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"URBAN MOBILITY, ROADS NETWORK OPERATION AND ITS APPLICATIONS"

Interconnected vehicles: the French project SCORE@F

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IFSTTAR

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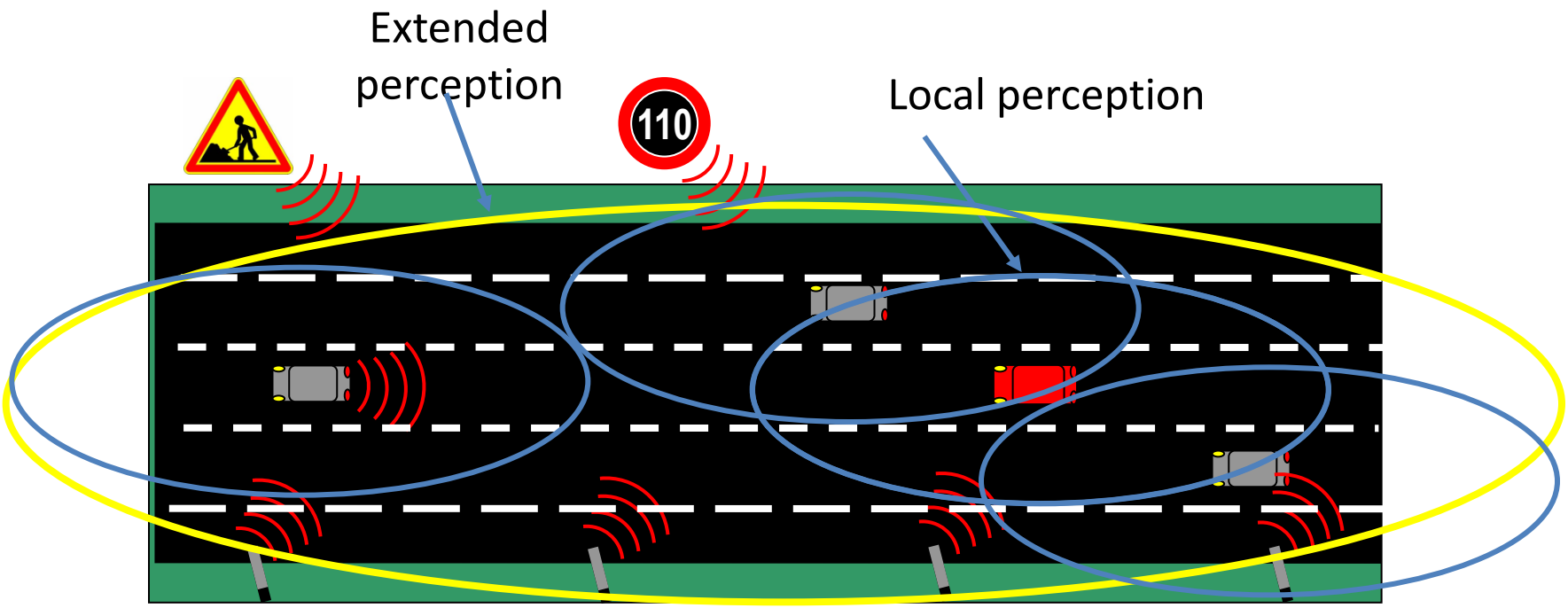
What are cooperative systems ?

- System in which vehicles, roadside equipments, traffic management centers cooperate by exchanging information
- Information exchange relies on wireless communication
- Vehicles becomes “mobile sensors” providing information on their location, speed, state (lights, wipers, ABS, ESP etc)
  - From which it is possible to estimate road network status (traffic, travel time, bad weather condition, unusual situations)

