Executive Overview

TITLE: D1.3.5-Comparison between simulations and real tests (CARLINK-UMA scenario)

SUMMARY: In this deliverable we compare the results of the real test performed at UMA [4] with the results of JANE [6] and VanetMobiSim/Ns-2 [5] simulations concerning the CARLINK-UMA one-hop scenario. With this comparison we try to throw light on the relative advantages of every VANET simulator for obtaining realistic results. The partners of CARLINK may use this result to propose new scenarios for simulation (e.g., the scenarios presented in *D1.2 Definition of Scenarios*). We can estimate and optimize the performance of these scenarios before being deployed, what could assist the selection and configuration of the communication technologies and protocols, in order to obtain the maximum quality of service for the users of the CARLINK platform.

GOALS:

1. Comparison between real test and simulation results.
2. Evaluation of VANET simulators in real scenarios.

CONCLUSIONS:

1. VanetMobiSim/Ns-2 is the best option to perform large-scale simulations for CARLINK.
2. JANE is useful to develop wireless ad-hoc network applications for the CARLINK consortium.

D1.3.5-Comparison between simulations and real tests (CARLINK-UMA scenario)

CARLINK::UMA

November, 30th 2007

1 Introduction

In this deliverable we compare the results of the real test performed at UMA [4] with the results of JANE [6] and VanetMobiSim/Ns-2 [5] simulations concerning the CARLINK-UMA one-hop scenario. With this comparison we try to throw light on what is the VANET simulator which generates as realistic results as possible.

When we studied the VANET simulation state-of-the-art [2], we made a list of desired requirements that should meet the VANET simulator to be used in CARLINK. These requirements are the following:

1. Accurate simulation of wireless communications.
2. Realistic mobility models for the devices: vehicles mobility models.
3. Scalability.
4. Statistics gathering.
5. Visualization GUI.
6. Digital map integration.
7. Open Source.
8. Widely accepted.

We started using JANE due to its innovative method [3] for deploying wireless ad-hoc network applications. Actually, Puzzle-Bubble [7] and FSF [8] were developed using JANE. We used these applications for the real tests performed at UMA. However, after the study of the state of the art we concluded that JANE was not ready to make realistic VANET simulations. In fact, JANE only meets the requirements 4, 5, and 7 of the ones proposed in the previous list.

After studying the state-of-the-art of VANET simulation, we decided to analyze VanetMobiSim/Ns-2 deeply as the new simulator for CARLINK. VanetMobiSim/Ns-2 is the result of using two different applications. On the one hand, Ns-2 is the widely used network simulator for the evaluation of communication protocols. On the other hand, VanetMobiSim is a tool for generating realistic vehicular mobility models. These models constitute the input of the Ns-2 simulation.

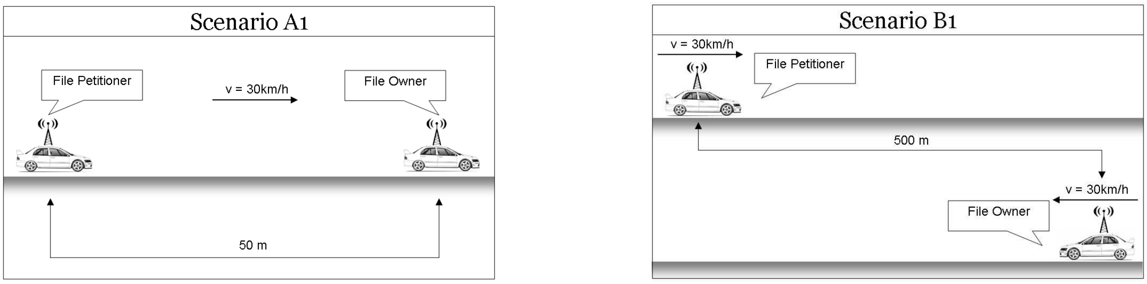
VanetMobiSim/Ns-2 meets all the desired requirements previously defined. However, it is interesting to check how close are its results compared to the JANE simulations and the real tests results.

