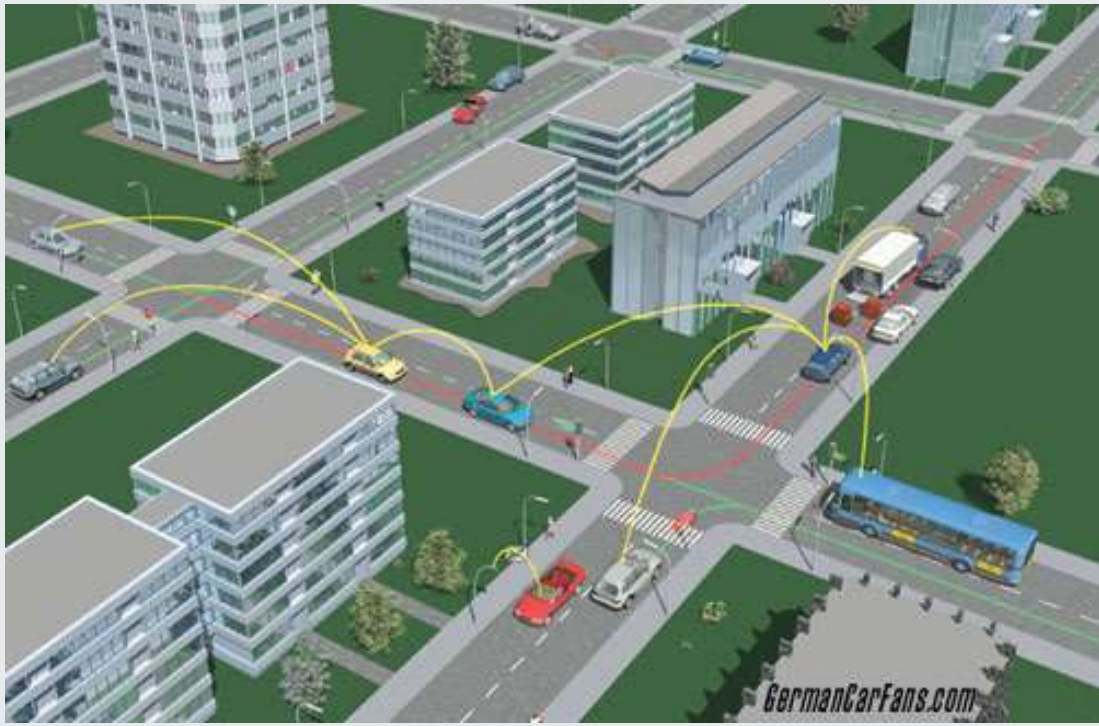
TÉCNICO LISBOA

06
Future Road Environments
C-ITS Applications

Alessio Ciavarella, Alberto Cunha

Intelligent intersection

"BMW ConnectedDrive seeks to intelligently network the driver with his car and the surroundings, thus making road traffic safer, more efficient, and more comfortable"



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Overview

- Introduction to Cooperative Intelligent Transport System (C-ITS)
- C-ITS issues and challenges

Cooperative-Intelligent Transport System (C-ITS)

