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## Executive Overview

**TITLE:** D1.3.2-VanetMobiSim/Ns-2: A VANET simulator for CARLINK

**SUMMARY:** This document provides a brief introduction and analysis of the simulation tool VanetMobiSim/NS-2 proposed for the simulation of different CARLINK scenarios.

**GOALS:**

1. Specifying CARLINK needs concerning VANET simulation.
2. Proposing VanetMobiSim/Ns-2 as a VANET simulator.
3. Showing the connection between VanetMobiSim and Ns-2.
4. Featuring Ns-2 as a tool for network communication simulator.

**CONCLUSIONS:**

1. For a trustworthy VANETs simulation in CARLINK project it is necessary to use a simulation tool that includes both a traffic simulator and a network simulator. The simulator proposed here is one composed by VanetMobiSim, as a traffic generator, and Ns-2, as a network simulator.
  2. VanetMobiSim provides macro-mobility and micro-mobility descriptions to achieve realistic vehicular mobility models.
  3. Ns-2 is a reliable simulator which includes several implemented wireless family protocols and mobility options.
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# D1.3.2-VanetMobiSim/Ns-2: A VANET simulator for CARLINK

CARLINK::UMA

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## 1 Introduction

Nowadays, Vehicular Ad-hoc Networks (VANETs) arise since vehicles are able to use wireless communication technologies. The existence of this kind of networks opens the way for a large range of applications for solving several traffic problems and for working in providing the drivers with new and useful services.

The evaluation of VANETs protocols and applications composed by a large number of nodes is only possible by using simulation tools, because carrying out this by real outdoor experiments is extremely difficult and expensive [1].

In this document, **VanetMobiSim/Ns-2** is presented as the simulation tool to be used in CARLINK project. This deliverable is organized as follows: In Section 2 VanetMobiSim/Ns-2 is presented as CARLINK's VANET simulator. In Section 3 and Section 4 VanetMobiSim and Ns-2 are respectively more deeply analyzed and featured, and finally some conclusions are showed in Section 5.

## 2 VanetMobiSim/Ns-2. The VANET simulation tool for CARLINK

After the evaluation of VANET simulators [1], the VANET simulation tool selected is one belongs to the group of simulators that consist of two different tools (Figure 1):

1. Traffic simulation tool that generates a vehicular mobility traces.
2. Network simulator that generates the communication environment.

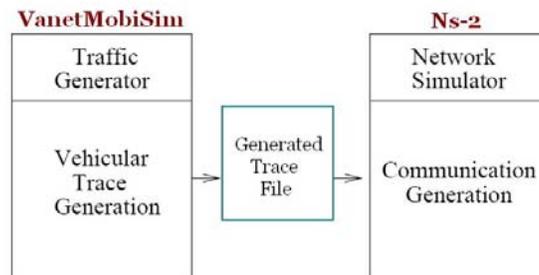


Figure 1: Simulator basic architecture.

The main advantages of the use of this kind of VANET simulators are:

- It is possible developing complex vehicular mobility models for the simulations.
- The mobility model may be generated just once and then used for simulating different kind of network configurations.
- Reusing software. Widely accepted network simulators may be used.

The primary drawback of this kind of approaches is that the vehicle mobility may not depend on the network events, therefore some kind of applications could not be simulated with this tool.

As it has been shown in [2] to achieve realistic vehicular traffic simulations the mobility model has to take into account both macro-mobility and micro-mobility features of the scenario. **VanetMobiSim** has been selected because the mobility models generated with this tool fulfil this requirement. Also it has been chosen because it is free available and its resulting mobility traces may have several formats to be compatible with several network simulators.

**Ns-2** is the network simulator chosen because it is a widely accepted network simulation tool, it provides a wide range of protocols. Moreover, it has been really validated and VanetMobiSim is able to return the mobility trace in Ns-2 file format.

That is, the traffic simulator used is VanetMobiSim [5] and the network simulator is Ns-2 (see Figure 1). These will be presented more deeply in the following sections.