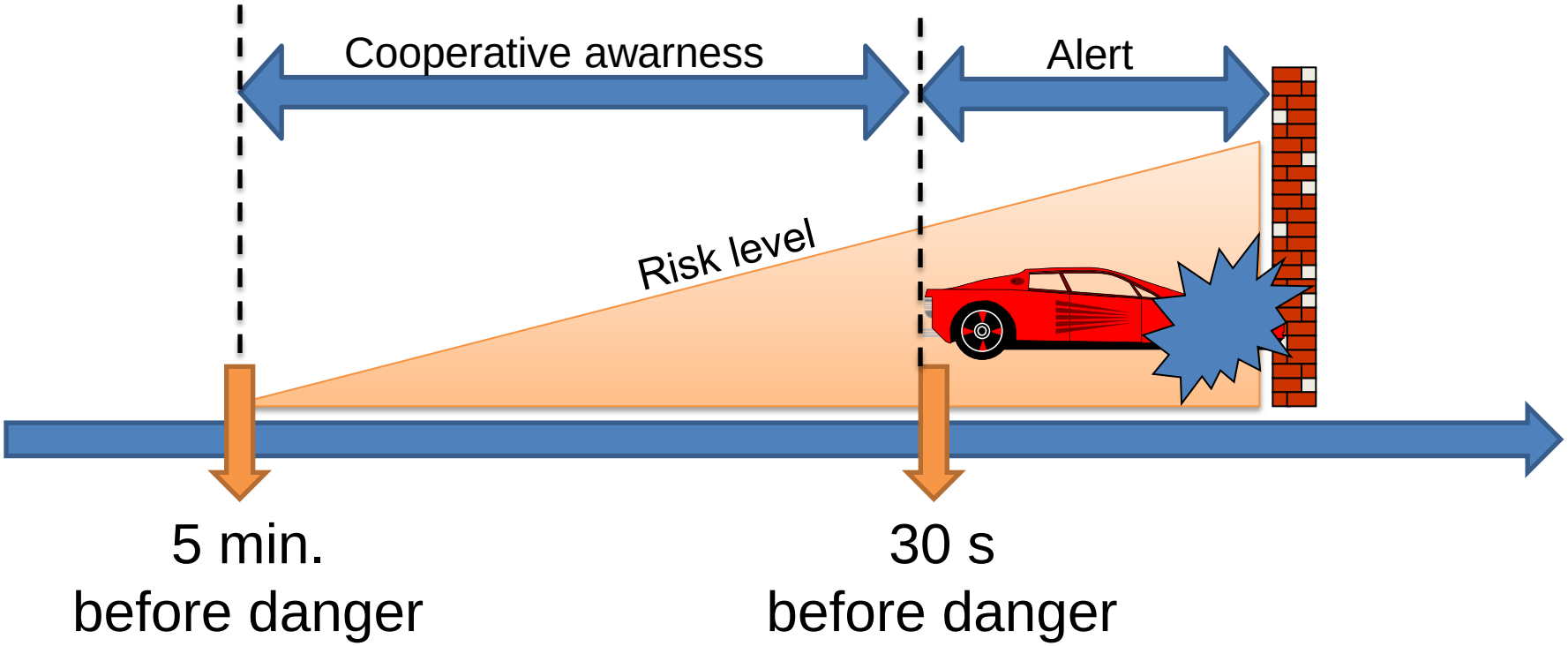
Why cooperative system ?

- Anticipation is a key element of road safety
  - Driver anticipation capabilities are limited by its perception of environment (some hundred meters but less by night or bad weather conditions)
- Cooperative systems helps to improve safety ?
  - By anticipating the difficulties on the road
  - Earlier the driver is aware of hazards, better are its chances of avoiding and accident
- Cooperative systems helps to improve mobility ?
  - By providing the traffic management centre with accurate and real-time information (on accident, weather conditions etc.)
  - By providing recommendations to the driver at the right time and the right place

How to extend perception of environment



From cooperative awareness to alert



The French SCORE@F project

- Goals : to prepare the deployment of services based on cooperative systems
  - Safety services
    - Cooperative awareness services
    - Alert services
  - Traffic Management services
  - Mobility and comfort services
- SCOREF regroups various activities
  - Research and development
  - Technical test and validation
  - Assessment in “naturalistic driving conditions”
    - Usage and acceptation by the driver,
    - Impact on behaviors