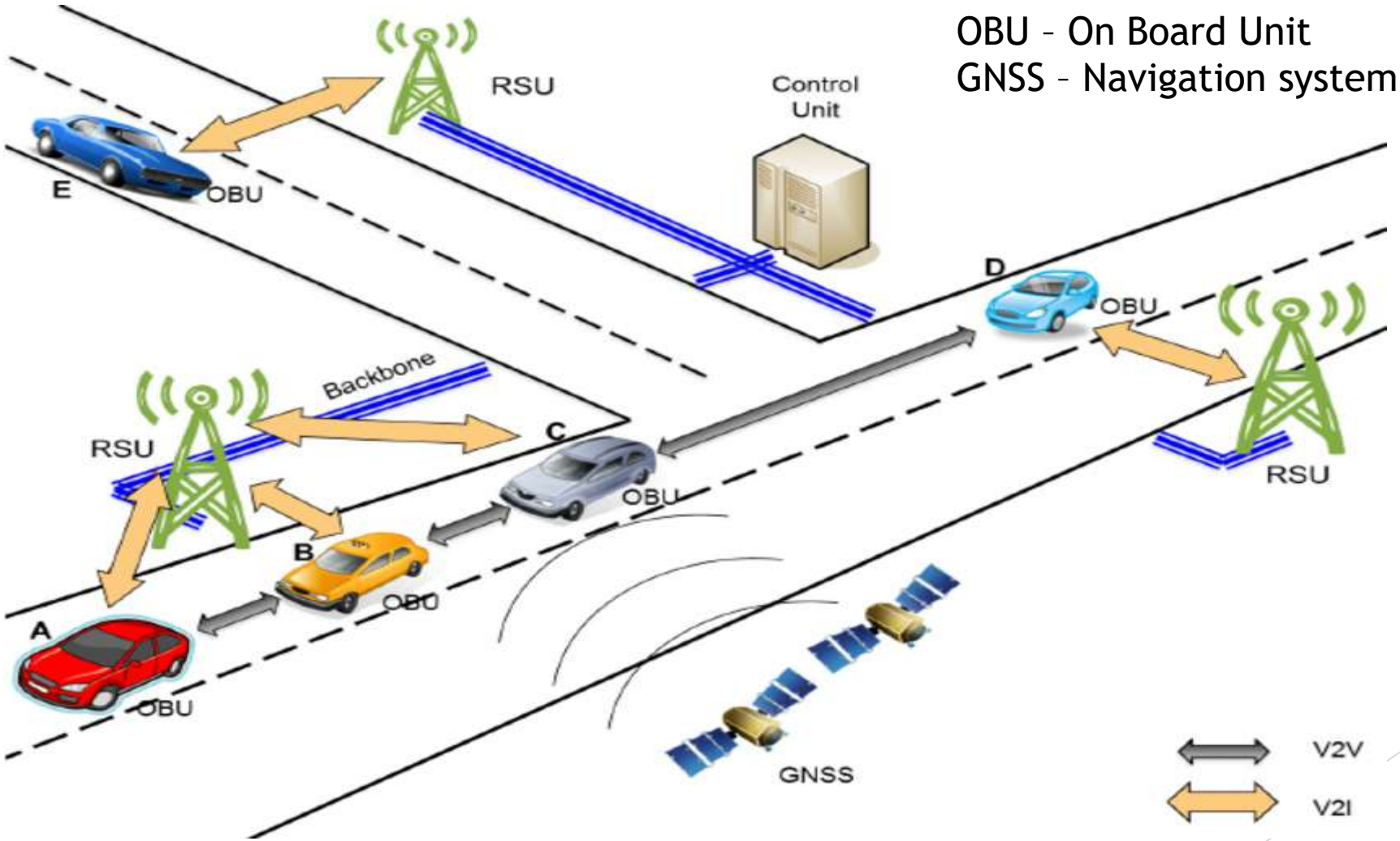
A system that connects and integrates different transport systems and the infrastructure through the use of Information and Communication Technologies.

The objectives are:

- Improvement of road safety
- Reduction of traffic jam
- Reduction of pollution
- Creation of the basis for future autonomous driving vehicles