2 Experimental setting

In this section we present the conditions where the ad-hoc operation mode of the IEEE 802.11b standard has been evaluated. These conditions are exactly the same for both, the real tests and the simulations (JANE as well as VanetMobiSim/Ns-2).

The goal is to transfer files between two cars connected by using the ad-hoc operation mode of the *IEEE 802.11b MAC Layer Standard* in a line-of-sight scenario. Concretely, each car is equipped with one *PROXIM ORiNOCO PCMCIA transceiver*[1] connected to a range extender antenna. The wireless network cards output power is 12 dBm and the range extender antennas gain is 7 dBi.

The mobility models represent the two real scenarios already tested in [4]. Each mobility model consists of a road segment split into two lanes representing bi-directional traffic. Depending on the initial and final positions, we differentiate two scenarios: **Scenario A** and **Scenario B** (see Figure 1). In the first one, both vehicles starts at the initial position of the same lane, and they move along this lane separated by 50 m (Figure 1a). In the Scenario B, one vehicle starts the movement at the initial position of the first lane and the other vehicle starts at the final position of the second lane, 500 m separated one from the other, and they move in opposite directions (Figure 1b). In both cases, the two vehicles move with a constant velocity equal to 30 km/h.



a) Scenario A

b) Scenario B

Figure 1: Mobility models

The experiments were composed of different tests. Each one consisted of transferring a file in one of the previously specified scenario A or B (Figure 1). We used two different file types: **file type 1** with 1-MB size (representing traffic information documents) and **file type 2** with 10-MB size (representing multimedia files).

We use the VDTP protocol [1] to make transfers among the MEUs. For each transfer, VDTP splits the file into several chunks. The chunk size can be configured manually with VDTP and we have set its value to 25 KB in all the tests.

The complete experiment consisted of carrying out **ten repetitions** for each test. The tests were named as follows: **Test A1**, **Test A2**, **Test B1** and **Test B2**. In this notation, the upper case characters describe the scenario and the number denotes the file type used in each test.

3 Results

This section presents the differences between real results and simulation results. The goal of JANE and VanetMobiSim/Ns-2 is to generate simulation results as close as possible to the real test results in the same conditions. This way, we expect to know which is the more realistic simulator regarding to the experiments described in Section 2. Firstly, we present the results of real tests and simulations all together for each test. Secondly, we present the difference between each simulator and the real tests.

[1] `http://www.proxim.com`

Figure 2 shows the results of transferring ten times the file type 1 in the Scenario A. The mean transmission time in the real tests is 1.618 seconds, with a mean transmission rate equal to 626.992 KB/s. The mean transmission time achieved using the VanetMobiSim/Ns-2 simulations is 1.679 seconds, with an mean data rate equal to 609.778 KB/s. In the case of the JANE simulations the mean transmission time is 1.8 seconds, with a mean data rate equal to 563.812 KB/s.

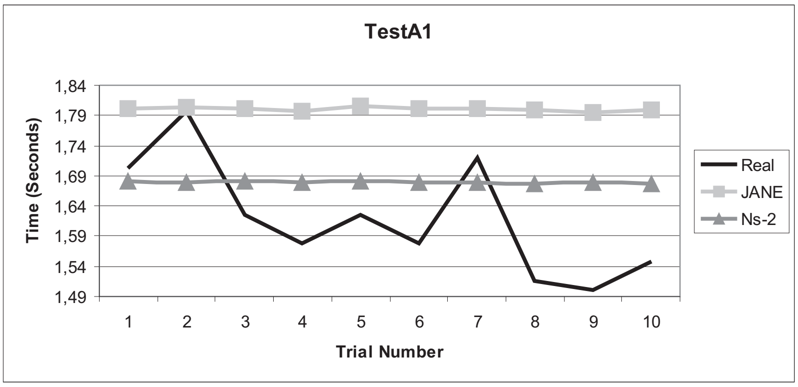


Figure 2: Test A1. This figure presents the transmission time when transferring 10 times the 1-MB file in Scenario A.

