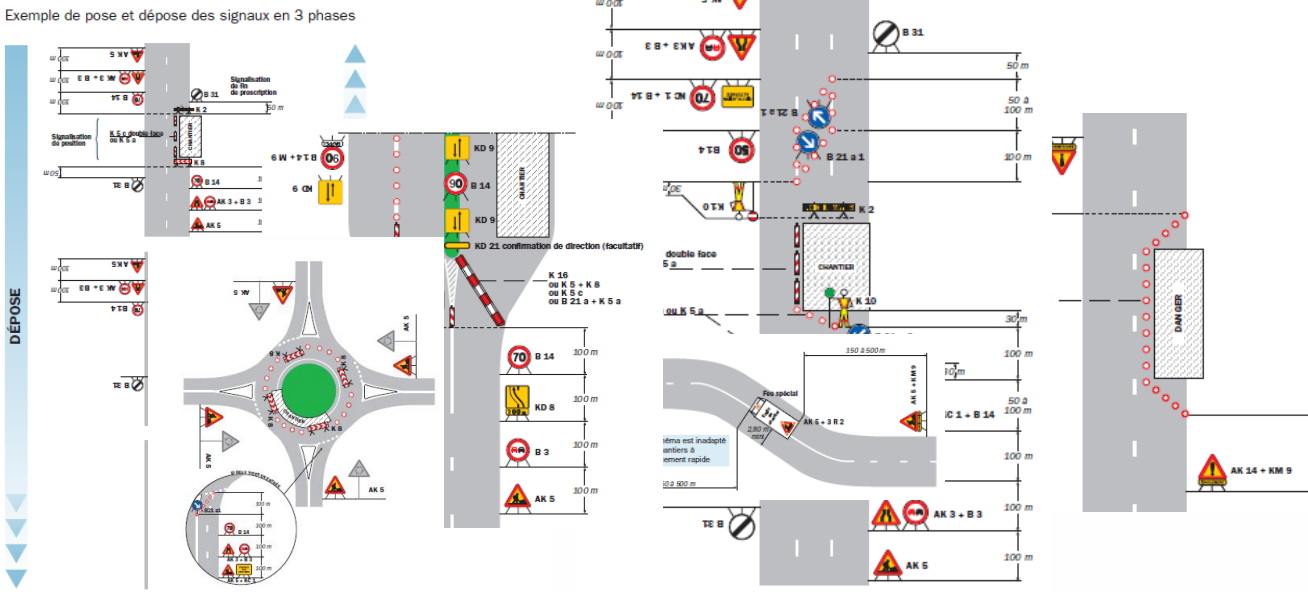
- **Coming from differents fields:**
  - Road operators, experts, OEM, academics, OEM suppliers, road operators suppliers…

- **With their own specific wording**

A roadworks area for a driver:

A roadworks area for a road operator:





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12 actors and 9 suppliers

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- **With a different approach of the Road Safety and HMI:**

- **With different purposes and different technical, economical and time constraints:**

  - **From the Ministry side:** the road safety but also the road operators safety, the preparation of the vehicle and road of the future…

  - **From the OEM side**: very important and specific constraints on the maturity, validation, quality, schedule, etc.

  - **From the Road operator side**:complementarity with existing system (TIPI, VMS..), public contracts, physical installation of the Road Side Units, staff information…

  - **From the research and academic side**: behaviour and technical evaluation, but also understanding and knowledge acquiring, publication…

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It was mandatory

- **To define mutual purposes**
- **To find a mutual wording and a mutual way to work**
  - Around twenty working groups
  - Technical steering committee each month

- **To understand the constraints and purposes of the others**
- **To learn to trust each other…**

It's also the C-ITS!

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The discussions, some examples

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- Use-cases: what for ? Is this the same purpose for the driver? For the road operators?

- Logs definition
  - for evaluation purposes (academics)
  - For supervision purposes (road operators)
  - For validation purposes (suppliers)

- A PKI: why? For who ? To cover which needs and which perimeter?

- The standards
  - The specification are based on the standards
  - We noted that the understanding of these standards was not the same for everybody

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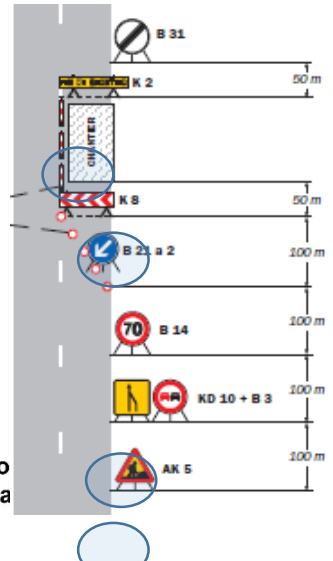
Exemple: the event position

- **From an OEM point of view:**

Cause-code: « roadworks… »
Event position: « …there »

« Warning, Roadworks at 300 m »

- **But what is actually the event position?**



→ There can be different opinions, but it's mandatory to harmonize this field to have a reproductible and efficient HMI

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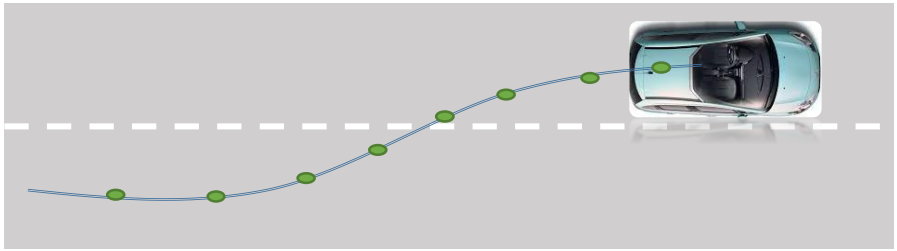
Exemple: the trace

- **For a vehicle:**



- **But for a stationary raod side unit?**

- The trace allows to know if an event is on the vehicle's trajectory or not

→So if it is not well described, an event can be ignored

→It's mandatory to build a relevant trace, even for the RSU

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Exemple: around the Security

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- **The security implementation can have consequences on the performance of the use-case:**
  - Permission: is a Road Side Unit allowed to emit a « emergency braking »?
  - Is it relevant to change the pseudonyme when the vehicle is doing an emergency manoeuver?

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To conclude

- **A mutual understanding is mandatory to have reliable and workable messages**

- **SCOOP facilitated the collaboration between the OEM and the road operators:**
  - Partnerships between the OEM and road operator
  - NFI Infrastructure WS

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Seminar – 5th and 6th April 2018

Projet SCOOP
véhicules et routes connectés
connected vehicles and roads

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SECURITY AND PRIVACY

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Security

Houda LABIOD & Mounira MSAHLI & Rémi BLANCHER

Telecom ParisTech IDNOMIC

Workshop SCOOP@F, 5th-6th April 2018

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Outline

- SCOOP@F: Context & Security Objectives
- Risk Analysis
- SCOOP@F PKI Architecture
- SCOOP@F PKI
  - Registration Phase
  - LTC Request/Response
  - PC Request/Response
  - TSL or CRL Request/Response
  - Achievements
- SCOOP@F Security
  - Tasks
  - Pseudonym Change Strategy
  - Communication Protocols
- C-ITS Contribution

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SCOOP@F Context

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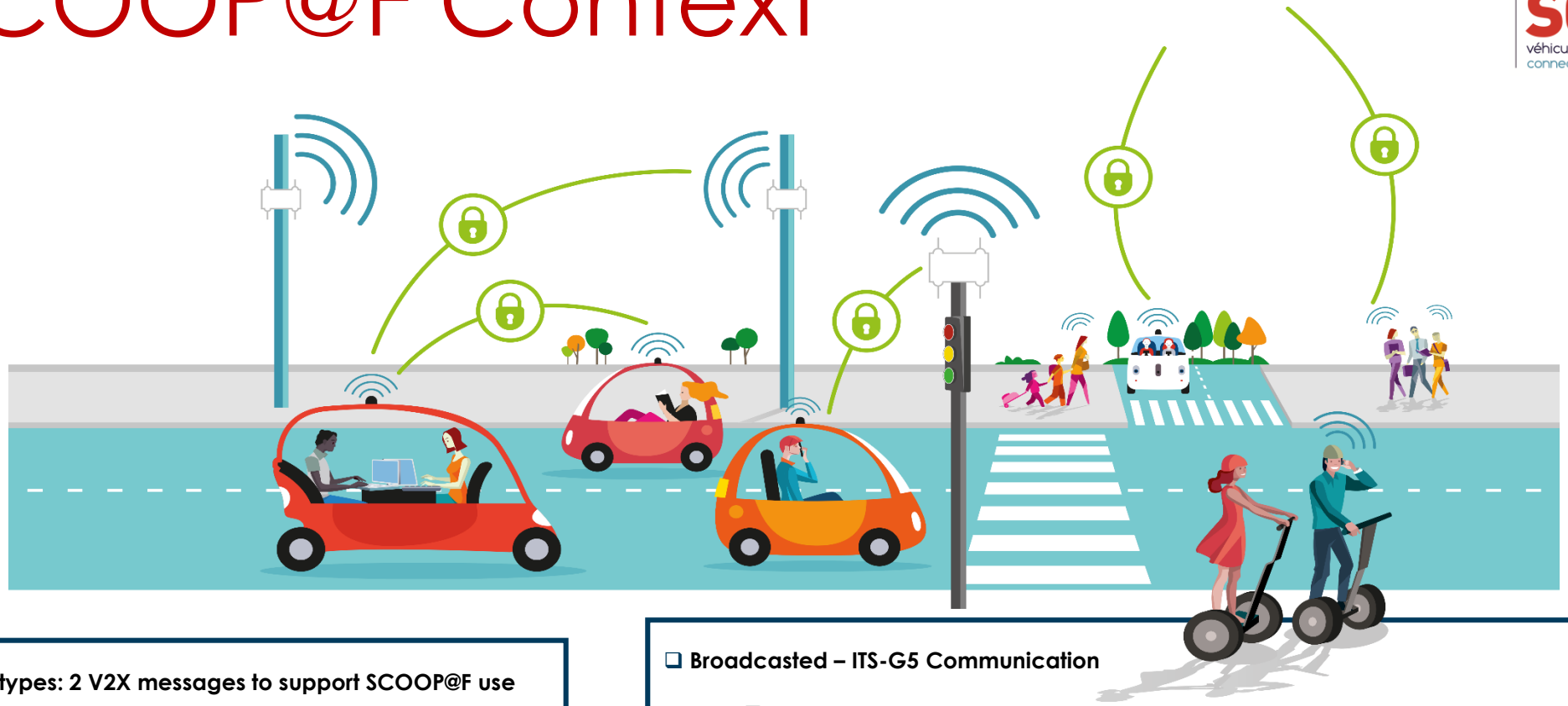

- ❑ **Data types: 2 V2X messages to support SCOOP@F use cases**
  - ❑ **CAM Cooperative Awareness Message**
  - ❑ **DENM Decentralized Environmental Notification Message**

- ❑ **Broadcasted – ITS-G5 Communication**
  - ❑ information is broadcasted without acknowledgment, Vehicle data (speed, position, trajectory), data dynamic perception of the environment
- ❑ **CAM, DENM messages are signed following the guidelines of the standard ETSI 103 097 v1.2.1.**
- ❑ **Anonymous secured messages**
  - ❑ **Pseudonyms delivered by a national PKI via RSUs or preloaded.**

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SCOOP@F: Security Objectives

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- A combination of wireless access technologies
  - ITS-G5 (IEEE 802.11p)/11/3G/4GBluetooth
- Variety of communication types
  - Vehicle-to-Anything (V2X)
  - V2V, V2I, I2V
  - ETSI C-ITS Release 1, Day 1 use cases

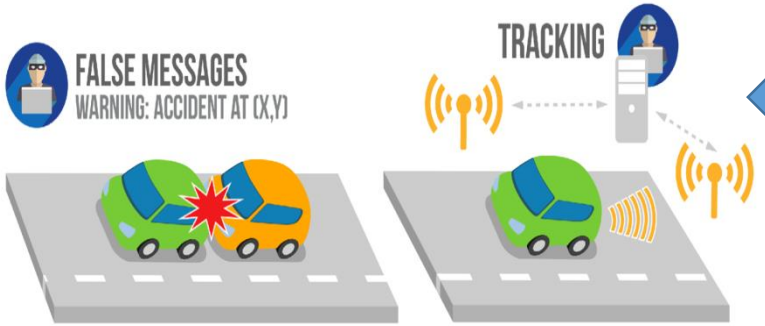
Multiple communication interfaces

ITS-G5, Wi-Fi, Bluetooth, NFC, 4G, USB, OBD…

Weaknesses

increase in the complexity of embedded systems and software

Cyber attacks



- on the vehicle (embedded system)
- on the infrastructure

How to secure the SCOOP@F system? How to protect the exchanged messages ? How to trust received messages ? How to guarantee the protection of privacy?

- End-to-end security architecture
- Trused C-ITS system
- Trade-off between scalability, security, safety, performance and cost
- Ensure the protection of personal data

PKI

Compliance to ETSI security standards

- Specify / implement / test and validate the security system
  - securing CAM and DENM messages
  - implementation of a certificate management system (**PKI**)
- Design an **interoperable** security system with the security systems of other C-ITS systems deployed across Europe

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Risk Analysis – Validated by ANSSI

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- Risk Analysis Method: EBIOS WAVESTONE
- Compliance Check with ETSI TVRA (TR 102 893 v1.1.1)
- Security objectives related to use cases were identified
  - Availibility, integrity, confidentiality, privacy, authentication and authorisation, traceability, plausibility.
- Risk scenarios were identified

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SCOOP@F PKI Architecture

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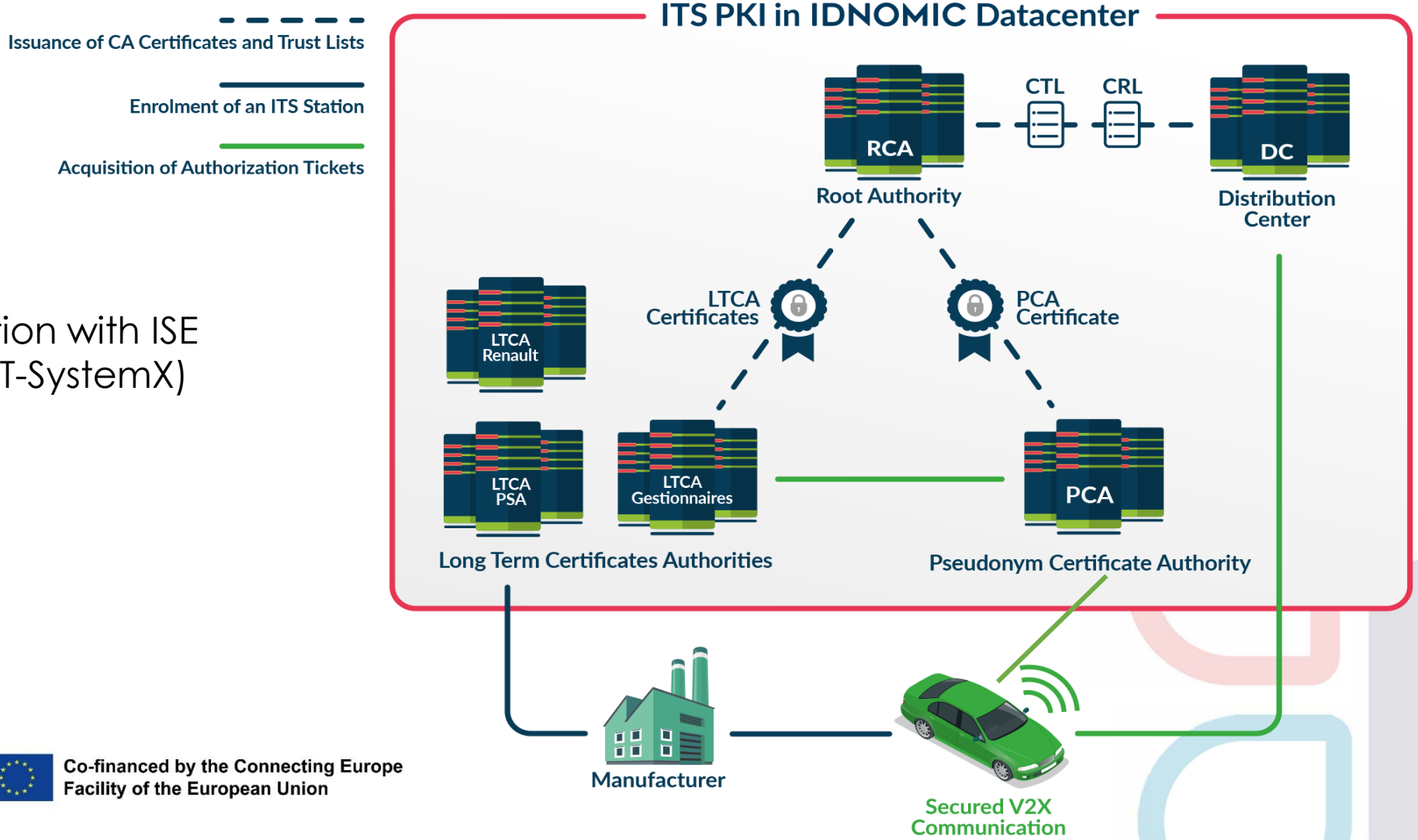

Collaboration with ISE Project (IRT-SystemX)

Common Certificate Policy CP

Common Certification Practice Statement CPS

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SCOOP@F PKI Architecture

- **ITSS:** ITS station (vehicle, RSU)
- **Long Term Certificate (LTC):** gives its holder (ITSSs) the right to request PCs.
- **Pseudonym Certificate (PC):** gives its holder (ITSSs) the right to perform specific actions.
- **Certificate Revocation List (CRL):** is a list digitally signed by a CA that contains certificates identities that are no longer valid
- **Trusted Service List (TSL):** is a signed list which contains trusted RCAs, LTCAs and PCAs certificates and PKI service access points. This list is updated frequently.

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SCOOP@F PKI Architecture

- **Root Certificate Authority (RCA):** is the root of trust for all certificates within the PKI hierarchy. It operates in an offline mode and is responsible for the management of LTCAs and PCAs (creation, security requirements authorizing the issuance of certificates to ITSSs).
- **Long Term Certificate Authority (LTCA):** is a security management entity responsible for the issuance of LTC and the validation of PCs as well as the management of the ITSSs (registration, status update, permissions…). It operates in an online mode.
- **Pseudonym Certificate Authority (PCA):** is a security management entity responsible for the delivery, the monitoring and the use of PCs. It operates in an online mode.
- **Distribution Centre (DC):** provides the ITSSs with the updated trust information such as TSL and CRL necessary to assure that received information is coming from legitimate and authorized ITSSs or PKI certification authority.

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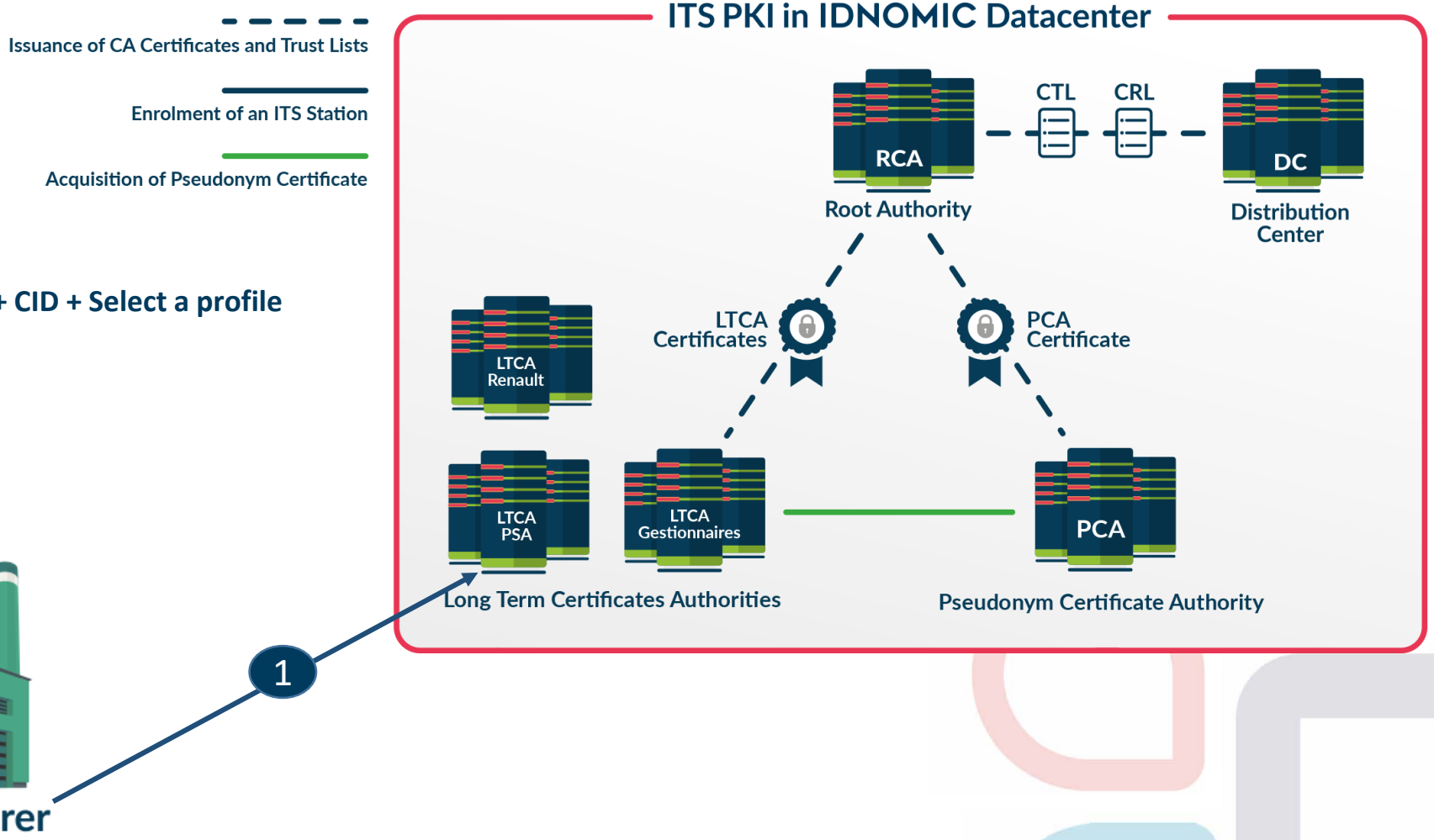
SCOOP@F PKI: Registration Phase



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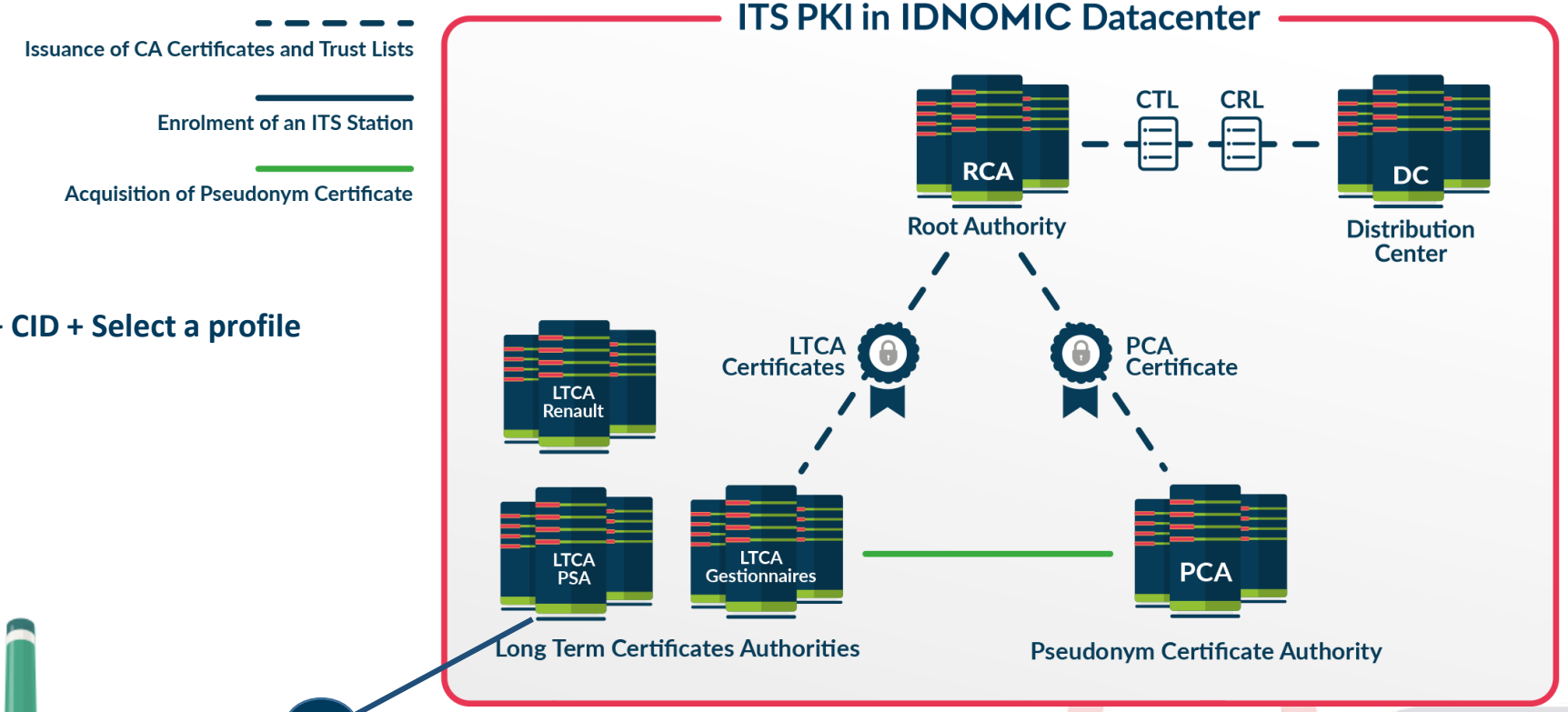
SCOOP@F PKI: Registration Phase



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SCOOP@F PKI: Request/Response LTC

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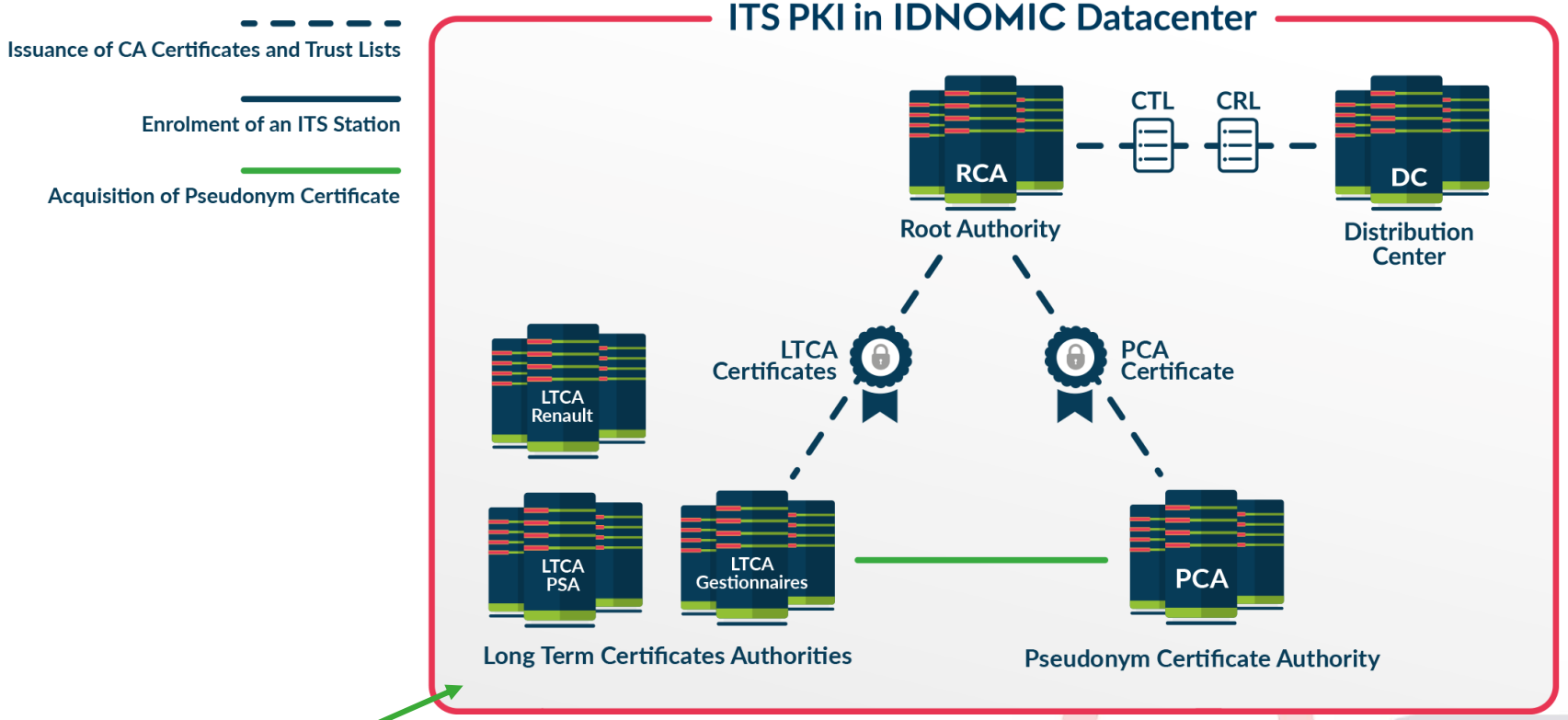
3. LTC Request