### 3 VanetMobiSim for generating realistic mobility models

VanetMobiSim is an extension to CanuMobiSim<sup>1</sup>, a generic user mobility simulator. CanuMobiSim provides an efficient and easily extensible mobility architecture, but due to its general purpose nature, suffers from a reduced level of detail in specific scenarios. VanetMobiSim is therefore aimed at extending the vehicular mobility support of CanuMobiSim to a higher degree of realism.

#### 3.1 VanetMobiSim general characteristics

VanetMobiSim has already been presented in [2]. In this subsection just the main characteristics are showed:

- It is open source mobility model generator.
- It is specific for VANETs.
- It is platform independent software.
- It supports both macro-mobility and micro-mobility specification.
- It use intuitive XML code to specify the different simulations.

The drawbacks, of using this software, are that for complex mobility model specification huge code is needed and it is partially missing and poor the offered documentation. A important characteristic is that VanetMobiSim has been really validated [5].

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<sup>1</sup><http://canu.informatik.uni-stuttgart.de/mobisim/>

### 3.2 Mobility models using VanetMobiSim

VanetMobiSim supports both macro-mobility and micro-mobility representation to define mobility models for the simulations. In this section they are just shown the mobility features will be used for CARLINK scenarios simulation. More information about them is presented in [2]. During the definition of the most of **macro-mobility models**, the next features will be defined as follows: The road topology will be *user-defined* and imported from *GDF maps*. The characteristic of the roads, as lines, speed limit, traffic signs, etc., will be defined using the different options that VanetMobiSim offers. The nodes trip will be *random* or defined by *activity sequences*. The shortest path between the different starting and end points will be computed using *Dijkstra* featured by the length, congestion level or speed limit. The used **micro-mobility models** belongs to IDM[4] family: *Intelligent Driver Model with Intersection Management* (IDM-IM) and *Intelligent Driver Model with Lane Changes* (IDM-LC). Because they are the closest model to the normal human behaviour.

### 3.3 VanetMobiSim operation

VanetMobiSim requires the presence of a *Java Run Time Environment version 1.5* and higher to be used in a computer. If the user has downloaded the source files, VanetMobiSim requires the presence of a *Java SDK version 1.5* or higher as well as *Apache Ant*.

To use VanetMobiSim, the user specifies the characteristics of scenario to simulate by using an XML file. This file is interpreted by VanetMobiSim and it returns the result. This result may have different forms and formats. It depends on the user output specification. It may be:

- Just the visualization of the scenario.
- The screen shot of the model defined by an *xfig* figure.
- GDF records of the defined spatial model.
- The mobility trace file. The trace file may have different formats depending on the network simulator that it will have the trace file as an input:
  - Ns-2 file
  - QualNet file
  - GloMoSim file
  - NET file

For CARLINK Ns-2 trace file will be used.

Let see the *VanetMobiSim user manual*<sup>2</sup> for more information about VanetMobiSim operation.

## 4 Ns-2 for network simulation

Ns-2 is a discrete event simulator targeted at networking research. Ns-2 provides substantial support for simulation of transport, routing, and multicast protocols over wired and wireless (local and satellite) networks.

Ns began as a variant of the REAL network simulator in 1989 and it has evolved substantially over the past few years. In 1995 Ns development was supported by DARPA through the VINT project at LBL, Xerox PARC, UCB, and USC/ISI. Currently Ns development is support through DARPA with SAMAN and through NSF with CONSER, both in collaboration with other researchers including ACIRI.

Ns-2 has been selected for networking simulation because it offers simulation of several protocols involved in both wired and wireless networks.

<sup>2</sup>[http://vanet.eurecom.fr/VanetMobiSim\\_1\\_0\\_Manual.pdf](http://vanet.eurecom.fr/VanetMobiSim_1_0_Manual.pdf)

## 4.1 Ns-2 general characteristics

Ns-2 is open source network simulator, so it is free available and the user is able to modify the source code (C++ and OTcl). This characteristic is really important because allow us to expand the functionality of the simulator, it is necessary to use it for CARLINK simulation as it is showed in the section 4.3.

