# Executive Overview

TITLE: D1.3.4-Simulation and evaluation of the CARLINK-UMA scenario by using JANE


SUMMARY: In this deliverable we use the *JANE* simulator to evaluate the performance of one-hop *VANETs (Vehicular Ad-hoc Networks)*: i.e., an ad-hoc network made up by only two *MEUs (Mobile End Users)*. We use the term *CARLINK-UMA scenario* when talking about scenarios where the MEUs can only communicate by using the ad-hoc operation mode of the *IEEE 802.11b/g MAC Layer Standard*, also known as WiFi. The goal is to present the simulation results about the data rates that can be achieved when transferring files directly between two MEUs with the WiFi Standard. These results are interesting for the global consortium in order to select the most appropiate technology for the ad-hoc communications among all those considered in the deliverable *D2.1 Architecture Definition* (see chapter 5) from a theoretical point of view.


GOALS:

1. Justifying the usage of the ad-hoc communications inside the CARLINK architecture.
2. Studying the performance of the IEEE 802.11b ad-hoc operation mode standard through simulation.

CONCLUSIONS:

1. We propose to include the IEEE 802.11b ad-hoc operation mode standard as an alternative to be considered, under certain conditions, in order to communicate two MEUs directly. These conditions are detailed in the remaining of this deliverable.

# D1.3.4-Simulation and evaluation of the CARLINK-UMA scenario by using JANE

CARLINK::UMA

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## 1 Introduction

In this deliverable we use the *JANE* simulator to evaluate the performance of one-hop *VANETs (Vehicular Ad-hoc Networks)*: i.e., an ad-hoc network made up by only two *MEUs (Mobile End Users)*. We use the term *CARLINK-UMA scenario* when talking about scenarios where the MEUs can only communicate by using the ad-hoc operation mode of the *IEEE 802.11b/g MAC Layer Standard*. The ad-hoc communications might be interesting for the CARLINK architecture due to several reasons:

- Providing a cheaper alternative, compared to GPRS, in order to conect MEUs to TSBSs *(Traffic Service Base Stations)* by using multi-hop communications when the one-hop communication is not possible.
- Sharing and broadcasting updated information among MEUs which are placed close one to another. It is important to avoid the congestion of V2I *(Vehicle to Infrastructure)* communications.
- Moreover, ad-hoc communications could be also useful to offer new complementary services for the consortium, e.g. gaming.

Next, Section 2 explains how to set up JANE to accurately simulate the CARLINK-UMA scenario. Section 3 outlines the experiments to evaluate the one-hop VANET. Finally, Section 4 present the simulation results and conclusions about the data rates that can be achieved when transferring files directly between two MEUs with the WiFi Standard. These results can be taken into account to assist the selection of the most appropiate technology for the ad-hoc communications inside the CARLINK project, from an empirical point of view.

## 2 JANE Simulation

This Section specifies the JANE components that have been tuned to simulate the CARLINK-UMA scenario in a trustworthy manner. As detailed in [2], JANE consists of a set of interacting modules that can be customized to exactly simulate the scenario under study. We have identified the *link layer*, *the mobility models*, and *the routing protocol* as the components that need to be fit.

### Link Layer

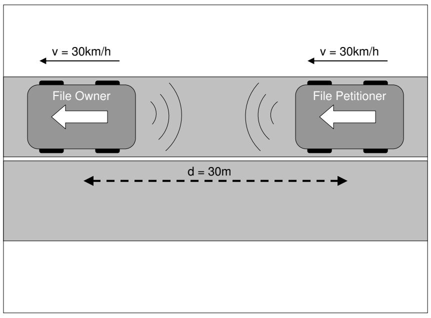
During the real tests at UMA [3], we used the *PROXIM ORiNOCO PCMCIA transceivers*[1] for each MEU, working in the ad-hoc operation mode of the IEEE 802.11b standard. JANE already provides an implementation for both: the IEEE 802.11b Standard and the ORiNOCO PCMCIA cards that we have used for the CARLINK-UMA scenario simulation.

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

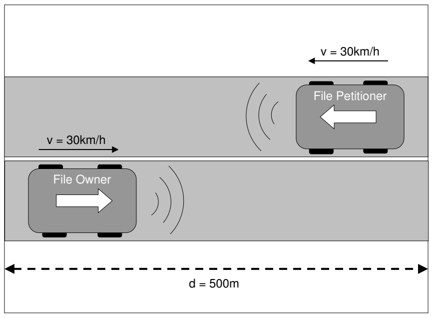
The wireless network cards output power was set to 12 dBm and the wireless antennas gain to 7 dBi, acording to the values indicated in the technical specification of the ORiNOCO PCMCIA cards, resulting the coverage range equal to 80 meters.

### Mobility Model

JANE allows us to configure the mobility model by means of XML scripts. The simulated scenario consists of a road segment split into two lanes representing bi-directional traffic. We have simulated two vehicles moving at 30 km/h as we did in [3]. Depending on the starting and final position 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 30 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).




a) Scenario A




b) Scenario B

Figure 1: Simulated Scenarios

### Routing Protocol

Note that the routing protocol does not play an important role in these scenarios (Figure 1), since only one-hop communications are used and therefore the MEUs uses directly the *link layer primitives*. Nevertheless, the simulations done for this work as well as the real tests [3] use the LMR routing protocol [4] for the multi-hop communications that will be studied in further experiments.

## 3 The Experiments

This section outlines the experiments carried out to simulate the CARLINK-UMA scenario. Note that we have simulated the same scenarios used in the real experiment already performed at UMA, therefore what we are describing here can be found also in [3].