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SCOOP@F PKI: Request/Response LTC

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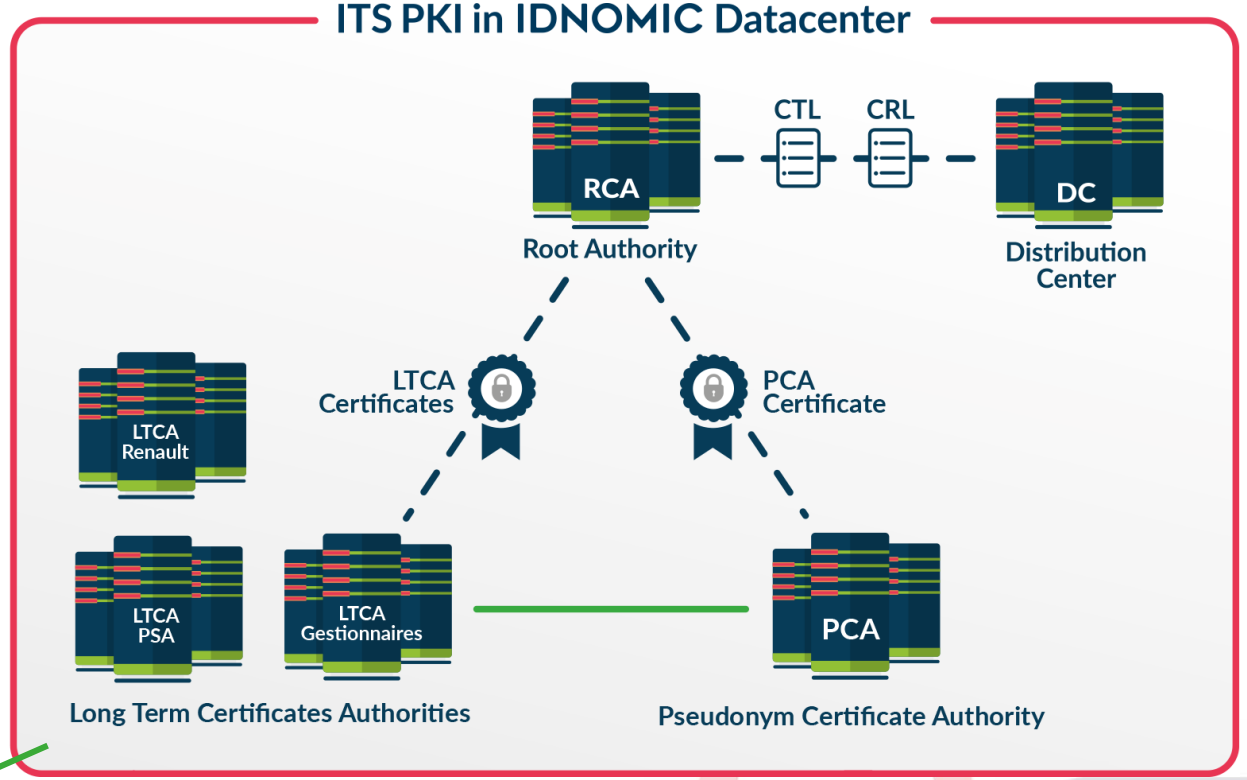
Issuance of CA Certificates and Trust Lists

Enrolment of an ITS Station

Acquisition of Pseudonym Certificate

3. LTC Request

4. LTC Response



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SCOOP@F PKI: Request/Response PC

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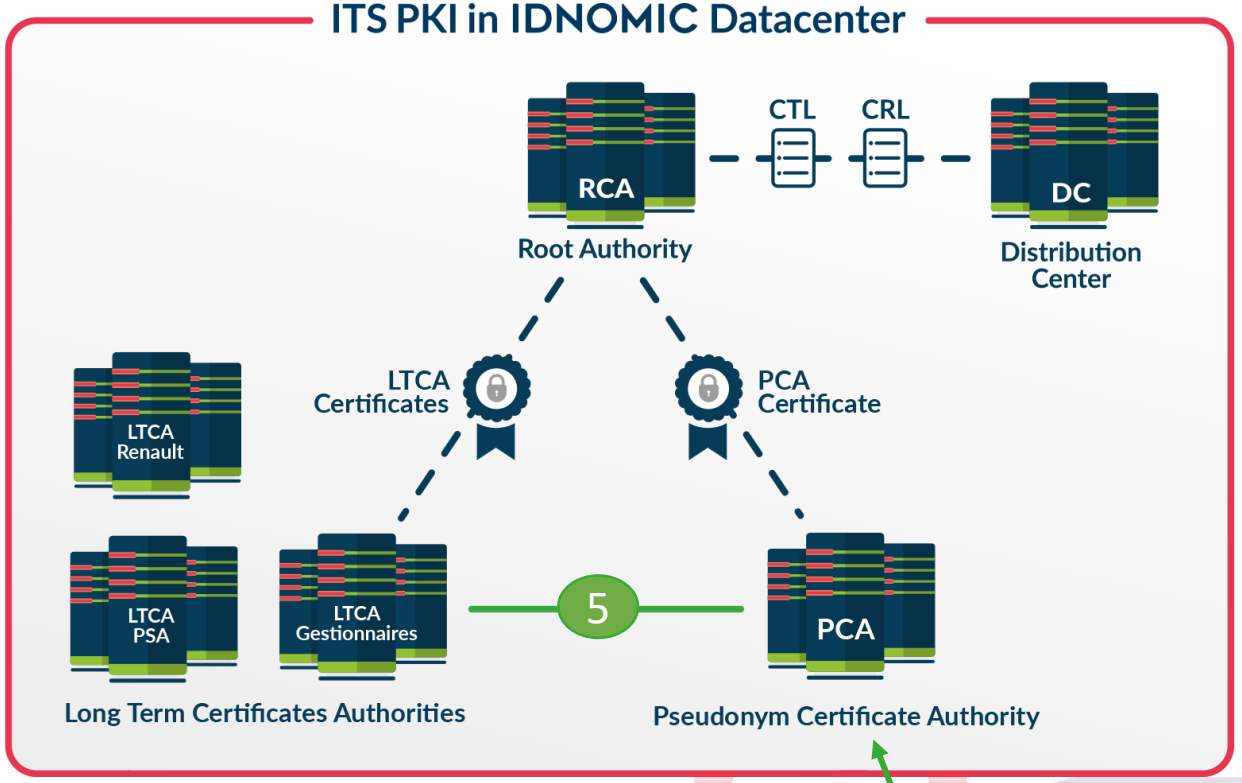
Issuance of CA Certificates and Trust Lists

Enrolment of an ITS Station

Acquisition of Pseudonym Certificate

5. PC Request



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SCOOP@F PKI: Request/Response PC

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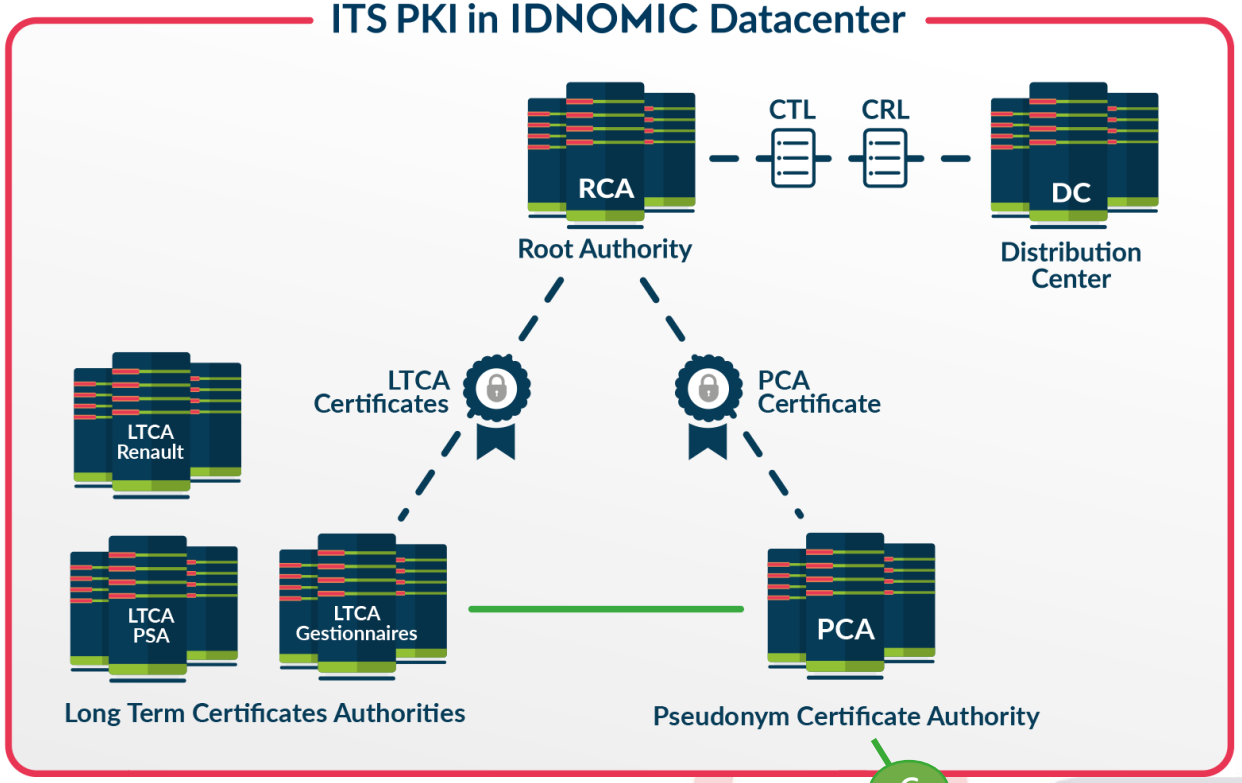
5. PC Request

6. PC Response



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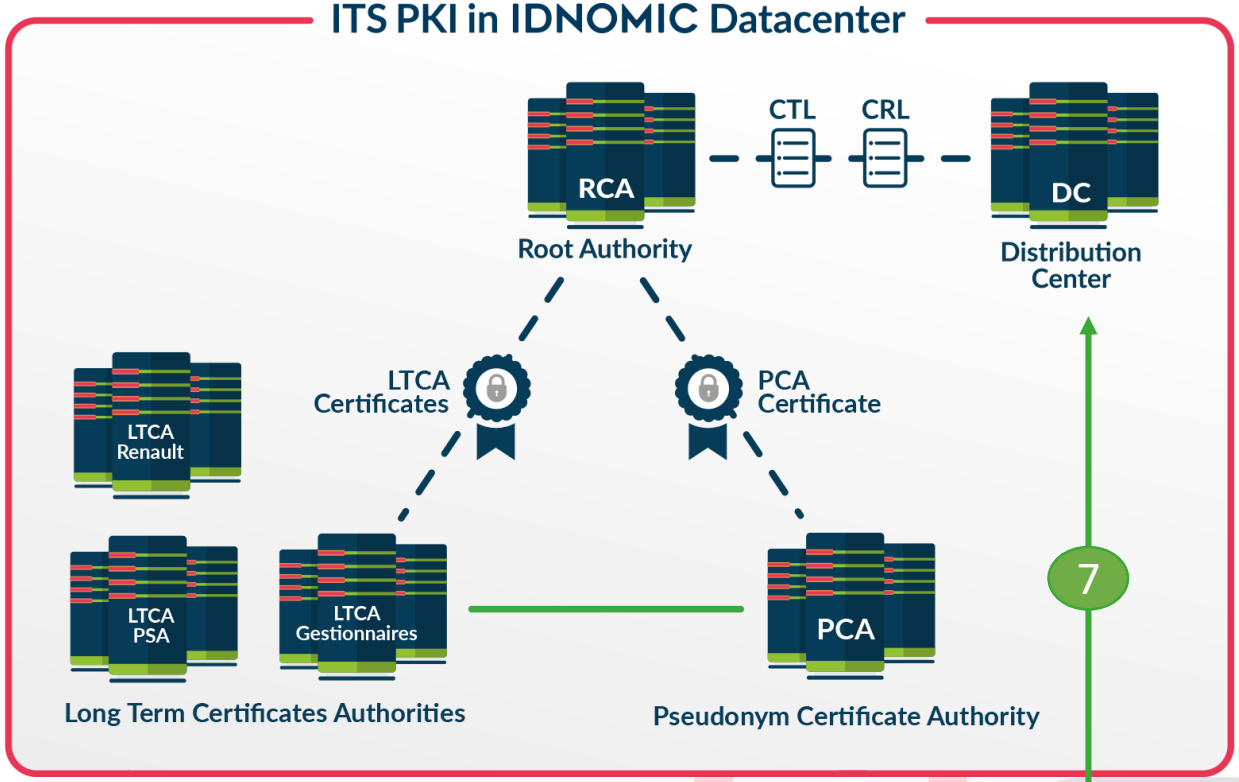
SCOOP@F PKI: Request/Response TSL or CRL

Issuance of CA Certificates and Trust Lists

Enrolment of an ITS Station

Acquisition of Pseudonym Certificate

7. TSL/CRL Request



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SCOOP@F PKI: Request/Response TSL or CRL

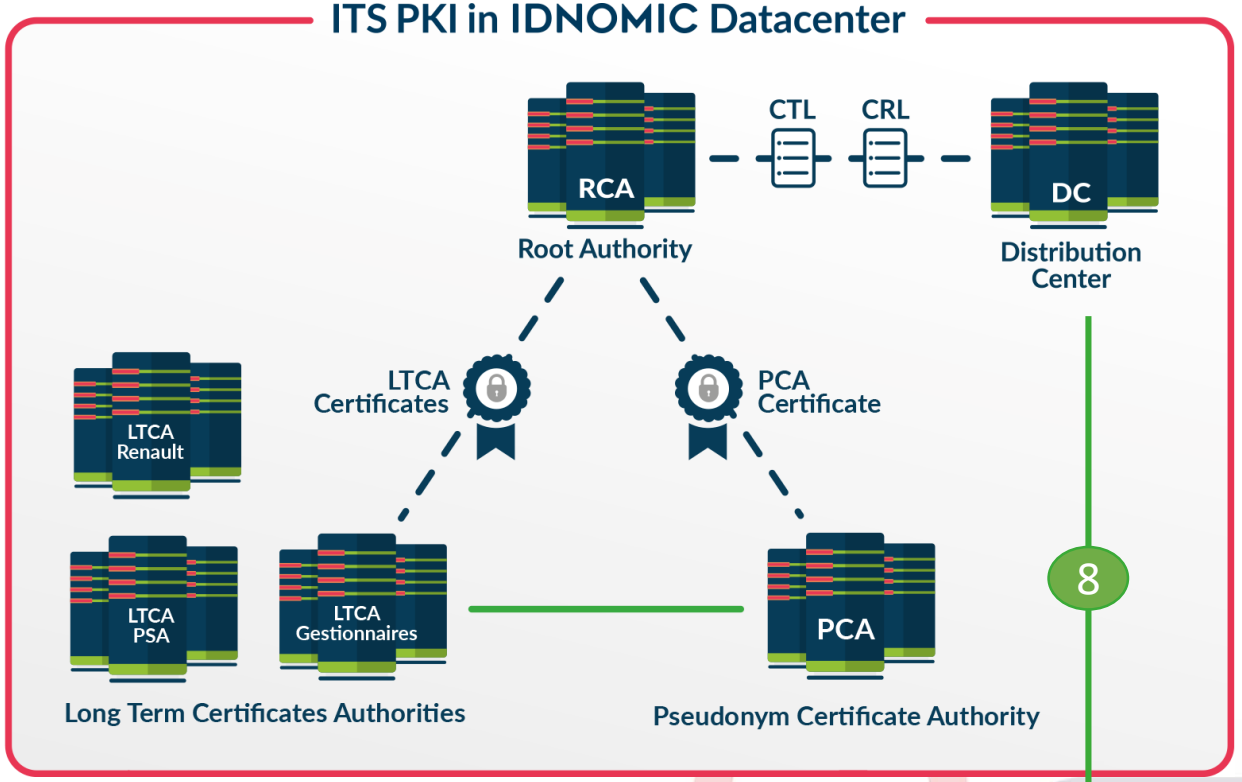
Issuance of CA Certificates and Trust Lists

Enrolment of an ITS Station

Acquisition of Pseudonym Certificate

7. TSL/CRL Request

8. TSL/CRL Response



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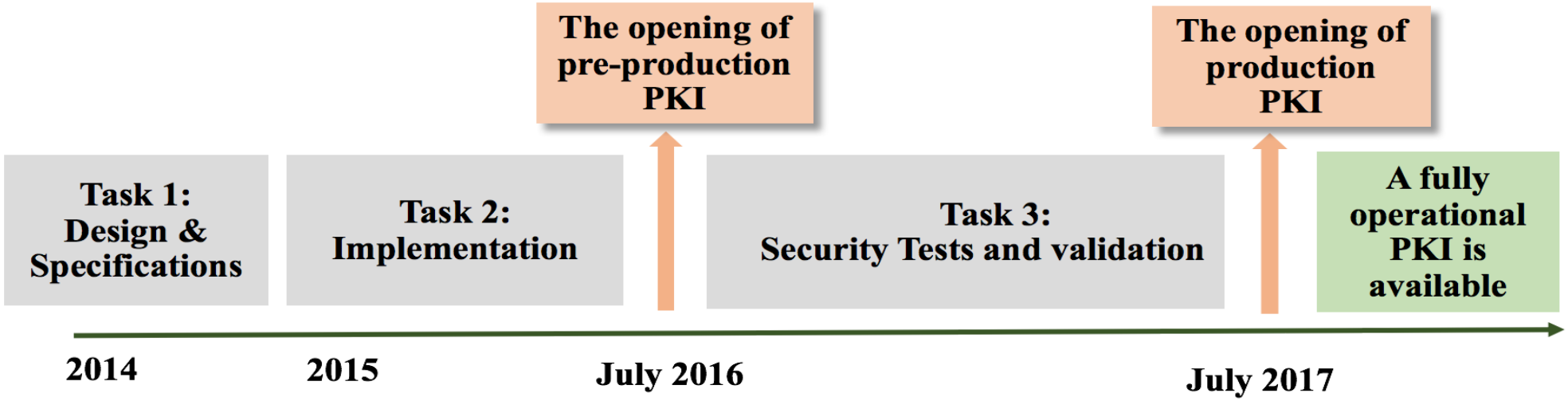
SCOOP@F PKI : Achievements



Key Ceremony of Production PKI (September 2016)

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SCOOP@F Security: Tasks

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- **Task 1: Specifications**
  - Used Algorithms
  - Anonymization/Pseudonymization of messages
  - Signature of messages/ Verification of signature
  - PKI Architecture
  - Security Protocols (services advertisement, PKI requests, Logs upload)
  - Access/ Registration

- **Task 2: Implementation**
  - PKI
  - PKI Communication Protocols
  - Registration mechanisms

- **Task 3: Tests & validation**
  - Security Validation
  - Test PKI
  - Production PKI
  - Checklists and tests plans

29 deliverables, ...

In SCOOP @ F, the latest available ETSI security standards are used

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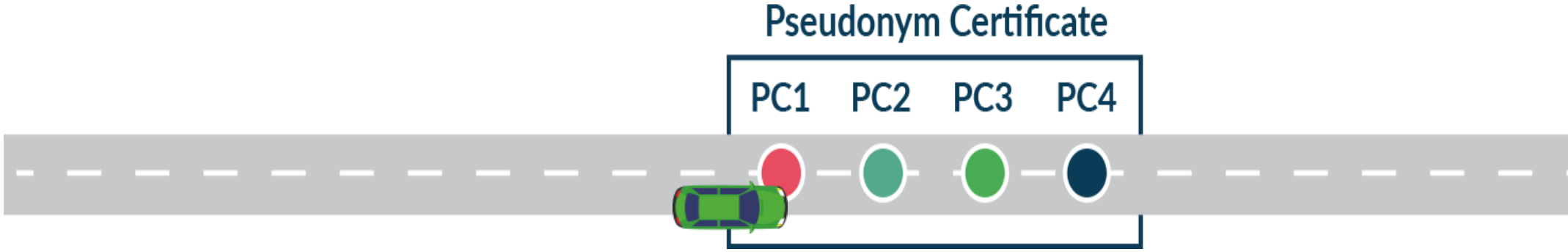
SCOOP@F Security: A Common Pseudonym Change Strategy



Parameters	Values
PC lifetime	1 week
Number of parallel Pseudonyms	10
Pseudonym preloading duration	6 Months
Pseudonym change method	Round Robin

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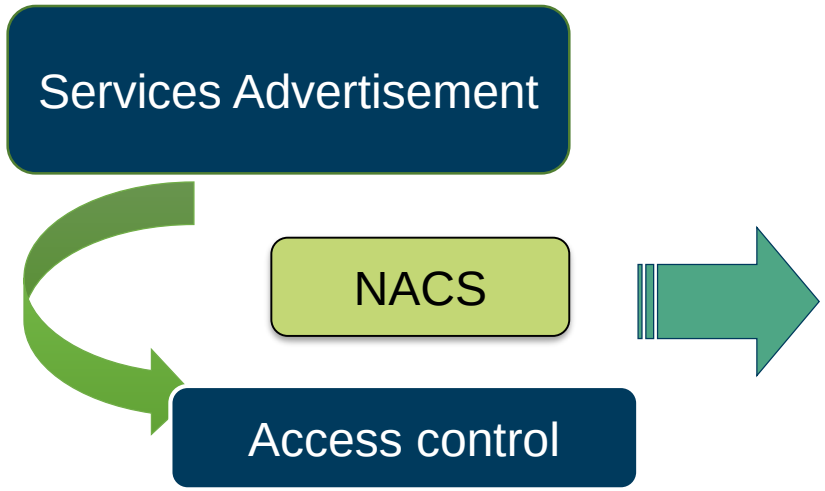
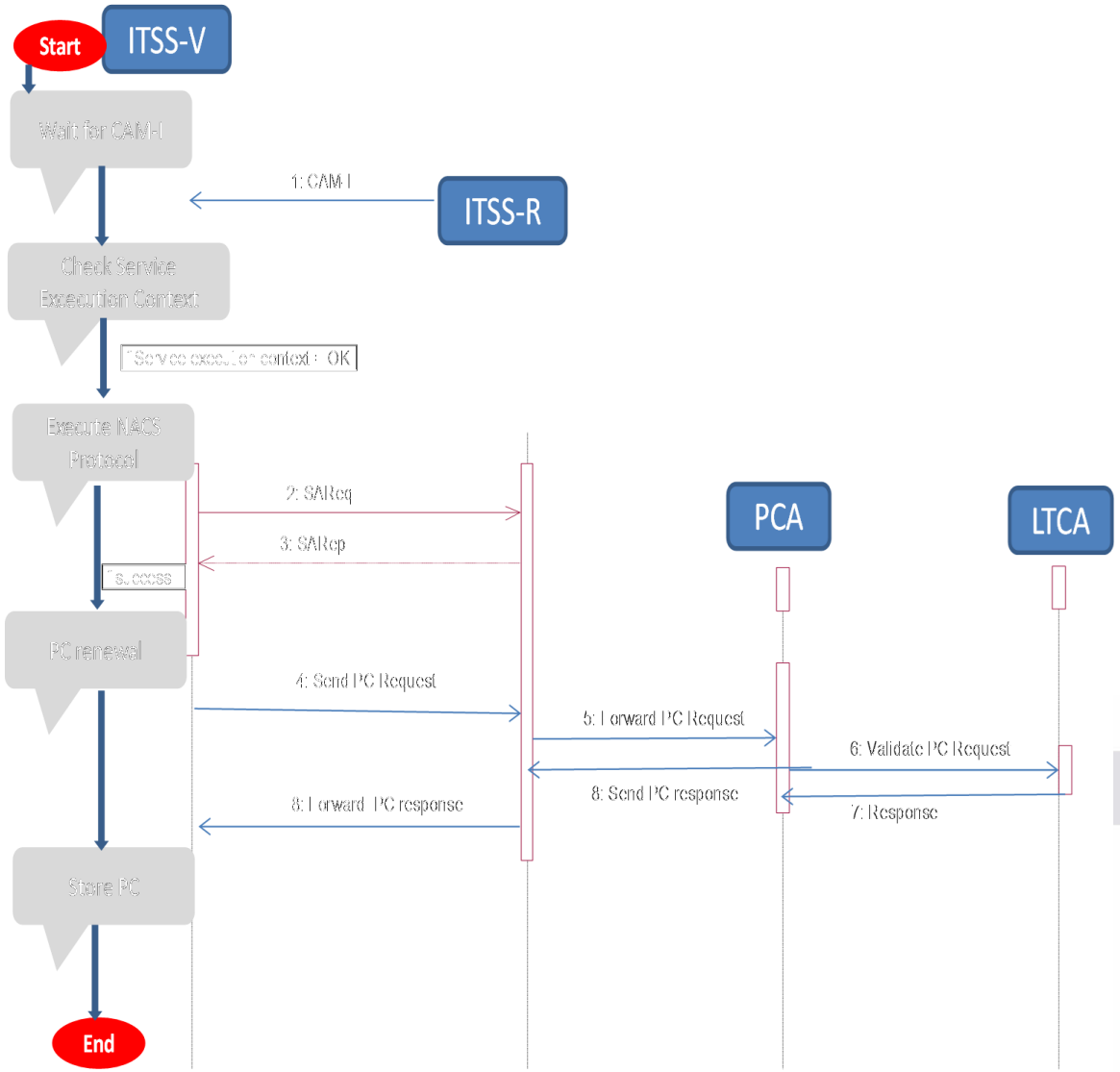
SCOOP@F Security: Communication Protocols

- **Two services**
  - Pseudonyms download
  - Logs upload (U-logs & T-logs)





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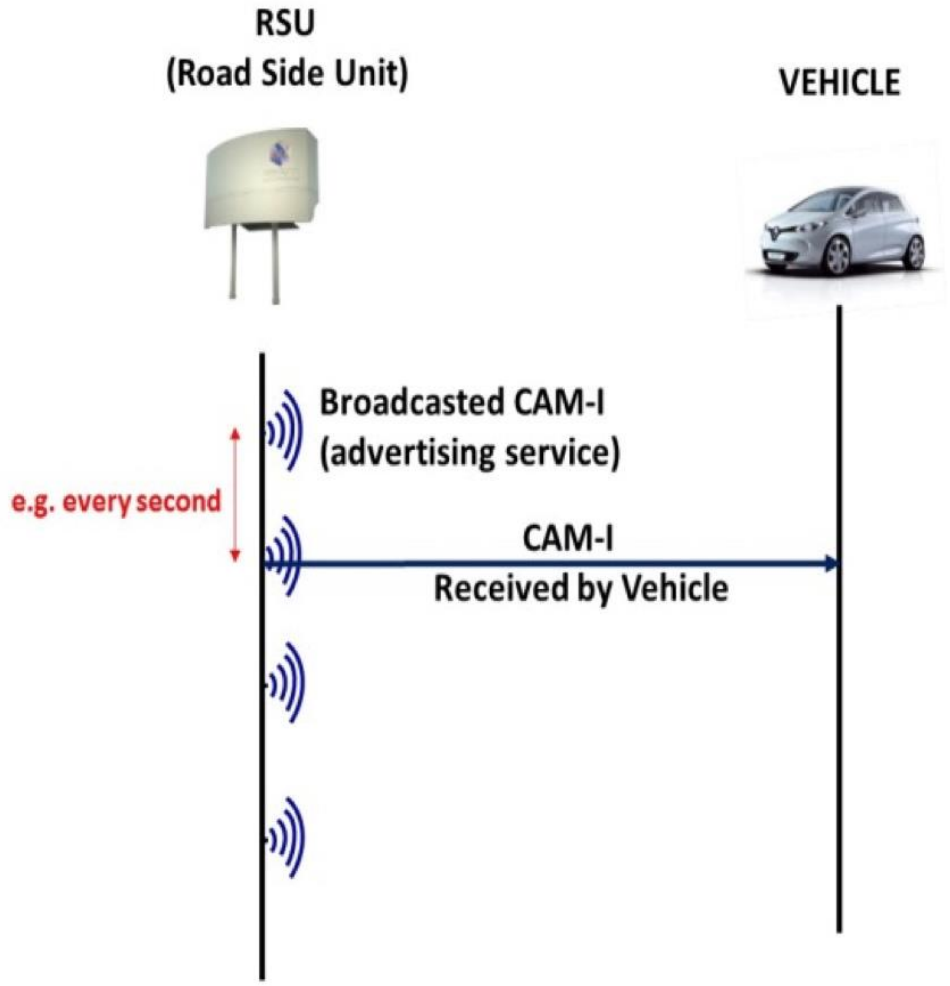
SCOOP@F Security: Communication Protocols

- **CAM-I**: message broadcasted by the RSU to advertise the presence of PKI service
- PKI requests and responses are relayed by the RSUs (ITS-G5) or using a Cellular Technology



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C-ITS contribution

- EU C-ITS Platform
  - Report C-ITS Platform Phase I, January 2016
  - EU C-ITS platform trust model
  - CP release 1, July 2017
  - Report C-ITS Platform Phase II, Septembre 2017
- ETSI
  - TS 103 097, TR 102 893 (TVRA), TS 102 940, TS 102 941, etc.