Partneship

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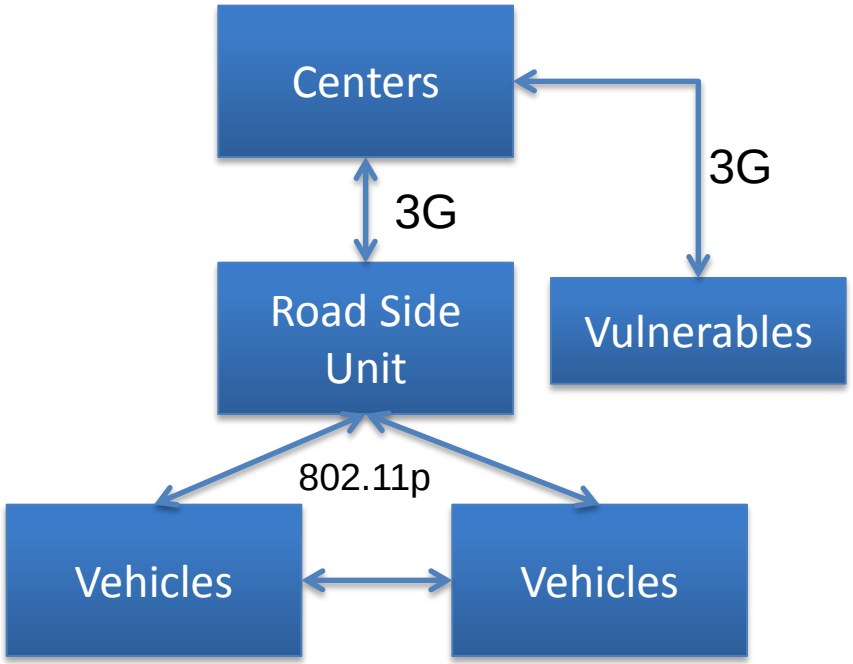
Prime contractor: Renault

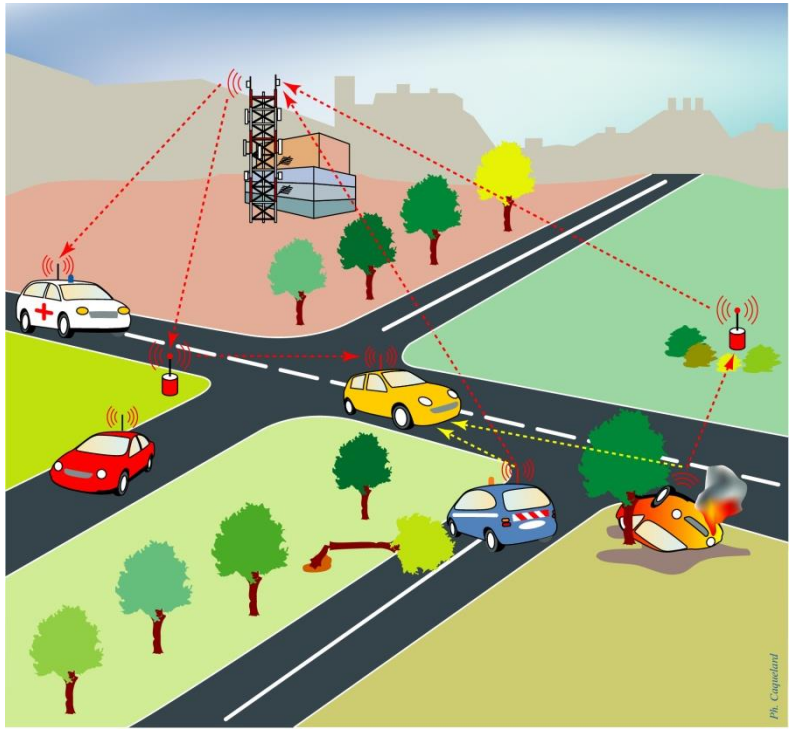
System architecture

- 4 entities
  - Vehicles (V)
  - Road side units (RSU)
  - Centers (TMC)
  - Vulnerable (e.g. pedestrians)
- A “dynamic network”
  - Vehicles, RSU, TMC are the “nodes” of a dynamic (and moving) communication network
  - Each nodes is an “ITS Station” (ITSS)
  - ITSS communicate one with each other thanks to various communication medias



Use cases : hazard warning

(use cases = end user services)

