UNIVERSIDAD
DE MÁLAGA

Executive Overview

Title: D2.2.4-MEUs ad-hoc communications performance evaluation in urban scenarios (DYNAMIC tests in the CARLINK-UMA scenario)

Summary: This deliverable aims for evaluating the WiFi router used in UMA for the CARLINK project in an urban itinerary.

Goals:

1. Description of the experiments.
2. Performance analysis and evaluation of the communications hardware. The experiments are subjected to the next conditions:
   - One-hop communications.
   - Ad-hoc operation mode (car-to-car).
   - Dynamic nodes in an urban scenario.

Conclusions:

1. The test reveals that is possible to transfer files in an urban scenario when the cars are separated up to 50 m and their speeds range from 5 Km/h to 40 Km/h.
2. The variability of the environment conditions can produce very different results between two consecutive transferences. In order to avoid a low quality of service in wireless ad-hoc communications, we recommend constant speed and short distances between vehicles.

D2.2.4-MEUs ad-hoc communications performance evaluation in urban scenarios (DYNAMIC tests in the CARLINK-UMA scenario)

CARLINK::UMA

February 28, 2008

1 Introduction

The CARLINK project aims for providing protocols and applications in order to establish wireless interconnection among cars. The main objective of CARLINK is to provide a platform for the connection and communication among cars which circulate through different scenarios such as: city, highway, etc. This connectivity allows the cars to broadcast useful information to the drivers (such as traffic or weather information), it could also allows them to share information and even run distributed applications (e.g. multiplayer videogames). The devices located in cars should be able to communicate with one another directly or using a Traffic Service Base Stations (TSBS).

In the UMA deliverables [4] and [5], we presented the WiFi equipment at UMA for the CARLINK project. In addition, the performance of the devices was measured in a static context, that is, devices (cars) were placed in fixed positions. In this deliverable, the cars travel across an urban itinerary. The experiments conditions are harder not only because of the mobility of the devices, but also for the appearance of other obstacles (cars, people, street elements...) which can be in movement or not.

Figure 1 shows the different milestones of all scheduled UMA deliverables, emphasizing within an ellipse this one. This deliverable is associated to the Work Package 2 (Wireless Traffic Service Platform) in the Task 2.2 (Platform Definition).

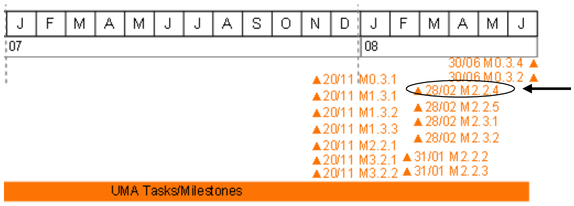

Figure 1: UMA time tabling scheduling shows the milestone of all our planed deliverables. This deliverable is marked within an ellipse

The deliverable is structured as follows: In Section 2 we describe all the experimental results. Finally, the conclusions of this work are drawn in Section 3.

2 Experiments

The tests consist basically of transmitting files between two MEUs equipped with a laptop, the Senao router and a DC adapter (please, consult [5] for more details) during the urban itinerary. We only consider an ad-hoc communication between the two cars (see in [2] a discussion about using the WiFi ad-hoc as an alternative for MEUs communication). This technology is considered in CARLINK [1], mainly when transmitting critical car to car data between two MEUs.

The urban itinerary is shown in Figure 2. This route placed in Malaga covers an area of approximately 4 Km. Since we performed static tests with the current hardware [5], we have avoided the presence of traffic lights in order to to keep the car in movement during all the travel. In the Figure 3 we show a capture during the travel (3.a) and the equipped hardware inside the cars (3.b).

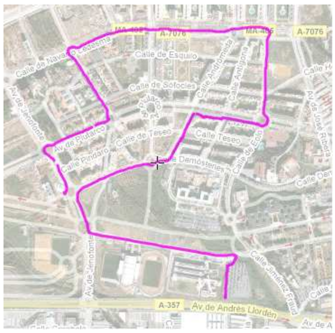

Figure 2: Itinerary track

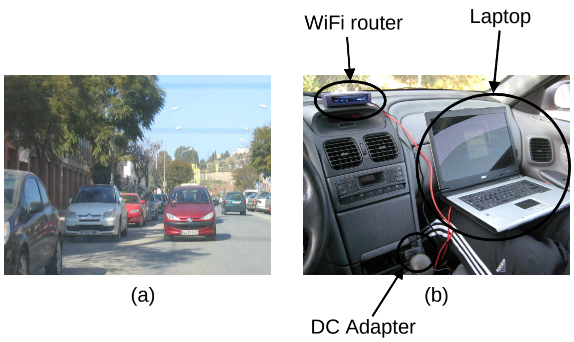

Figure 3: (a) A snapshot in the urban scenario during the itinerary. (b) The equipped hardware is placed inside the car

Table 1 shows the parameterization of the tests. We compare the obtained results by transferring 9 times a file of 1 MB size (filled with random dummy content). It has not been possible to finish more downloads during the travel. The distance between the cars during the travel is not constant and oscillates between 2 m and 50 m. We use the output tracking information given by the GPS for estimating the cars speed, which is between 5 Km/h and 42 Km/h. The selected software for carrying out the experiments is the Finding and Sharing Files (FSF) [6] application. This program has been developed at UMA, is used for sharing files in an ad-hoc network. FSF shows statistical data (i.e., transmission time, number of send packets, number of lost packets...) after each file transmission. The communication protocol used by this application (VDTP [3]) splits the file into chunks of 25 KB (this parameter is also configurable).