We also continue to follow …….

- ETSI TC ITS
- IEEE 1609.2
- C2C
- Amsterdam Group
- C-Road platform
- ISO TC204
- IETF

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Thank you for your attention!

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Privacy by design

Eric OLLINGER - DGITM

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The work with CNIL

- September 2015 – First meeting : presentation of the project and exchange on the privacy and DP stakes
- December 2015 – Dedicated meeting on security aspects
- First semester 2016 – Work on a dedicated deliverable on privacy and DP stakes for CNIL
- July 2016 – Deliverable sent to CNIL
- November 2016 – Meeting to clarify the last questions
- December 2016 – Official deposit of a request for authorization
- April 2017 – Deliberation of CNIL. Request requalified as a declaration with regard to the guarantees provided, the project is allowed to start processing data

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Structure of the work

- Identification of the data processing purposes
- For each of them,
  - identification of the corresponding data
  - identification of who is responsible of the data processing
  - identification of who has access to the data
  - identification of the duration of conservation of the data
- Security measures and confidentiality
- Consent from the data subject
- Possibility for the data subject to have access to their own data
- Activation/de-activation

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Processing purpose #1 : Services

- Corresponding data : CAM, DENM
- Responsible for the data processing : road operators
- Who has access to the data :
  - Traffic operators have only access to aggregated Datex files
  - Other drivers have access to the event contents shown on the HMI, no vehicle identification
- Duration of conservation
  - CAM messages are deleted by the RSU as soon as they have been aggregated translated into Datex
  - DENM messages are deleted by the RSU as soon as they have been translated into Datex
  - CAM and DENM messages are deleted on drivers' OBUs once outdated (several ms to a few min depending on the services) and at each reboot

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Processing purpose #1 : Services

- Question from CNIL : why not encrypt CAM and DENM messages?
- Answers from the project
  - In the standards messages are not encrypted, but signed
  - The principle of C-ITS is that a maximum number of drivers have access to the safety critical information as soon as possible
  - Encryption/decryption would significantly increase latency and harm safety critical services
  - Encryption/decryption would significantly increase the costs of OBUs

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Processing purpose #2 : Evaluation

- Corresponding data : logs
- Responsible for the data processing : research centers
- Who has access to the data :
  - Researchers
  - For private research centers : separation between geolocation data and speed data (rule in French law: a private company cannot have access to these law enforcement data)
- Duration of conservation
  - Data collection : up to 2020
  - Analysis of data : up to 2023

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Processing purpose #3 : Supervision

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- Corresponding data : logs such as configuration, status of an ITS station etc.
- Responsible for the data processing : road operators, PSA and Renault
- Who has access to the data :
  - Road operators, PSA and Renault
  - Their subcontractors in charge of maintenance
- Duration of conservation
  - Data collection : up to 2020
  - Analysis of data : up to 2020

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Security measures

- PKI architecture
- Security of each data server
- Duration of use of each pseudonym during a single trip: 1 hour
  - Due to the perspective for road operators to use the data for travel time and O/D
  - If less, the result would be an increase in the rotation frequency of the pseudonym certificate pool (10/week), resulting in less privacy

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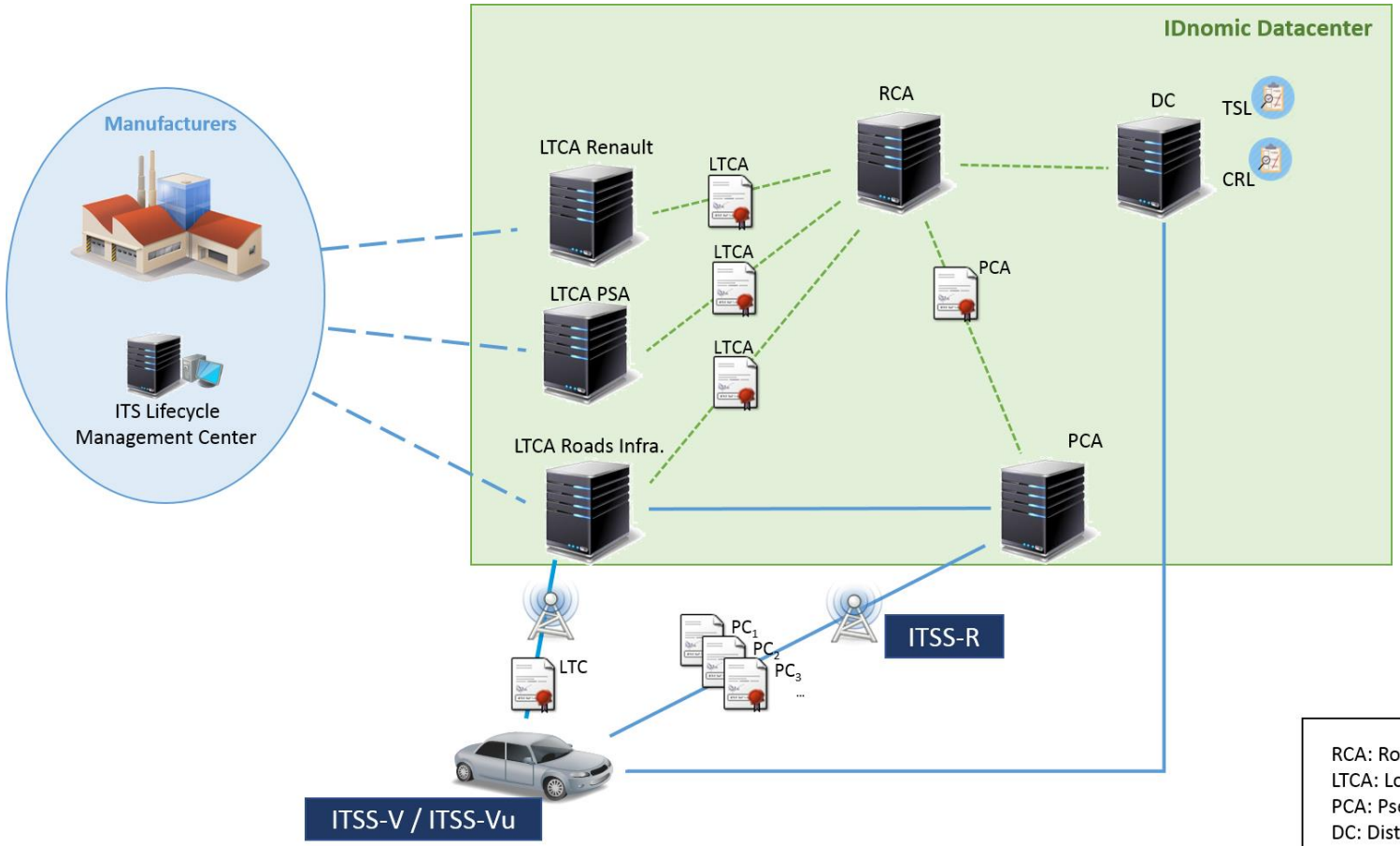
Security measures



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Consent from the data subject

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- Consent forms have been designed for final users
  - Explicit: written
  - Freely given
  - Informed and specific: the forms explain all the processing purposes and the duration of conservation, a link to the list of data is provided
- Information of employee representatives:
  - For fleet vehicles (sold by Renault)
  - For road operators' vehicles

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Possibility for the data subject to have access to their own data

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- The system is designed in such a way that it is not feasible (except for some specific vehicles)
- CNIL has considered this as acceptable, given the strong pseudonymisation measures put in place (exception in the French law)

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Activation / de-activation

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- The system can be easily activated/de-activated
- In order to get enough data for evaluation, the system will be activated by default (except for rental vehicles)
- Given the consent from the user, CNIL has considered this as acceptable for the project. However, this should be reconsidered for national deployment

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Perspectives for national deployment

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- Entry into force of the GDPR
- Opinion of Art. 29 WP on C-ITS
- National Mobility Law
- Delegated act on C-ITS by the European Commission

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Questions / answers

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AN OPERATIONAL SYSTEM

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Road operator infrastructure

L. HOARAU

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Scoop@F

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Operational network of Sanef

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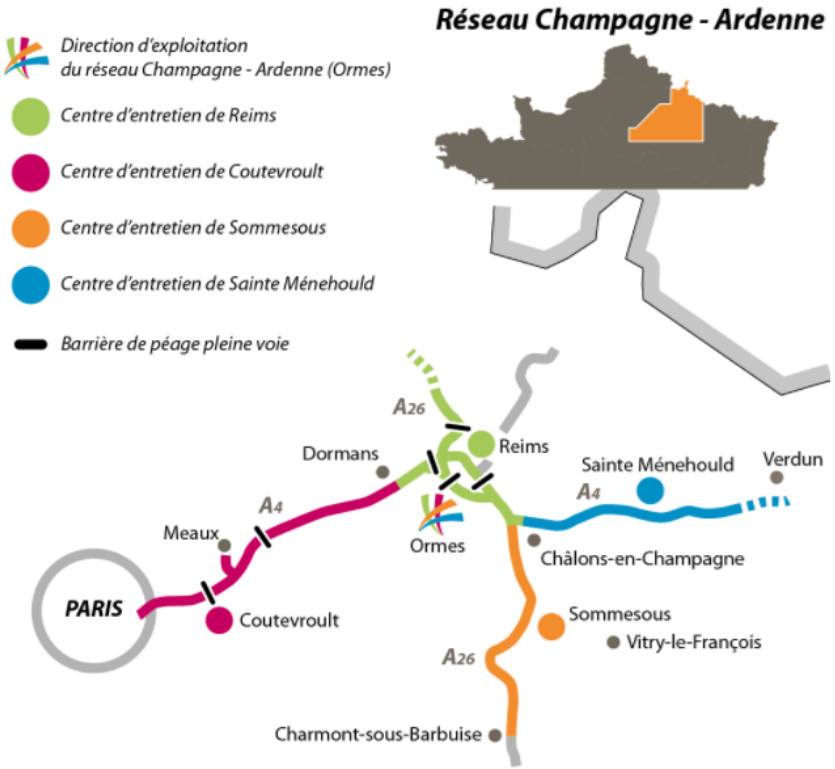
EAST Network

Réseau Champagne-Ardenne



Réseau Alsace-Lorraine

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General Architecture

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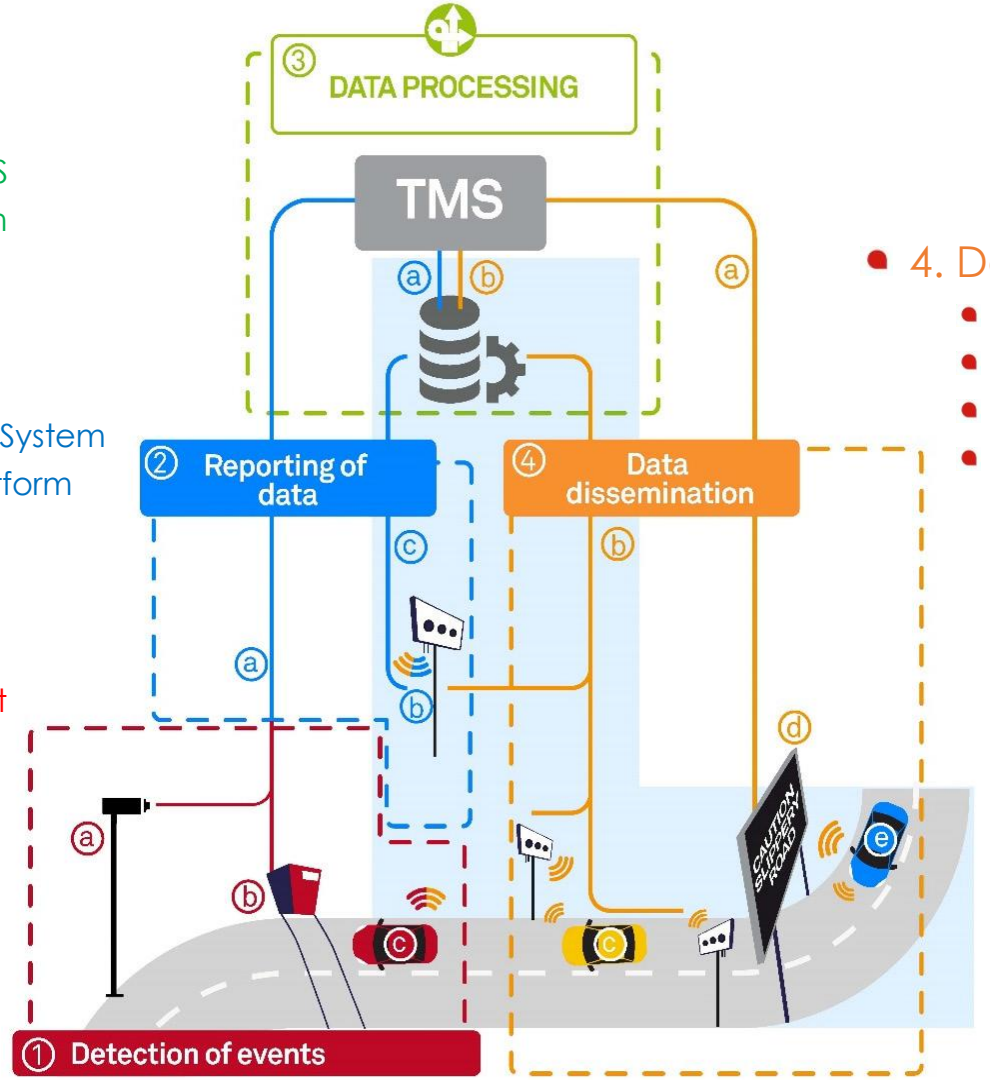
- 3. Data Processing
  - **a** : From SCOOP Platform to TMS
  - **b** : From TMS to SCOOP Platform
- 2. Reporting of data
  - **a** : To the Traffic Management System
  - **b,c** : To RSU then to SCOOP Platform
- 1. Detection of Events(**a,b,c**)
  - Traffic Management Equipment
  - By the OBU (manually by the user or automatically by the vehicle).



- 4. Data Dissemination
  - **a** : To VMS
  - **b** : To RSU
  - **c** and **d** : Translation and broadcast
  - **e** : HMI in the vehicle

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RSU Geographic location

- 21 Road-Side Units (ITSS-R)

VMS

TM MAST

PYLON

- Location :
  - 3 on Traffic Management Mast (12m)
  - 17 on Pylon (20/30m)
  - 1 on VMS
- Location Issues
  - Strategic Location
  - Existing infrastructure
  - Facilitate Maintenance
  - Users and Road Workers' Safety

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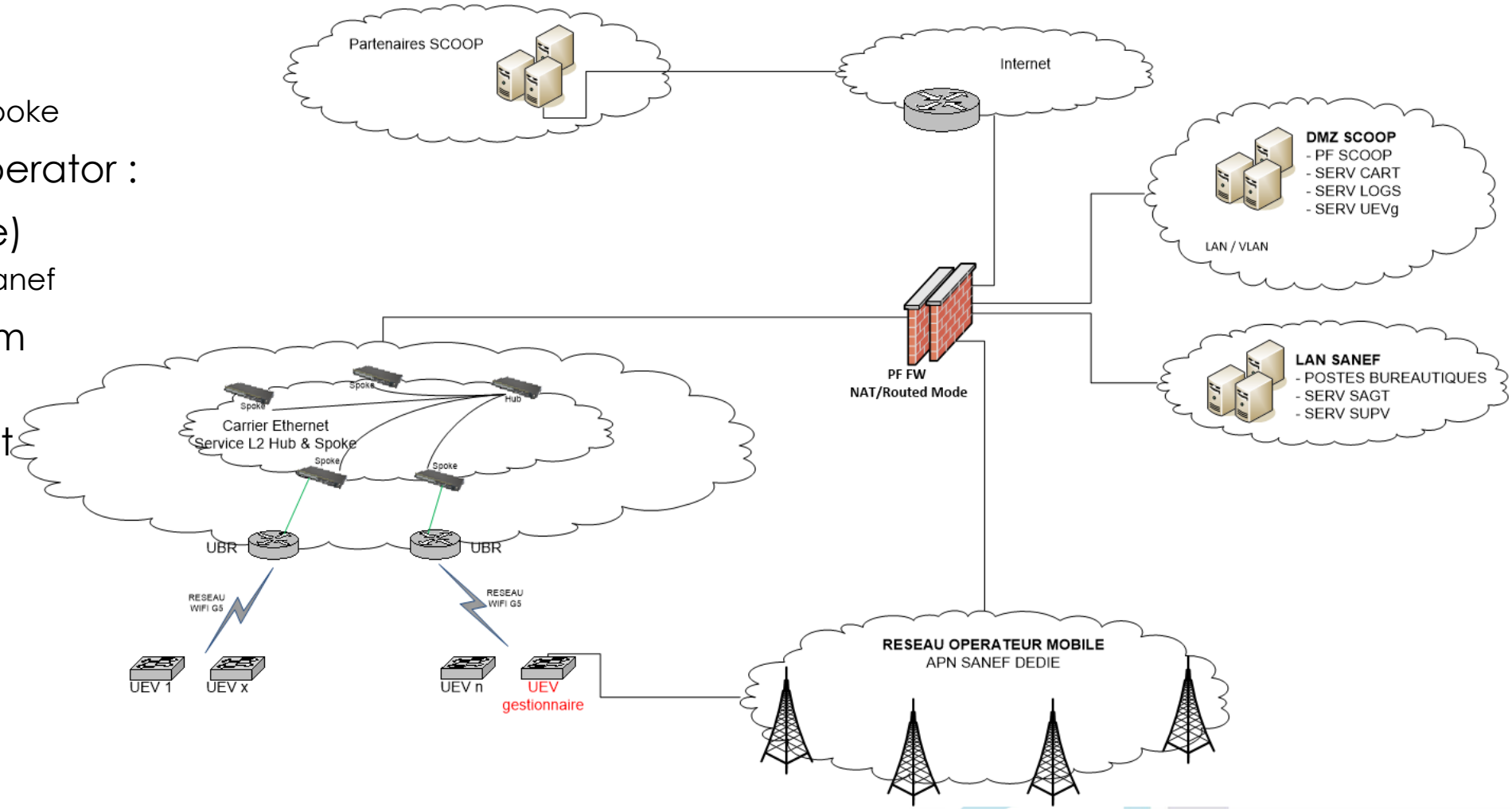
Network Architecture

- 21 x RSU
  - Service L2 Hub&Spoke
- 20 x OBU Road Operator :

  OBU + RSU (mobile)
  - Dedicated APN Sanef
- 1 x SCOOP Platform
  - DMZ SCOOP
- Flow Management



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Objectives

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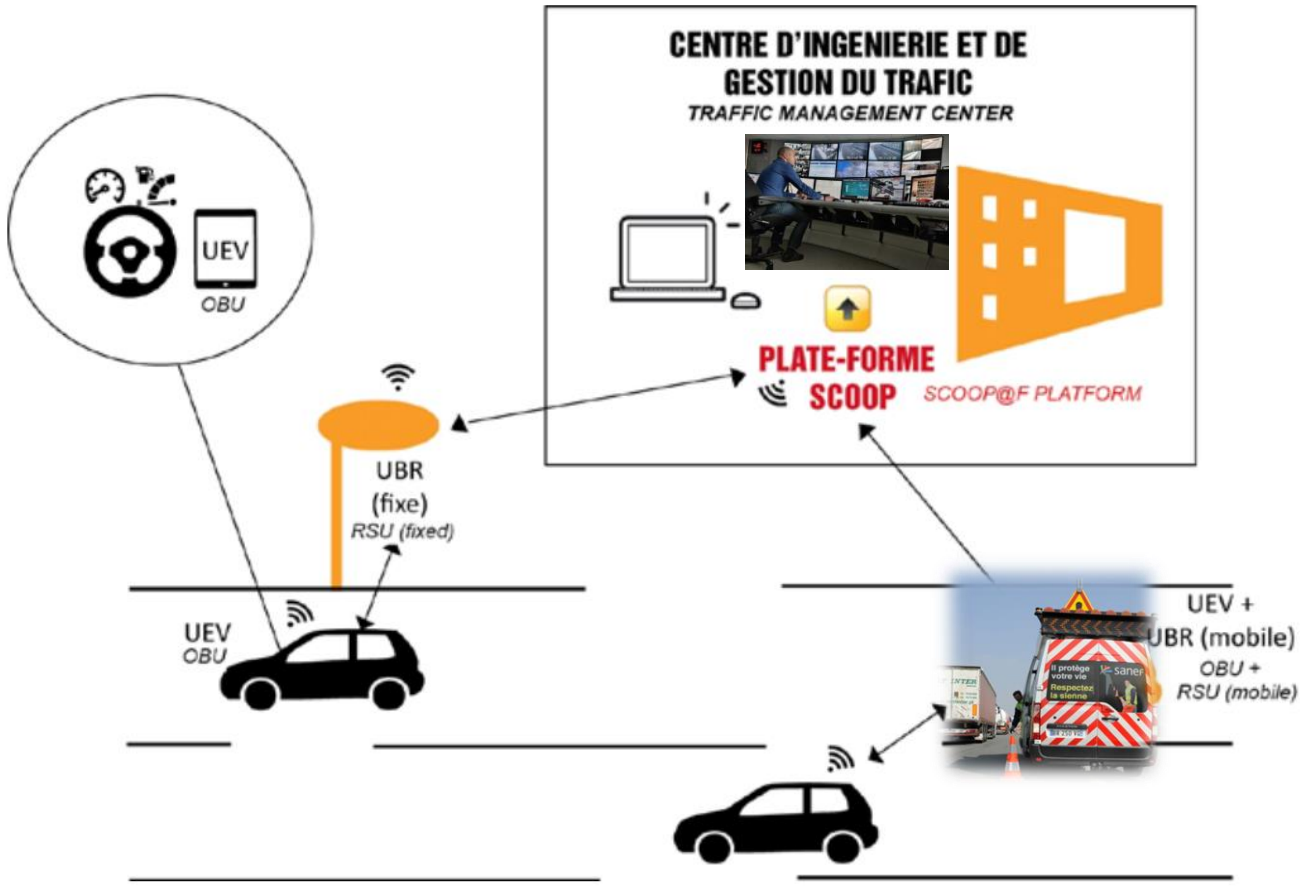
- OBU (RO) and RSU:
  - Access to reliable event data from vehicule
  - No intermediate: no additional costs
  - Provision of direct information to drivers, at any place (no need for a VMS)
  - Possibility to send accurate information on (even unplanned) road works
  - Possibility to send information directly from road operators' vehicles intervening
  - Direct link between road operators and vehicule



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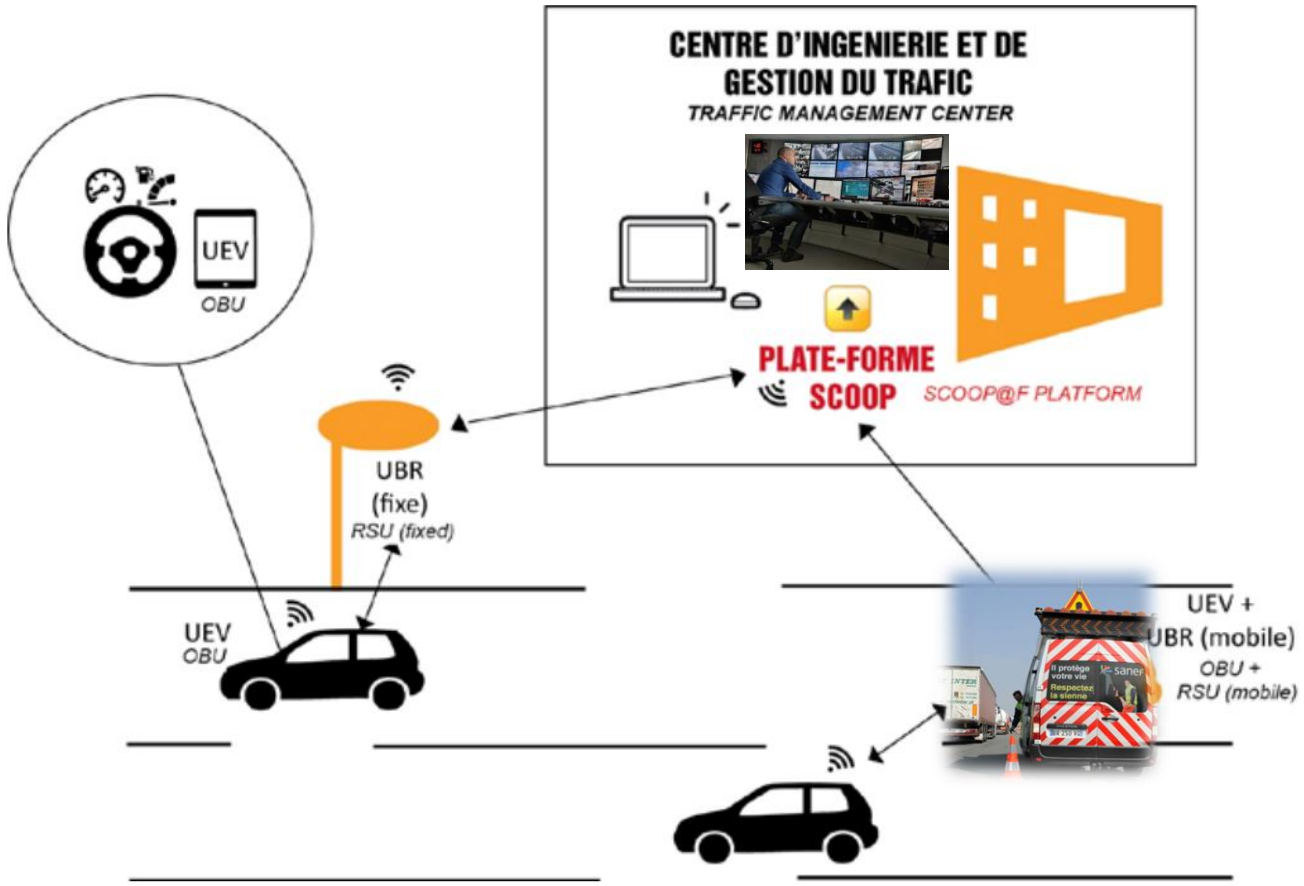
- SCOOP Platform
  - Controls all RSUs and road operators‘ OBUs (equipment status and events available on an HMI)
  - Delivers Datex II files directly usable by the TMC
  - Ensures fast transmission of information
  - OpenSource and modular solution : can be linked to different components with other systems



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Vehicles are available !