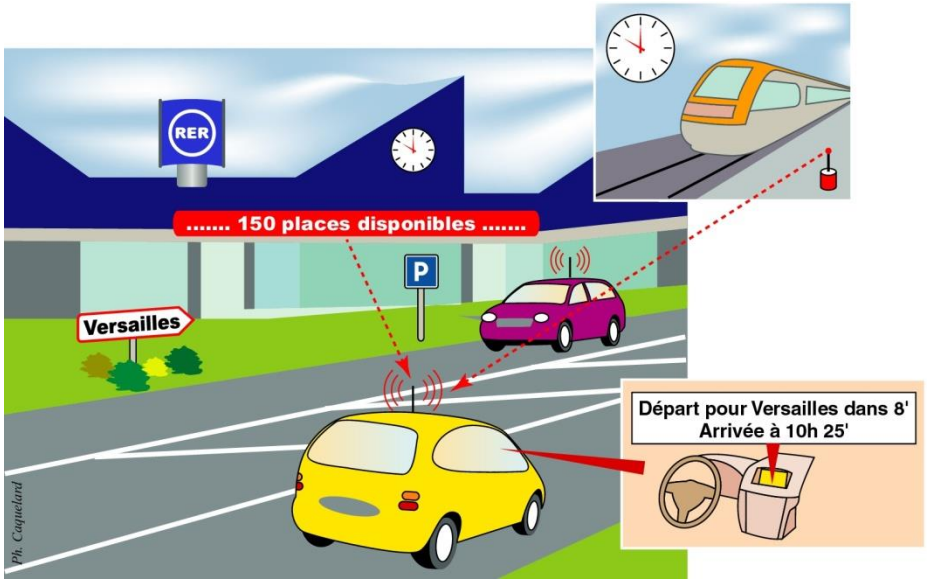


Accident on the road

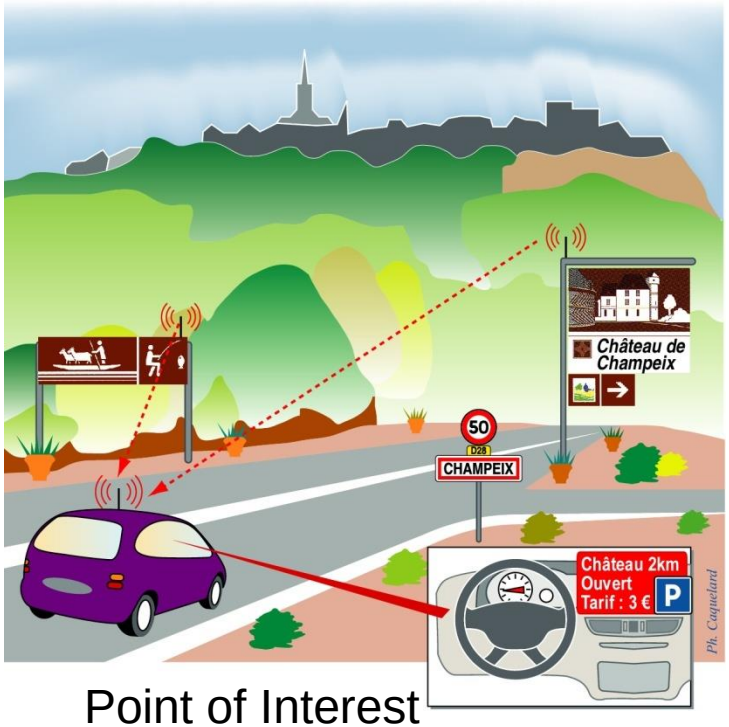
Bad weather conditions

Wrong way driver (« ghost driver »)