C-ITS infrastructure

RSU – Road Side Unit
OBU – On Board Unit
GNSS – Navigation system



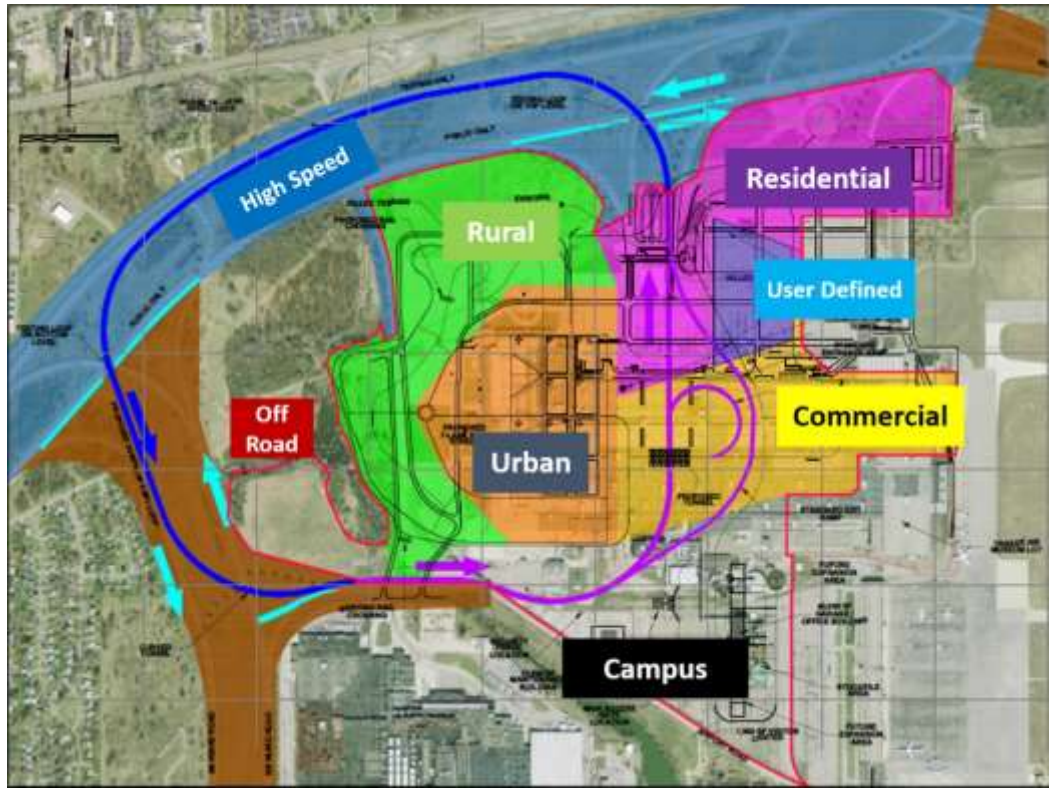
C-ITS issues and challenges

C-ITS systems have two main issues:

- many applications are related with road safety where people could be exposed to possible failures and misbehaviours
- are characterized by a complex infrastructure involving both network and car equipment. Therefore having a working system in real cities requires remarkable resources in terms of money and time

For these reasons they need to be developed and tested in a proper and controlled environment with reasonable resources.

Dedicated testing site installation



American Center for Mobility
www.acmwillowrun.org

One possible solution might be the realization of a specific site to make all the necessary tests.
But this solution still needs:

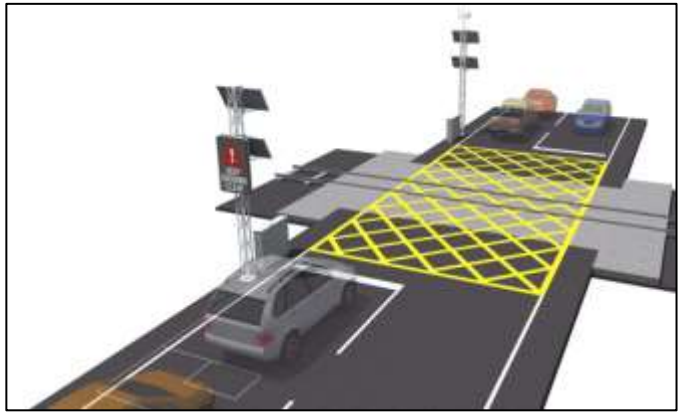
- infrastructure (roads, railways, …)
- equipment (chips, antennas,…)
- vehicles (cars, buses, …)
- real users substituted by dummies (drivers, pedestrians, cyclists, …)