C. TISSOT

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Reasons for OEM participation

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One project to address two main objectives:

- Prepare the deployment of **basic cooperative ITS services**:
  - Large scale testing of Day-1 services with serial vehicles, technical service cars from infrastructure providers and several hundreds of Road Side Units (RSU)
  - Granting services harmonization by basing all technical & functional specifications and developments on publicly available standards
  - Provisioning of an efficient security system
  - European Interoperability with foreign partners (E,P,A) and C-ROADS involvement

- Design and test **enhanced cooperative ITS services**
  - Elaborating a hybrid communication system (ITS G5 and existing cellular)
  - Enabling the evaluation of the long term infrastructure equipment strategy
  - Contributing to interoperability of cooperative ITS in the EU

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Overview of standards & norms

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ITS Norm	Reference	Version
Access Layer		
Radio-Communications Equipment	ETSI EN 302 571	1.1.1
Access Layer Specification	ETSI EN 302 663	1.2.1
Communication Architecture	ETSI EN 302 665	1.1.1
Harmonized Channel Specification	ETSI TS 102 724	1.1.1
Mitigation techniques to avoid DSRC interferences	ETSI TS 102 792	1.1.1
Transport Layer		
Vehicular Communications; Geo-Networking	ETSI EN 302 636-4-1	1.2.1
	ETSI EN 302 636-5-1	1.2.1
Facilities Layer		
Vehicular Communications; CAM	ETSI EN 302 637-2	1.3.2
Vehicular Communications; DENM	ETSI EN 302 637-3	1.2.2
Vehicular Communications; Geogr. Area of Definition	ETSI EN 302 931	1.1.1
Users and Applications Requirements	ETSI TS 102 894-1	1.1.1
	ETSI TS 102 894-2	1.2.1
Applications		
Application Object Identifier (ITS-AID)	ETSI TR 102 965	1.1.1
V2X Applications (RHS)	ETSI TS 101 539-1	1.1.1
Vehicular Communications; Basic Set of Applications	ETSI TS 102 638	1.1.1

Security

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Some specific project choices

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Commercial:

- **PSA** sells serial cars to mainly **private customers**
- **RENAULT** sells serial cars to **fleet customers**

Technical:

- Road operator's cars will also be equipped with ITS G5-OBU and participate actively to the eco-system ➔ hybrid position between a vehicle (CAM&DENM) and a mobile RSU
- Some use cases will be declared manually by the driver ➔ this is not foreseen neither in the standards nor in the C2C CC requirements but allows us to get more feedback on concrete cases
- Neither on-board road data basis nor (common) mapping will be used for some cars ➔ position and orientation information could therefore be critical
- Some RSU with additional CAM functions: tolling station announcement, security certificate & logging data transit
- Operational PKI

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High Level System architecture

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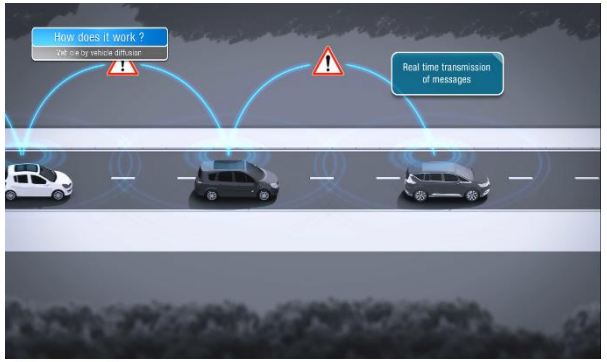

Data types: 2 V2X messages

- CAM Cooperative Awareness Message
- DENM Decentralized Environmental Notification Message

Exchange principles :

- Broadcasted without receipt confirmation
- Hoping to extend the dissemination area
- Completely anonymous with constantly changing pseudonyms (no traceability) delivered by a national PKI via RSU and TCU
- No data storage in the car; project LOGs via RSU and TCU
- No CAM usage by the car for ADAS at this stage

Data ownership:

- Data access only for certified partners respecting the communication protocol specifications
- European directive: road safety data for free

/!\ The use of cellular communication will be deployed for:
- PKI certificate management and LOG upload
- Extension of the coverage zone for services that do not need a high reactivity

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On-Board architecture

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Components :

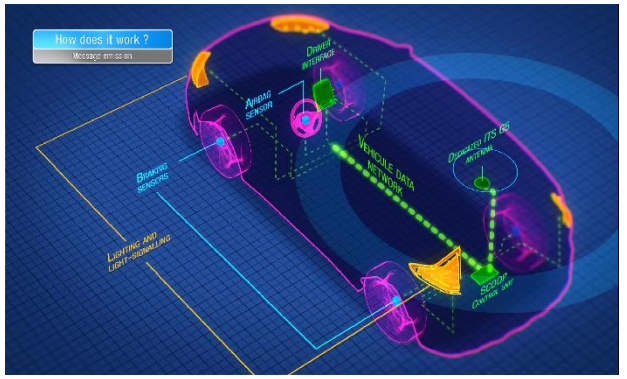
- V2X Stand-alone ITS G5 communication unit
- Antenna combining FM, GNSS and 2 ITS G5 channels
- SCOOP soft on serial Head Unit
- Bluetooth connection between V2X Unit and Head Unit (Renault)

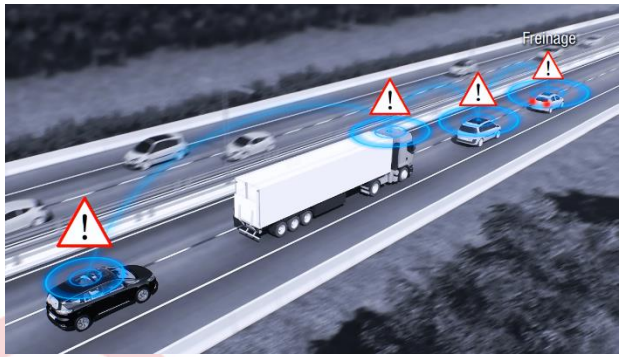
Exchange principles :

- V2X Unit: modulation / demodulation, construction of automatically triggered messages, relay of messages, security and pertinence check of all in-coming messages, construction of LOG files, diagnostic, …
- HU/ HMI: 2nd priorization of incoming messages (SCOOP and non-SCOOP), display of C-ITS alerts, triggering of manual messages, transmission of CAN information, diagnostic via HMI, …

Software developments :

- V2X – complete ITS G5 protocol integration including regular pseudonym requests and technical and usage log downloads
- HMI adaptation to integrate the SCOOP display properly and to allow manual declaration of an event





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Compliance assessment

Compliance assessment of these developments were following the validation criteria

- on desk,
- on track and
- on open roads.

Specification, development and validation tasks are deeply interconnected and interdependent, notably due to the reinforced loop process.

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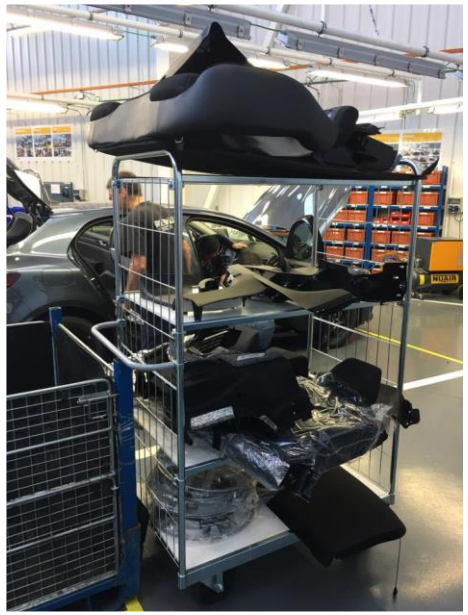
Mounting process

- in the plant for Renault and
- in the dealer network for PSA



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Selling process

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The sales and after-sales processes are the same as for any other serial car to make them as much convenient for customers as possible.

Vehicles are ready for driving!

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The production of SCOOP vehicles is yet scheduled, the pipeline for commercial contracts opened. So, potential customers might refer to conventional car manufacturer vendors or address
their request to: http://www.SCOOP.developpement-durable.gouv.fr/en/and-you-a4.html

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Questions /answers

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EX ANTE EVALUATION BUSINESS MODEL

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Health risk assessment

Evaluation of electromagnetic field exposure

Divitha Seetharamdoo
IFSTTAR/COSYS/LEOST

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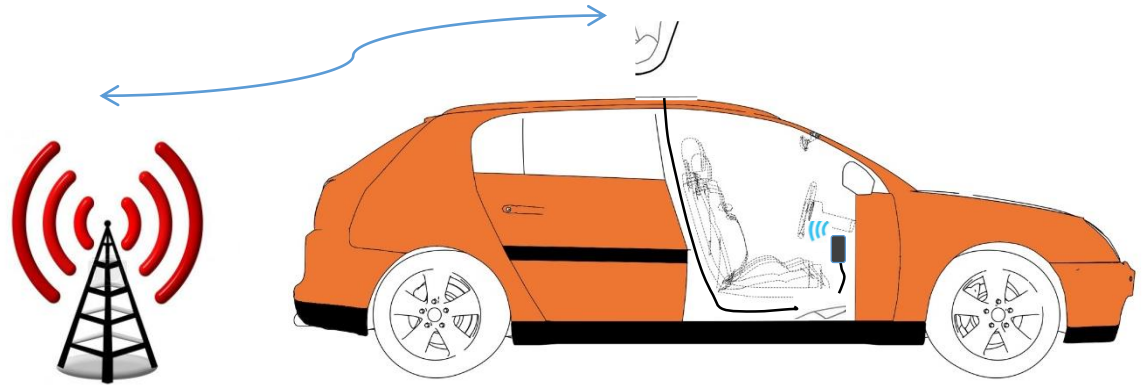
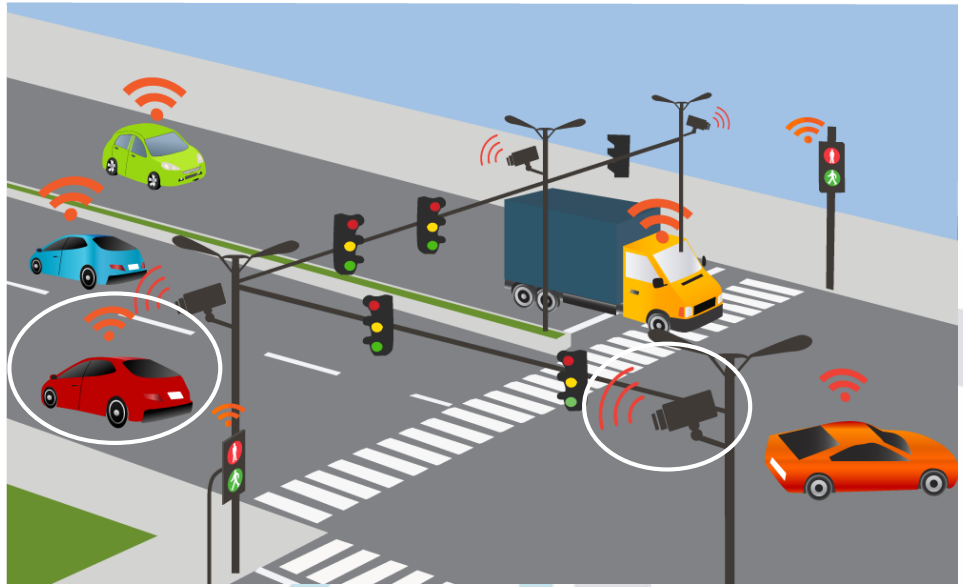
Context

- Deployment of 802.11p radiocommunication systems
  - Human exposure to electromagnetic waves due to the presence of supplementary RF sources



RoadSide Unit (RSU)

OnBoard Unit (OBU)



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Regulatory Framework

- Objective
  - Definition of guidelines and requirements for limiting exposure to time-varying electric, magnetic and electromagnetic fields
- European council recommandation 1999/519/EC on limitation of exposure of the general public to electromagnetic waves
  - Based on the recommendations of ICNIRP (International commission on non-ionizing radiation protection)
  - Recommandation transposed in France - Decree 2002-77
- European council directive 2013/35/EC on the minimum health and safety requirements regarding exposure of workers to risks arising from electromagnetic fields
  - Recommandation transposed in France by Decree 2016-1074

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Our objectives

- Analyse the exposure level due to EM emissions from systems deployed by the Scoop project

- Focus : Radio frequency electromagnetic emissions from the Roadside unit (RSU) and Onboard Unit (OBU
- Both public and occupational exposure

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Human Exposure analysis in the framework of Scoop project

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- General principle of evaluation of Human Exposure to EM fields
- Analysis of the regulatory framework with respect to the EM emissions added by Scoop radio communication systems
  - Part 1: Analysis of published research work on human exposure to EM fields for equivalent systems
  - Part 2: Ongoing and future work

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Human EM exposure assessment

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- ITS G5/802.11p systems
  - Max. equivalent radiated power (ERP) = 2 W
  - Center frequency = 5,9 GHz
- Evaluation of EM exposure : the main parameters

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Illustrations : IFSTTAR, Epictura

Human EM exposure assessment

- The integration constrainsts of the radiocommunication systems are essential factors influencing EM exposure
  - Within vehicles, this evaluation is the responsibility of the car manufacturers; they attest that the maximum exposure limit is respected
  - Outdoor, after deploying the RSU, a neutral body (e.g. a certified laboratory) in agreement with the ANFR (Agence nationale des fréquences) performs measurements and these can be made available to the general public

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Limits in the exposure levels

- Application of the general regulatory framework to the emission sources introduced by the deployment planned in Scoop project
- Two different populations:
  - Workers (healthy adults exposed during working hours),
  - Public (24h exposure, 7 days/week for adults, children, old people...)

	Population générale Valeurs limites d'exposition	TRAVAILLEURS Restriction de base
Champ électrique de référence	61 V/m	137 V/m

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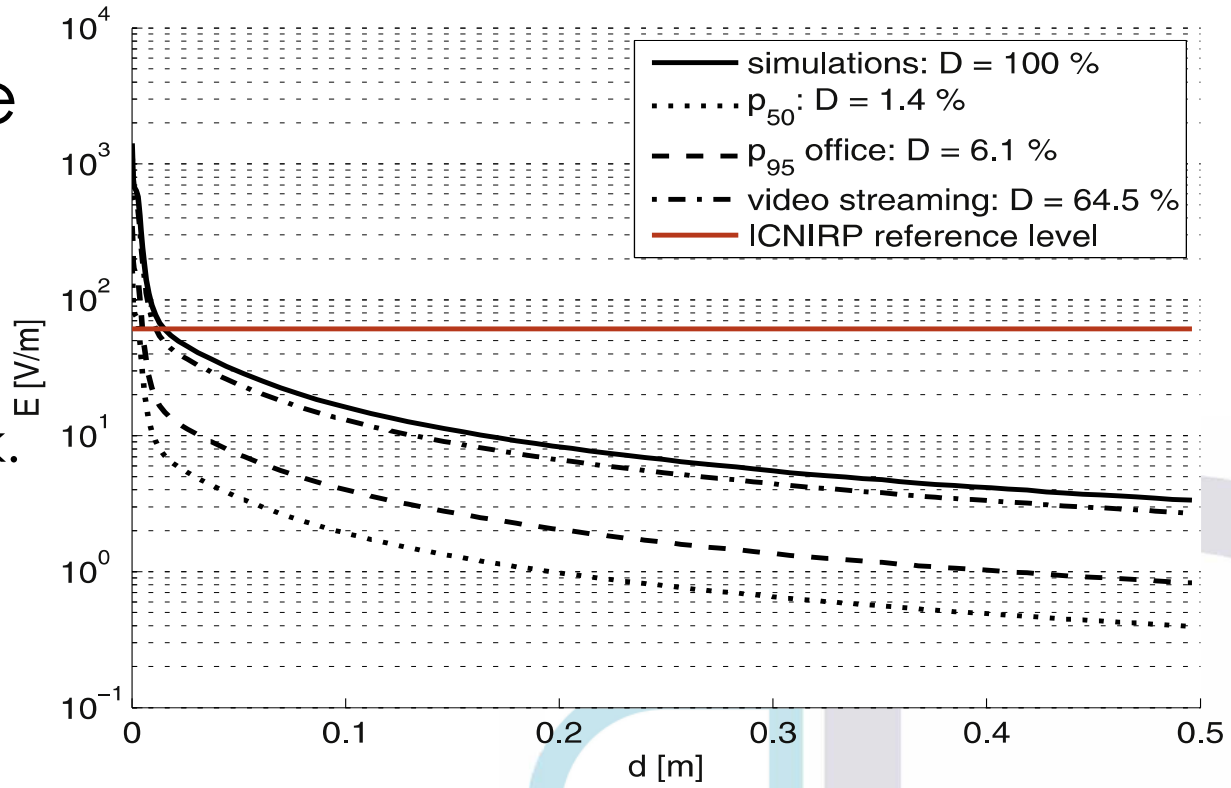
Example of previously published exposure levels

- Measurement of the exposure levels for a Wi-Fi system operating at 2.4 GHz in indoor environment

- How do these levels compare to the prescribed limits?
  - Generally lower than the threshold
  - Much smaller (factor of 10) for regular activities such as common office work.



Joseph, W., Verloock, L., Goeminne, F., Vermeeren, G., Martens, L., 2012. Assessment of RF exposures from emerging wireless communication technologies in different environments. Health Phys. 102 (2), 161-172.

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Conclusion

- The general regulatory framework for limiting exposure level to EM fields applies to the Scoop project
  - Limiting the exposure level to 61 V/m for the general population
- The emission level of the wireless system deployed in the their integration constraints, the exposure levels are *a priori*:
  - Much less than the limits prescribed by the recommadation 1999/519/CE of the European council
  - comparable to existing radio systems

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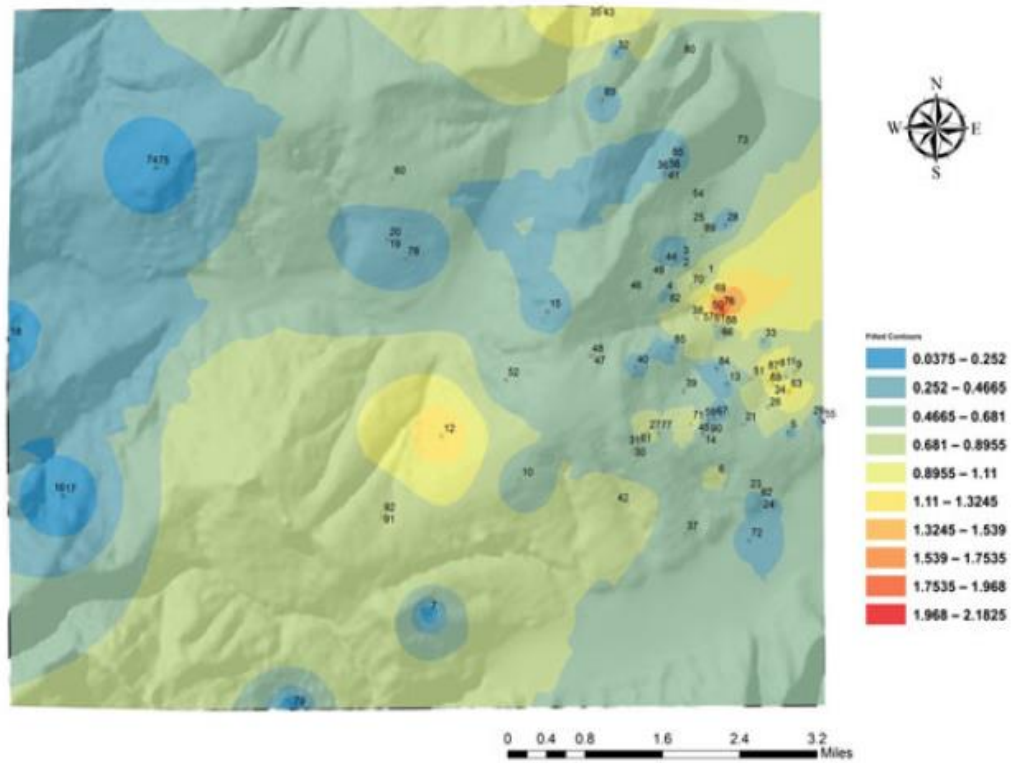
Ongoing and future work...

- Human exposure to EM field risk perception

- Numerical simulations as well as measurement campaigns are planned during the coming TestFest[1] in Reims

  - First EM field exposure map due to the deployment of ITS-G5 systems



Kurnaz, Cetin and Korunur Engiz, Begum and Bozkurt, Murat Cem, Measurement and evaluation of electric field strength levels in primary schools and secondary schools in a pilot region, **Radiation protection dosimetry** 2017

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[1] *http://intercor-project.eu/event/register-now-for-the-intercor-pki-security-testfest/*

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Thank you for listening

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Organisational impacts

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Aims

- The implementation of a new technological system has an impact on: tasks, skills, management, organisation… (Bobillier-Chaumon, 2013; Valléry, 2003).
  - Promote the implementation of the SCOOP system
  - Improve technology, make organisation and humans move forward
  - Study the potential interactions between technology, organisation and humans
  - Accompany on a daily basis (for the DIR Ouest study)
- A basis is to understand how employees work and communicate without SCOOP (field workers and traffic supervisor)
  - Anticipate changes that may occur in this work ;
  - Propose detailed recommendations to prepare for change.

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Aims

- Adapt the technology ;
  - Technical recommendations.
- Adapt how it will be used ;
  - Organisational recommendations: working methods, procedures, coordination between field workers and traffic supervisors.
- Promote change among agents ;
  - Communication, training, consultation process, management.
- And then … Succeed the deployment !

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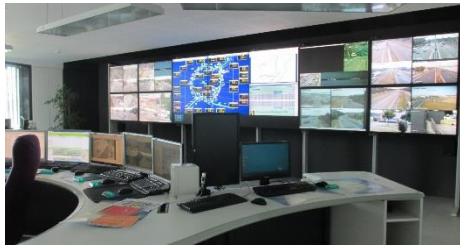
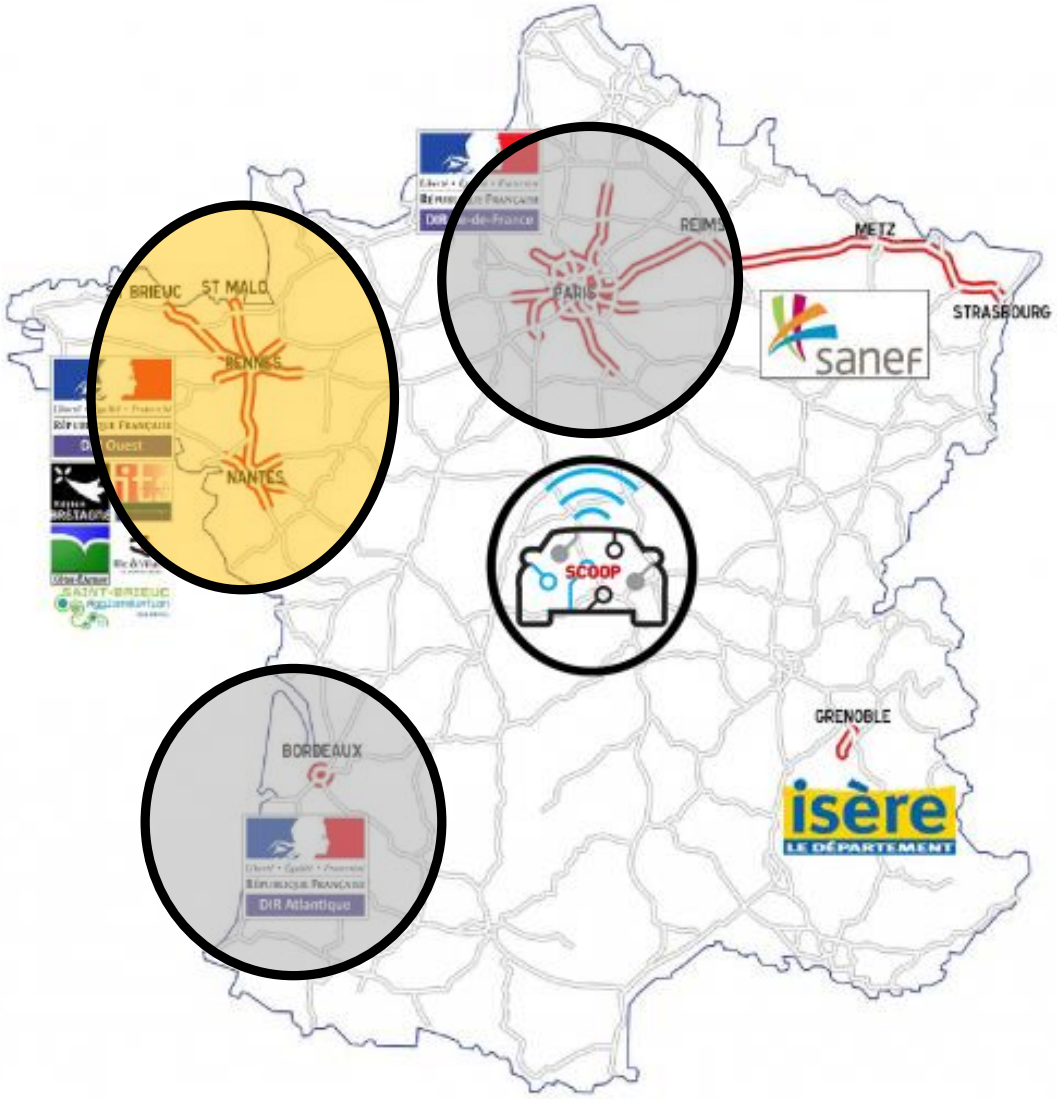
Study framework

- CEI (intervention centres) of the DiRIF and the DIR Ouest (interdepartmental roads departments)
  - Fields workers and managers
- CIGT (traffic management and engineering centres) of the DIR Atlantique and the DIR Ouest
  - Traffic supervisors and managers





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Projet SCOOP
véhicules et routes connectés
connected vehicles and roads

Projet SCOOP
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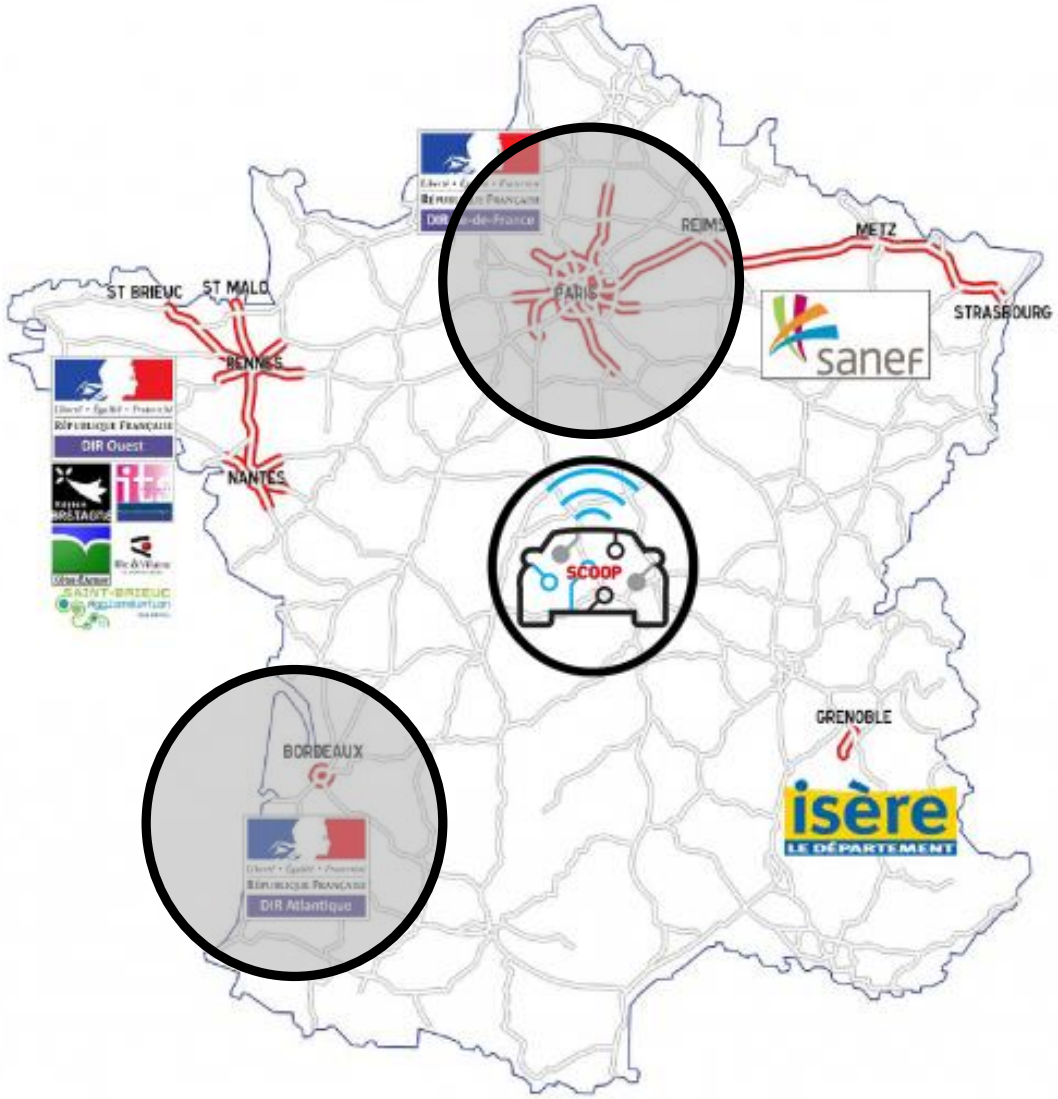
DiRIF & DIR Atlantique



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Theoretical background

- French ergonomics (Leplat, 1986)
  - The need to distinguish what needs to be done, the goal (tasks) and what workers really do to do this task (activity).
  - Importance of
    - Analysing the real behaviour of operators.
    - Understanding how the activity is constructed by a given operator in a given context.
  - The operator is not only the 'human factor' but a 'human actor' (Weill-Fassina et al. 1993).
  - For one task, they are a lot of different activities.