Use cases (cont.) : mobility & comfort



Multimodal information



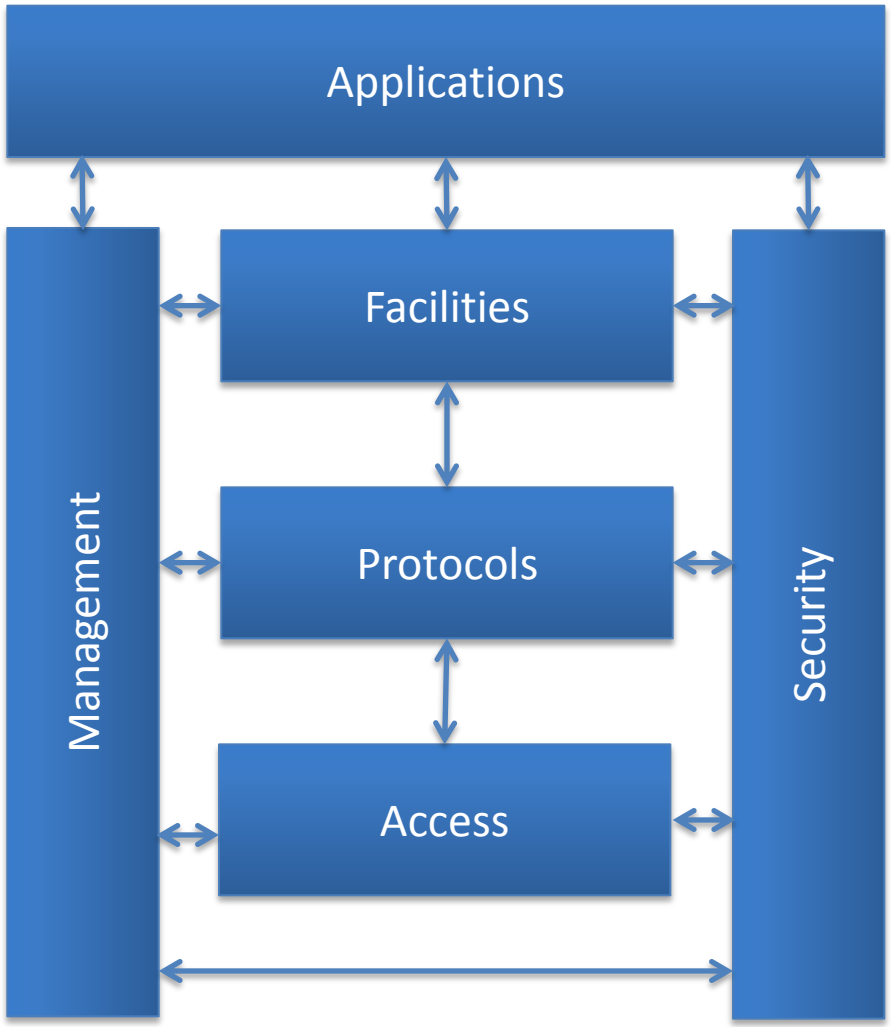
Point of Interest

Key technology : communication

- Médias
  - Short range (about 600 m) : 802.11p : band : 5.9 GHz (5.85-5.925 GHz)
    - For vehicle to vehicle communication (V2V)
    - For vehicle to Road Side Unit (RSU) communication (V2I)
  - Long range : 3G now, 4G tomorrow
    - For RSU to Traffic Management Centers (TMC) communication
- Protocols
  - IPv4, IPv6,
  - Geonetworking : to deliver safety messages within a designated destination area
- Messages (ETSI, SAE J2735)
  - CAM : every seconds to provide information on presence, positions and status of vehicles or RSU
  - DENM : on occurrence of road events (e.g. “accident”)
  - Others messages for specific information (DATEX2, etc)

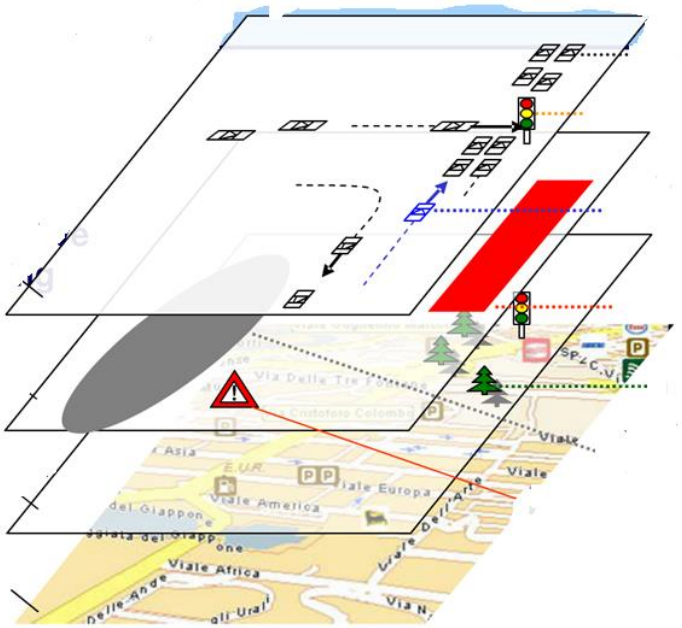
Key technology : ITS Station (implemented into vehicles, RSU, TMC)

- Application Layer
  - Supports the end user services
- Facilities Layer
  - Supports services shared by application layer (localization, access to CAN bus, local dynamic map etc)
- Management
  - Provides support for parameter tuning according to communication « profiles »
- Security
  - Supports for communication integrity, confidentiality, authentication



Key technology : local dynamic map

- Each ITS Station has its LDM
  - The LDM contains a dynamic description of vehicle environment which is essential to the operation of the majority of applications.
  - It is a database that contains topographical, positional and status information related to ITS stations within a geographic area surrounding each vehicles.
  - This database is dynamically updated by information received from in-vehicle sensors, neighbors vehicles, TMC and RSU.