Figure 3 shows the results of transferring ten times the file type 2 in the Scenario A. The mean transmission time in the real tests is 17.328 seconds, with a mean data rate equal to 585.176 KB/s. The mean transmission time achieved using the VanetMobiSim/Ns-2 simulations is 16.757 seconds, with a mean data rate equal to 611.053 KB/s. In the case of the JANE simulations, the mean transmission time is 17.9 seconds, with a mean data rate equal to 564.494 KB/s.

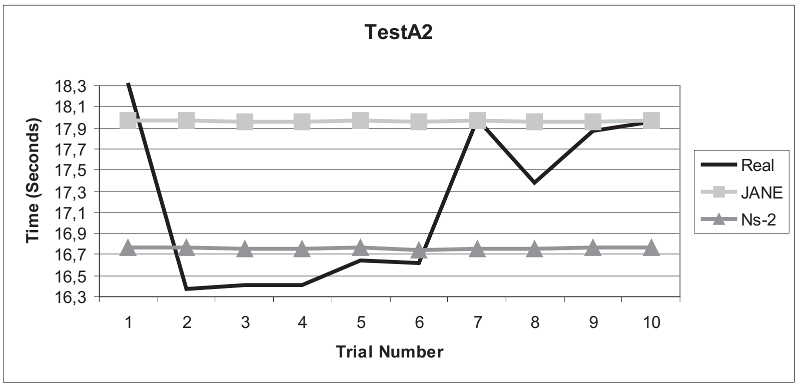


Figure 3: Test A2. Transmission times when transferring 10 times the 10-MB file in Scenario A.

Figure 4 shows the results of transferring ten times the file type 1 in the Scenario B. The mean transmission time in the real tests is 2.732 seconds, with a mean data rate equal to 371.404 KB/s. The mean transmission time achieved using the VanetMobiSim/Ns-2 simulations is 2.678 seconds, with an average transmission rate equal to 391.451 KB/s. In the case of the JANE simulations the mean transmission time is 1.8 seconds, with a mean data rate equal to 563.724 KB/s.

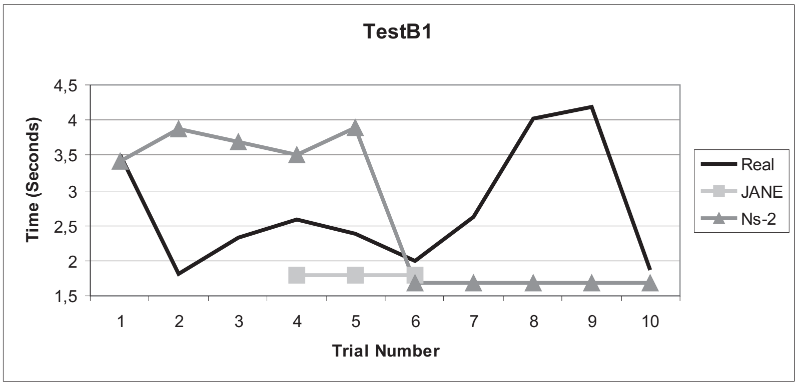


Figure 4: Test B1. Transmission times when transferring 10 times 1-MB file in Scenario B.

Figure 5 shows the results of transferring ten times the file type 2 in the Scenario B. The mean transmission time in the real tests is 20.198 seconds, with a mean data rate equal to 502.017 KB/s. The mean transmission time achieved using the VanetMobiSim/Ns-2 simulations is 19.945 seconds, with a mean data rate equal to 513.397 KB/s. In the case of the JANE simulations, any transfer was successful (i.e., none of the files was completely downloaded from the file owner to the file petitioner).