Task	• Goal that is set • Conditions in which it should be achieved
Activity	• What is undertaken by the subject to accomplish the task

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Method

Phase 0
- State of art + SCOOP system understanding
- Questionnaires administered to pilot sites managers
- Interviews with pilot sites managers

Phase 1
- Ex-ante
  - a. Field workers: observations + verbalizations
  - b. Traffic supervisor: observations + verbalizations.

Phase 2
- During implementation: participation as observer and recommendations

Phase 3
- Ex-post
  - a. Field workers: observations + verbalizations
  - b Traffic supervisor: observations + verbalizations.

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Method

- Who?
  - 6 field workers / 3 intervention managers with different levels of experience
  - 3 traffic supervisors / 1 chief / 2 managers with a long work experience
- What?
  - Various activities in road operation: patrol, intervention, night roadworks (marking)
  - Activity of traffic supervision
- How?
  - Observations
  - Verbalisations

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Results

- For each activity:
  - Identification of the sensitive elements to monitor and of the difficulties to which the system can provide a solution
  - Focus on information circulation
  - Proposition of recommendations

  For example: take into account the diversity of the local functioning during the conception of the system -> Introducing flexibility.

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Results: advantages of SCOOP

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For intervention	For traffic supervision
• Less administrative tasks • More security/efficiency because of the information given to road user • More precise location of an event to facilitate the intervention	• Better information to users: precise (geolocation), real-time (without a need to call at the beginning and at the end of an event) • Automation of a part of the log book filling

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Results: key issues of SCOOP

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For intervention

- Anticipation of field problems (ie. no geolocation in tunnels)
- Automation of the system during the access to an event (driving task)
- Taking into account managers tasks
- Keep direct communication with phone

For traffic supervision

- Associate the operator to define what need to be automated
- Interfaced the different tools
- Think about the organisation of the work between road police and operators

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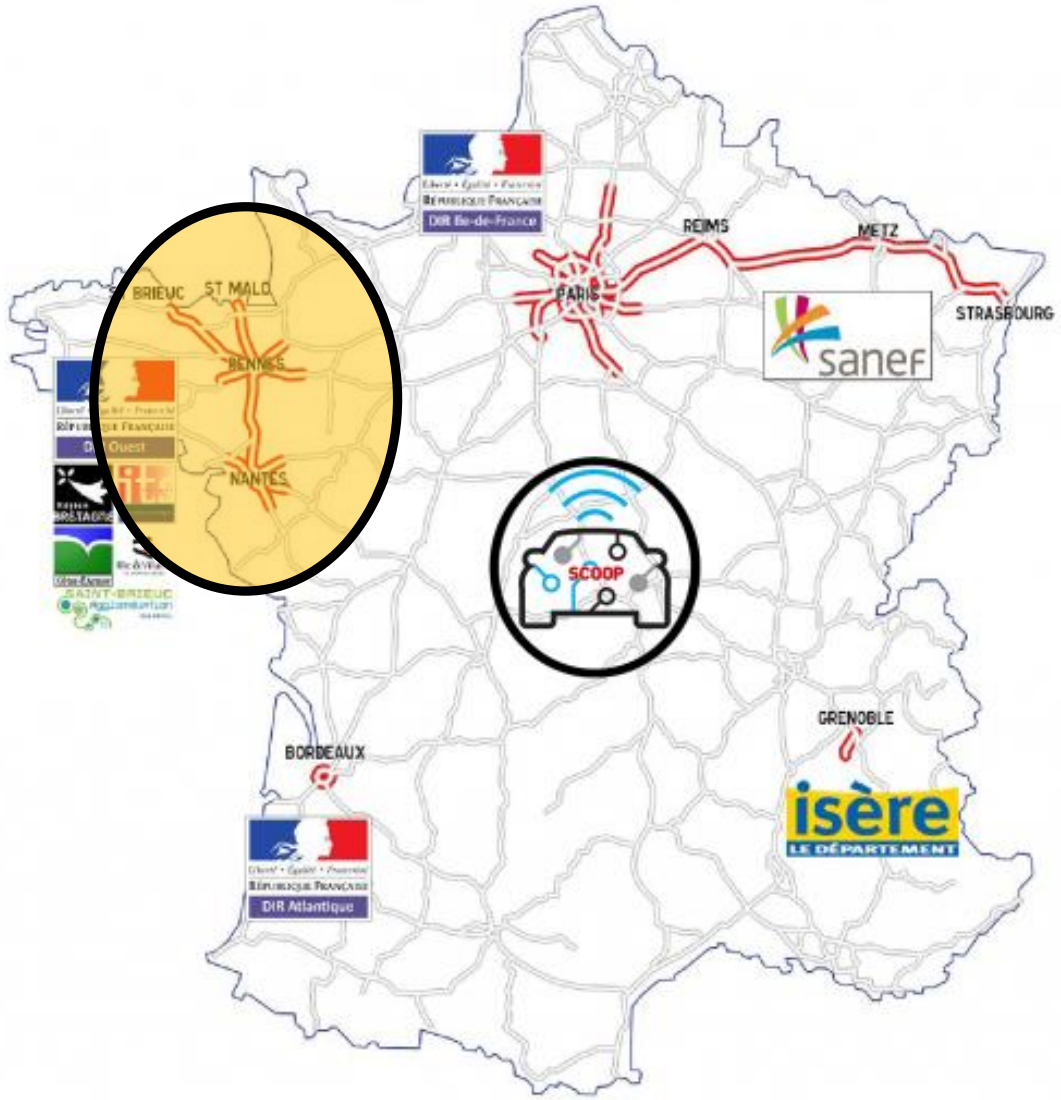
DIR Ouest



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PhD logic : Action research (Lewin, 1946)

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Why accompany ?

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- It is not enough to deploy technology to make it work (Andréani, 2001 ; Jørgensen, 2008)
- Is technology well perceived ? Does it seem useful ? Is it compatible with agent activity ? Will it really be used ? …
- And…once deployed, technologies come to re-examine and transform organizations (Brangier, 2010)
- **To succeed, we must accompany the deployment !**

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Projet
SCOOP
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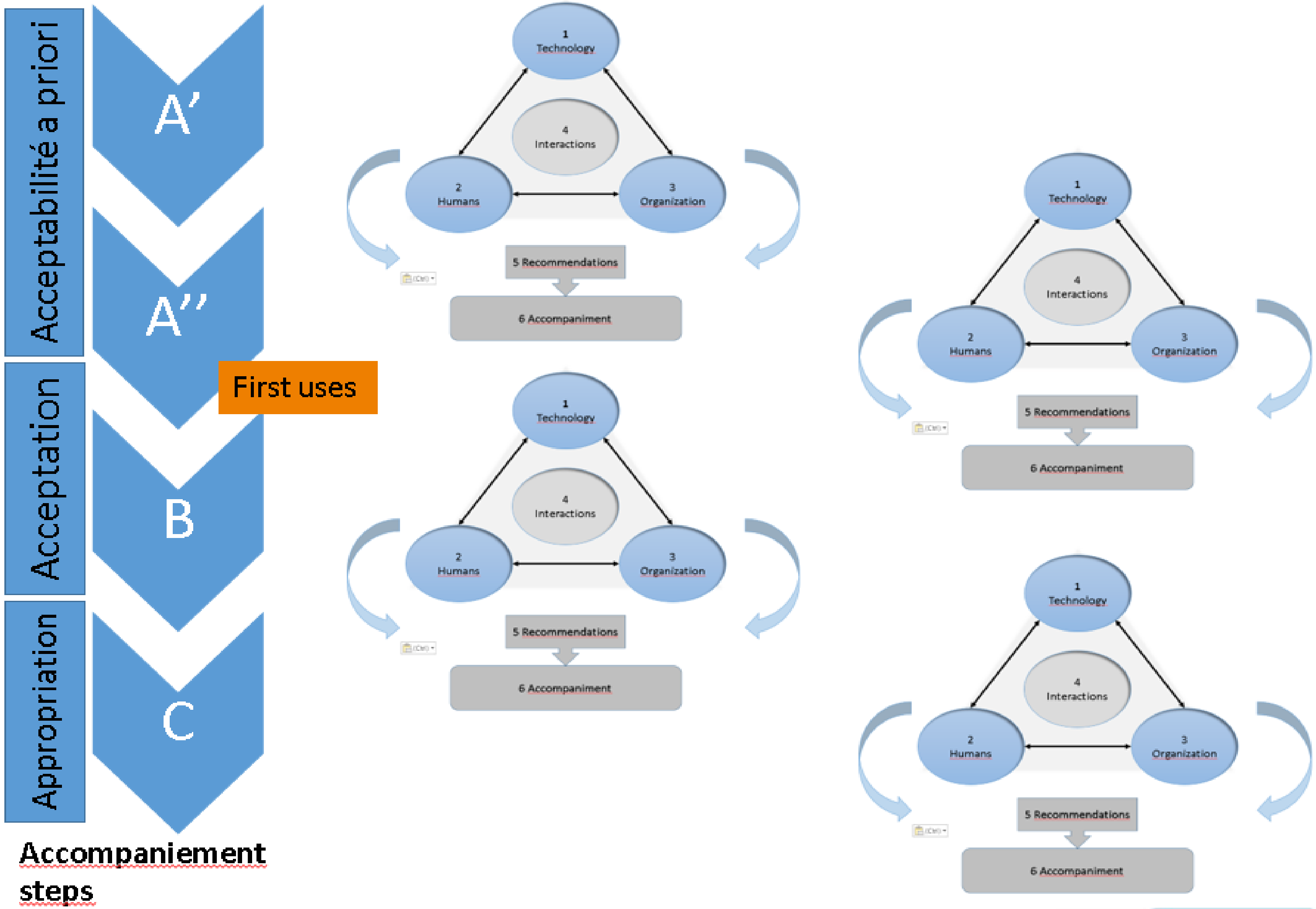
connected vehicles and roads

Method



Accompaniement steps

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First analyzes and methods

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- **Who?**
  - 8 field workers / 3 intervention managers
  - 5 traffic supervisor / 1 chief
- **What?**
  - Activities of intervention and traffic centers : patrol, intervention, roadworks, winter viability
- **How?**
  - Observations
  - Interviews

- **Who?**
  - 9 field workers / 5 intervention managers
  - 7 traffic supervisor / 2 chief
- **What?**
  - Relationship with Scoop
- **How?**
  - Focus-group (N=23)
  - Surveys (N=34)

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First analyzes and first results (1/4)

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- **Scoop re-questions the activities and organization :**

- Create new working procedures integrating Scoop and taking into account the daily reality of agents
- Train agents based on this reality

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First analyzes and first results (2/4)

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- **Accordance between project goals and representation of the agents toward their profession**

- **Questions about the added value of the project**

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First analyzes and first results (3/4)

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- **Concerns about ergonomics**

→ Risk of deployment failure

- Improvement of the use while driving
- Creating a connected van (inter-connected tools)
- Creating a unique tool to help manage traffic

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First analyzes and first results (4/4)

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- **Fears related to geolocation misuses**

→ Risk of deployment failure

- CNIL: possibility to disable Scoop
- PKI: individual data protection
- Communicate on the measures implemented and show the agents that their opinion is taken into account !

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To be continued

- **Impact studies** :
  - On other trades
  - On all the activities of the organisation
  - At different times





- **Final report** :
  1. Scoop impacts for road managers,
  2. Recommendations for future deployments,
  3. Tools to accompany future deployments.

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Thank you for your attention !

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C-ITS Business Model

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Business Model Ontology

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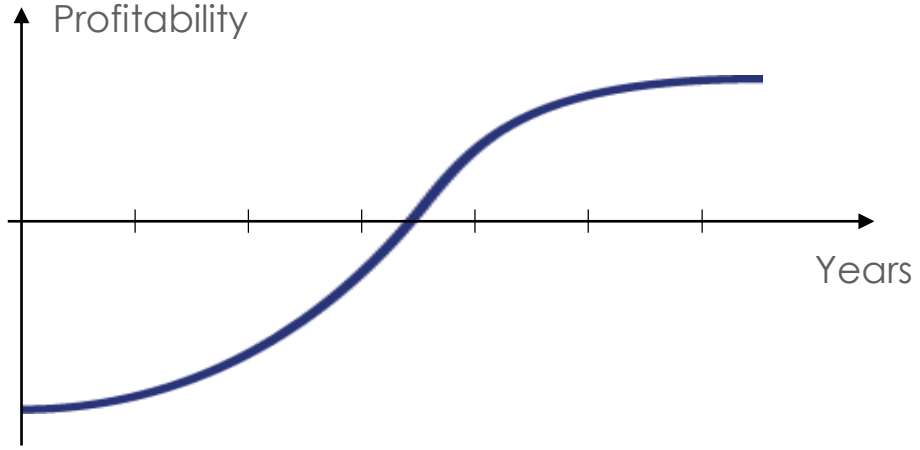
A Business Model describes the way an organization produces and delivers value to its customers/users

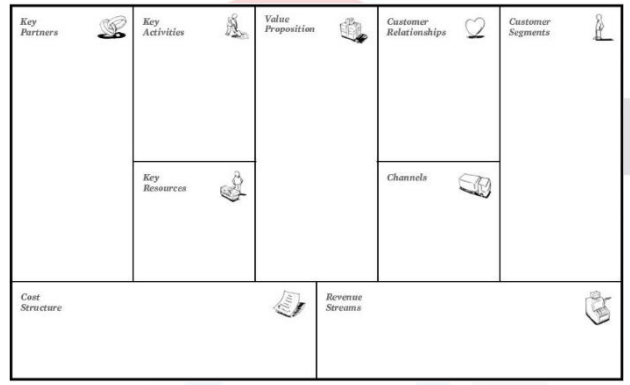
A qualitative description

- As a basis to embrace project finance
  (cost/Benefit analysis, Business Plan)



Topics to be described

- Canvas frame as a good guideline



Osterwalder & Pigneur, HEC Lausanne

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C-ITS Business Model Design

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A complex ecosystem of stakeholders collaborating to produce value:

- A network model more than a chain model,
- A systemic approach to embrace the C-ITS stakes from a global point of view,
- A need to describe the whole organization to highlight the collaborations/dynamic between stakeholders.

Simplicity of Canvas frame due to components segmentation, but:

- A static point of view,
- A difficulty to expose internal organization.

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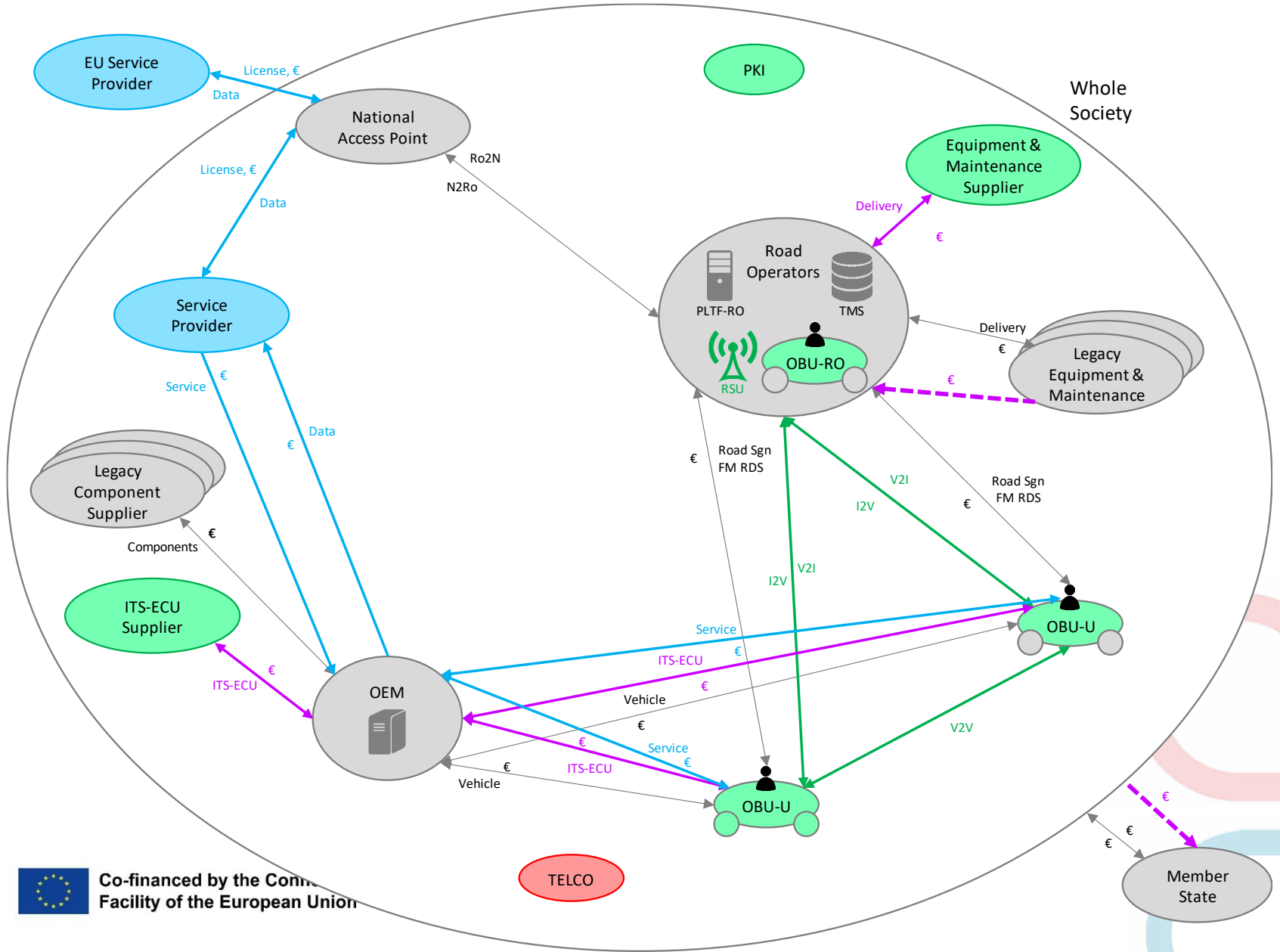
C-ITS « Value Network »



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Chanal,
IAE Grenoble

C-ITS « Value Network »

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Several graphs needed for readiness:

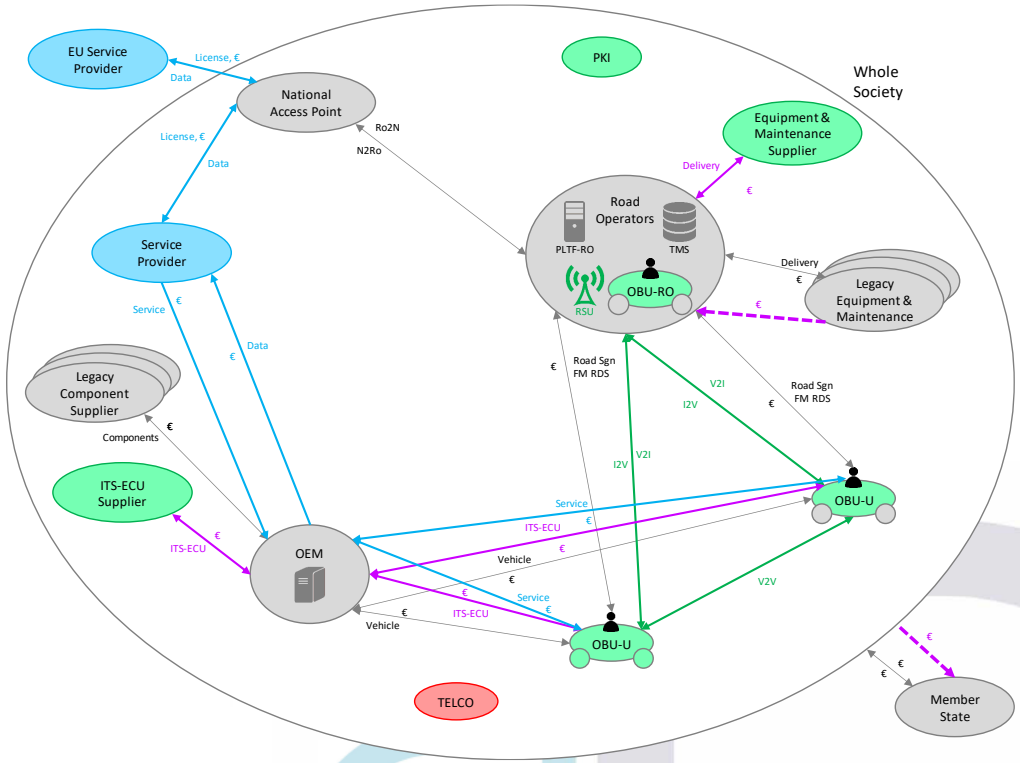
- Current situation (C-ITS cost/benefit analysis to be compared with)
- G5-based organization/functionalities
- Hybrid G5/Cellular-based organization/functionalities
- PKI organization/functionalities
- Variants / redundant technologies

Complementary description of every flow

Also for readiness:

- Single flow (data, product, service, cash)
- Double flow : counterparts between stakeholders
- Money saving
- Multi-flow

- Legacy/current situation
- Service providers Organization
- C-ITS - G5-based Communication
- C-ITS - Cellular-based Communication
- C-ITS - Communication based on other support/technology



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C-ITS Value Chain Model

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Value Network model:

- No description of activities/resources supported by stakeholders

A Value Chain model dedicated to C-ITS (C-Roads Platform)

Roadwork Warning

Generic value chain for traffic information incl. detailed process steps			Content provision												Service provision													End User
			Content Collection						Content Processing						Service Provision							Service Presentation							
Road Works Warning triggered from the TCC - ETSI ITS G5			Detection	Data delivery	Data reception	Data pre-processing	Data delivery	Commu-nication	Data reception	Content fusion	Data processing	Quality check	Content delivery	Commu-nication	Content reception	Content fusion	Service generation	Pre-formatting	Service delivery	Commu-nication	Service reception	Service decoding	Info fusion	Service rendering	Service presentation			
Roles		Example Actors																										
R-ITS-S (RSU)	Operator	DIR Ouest, SANEF…							X	X	X	X	X	(1)	X	X	X	X	X	G5								
C-ITS-S (SCOOP platform)	Operator	DIR Ouest, SANEF…			X	X	X																					
Communication	Provider	Telecom operator, Unity Media, fixed cable						Cellular, Fiber or Cable																				
Service Application	Provider	TomTom, INRIX, Here																										
V-ITS-S 1	Operator	Renault, PSA…																		G5	X	X	X	X	X			
V-ITS-S 2																				G5	X	X	X	X	X			
TCC (SAGT)	Operator	DIR Ouest, SANEF…	X	X																								
Road Infrastructure (V-ITS-S-RO)	Operator	DIR Ouest, SANEF…																										
Infrastructure PKI	Operator	IDNOMIC									X											X						

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V-ITS-S 2																											
TCC (SAGT)	Operator	DIR Ouest, SANEF…	X																								
Road Infrastructure (V-ITS-S-RO)	Operator	DIR Ouest, SANEF…																									
Infrastructure PKI	Operator	IDNOMIC									X										X						

This model:

- is a complementary decription of processes, activities and organization, but not resources,
- is dedicated to main functionalities such as use cases (no possible description of complementary functionalities like PKI)

A detailed Business Model description needs several frames

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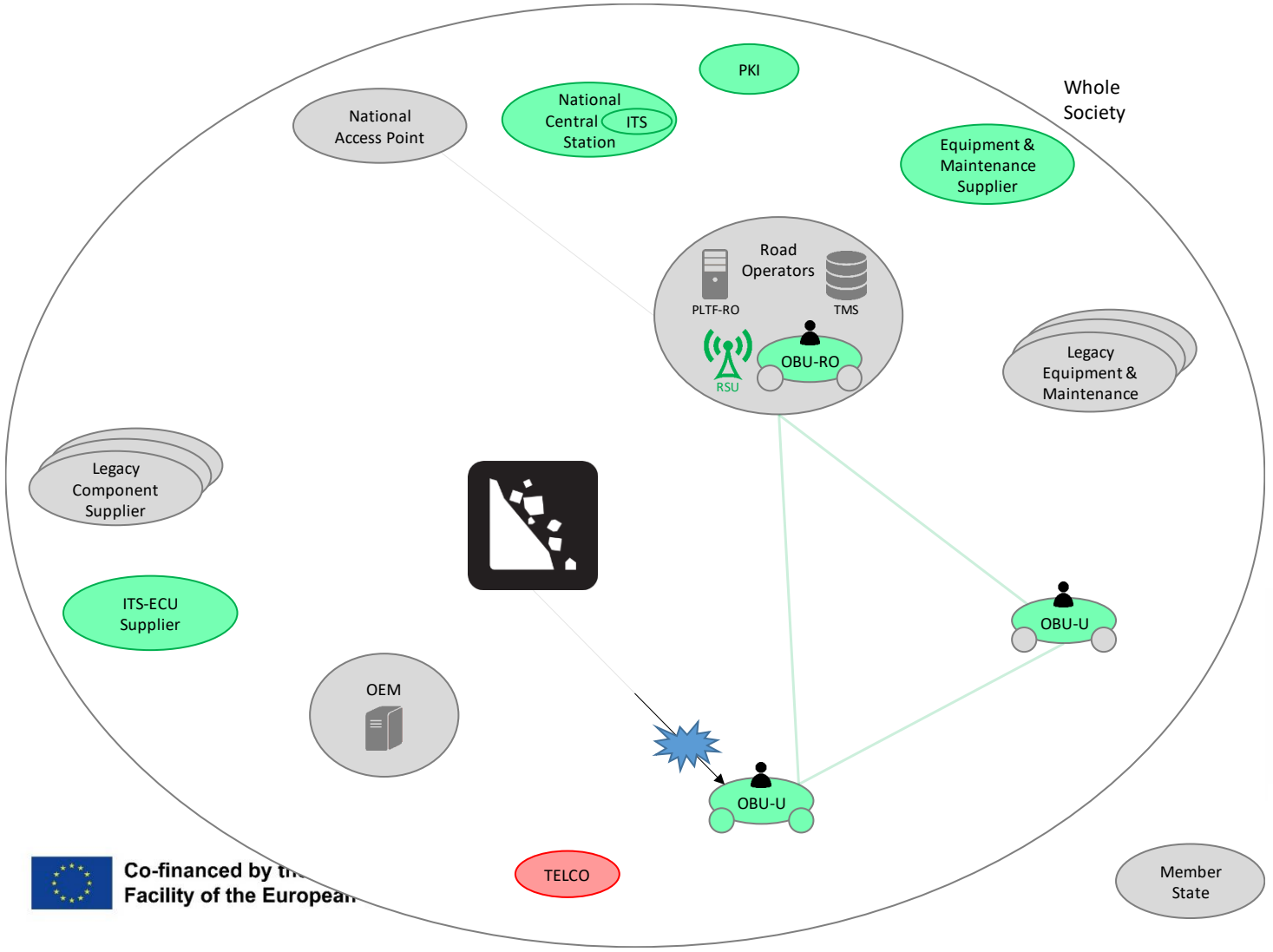
Resources description