Table 1: Test parameterization

Equipped network hardware	Senao router NCB-3220
Wireless Ad hoc Application	FSF [6]
WiFi Standard	802.11b/g
File sizes	1 MB
Distances	2 m - 50 m
Speed	5 Km/h - 40 Km/h
Chunk file size	25 KB
Number of trials	9

Figure 4 illustrates the obtained transfer rates and the download times in the nine trials. The transfer rate values oscillate among 0,07 MB/s and 0,56 MB/s, being the resulting average value of 0,28 MB/s. In the IEEE 802.11g standard, the maximum theoretical value is 6,75 MB/s, representing the resulting average rate (0,28 MB/s) its 4,14%. This way, it is noticeable the fall in the download speed in an environment with mobile devices and obstacles. In the static tests performed with this hardware [5], the environment conditions were equals in all the independent trials. However, during this test, each file transference can be submitted to very different conditions: car speeds, distance between the devices, presence of obstacles, etc. This way, the variation in the transfer rate among different trials can be high. For example, the first and fifth trial represent the lowest values (0,1 MB/s and 0,07 MB/s), while the second one obtains the highest value (0,56 MB/s).

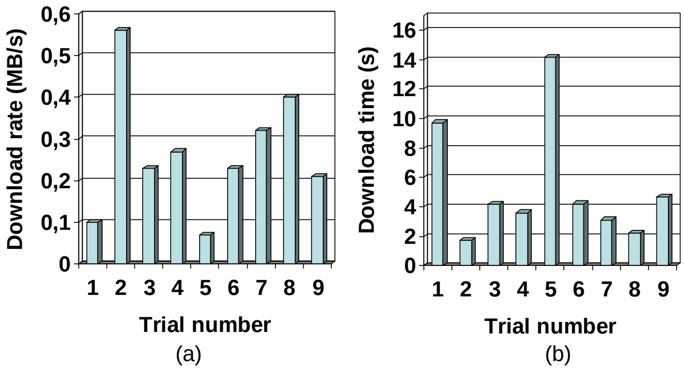

Figure 4: Transfer rates and download times in the different trials. The obtained rate values are between 0,07 MB/s and 0,56 MB/s. These values values are fluctuating because of the variability in the environment conditions (i.e., presence of obstacles, increasing/decreasing of the distance between the devices, etc.)

In Figure 5 we can see the percentage of lost packets in each file transference. Just like the previous figure, there are significant differences among the different trials. The highest percentage of lost packet are reached in the first and fifth trial, showing the main reason of the lowest download rates. When a packet is lost, the application penalizes the download with a timeout value of 2 seconds.

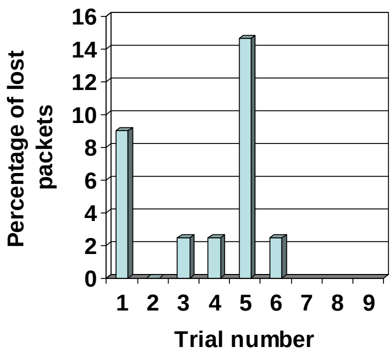

Figure 5: Percentage of lost packets in the different trials. In the first and fifth trial the highest values are reached, being the download rate more penalized because of the predefined timeout value in the application (2 seconds)

3 Conclusions

This deliverable aims at evaluating the real performance of the WiFi router equipment at UMA. All the transferences have used the ad-hoc operation mode of the 802.11g protocol, considering one-hop communication between the cars. Unlike the static test in the D2.2.2 deliverable [5], this time the devices were in movement, traveling across an urban itinerary. In these conditions, two consecutive transferences can produce very different results because the environment conditions can change very fast (e.g. appearance of new obstacles, the distance between the vehicles increases, etc). The tests reveal that is possible to transfer files between two cars in an urban scenario, being the MEUs separated up to 50 m, moving at a speed between 5 Km/h and 40 Km/h. It is not advisable to increase the speed or the distance between the vehicles for avoiding a very low quality of service if we take into account that the obtained average download rate represents the 4,14% of the maximum theoritical value estimated in the IEEE 802.11g standard.

References

[1] CARLINK. CARLINK D2.1 - Architecture definition. Chapter 5: Communications technologies. CARLINK consortium, September 2007.

[2] CARLINK::UMA. CARLINK::UMA D1.3.4- Simulation of the CARLINK-UMA scenario by using jane. University of Malaga, November 2007.

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

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[6] CARLINK::UMA. D3.2.2 Design and Implementation of CARLINK Wireless ad-hoc applications: Finding and Sharing Files. University of Malaga, October 2007.