Use cases - Crossings

- **Pedestrian/bicycle crossing**

- Meeting point of different road users (drivers, pedestrians, cyclists)
- Implement and test V2I and V2P communication
- Evaluate methods to improve crossing safety

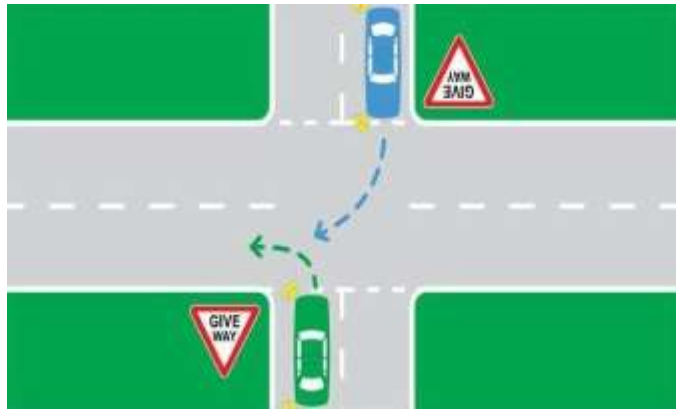
- **Level crossing**



- Evaluate interaction among different means of transport (cars, trains)
- Implement and test V2I communication
- Improve the working logic and safety of the level crossing (e.g. approaching of emergency vehicle)

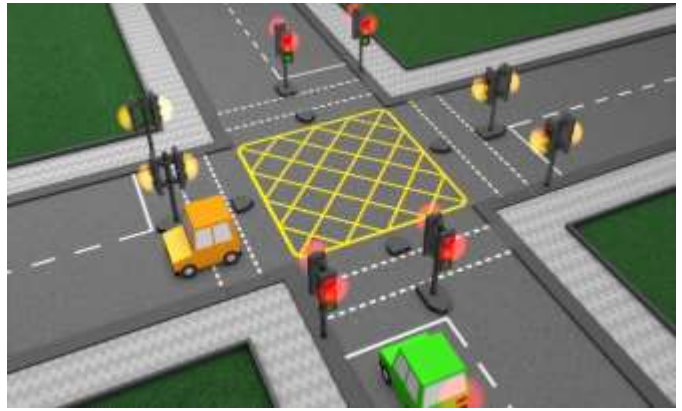
Use cases - Intersections

- **Intersection with modified priority**



- Traditional road signals may be substituted by “intelligent” ones
- Evaluate different systems to control the intersection (e.g. centralized or distributed)
- Test specific algorithms for decreasing traffic congestion

- **Traffic light**



- Traditional traffic signals may be substituted by “intelligent” ones using V2X technologies
- Improve the traffic light logic according to traffic conditions
- Implement GLOSA systems (Green Light Optimal Speed Advisory)

Use cases – Hazard situations

Many road hazards might be encountered while driving along roads (ice, animals, obstacles, etc.). When these situations occur the vehicles that are involved can warn the others in order to let them take the appropriate countermeasures.

The evaluation of these use cases permits to:

- emulate various road hazards
- implement and evaluate the V2V message exchange
- evaluate the possible countermeasures that shall be taken by the vehicle

Use cases – Active Road Signs

Nowadays, road signs are still passive entities that lay on the road side to:

- impose a prohibition (e.g. speed limit)
- notify a warning (e.g. dangerous curve)
- change intersection priority (e.g. give way)

The aim of this use case it to:

- explore the possibility of making the traditional road signs active entities able to communicate with approaching vehicles
- define a message format to support this kind of application
- Simulate the actions taken by the vehicles