Value Network Animation (storytelling): a possible way to track processes, activities and finally resources



Detection/reception

Processing

Emission

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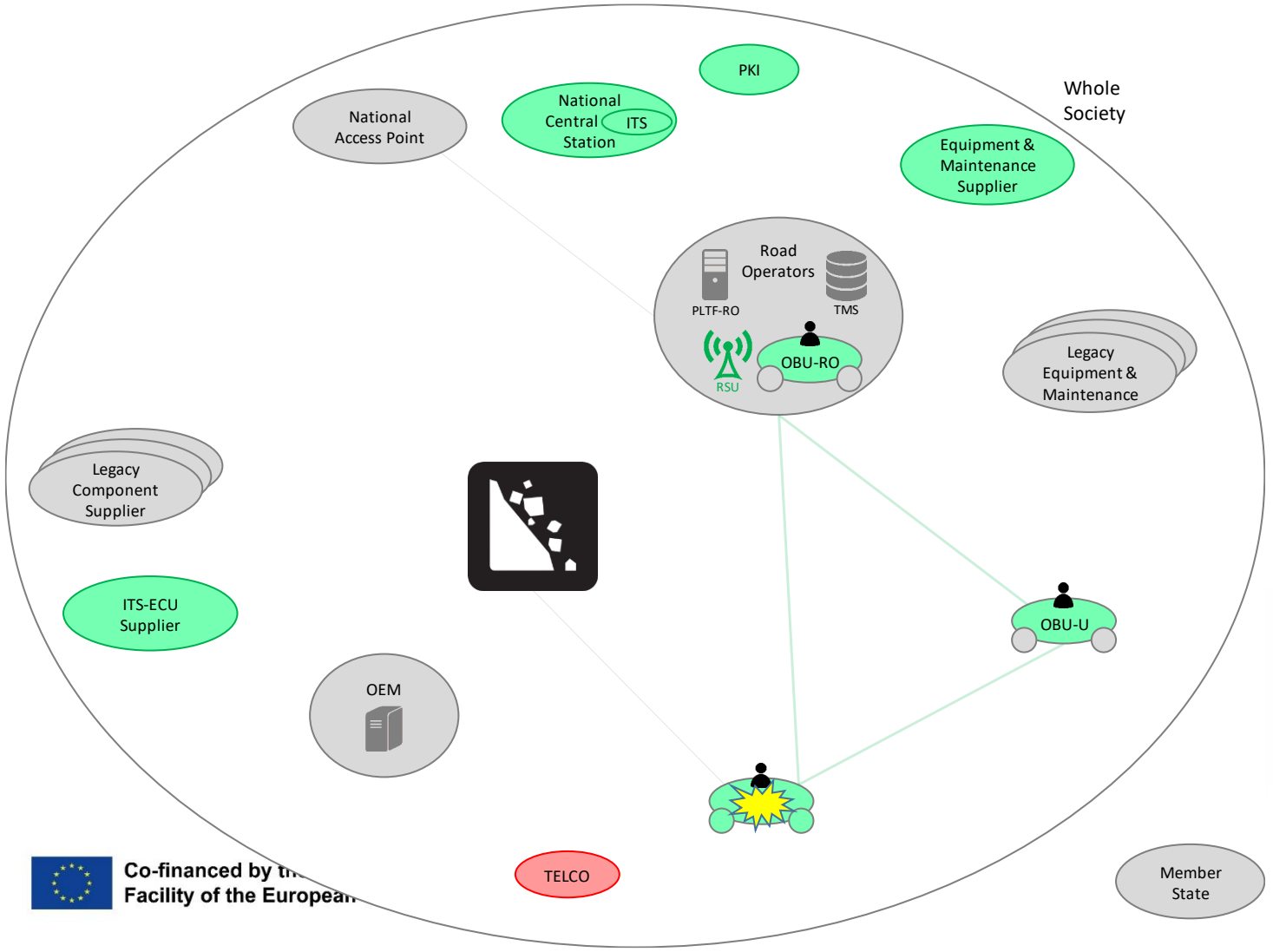

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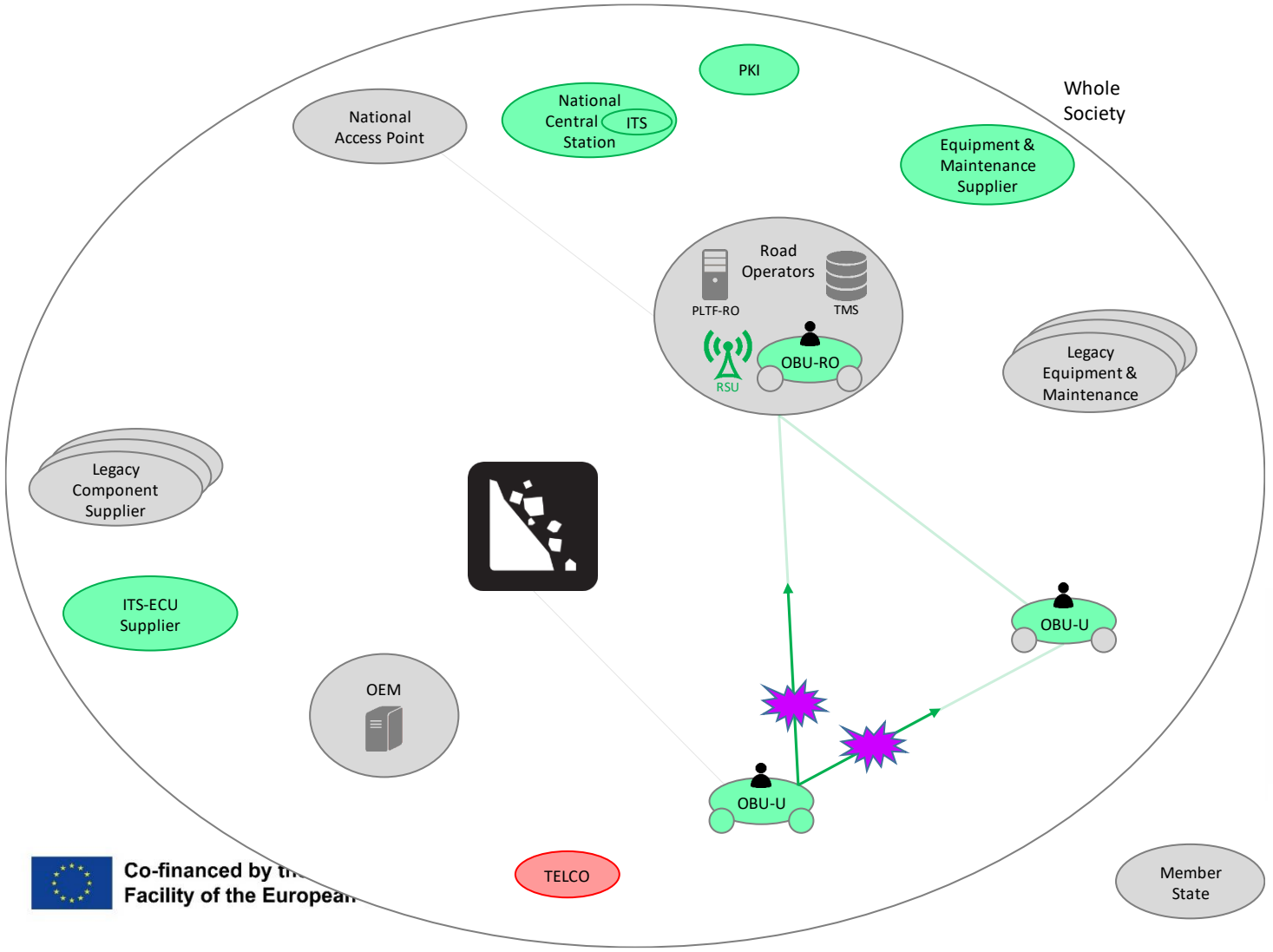

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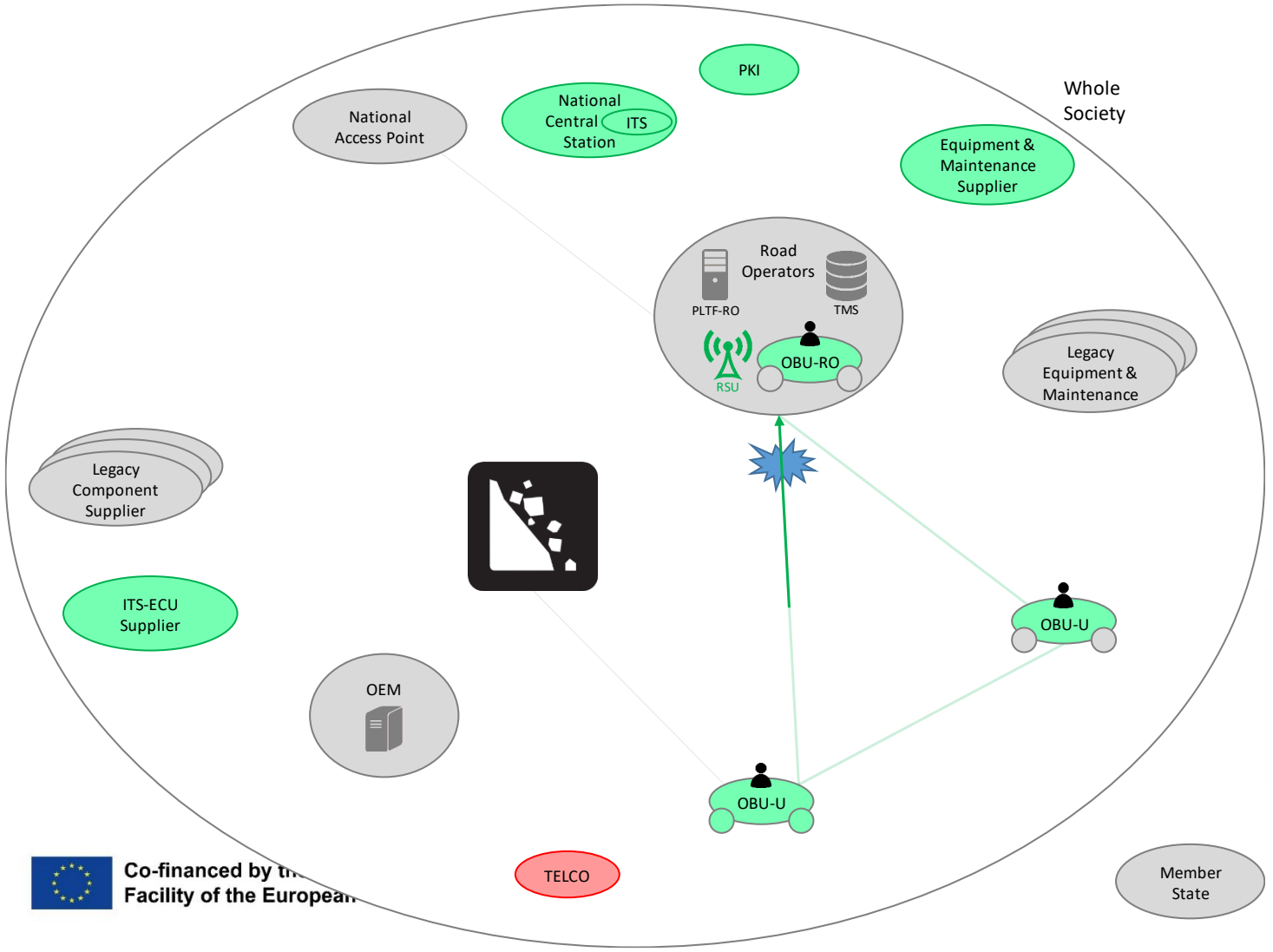

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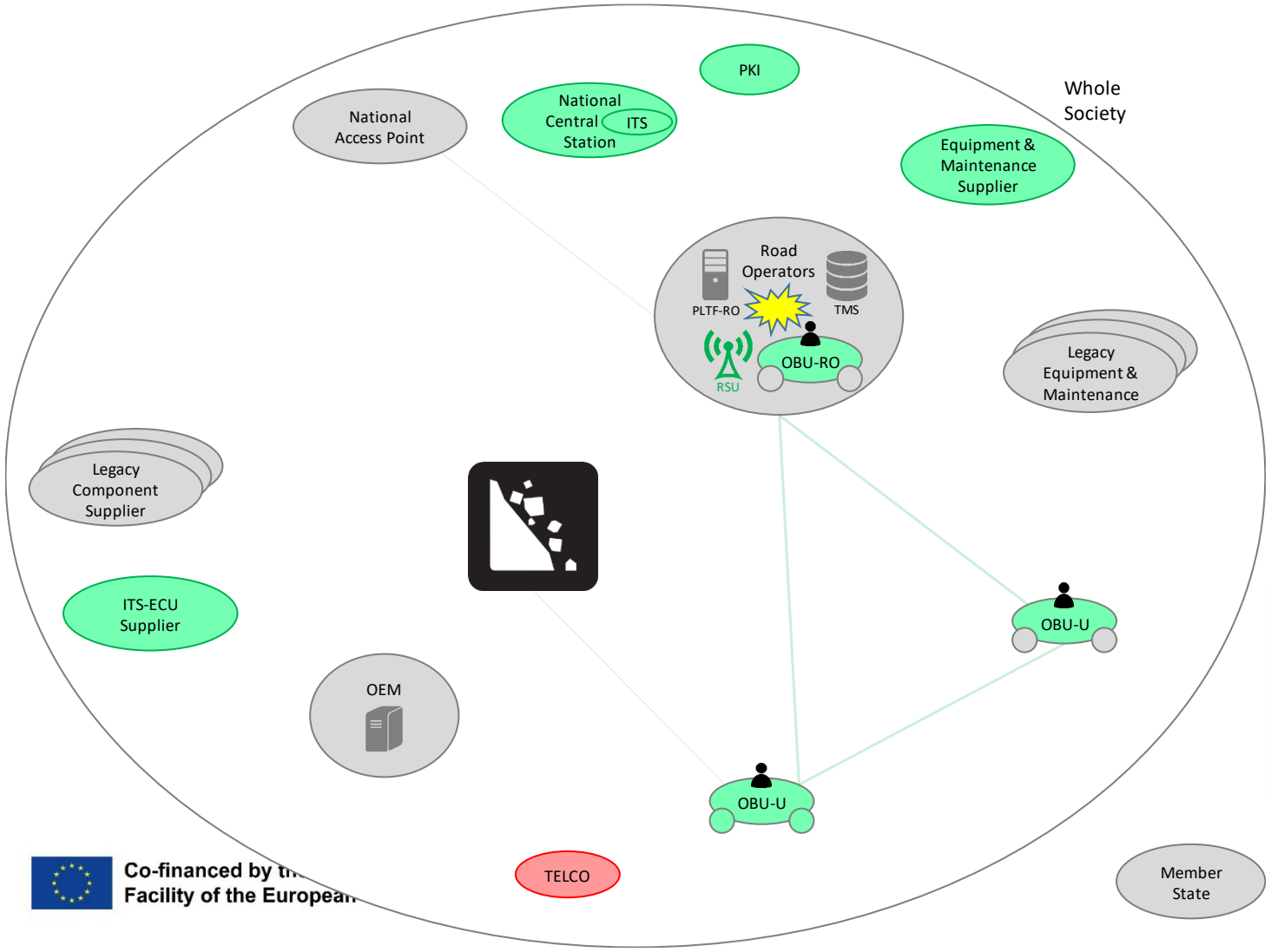

Detection/reception

Processing

Emission

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connected vehicles and roads

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Resources description

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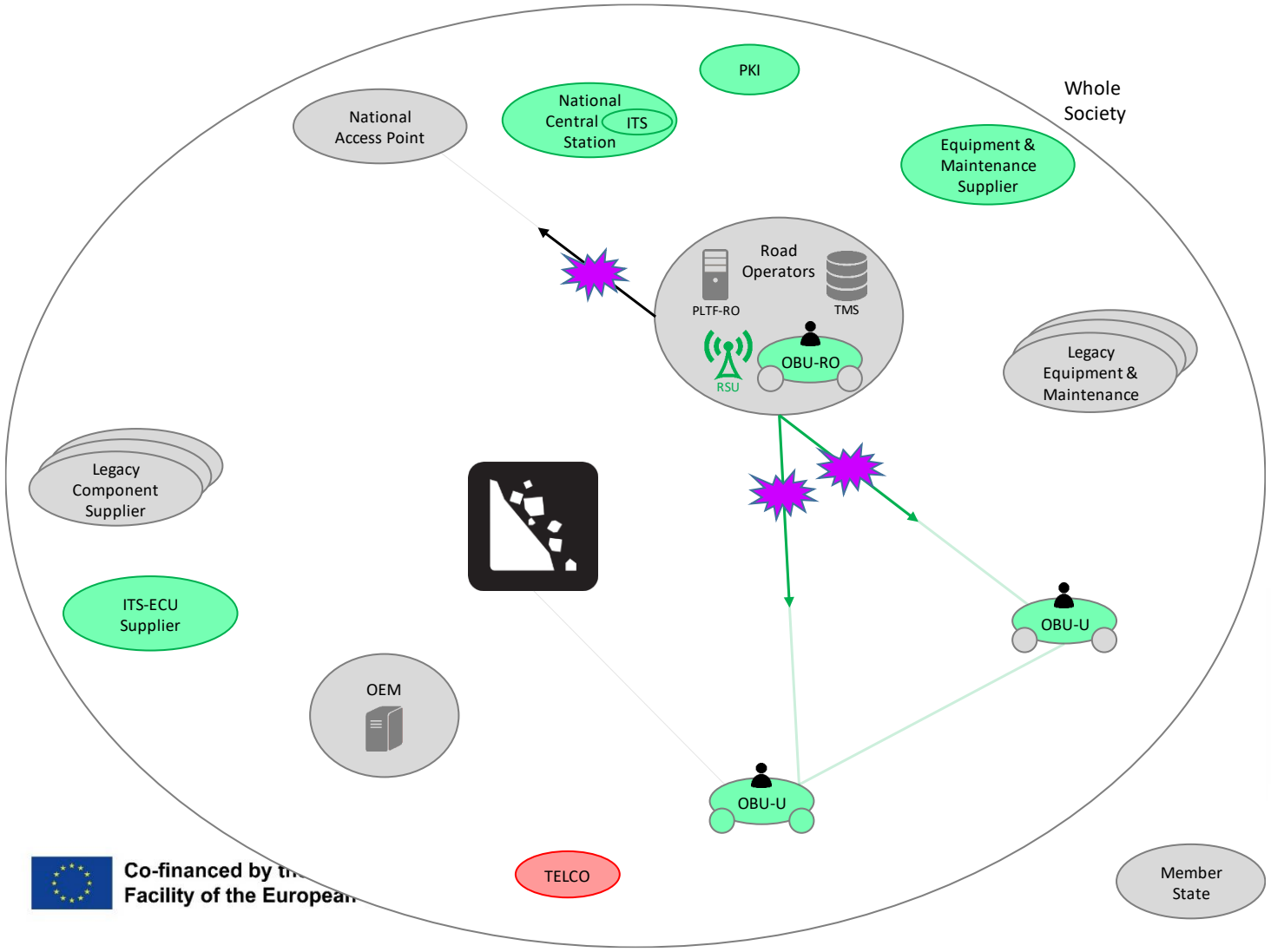

Detection/reception

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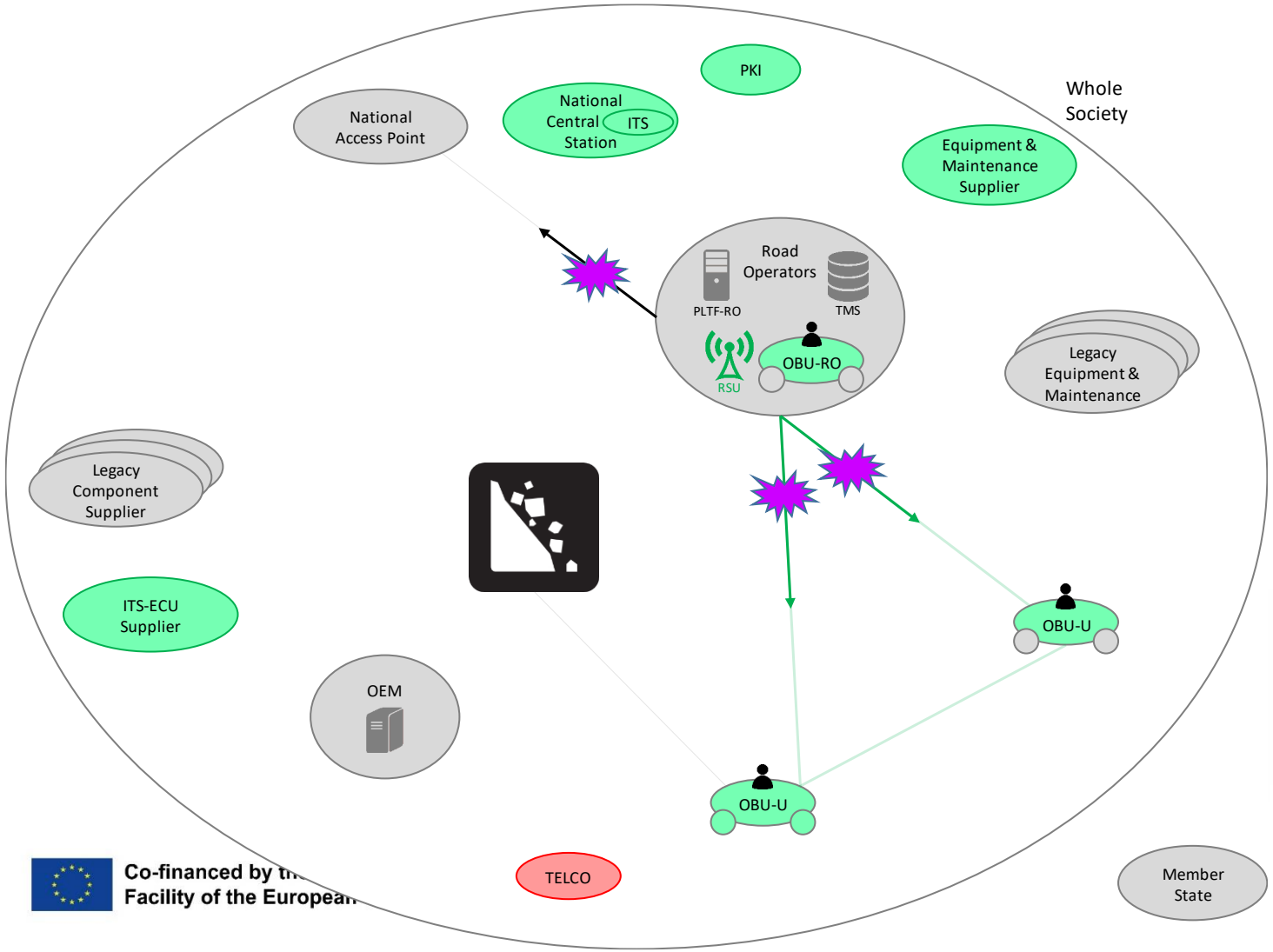

Detection/reception

Processing

Emission

At each step, ask « How? » until identifying activities and resources supporting those activities.

And also:

- Are any existing resources supposed to disappear due to C-ITS deployment?
- Are any existing resources supposed to be reused for C-ITS (no investment)?

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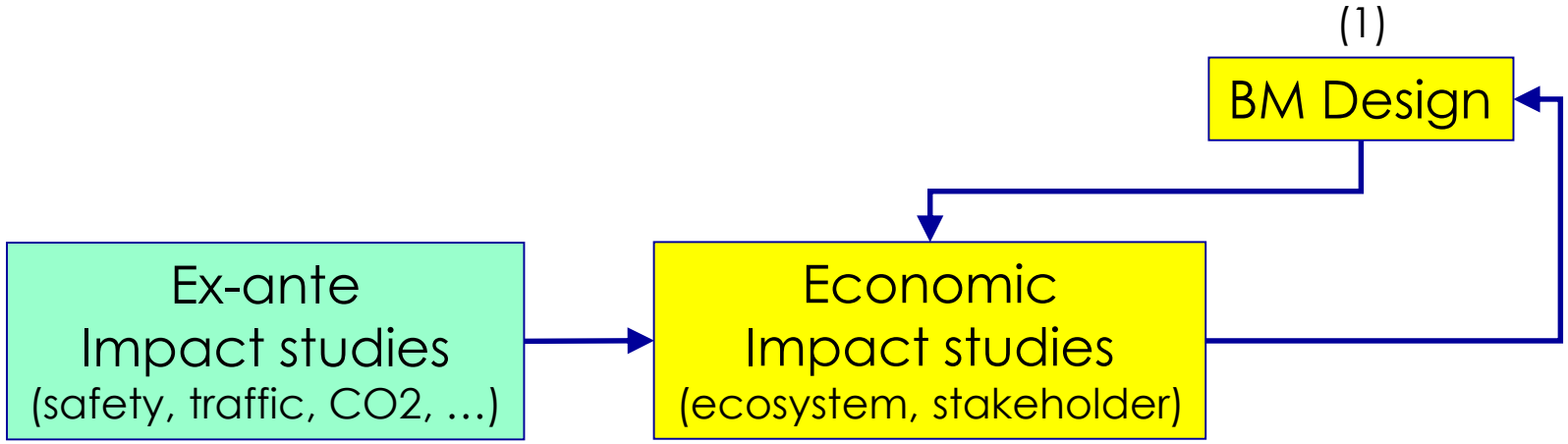
Next steps

Step 1



(1) complementary frames/tools could be used such as Base-X model (Grefen, Eindhoven)

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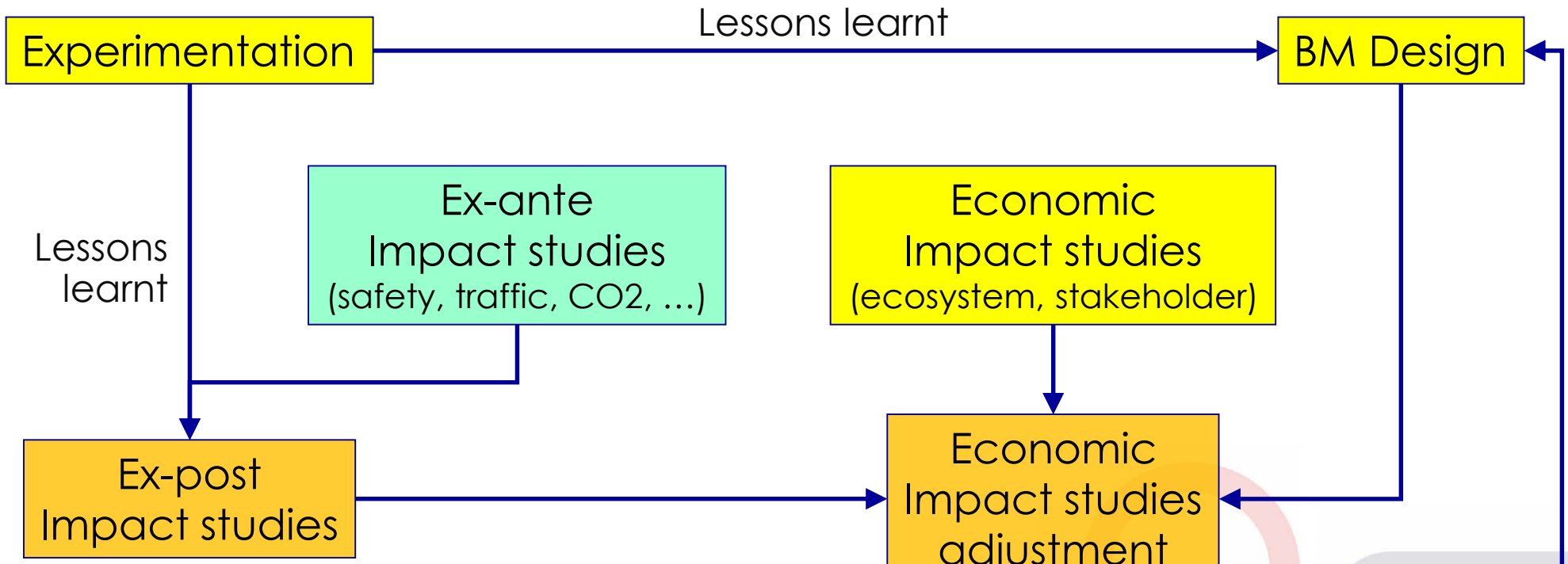
Next steps

Step 2



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Done	Ongoing	To be done

Next steps

Some issues should be adressed when refining C-ITS Business Model and embracing economic impact studies:

- Are C-ITS profitable at the scale of the whole ecosystem? If not, how can one make it possible?
  - Are end-users ready to pay for some C-ITS services (safety considered as due)?
  - Can one increase the offer value with complementary services based on data? With which pricing model (all-in-one paying package, freemium model)?
  - Can one consider extending the ecosystem to other stakeholders (ex: insurers)?
- Are C-ITS profitable at the scale of each stakeholder? If not:
  - Will the place of each stakeholder in the ecosystem need to be reconsidered?
  - Are financial compensations possible between stakeholders?
- Which revenue model internal to the whole ecosystem?
  - Fixed yearly fees *versus* Pay-per-Use for Authorization Tickets (PKI) and cellular network use.