Figure 5: Test B2. Transmission times when transferring 10 times 10-MB file in Scenario B.

In order to compare all these results, the Figure 6 presents the mean data rate for each test. It is easy to check that VanetMobiSim/Ns-2 generates more realistic results than JANE. Anyway, let us have a look to the numerical differences presented in Table 1. Each entry (i, j) in this table denotes the absolute difference (in KB/s) between the real experiment results and the simulation results with the simulator i in the test j.

Ns-2 presents the biggest difference with the real experiment in the Test A2: 25.877 KB/s. JANE presents the biggest difference with the real experiment in the Test B1: 192.32 KB/s. Moreover, it was not possible to transfer any file completely in JANE with the same conditions as VanetMobisim/Ns-2.

The physical conditions for both simulators were exactly the same than the conditions in the real experiments (detailed in 2). However, the coverage radius for the cars had very different values in each

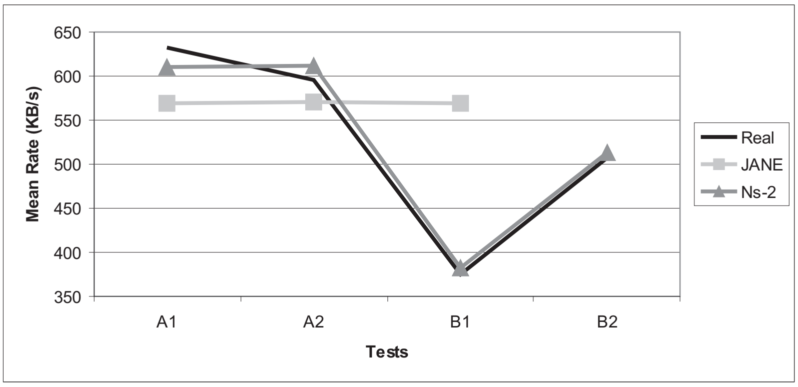


Figure 6: Comparison between real tests and simulations concerning the download data rate.

simulator: 80 metres in JANE and 100 metres in Ns-2. The smaller the coverage diameter the smaller the time frame for the connection between the file petitioner and the file owner in the Scenario B. Furthermore, the mean data rate achieved in JANE was also lesser than the one achieved in Ns-2 during all the tests. It explains the difficulties for JANE in order to transfer the 10-MB file in the Test B2.

Table 1: Mean data rate differences (absolute value in KB/s) between real and simulation results.

	Test A1	Test A2	Test B1	Test B2
JANE	63.18	20.682	192.32	N/A
VanetMobiSim/Ns-2	17.214	25.877	20.04	11.38

4 Conclusions

It is interesting to notice that the times between different file transfers in the simulations are very similar, contrary to the times obtained in the real experiments (see figures 2, 3, 4 and 5). This reflects the difference between the simulations and the real world. The simulation experience shows us that the real world is quite difficult to simulate in a trustworthy manner. Due to its complexity, a lot of events that plays an important role in the real experiments are missed in the simulations: passing by obstacles, reflection problems, signal interferences, etc. It is advisable to keep this idea in mind when using the simulation results to evaluate any complex scenario before being deployed.

Moreover, the results presented in Section 3 reveal that VanetMobiSim/Ns-2 is the most realistic VANET simulator. Therefore, we have decided to use it in order to perform further complex and larger-scale simulations for the CARLINK consortium. Finally, JANE is not discarded at all. Due to its innovative method for developing new wireless ad-hoc network applications JANE can be useful for the consortium specially for testing complex high-level applications deployed on the VANET.

References

[1] CARLINK::UMA. D2006/10 - VDTP: A File Transfer Protocol for Vehicular Ad hoc Network. Technical report, University of Malaga, Spain, 2006.

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[8] CARLINK::UMA. D3.2.2 - Design and implementation of CARLINK wireless ad-hoc applications: Finding and Sharing Files. Technical report, University of Malaga, Spain, 2007.