# Simulation Platform for the Prototyping, Testing, and Validation of Cooperative Intelligent Transportation Systems at Component Level

Gruyer Dominique[a], Chapoul Jerome[a], Glaser Sebastien[b]

[a]LIVIC/COSYS/IFSTTAR Versailles, France, [b] CARRS-Q, Queensland University of Technology, Brisbane, Australia

## Abstract

Cooperative Intelligent Transport Systems (C-ITS) are widely considered as the next major step in the development of driving assistance systems (ADAS), and Autonomous Vehicle (AV), aiming at increasing robustness of information for algorithms thus, increasing services, safety and comfort aspects for drivers. Infrastructure managers also benefit from C-ITS data as up-to-date and detailed information about road uses. Simulation platforms that allow prototyping and evaluating of such applications, are crucial. We propose a virtual cooperative simulation platform which integrates models and tools for road environments modelling, embedded virtual sensors and communication devices, which are all consistent with the laws of physics.

## Introduction

The development of C-ITS for safety improvement requires additional resources in terms of extended and enriched perception functions which are both time-consuming and expensive. Therefore, it becomes essential to have a simulation platform that allows prototyping and evaluating extended, enriched and cooperative ADAS in the early stages of the system's design. This virtual cooperative simulation platform has to integrate models and tools for road environments modelling, embedded virtual sensors (proprioceptive & exteroceptive), infrastructure-based sensors and Inter-Vehicular Communication (IVC) devices, which are all consistent with the laws of physics. Similarly, a physics-based model for vehicular dynamics coupled with actuators (steering wheel angle, torques on each wheel) is required. Within such a simulation platform, it becomes possible to obtain a fine and accurate simulation of each component of cooperative applications, especially for the communication systems, in order to model the fine interaction of these complex systems

## Positioning with regards to the state of the art

Several simulation softwares already address the simulation of specific C-ITS applications in complex environment. They mostly focus on the system level and overall impact assessment: IPG simulation software derives from the vehicle dynamic simulation, TASS PreScan came from the traffic simulation environment and I-Tetris is the result of a European Project. They have enhanced simulation capacities but do not take into account a fine description of the sensors and communication devices and the impact of environment.

## Methodology

In order to have a realistic simulation, we need the capability to simulate realistic sensors, vehicles, cooperative ADAS applications, and more important, realistic communication means (propagation channel, antenna diagram), which is done by interconnecting state of the art softwares and libraries.

- The cooperative ADAS prototyping is made with existing softwares (Matlab or RTMaps).
- The communication standard with the OSI layers is provided by the NS3 library. NS3 is a simulator of communications protocol and networks. It contains implementations of Geonetworking protocols (Car2X), Geo-Unicast, TopoBroadcast and advanced protocols. It also contains an IPv6 stack.

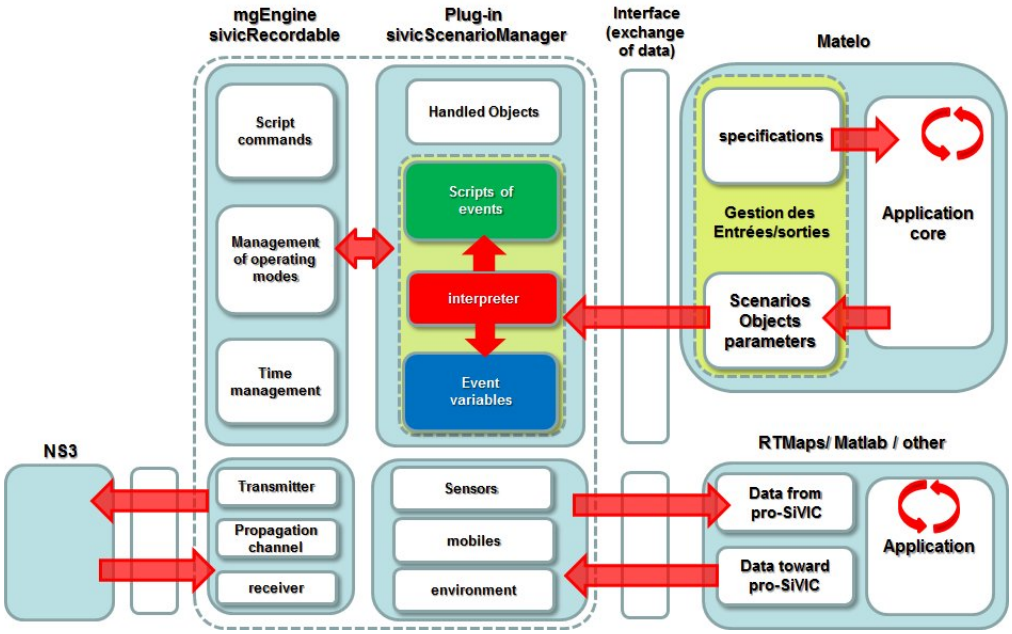


***Figure 1 General simulation architecture for the simulation platform***

- The vehicle, infrastructure, embedded sensors, communication propagation channel, and antenna diagram are simulated in the pro-SiVIC platform. Pro-SIVIC (CIVITEC-ESI) allows to simulate custom scenarios involving environment conditions, multiple sensors and communication systems, up to physical model, dynamic actors and people to perform prototyping and testing stages through simulation.
- The interconnection of softwares is obtain with the pro-SiVIC's DDS communication bus.

## Results and Conclusion

This paper present the development of a new simulation platform dedicated to the prototyping, the test and the evaluation of cooperative applications involving communication means. In order to process this issue of cooperative ITS development, we propose an adaptive (complexity of the use case), distributed (several applications and several computers) and interconnected simulation platform.

From a technical point of view, this work provide a reliable, efficient, generic, and dynamic environment for the development of C-ITS application. More precisely, about the communication means, we propose a realistic environment with the simulation of OSI layers, propagation channel (wave gain and energy attenuation, multi-reflexion path length, Doppler information …), and antenna diagrams.