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Next steps

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Some issues should be adressed when refining C-ITS Business Model and embracing economic impact studies:

- Which scenario of deployment for the service to be efficient the earliest possible, considering:
  - A minimum penetration rate to get that efficiency,
  - Priority territories regarding impact studies,
  - Technologies, i.e. G5 and Cellular,
  - Car makers roadmaps and the possibility to propose aftersale solutions,
  - The delay of return on investment?

- How to deal with public and private interests?
  - Free of charge *versus* profitability,
  - Time line considerations for return on investment.

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C-ITS Business Model

Thank you for your attention

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Questions / answers

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EX POST EVALUATION

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Road Safety

Cyril CHAUVEL

Laurette GUYONVARCH

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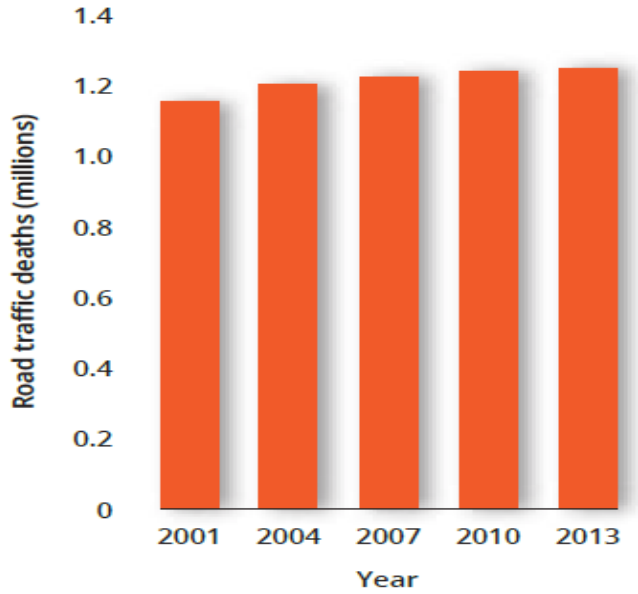
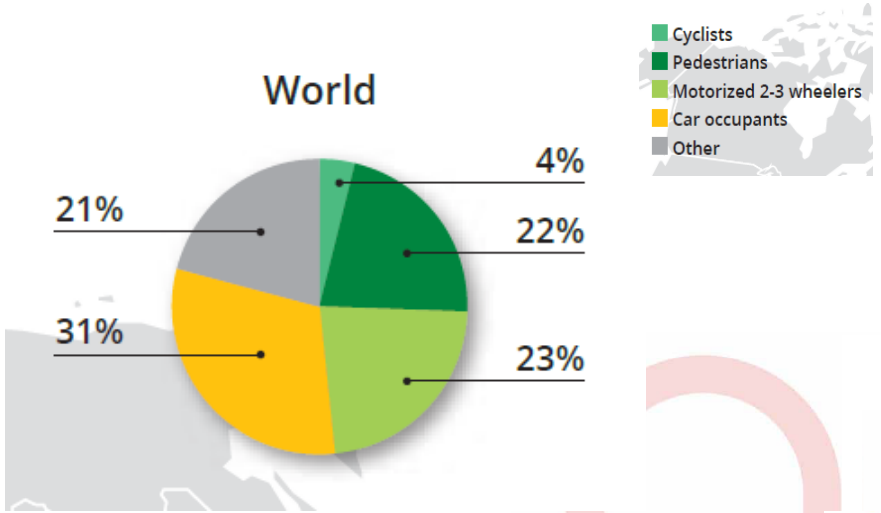
World Road Safety

1,24 millions of fatalities

20-50 millions of injured people per year

➔ twice in 2030 (9th to 5th leading cause of death)





Period 2011-2020: "Decade of Action for Road Safety"

Together we can save millions of lives.
DECADE OF ACTION FOR ROAD SAFETY 2011-2020
www.decadeofaction.org

United Nations

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Europe Road Safety

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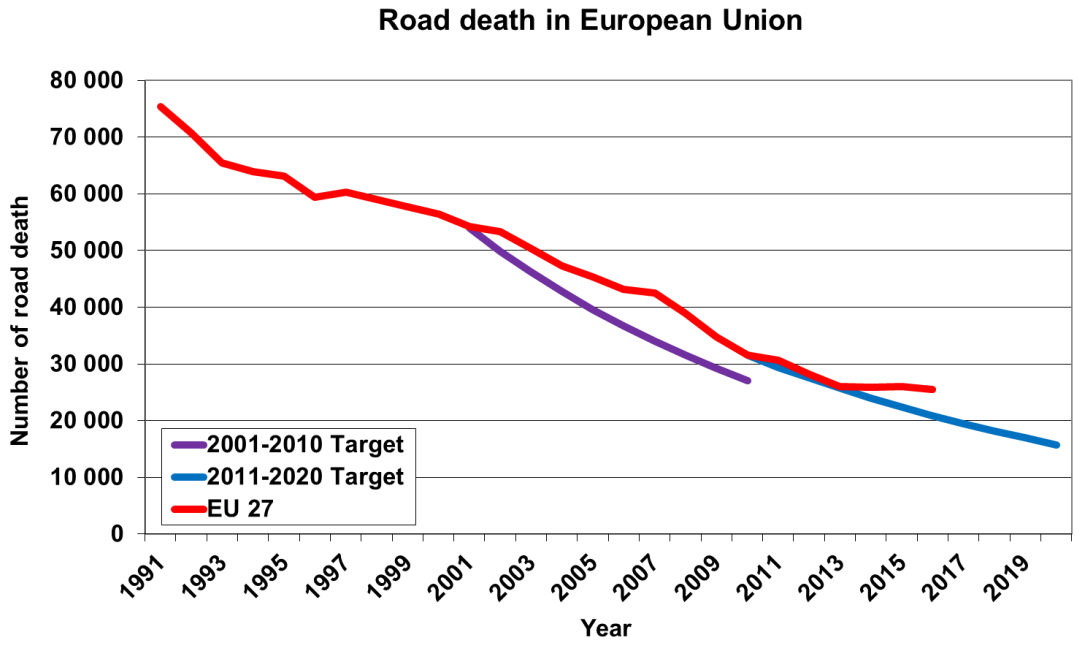

EU targets: halve the number of fatalities

- between 2001 and 2010: 43% performed
- between 2011 and 2020: 48% targeted

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France Road Safety

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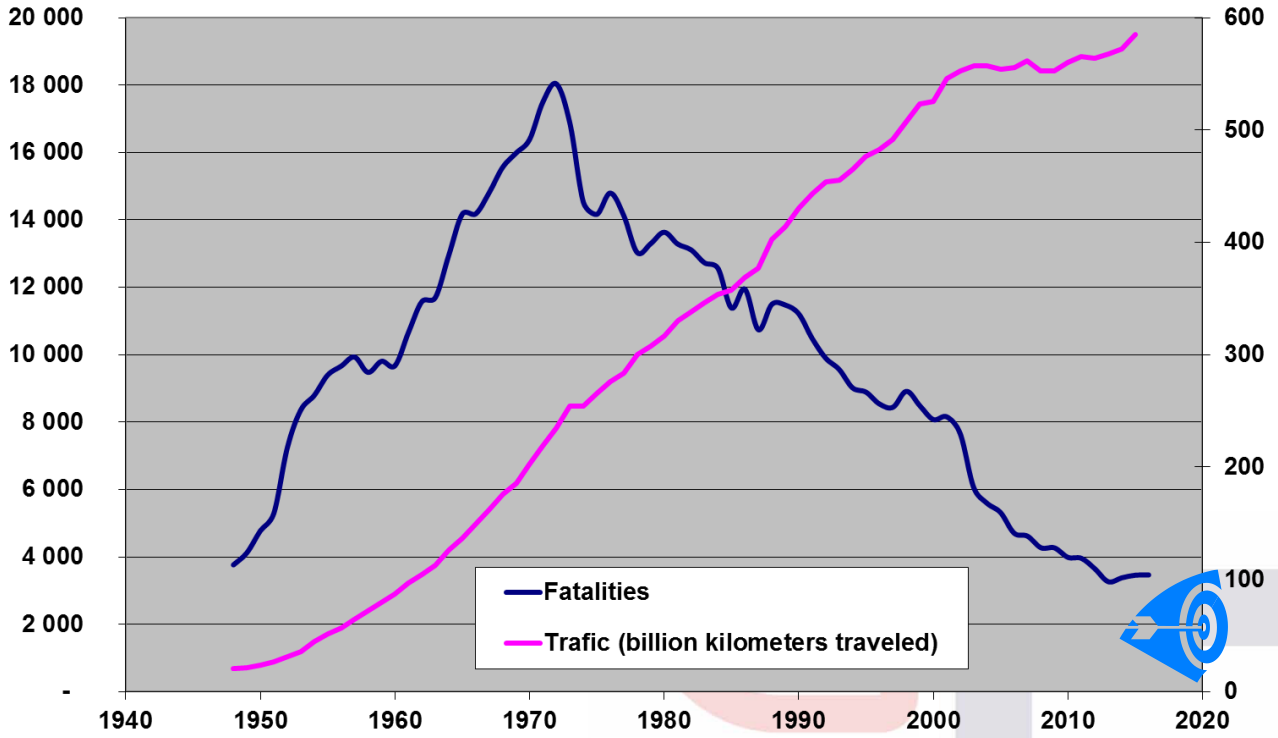
- Mortality change in France since 1972
  - Mortality divided by 5.2
  - Traffic multiplied by 2.5
- 2020 target:< 2000 fatalities



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Estimation of SCOOP real benefits

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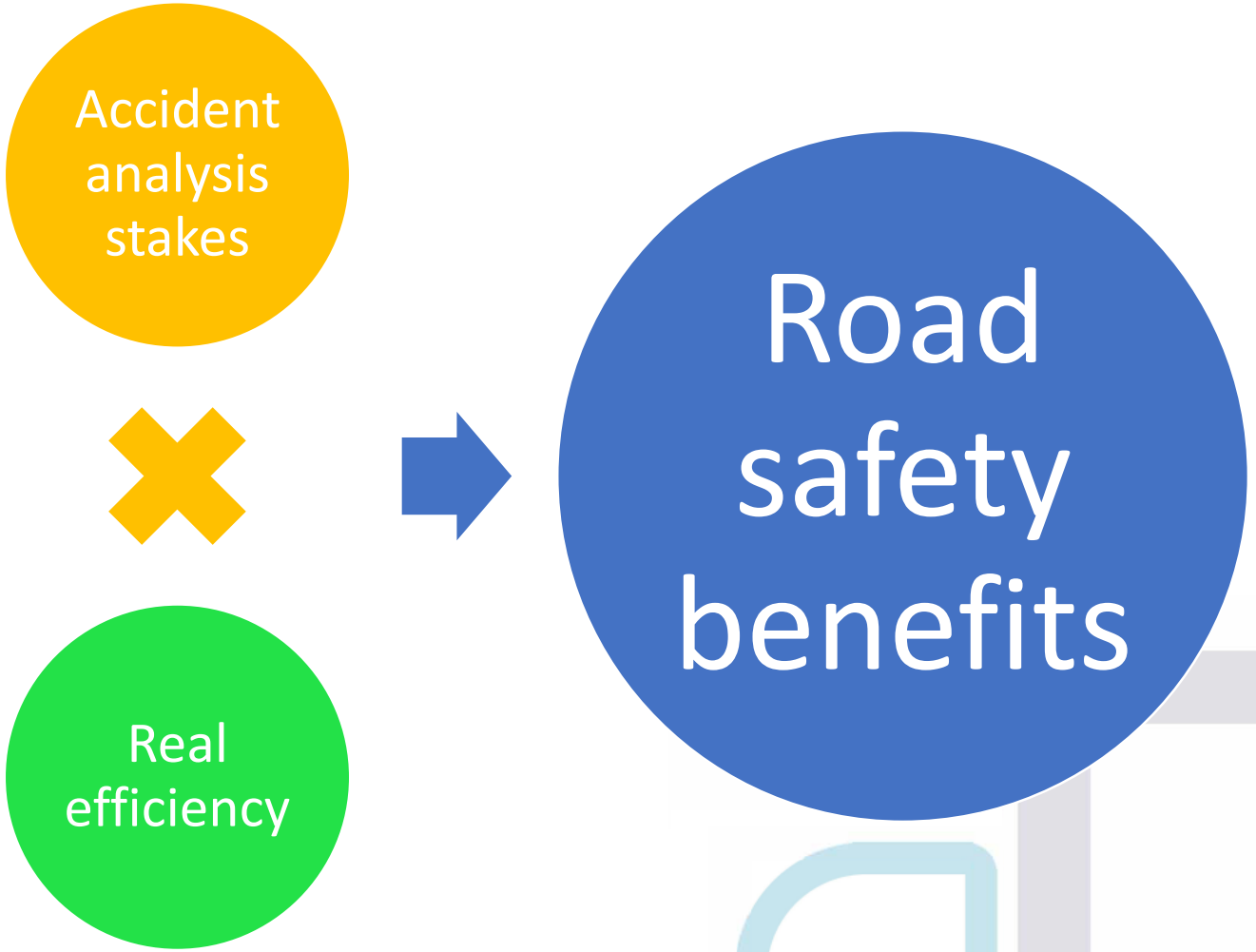
connected vehicles and roads



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Accident analysis stakes

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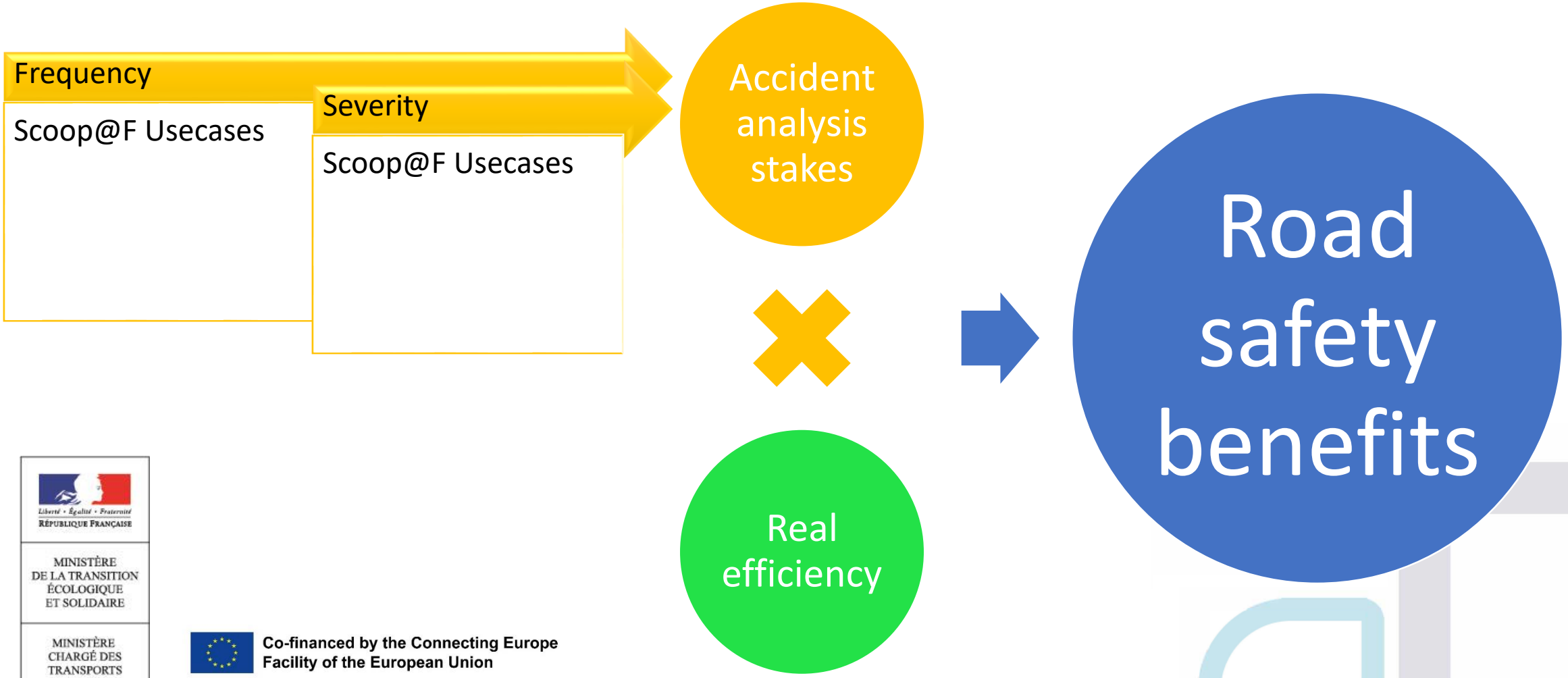
connected vehicles and roads



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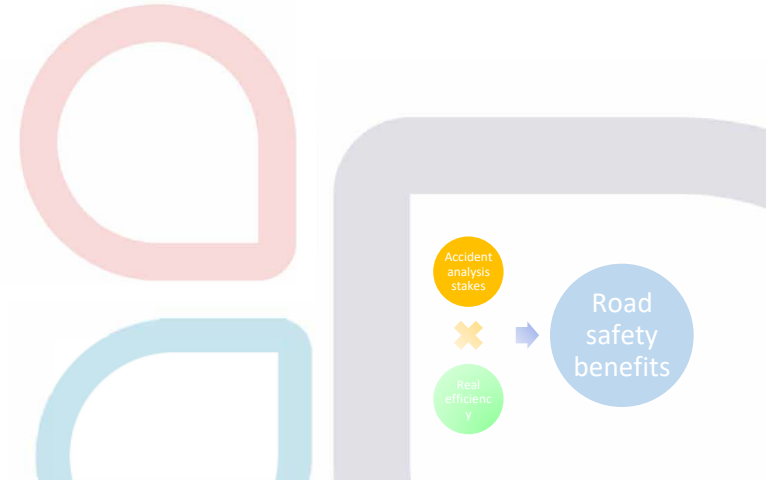
VOISESUR data base

- 2011 French accident based on police reports
  - All fatal accidents (3 600)
  - Sample of injured accidents (4 000)

- Detailed variables for each accident
  - Driver functional failure
  - Explanatory elements
  - Conflicts
  - Maneuver
  - Network/ location
  - Injury severities



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Accident analysis data

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Accident types

FATAL
at least one fatality

INJURED
at least one injured victim

Severity for victims

Dead

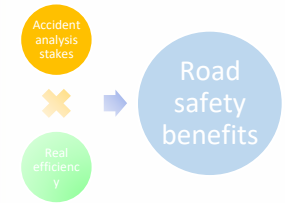
Injured

not injured

Indicators

Frequency

Severity



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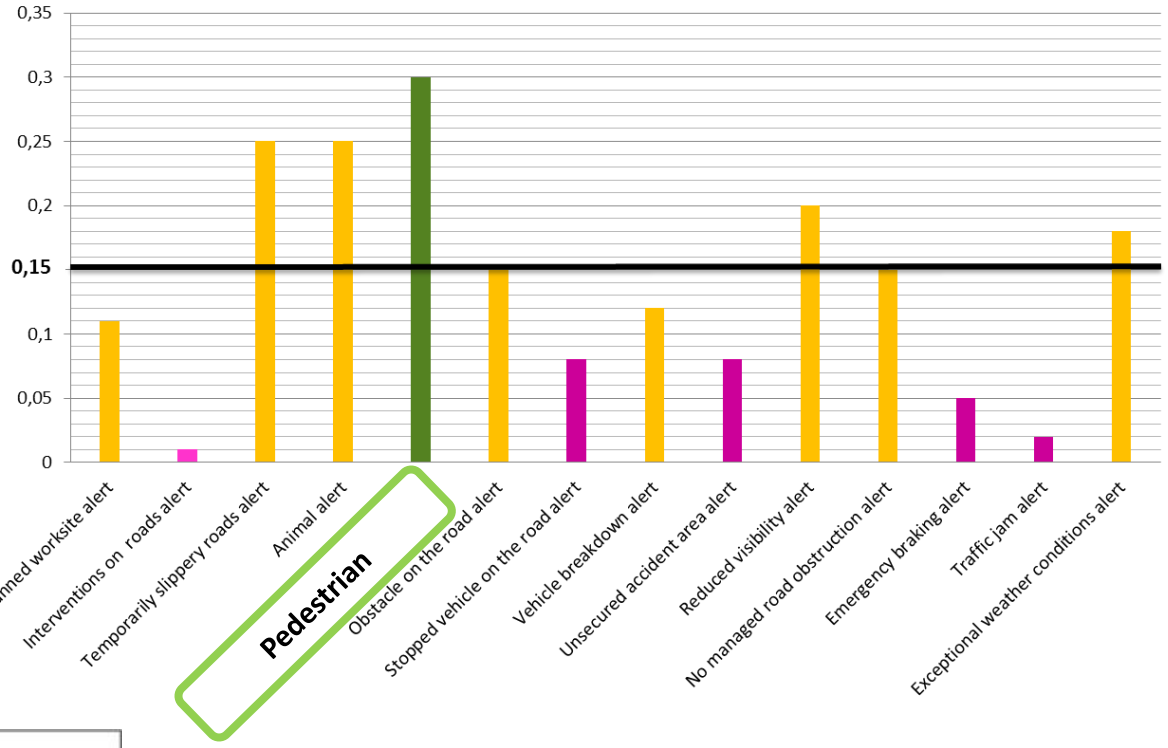
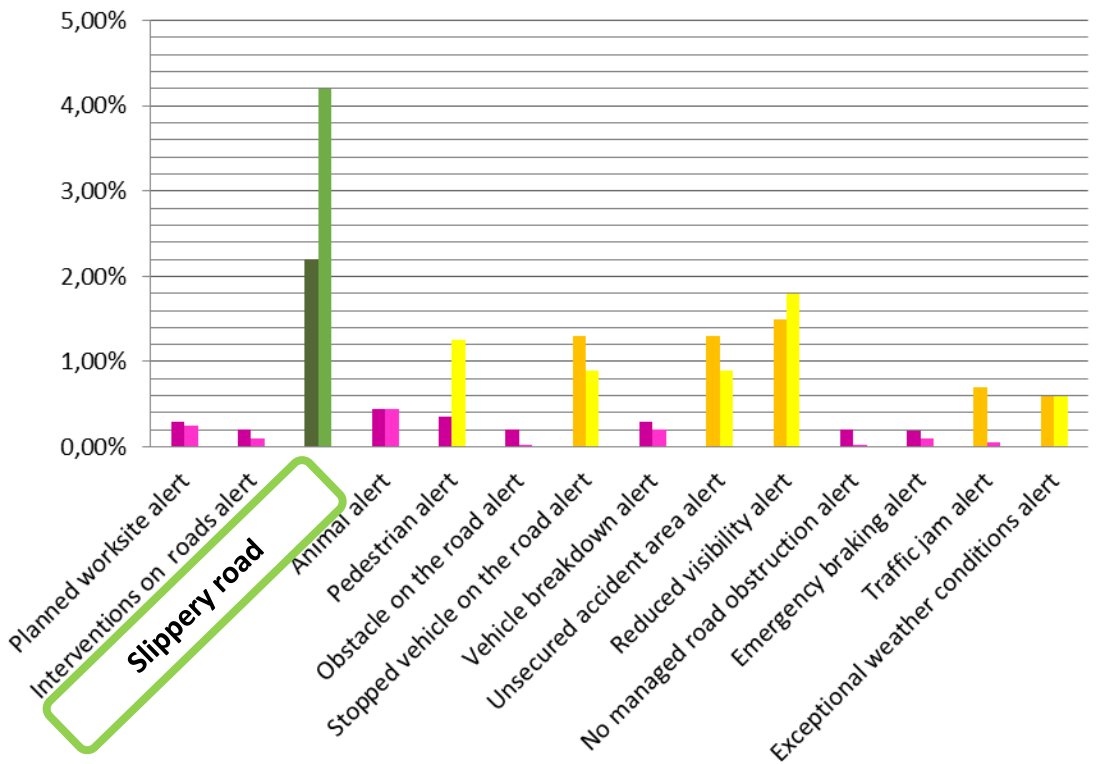
Results for personal cars



Accident severity



Accident frequency

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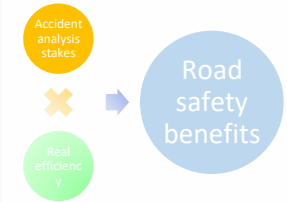