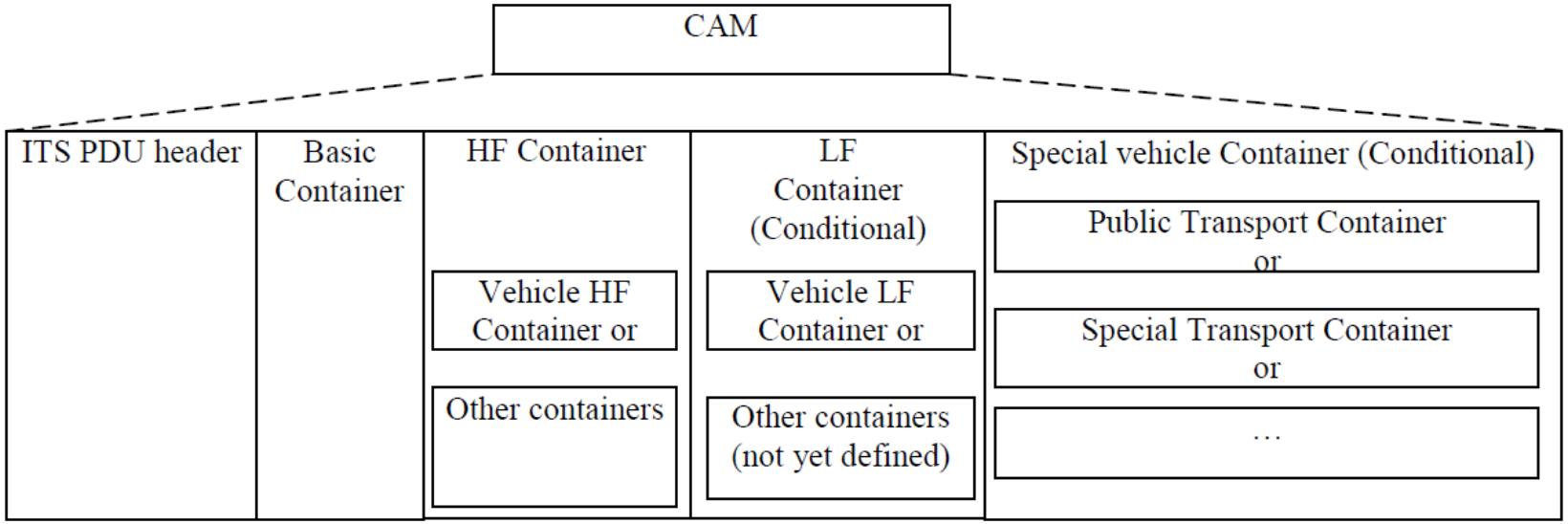
Message definition

The V2X communication involves the use of well-defined messages:

- CAM – Cooperative Awareness Message
- DENM - Decentralized Environmental Notification Message

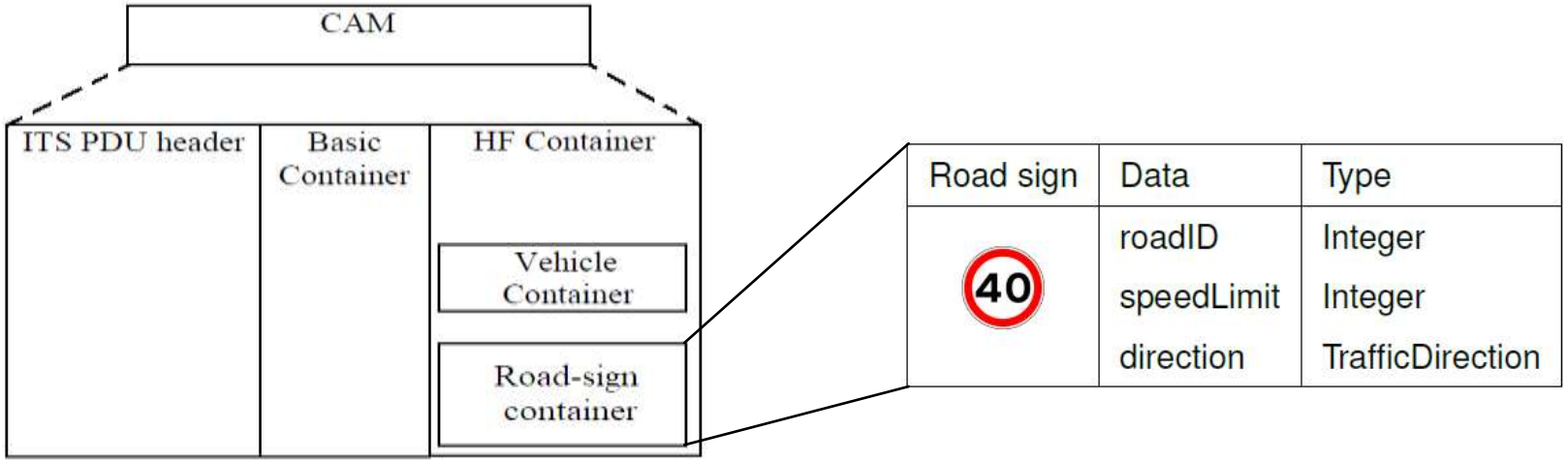
defined by the ETSI (European Standard Telecommunication Institute).