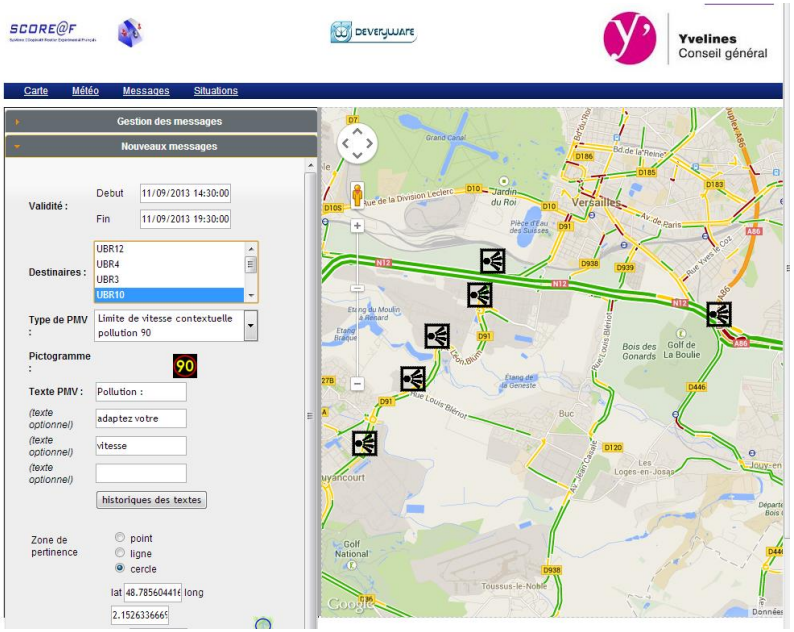
Test sites on Yvelines area (near Paris)

Satory Test track

Human-Man-Interface (example 1)

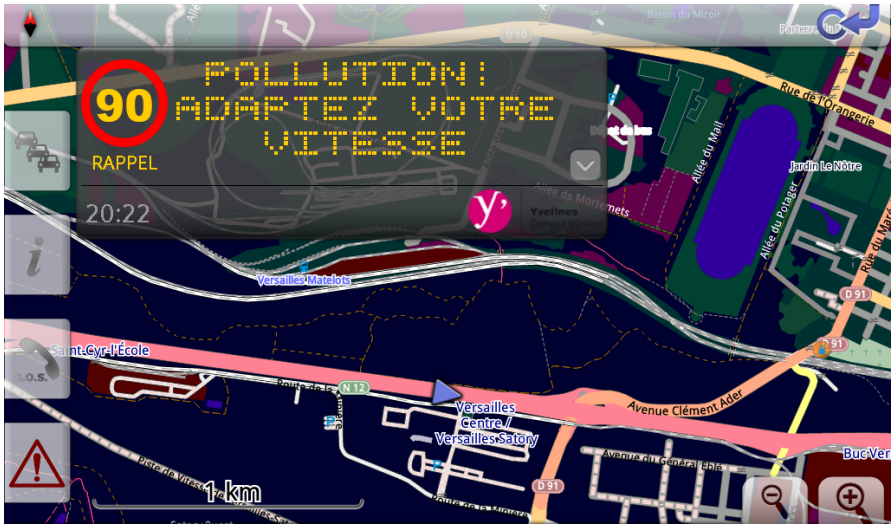
In-vehicle Signage (on-board VMS)

From



Trafic Management Center

to



In –vehicle (Android Tablet)

Information from traffic management centre relayed by road side unit and displayed on HMI like variable message sign (VMS) such as : speed limit, circulation limitation, safety recommendation sign etc