Estimation of SCOOP real efficiency

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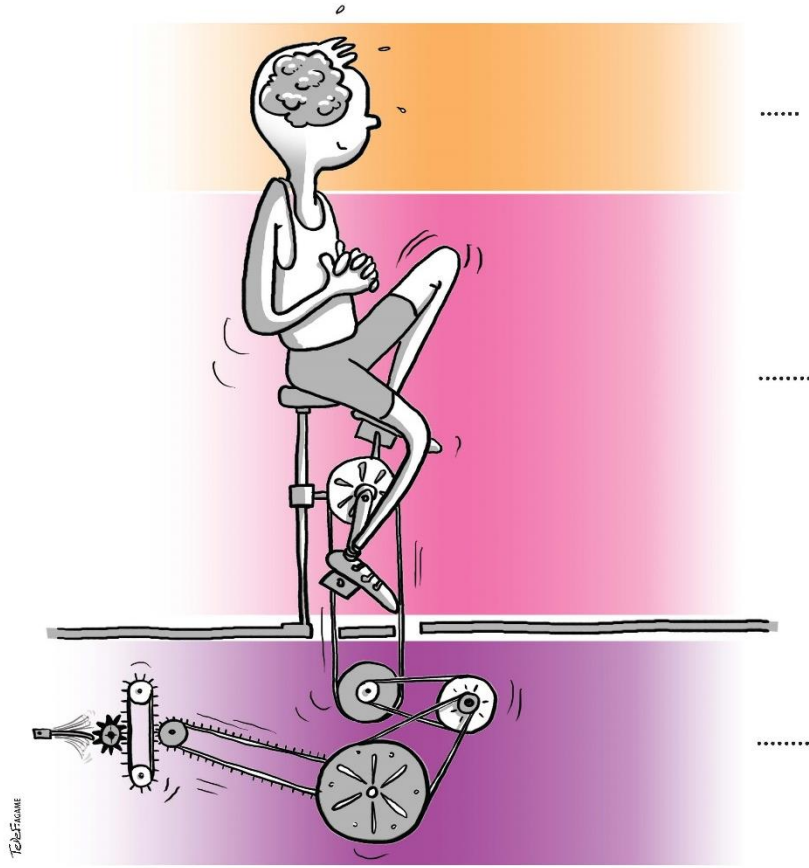
connected vehicles and roads



..... Driver experience (subjective)

..... Impact on driving (objective)

..... System operation

Accident analysis stakes

×

Real efficiency

→

Road safety benefits

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Driver behavior

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Driving Data recording

Data analysis

Interviews

Focus groups

Questionnaires

Acceptability

Driver behavior study

Accident analysis stakes

Real efficiency

Road safety benefits

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Data Acquistion System

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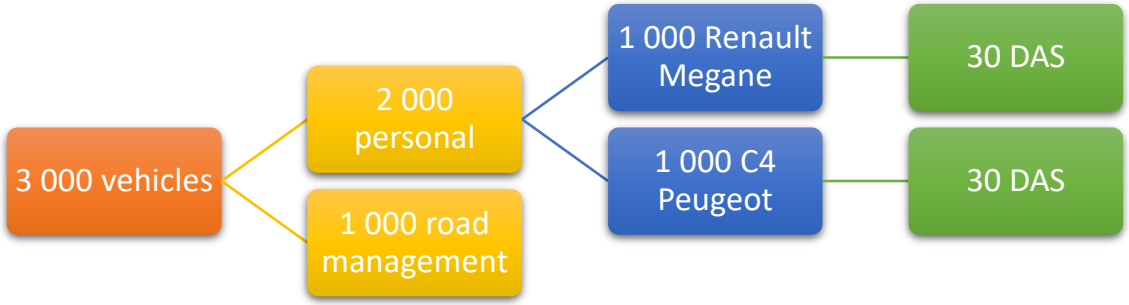

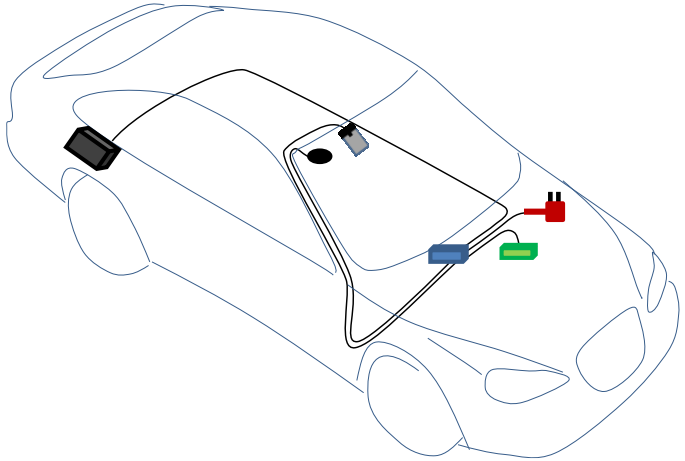

GPS
Mobileye
datalogger
CAN connector
SCOOP@F unit
Power supply

- Recorded data (sync)
  - Position
  - Vehicle data : speed, brake, steering wheel…
  - Contextual variable: Time headway, road signs, type of obstacles…
  - Displayed / transmitted messages
- DAS Fleet equipment status
  - Renault/ PSA cars
  - Paris, Brittany area

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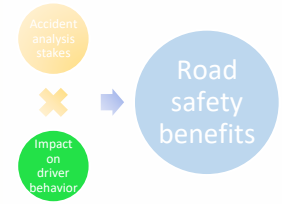
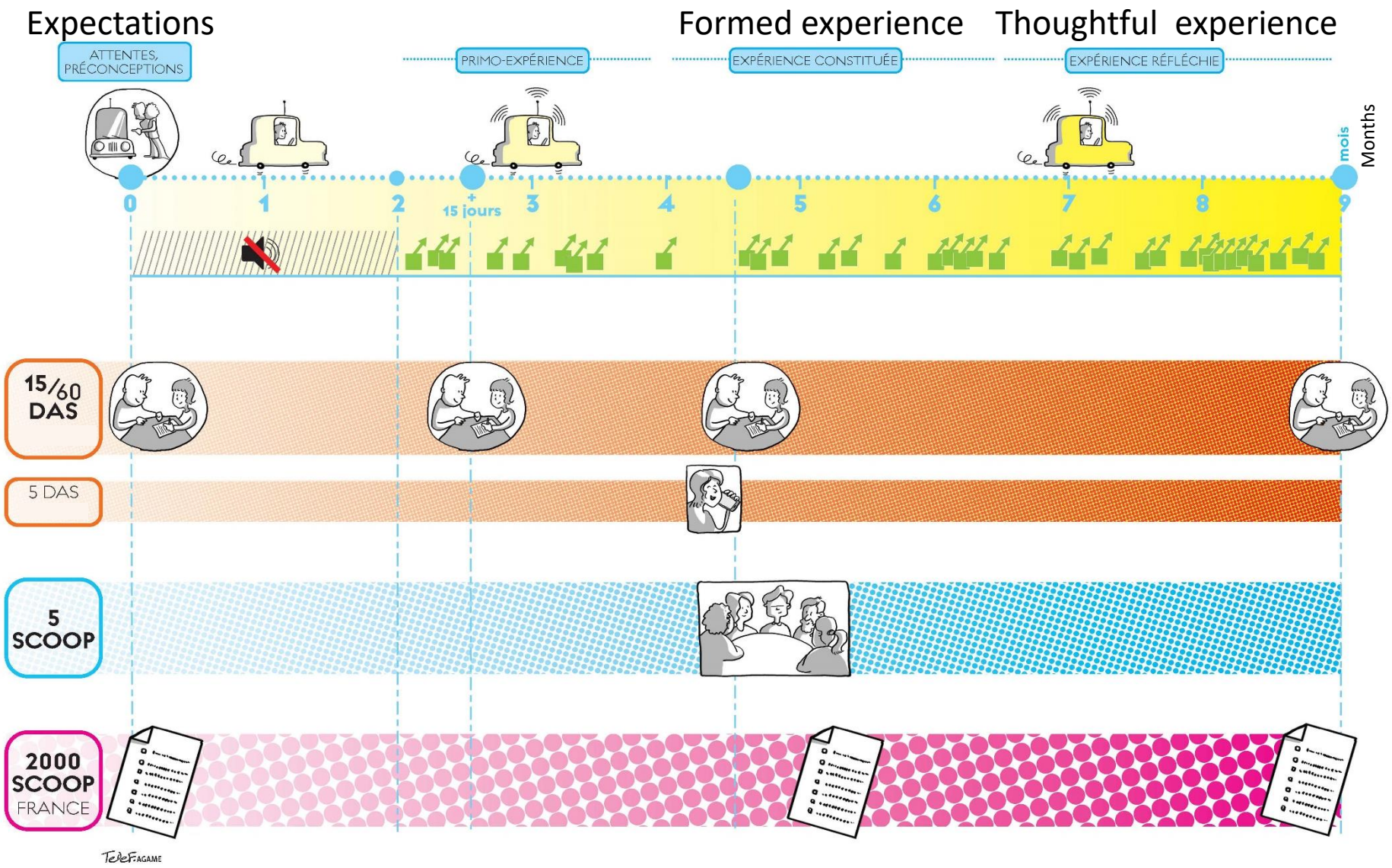


Acceptability



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connected vehicles and roads

Accident analysis stakes
Impact on driver behavior
Road safety benefits

SCOOP real efficiency

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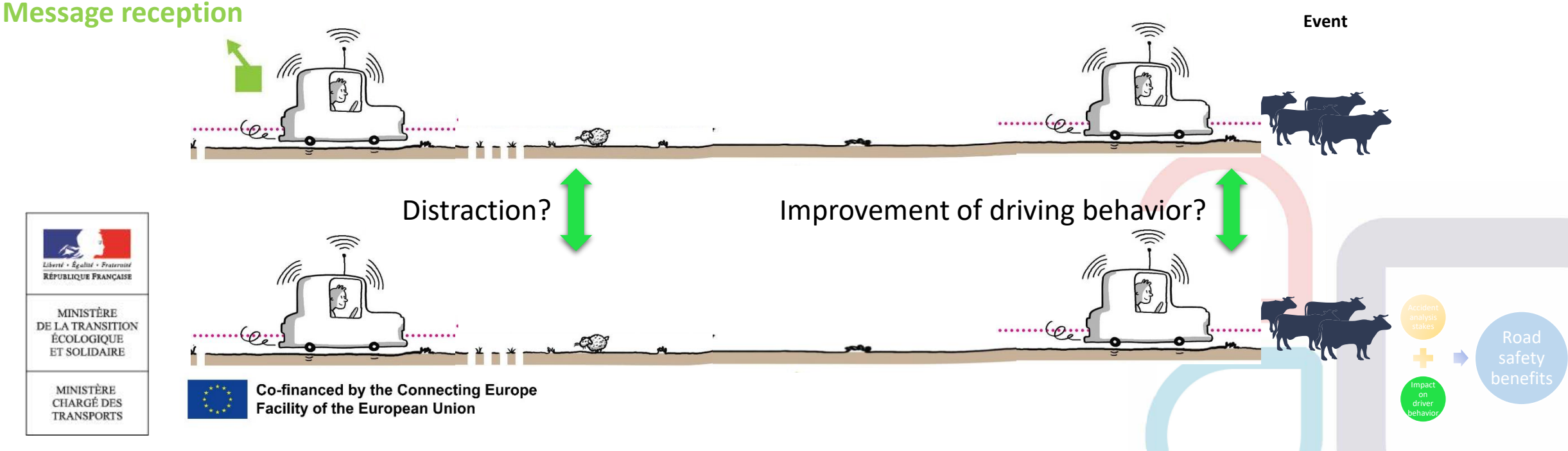
- Distraction
- Decrease in accident frequency
- Decrease in accident severity



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SCOOP and road safety

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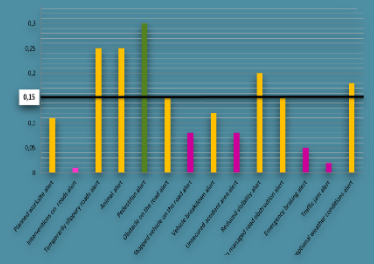
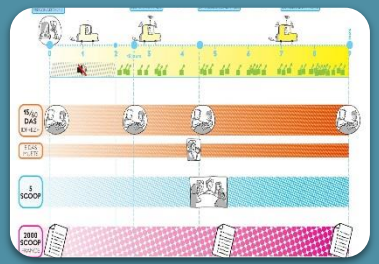


Accident analysis stakes

- Frequency
- Severity



Developpement of evaluation methodologies

- Driver behaviour: Impact on driving and acceptability
- Real efficiency
- Real benefit

Drivers recruitement

- First vehicles driving in paris area
- On going recruitement in Paris and Brittany area

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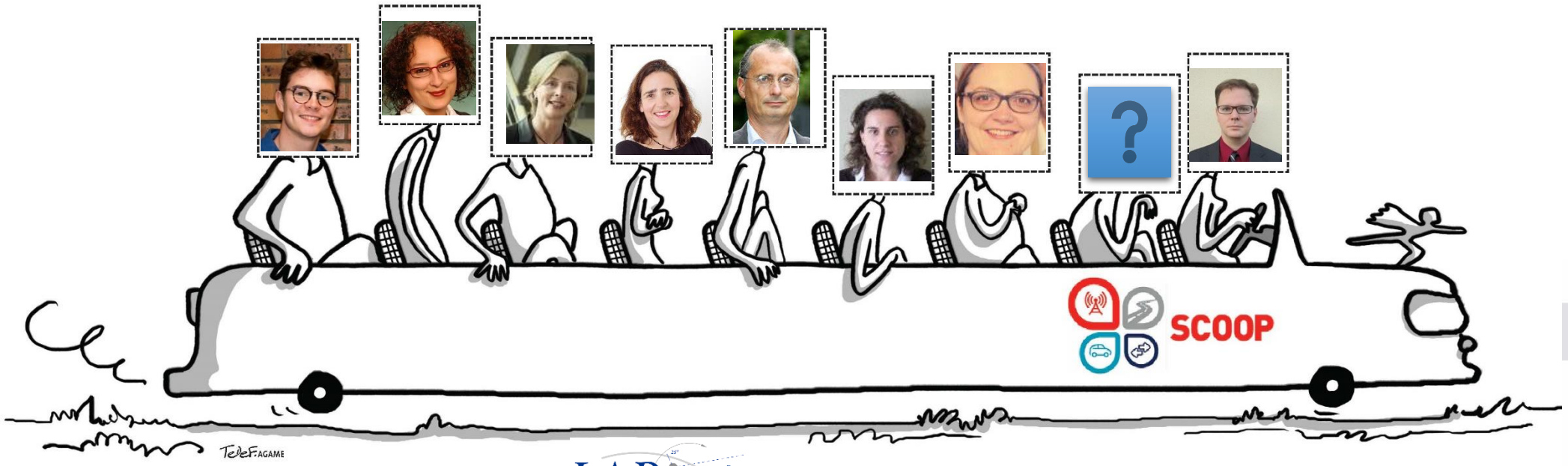

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Traffic and environment evaluation

Traffic and pollutants emissions impact evaluation of SCOOP system

IFSTTAR LICIT

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Issues, goals, constraints

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possible thanks to large amount of data collected from SCOOP vehicles as main input of the model

issues fields	evaluated goals (thanks to SCOOP system)	evaluation constraints	simulation use
traffic	trafic regulation by SCOOP vehicles drivers anticipated actions (break, lane change...)	overall traffic conditions knowledge needed : location, speed and acceleration of every vehicle (SCOOP and no SCOOP)	to evaluate consequences over non-SCOOP vehicles

correlated impacts

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Issues, goals, constraints

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environment	pollutants emmissions reduction	indicator to build from speed and acceleration data (logs)	to build indicators over all traffic

correlated impacts

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Issues, goals, constraints

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safety	risk situation frequency reduction	overall traffic conditions knowledge needed : location, speed and acceleration of every vehicle (SCOOP and no SCOOP)	to build indicators over all traffic

correlated impacts

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Issues, goals, constraints

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environment	pollutants emmissions reduction	indicator to build from speed and acceleration data (logs)	to build indicators over all traffic
safety	risk situation frequency reduction	overall traffic conditions knowledge needed : location, speed and acceleration of every vehicle (SCOOP and no SCOOP)	to build indicators over all traffic
socio-economic	composite : fuel consumption, pollutants emissions reduction and safety increase	make projections at different penetration rates (futur)	to simulate differente penetration rates from main deploiment

correlated impacts

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Evaluation target

- Clients users(UEVU)
  - Vs roadworks users (UEVG)

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  - Inducing specific drivers strategies

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- Clients users(UEVU)
  - Vs roadworks users (UEVG)

- When SCOOP event occurs
  - Inducing specific drivers strategies

- Selected use case: **mobile roadworks**
  - Reliable (declared by network manager)
  - Predictable
  - Reproducible

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Performance indicators

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Evaluation	Traffic efficiency	Pollutants emissions	Safety
Hypotheses	Improvement	Decrease	Improvement
Pre identified factors	Dynamic traffic regulation induced by Scoop vehicles : Stop & go, speed waves, hard brakes reduction…		
Proposed indicators	Mean speed, mean outflow, total time spent, detectors in congestion, vehicles in congestion…	Fuel consumption And emissions by pollutants	Time To Collision (TTC), Time exposed to TTC, Post-encroachment time, Maximum speed…
Required Data	Speed (1hz or agregated <= 6min), outflow (agregated <= 6min), individual travel times and trajectories (1hz)		

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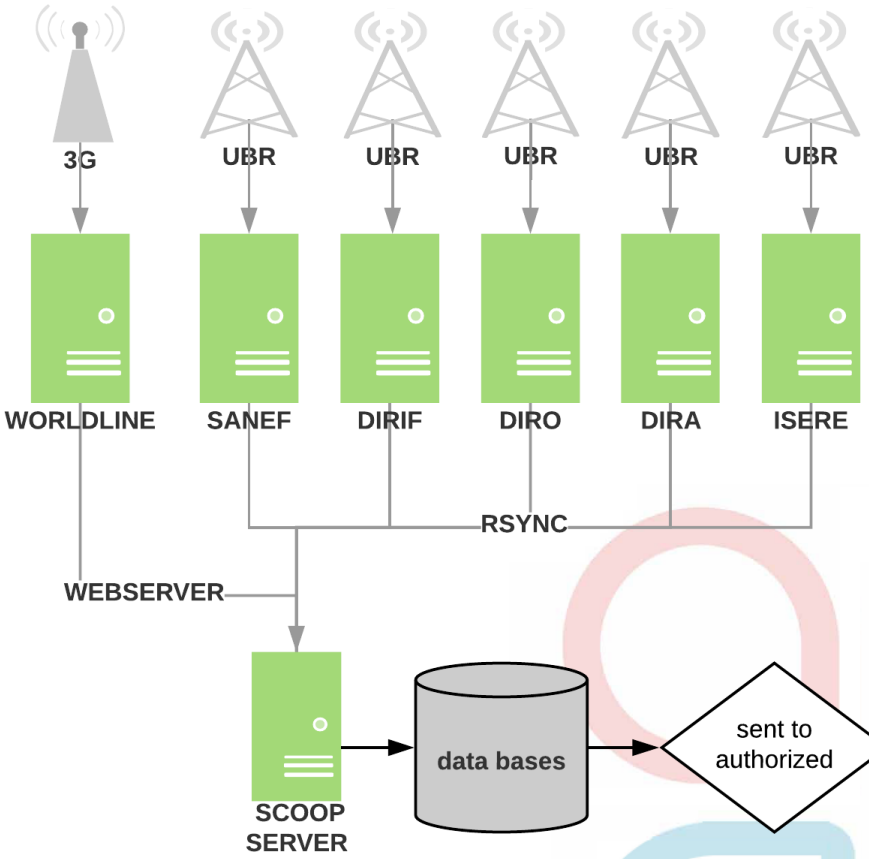
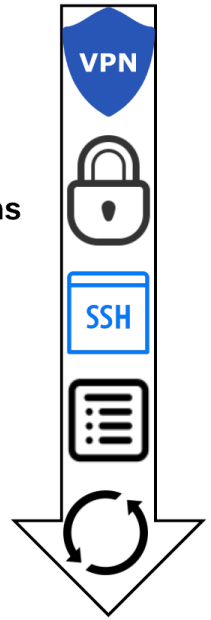
Data collection

- Target: 3 000 vehicles



technical specifications



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scenarised experiment

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- Parameters calibration process
  - Confirm observed phenomena in controled environment
  - Acquire continuous speed / location

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scenarised experiment

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- Parameters calibration process
  - Confirm observed phenomena in controled environment
  - Acquire continuous speed / location

- Means (all partners)
  - Roadworks (real)
  - 10 OBU vehicles
  - 5 witness vehicles
  - 3 days (8h)
  - > 20 drivers

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Simulation

- SYMUVIA : LICIT in-house platform
  - Microscopic traffic simulation
  - Coupled to emissions, dispersion, noise rendering engines
  - To perform KPI's computing

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Simulation

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- A major investment for SCOOP : **SYMUCAT** (SymuVia plug-in)
  - Reproducing communications techs
  - And traffic strategies attached to C-ITS

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- A major investment for SCOOP : **SYMUCAT** (SymuVia plug-in)
  - Reproducing communications techs
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- To evaluate impacts at different penetration rates (upscaling)
  - Reference situation (experimentation)
  - Future development (10, 20, 30, 40%...)

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SIMULATION MOVIE TO BE DELIVERED

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Achievements

- Evaluation method
  - ✓ Logs data input
  - ✓ Complementary scenarised input
- Log files processing
  - ✓ Roadworks to IFSTTAR transfer
  - ✓ Storage
  - Broadcast (awaiting data)
- Software development
  - ✓ Communication systems
  - C-ITS strategies (awaiting data)
- KPI's and analyzes
  - ✓ Reference situation
  - Experiment situation (awaiting data)

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Socio-economic appraisal of C-ITS development

Thibaut LIMON - DGITM

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Objective : estimate **the service that C-ITS development provides to the society**

Three parts:

1) **A strategic analysis** which proposes a clear presentation of the existing and forecasted context, objectives, options and base case.

2) **An impacts analysis**, combining a qualitative and quantitative analysis of the impacts of the projects and a **cost-benefit analysis**

3) **A synthesis** that presents whether projects' objectives are reached and what are the different effects of the project.

⇒ In France, a technical note from the Ministry of Transport presents the method for project appraisal. It is completed by a toolbox providing more detailed technical guidance:

https://www.ecologique-solidaire.gouv.fr/evaluation-des-projets-transport

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Strategic analysis

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- **Objectives** :

Improve road safety

Improve mobility (improving traffic flow, information provided to users)

Improve the operating conditions of the road operators

- **... through the deployment of RSUs and connected vehicles with hybrid technology (ITS-G5 + cellular), enabling the provision of C-ITS services.**

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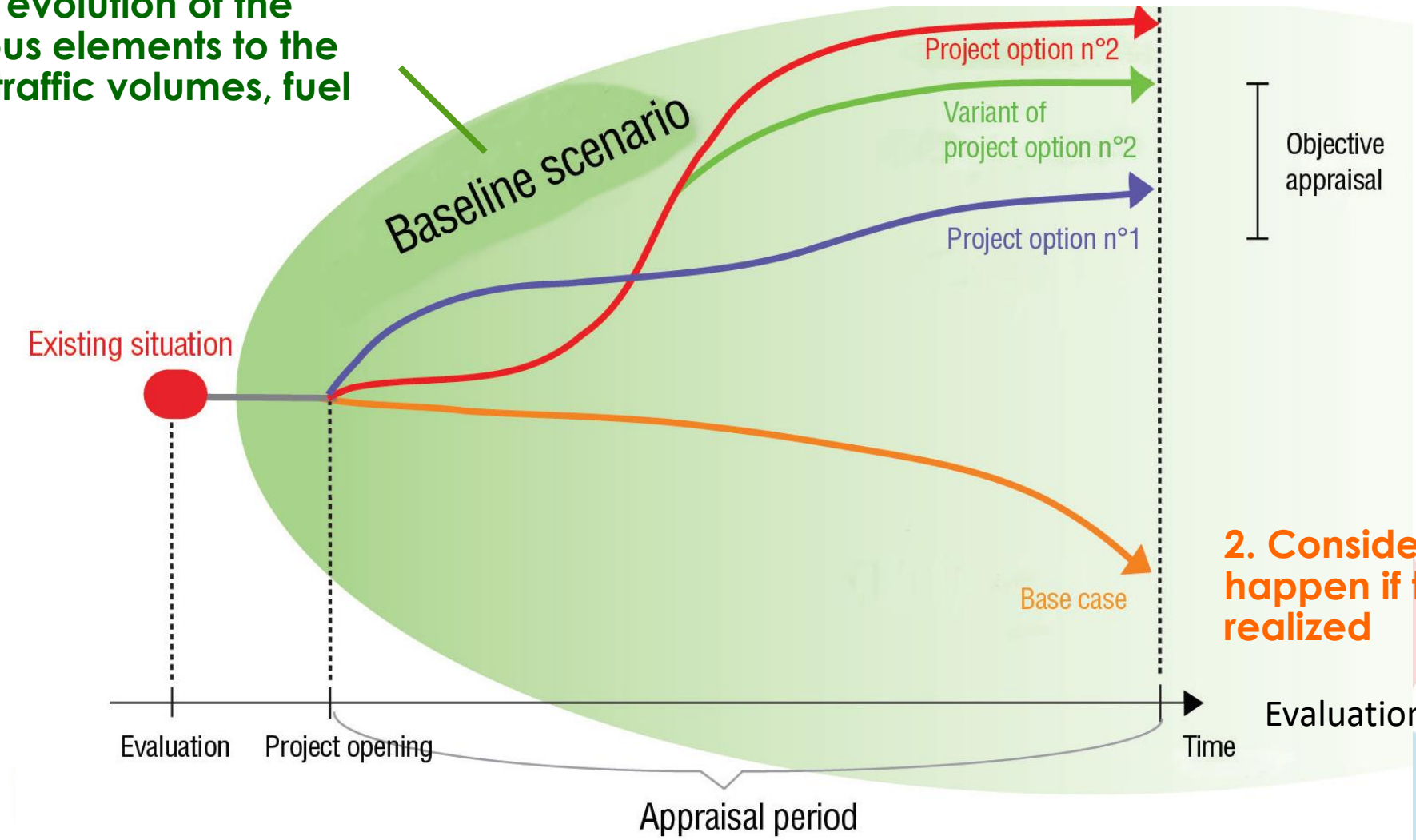
Strategic analysis

3. Determine different project options (functionalities, equipped road networks, penetration rates, costs ...)

1. Fix the evolution of the exogenous elements to the project (traffic volumes, fuel costs ...)



2. Consider what would happen if the project is not realized

Evaluation horizon: 2030

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Strategic analysis

The definition of the base case is not obvious:

- Generalization of "Waze" type systems allowing I2V use cases? What quality ?
- Development of competing technologies (C-V2X) allowing V2V and I2V use cases? What quality ? What horizon?
- ...

Different project options will be evaluated, where will vary:

- The road networks equipped with RSU
- The penetration rate of equipped vehicles
- The use cases available (at least, the Day 1)

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Impacts analysis : costs

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Supported by two types of actors: road operators and car manufacturers

- **Road operators:**
  - Fixed costs: development, IT equipment
  - Variable costs : RSU
  - Evaded costs: purchase and maintenance of equipment (variable message signs, counting loops, etc.)
- **Car manufacturers**
  - Variable costs, depending on the number of equipped vehicles
- **Government grants** for investment and operation.

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Impacts analysis : “physical gains”

- **These gains depend on the use cases considered**
- **Road safety** (Road works warning, Hazardous notification…):
  - Decrease in the number of accidents => Decrease in the number of fatalities, serious injuries, minor injuries, as well as material damage
  - Beneficiaries: Equipped Users, Other Users, Road operator agents
- **Mobility** (Smart routing, traffic information…):
  - Reduced transport time => "time saving"
  - Better reliability in travel times
  - Beneficiaries: equipped users

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Impacts analysis : “physical gains”

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- **Environment** (In-vehicle signage, Smart routing…):
  - Evolution of traffic conditions => decrease in fuel consumption => decrease in GHGs and air pollutants emissions
  - Decrease in transportation costs (fuels)
  - Beneficiaries: equipped users

Main inputs for estimating the "physical gains": the Scoop impact studies

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Monetarization: from physical effects to monetary values, using the "reference values"

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- **Road safety**

Dead (VVS : valeur de la vie statistique)	3 000 000 $€_{2010}$
Serious injury (15 % de la VVS)	450 000 $€_{2010}$
Light injury (2 % de la VVS)	60 000 $€_{2010}$

- **Time savings:**

Eg.: 15.5 $€_{2016}$ / h per traveler: average time value for a particular vehicle performing a long-distance journey in an interurban environment

- **Environnement :**

Eg. : for GHGs, 32 $€_{2010}$ per ton of CO2 in 2010, 100 $€_{2010}$ per ton in 2030

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3) Calculation of the socio-economic net present value (NPV) for the national community.

Relevant additional analysis: for different types of road networks and associated traffic volumes (bidirectional, 2 * 3 lanes, 2 * 4 lanes, etc.)

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Thank you !

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Questions / answers

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