Cooperative Awareness Message



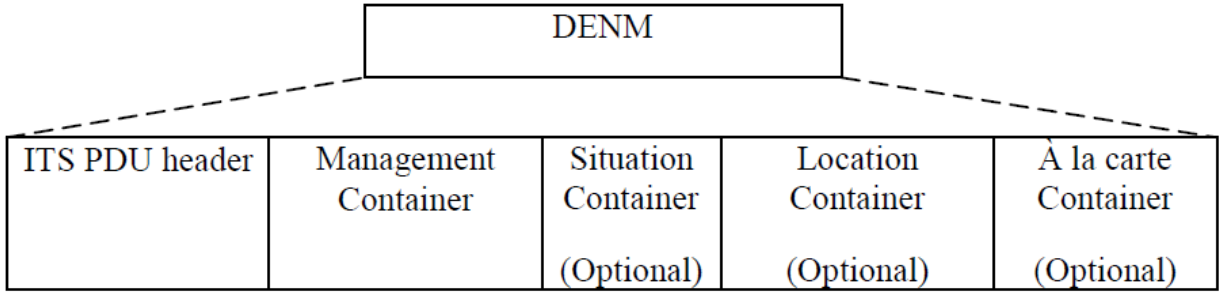
- Periodically generated (< 50 ms)
- Create and maintain awareness among C-ITS stations (RSU, vehicles, …)
- Support cooperative performance (e.g. estimate the collision risk)
- Contains status and attribute information of the originating C-ITS station (type, location, speed, …)

Custom CAM message



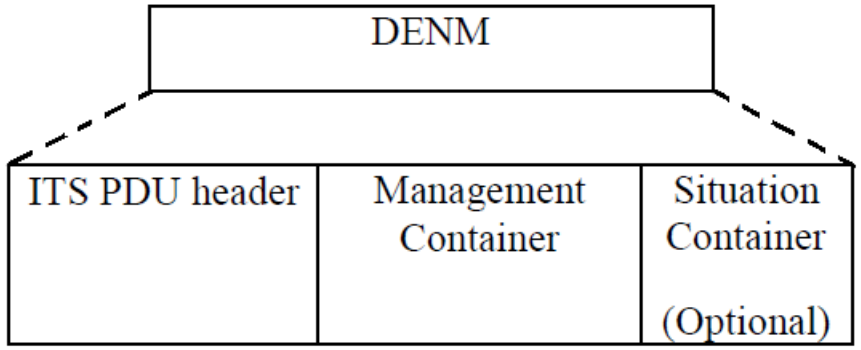
- Periodically generated (< 50 ms)
- Create and maintain awareness among C-ITS stations (RSUs, vehicles, …)
- Contains status and attribute information of the originating C-ITS station (type, location, speed, …)
- the **road-sign container** contains the data generated by “Active Road Signs”