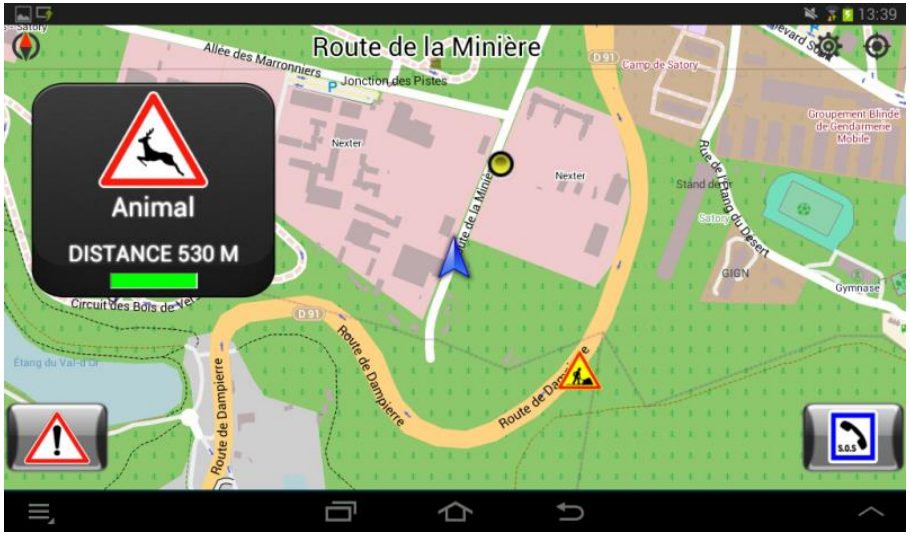
Human-Man-Interface (example 2)

Obstacle on the road

From

In –vehicle (Android Tablet)

to

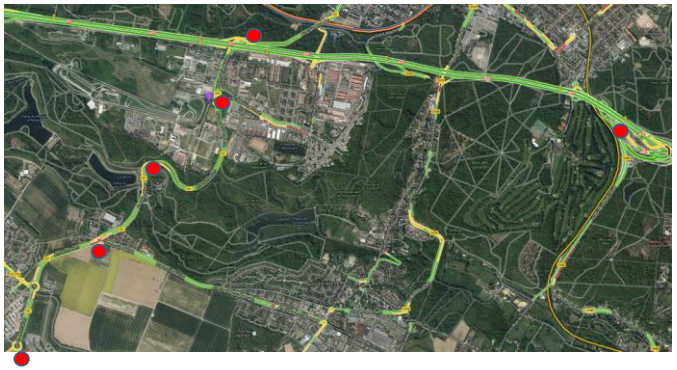


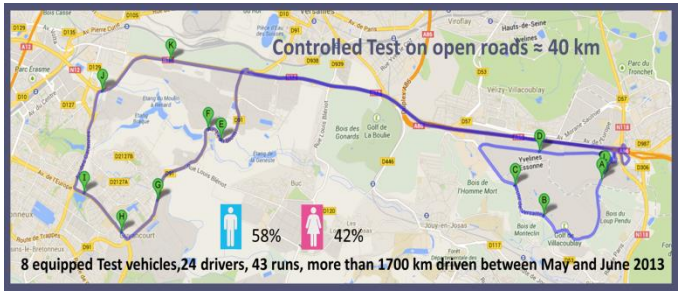
In –vehicle (Android Tablet)

Information triggered by a vehicle driver or passenger on obstacle observation and transmitted to neighbor vehicles thanks to direct V2V communication.
On reception by a vehicle information is displayed only if the vehicle is concerned.

Human factors assessment

- Naturalistic tests
  - During, the Naturalistic Test 16 drivers drove on their own cars, commuting over an equipped portion of infrastructure and using the system during a month. Drivers were informed regularly about events placed on their paths.
- Controlled tests
  - Controlled Test put together eight equipped vehicles driving at the same time following an imposed itinerary where they met around ten predetermined safety road use cases (UC). Half of these UC were informed by the SCORE@F HMI and half were not, in order to appreciate the impact of the messages on driving and to compare similar situations.
- Discussion
  - Controlled Test are more apt to assess the behavioral impact: drivers do meet similar conditions. Naturalistic Tests are more apt for the user acceptance analysis: drivers do experience C-ITS without constraint and through time.
  - Both were useful to HMI enhancements.





SCOREF is part of European DRIVE C2X project

Conclusion

- SCOREF : a proof of concept
  - System feasibility and efficiency was demonstrated
- SCOREF : a proof of interoperability
  - Key technologies are based on ETSI standards
  - ETSI organized « plug tests » to demonstrates interoperability
- SCOREF : a vision for a far future ?
  - No ! A vision for tomorrow !
  - Following Car2car consortium recommendation, car manufacturers are willing to deploy connected vehicle very soon : 2015 (Germany), 2017 (France)
  - Moreover, emergence of Electric Vehicle will stimulate the deployment of cooperative system with the concept of “Smart Grid”