Ns-2 provides a packet level simulation over a lot of protocols. In short, it supports several transport protocols e.g. UDP and almost all variants of TCP, several forms of multicast, wired networking, several ad hoc routing protocols and propagation models, data broadcasting, satellite, etc.

For CARLINK is important to stand out that Ns-2 supports several protocols of wireless communication, it is possible to specify both physical and MAC protocols as wireless IEEE 802.11x protocols and WiMAX IEEE 802.16.

It incorporates different traffic generators as web, telnet, CBR (constant bit rate generator), etc. for using them in the simulations. Also, Ns-2 provides the possibility of use mobile nodes. The mobility of these ones may be specified either directly in the simulation file or by using another file where the mobility trace is specified. In our case, the trace file is generated by VanetMobiSim.

Finally, other important feature is that it incorporates several add-ons as the visualization tools NAM<sup>3</sup> (Network Animator) and TraceGraph<sup>4</sup>.

## 4.2 Ns-2 operation

Ns-2 may be installed over either UNIX and UNIX-based operating systems or over Microsoft Windows operative systems using *Cygwin*.

To use Ns-2 for simulating some specific network, the user has to specify this one in a file write in OTcl (Object Tool Command Language) script language and execute ns with this file as an input. The main drawback of using this tool appears when the user has to define the simulation, because the code needed to achieve that is huge and complex when the user is not very experienced. For this reason the simulations usually are defined using more than one file to structure the code in different parts that can be reused in other simulations, e.g. one file defines the network configuration and another file defines the mobility of the nodes.

The results' format of the simulations are defined by the user and then they may be analyzed by using visualization tools. These results may be primary of two types:

- Traces: They record each individual packet as it arrives, departs, or is dropped at a link or queue.
- Monitors: They record counts of various interesting quantities such as packet and byte arrivals, departures, etc.

Let see *The Ns manual*<sup>5</sup> for more information .

## 4.3 Adding CARLINK features to Ns-2

The Vehicular Data Protocol (VDTP)[3] is one used for providing file transfer service for VANET applications in the CARLINK project. This protocol has been developed in UMA group, so Ns-2 is not able to provided it for its simulation.

For this reason, one of the most important characteristic of Ns-2 is that this simulation tool allows us to expand its functionality, because it facilities us the addition new ones using C++ and OTcl languages. In this case, VDTP protocol has been developed and added to Ns-2 to be able to simulate the file transferring between MEUs.

It is not ruled out that this advantage will be useful during the entire project.

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<sup>3</sup><http://www.isi.edu/nsnam/nam/>

<sup>4</sup><http://www.angelfire.com/al4/esorkor/>

<sup>5</sup><http://www.isi.edu/nsnam/ns/doc/index.html>

## 5 Conclusion

In this document, it has been presented VanetMobiSim/Ns-2, the VANET simulation tool proposed to be used during the CARLINK project. After evaluating the VANET simulators in [1], the simulation tool selected is composed by a traffic simulator specific for VANETs, VanetMobiSim, and by a generic network simulation tool, Ns-2. VanetMobiSim is used for creating the mobility models as close as real vehicular mobility. The result of this tool will be an Ns-2 trace file. After that, Ns-2 using the trace file generated by VanetMobiSim simulates the network communications and the statistics results of the VANET are obtained.

The main advantages of using this approach are that it is possible to use a validated mobility model generator as VanetMobiSim and a widely accepted network simulator as Ns-2.

The final conclusion is that all the features introduced by both, VanetMobiSim and Ns-2, are necessary to reach a level of realism sufficient to confidently simulate VANETs in CARLINK project. An example of the obtained results with VanetMobiSim/Ns-2 simulation will be showed in the future documents.

## References

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