Decentralized Environmental Notification Msg



- Generated only in case of an hazardous event (asynchronous)
- May be repeated for a certain duration or untill its cancellation
- Contains information about the originating C-ITS
- Contains information about the event (type, location, …)

Custom DENM message



- Generated only in case of an hazardous event (asynchronous)
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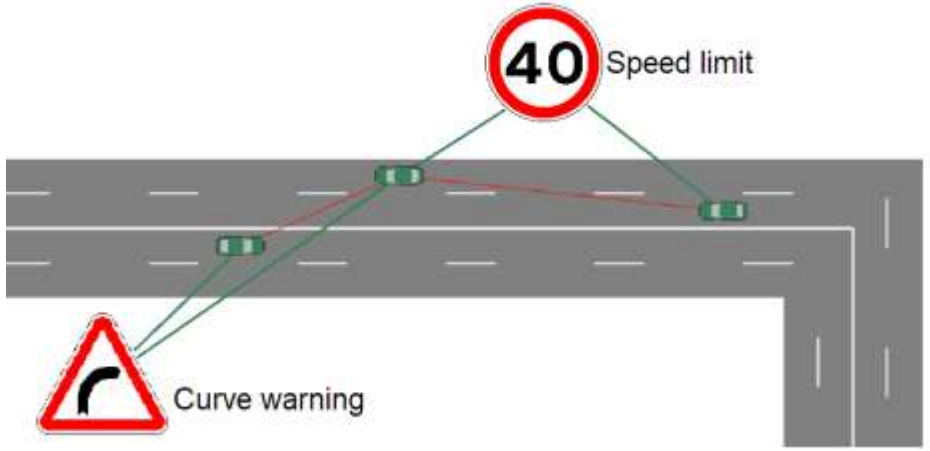
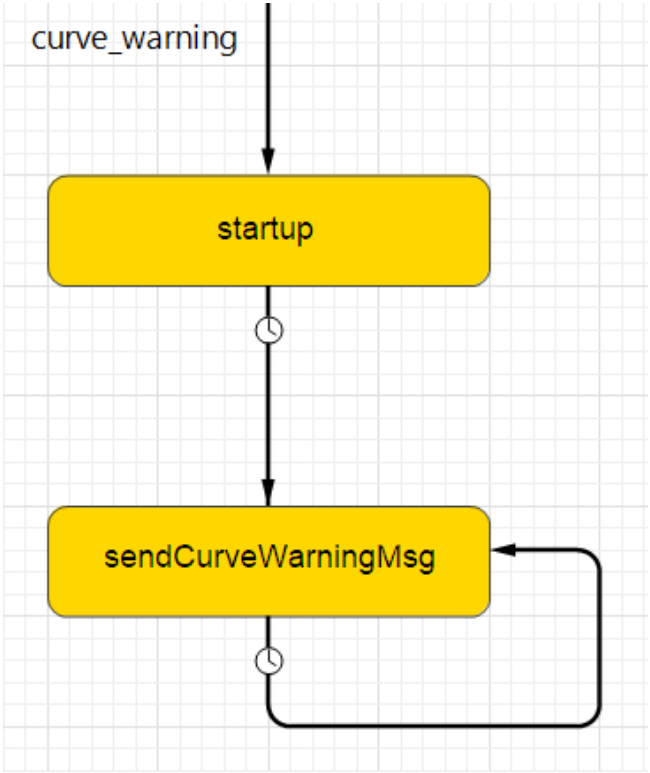
An example – The Active Road Sign agent





- Cars receive the message from the road sign
- Ignore non relevant messages
- Adapt their speed according to the received message

Icy road scenario evaluation results

Requirements	Result
Possibility of placing an hazard anywhere on the road	Yes
Possibility for cars to detect the hazard	Yes
Possibility to send warning message to close RSU in order to guarantee message delivery	Yes
Possibility for cars to get to the standard speed once that the hazard has been overtaken	Yes
Possibility for cars to change their path to avoid the hazard	No