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 between 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: **TestA1**, **TestA2**, **TestB1** and **TestB2**. In this notation, the upper case characters describe the scenario and the number denotes the file type used in each test.

# 4 Results and Conclusions

This section presents the results of simulating the experiments described in Section 3. As explained below, not all the tests were successful. We consider a test as successful when the file to be transferred is completely downloaded from the sender to the receiver. It is not alway possible due to the node movility and the network bandwidth.

Figure 2 shows the results of transferring ten times the file type 1 in the Scenario A. The average transmission time is 1.8 seconds, with an average transmission rate equal to 563.812 KB/s.

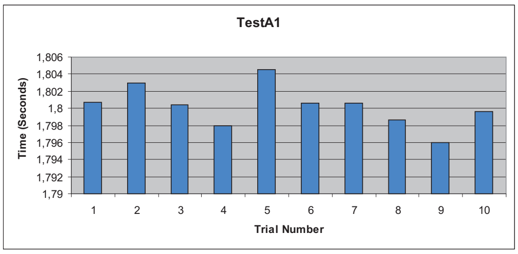



Figure 2: Test A1.

Figure 3 shows the results of transferring ten times the file type 2 in the Scenario A. The average transmission time is 17.9 seconds, with an average transmission rate equal to 564.494 KB/s.

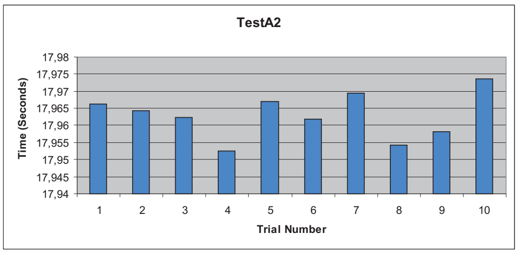



Figure 3: Test A2.

Figure 4 shows the results of transferring three times the file type 1 in Scenario B. The average transmission time is 1.8 seconds, with an average transmission rate equal to 563.724 KB/s.

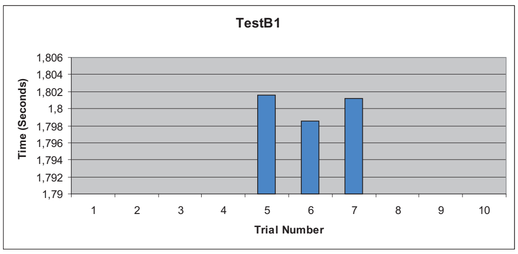



Figure 4: Test B1.

In the TestB1 we only could transfer three files of 1 MB. The problem is that the Scenario B delimites the timeframe in which the two MEUs can communicate with each other. This problem also occurred during the real tests [3] but we solved it by repeating the tests until we transferred ten times the file. However, when repeating the complete simulation experiment, we obtain exactly the same results from one execution to another since it works in an ideal transmission medium which is not exposed to random external interferences.

Finally, the timeframe delimited by the Scenario B made impossible to transfer any file of type 2 completely (i.e., the TestB2 did not produce successful results). It is understandable: the average time to transfer the file type 2 is equal to 17.9 seconds according to the results the TestA2 (Figure 3) and the connection between the MEUs remains during 10 seconds in Scenario B (observed during the simulation). Therefore, there is not enough time to download the file entirely. However, it is possible to transfer up to the 42.6% of the file type 2. It means: 4.21 MB in 10 seconds, what could give an idea of the maximum quantity of data that can be transferred by using the conditions detailed in Section 2.

### Percentage of Lost Packages

The transfer of the file type 1 means to interchange 42 PDUs (*Protocol Data Unit*) between sender and receiver whereas the transfer of the file type 2 implies the transmission of 407 PDUs. The percentage of lost PDUs has been equal to **zero** during all the successful transfers. Let us remember that the simulation works with an ideal transmission medium without interferences.

### The best and the worst transmission rates

The best and the worst transmission rate occurs both in the TestA1 (see Figure 2). The first one is the ninth transfer with 565.148 KB/s and the second one is the fifth transfer with 562.445 KB/s.

### Final conclusions

Analyzing the simulation results, we can conclude that the usage of the ad-hoc operation mode of the IEEE 802.11b Standard could be used under certain conditions. If the information exchange occurs in scenarios like A, an important quantity of data can be transferred: we got a transmission rate of 564.825 KB/s while transferring 10 MB (see the fourth transfer in Figure 3). However, if the information exchange occurs in scenarios like B, the amount of transferred data is smaller. More precisely, the obtained simulation results allow us to conclude that the maximum amount is up to 4.21 MB. It is an upper bound that restrict the quantity of data to be exchanged between MEUs in the conditions described in sections 2 and 3.

## Future Work

We would like to performe further simulations by including more complicated scenarios. We are specially interested in increasing the number of MEUs to evaluate the performance of multi-hop communications. The first step is to add one new MEU and to repeat the experiment described in Section 3 in order to evaluate two-hops communications through simulation. We will use these results to predict the performance of the ad-hoc operation mode of the IEEE 802.11b Standard in further real tests. Later, we would like to perform new real tests with the two-hops scenario and compare the simulation results with the results obtained in these real tests.

# References

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

[2] CARLINK::UMA. D2006/7 - JANE: A Tool for Implementing Applications in Real Ad-hoc Networks. Technical report, University of Malaga, Spain, 2006.

[3] CARLINK::UMA. D2006/8 - VDTP Performance Evaluation: An Outline of the Real Experiment. Technical report, University of Malaga, Spain, 2006.

[4] M. Scott Corson and Anthony Ephremides. A distributed routing algorithm for mobile wireless networks. *Wirel. Netw.*, 1(1):61–81, 1995.