Executive Overview

Title: D2.2.1 - WiFi card performance evaluation using one-hop communications (STATIC tests in the CARLINK-UMA scenario).

Summary: The aim of this deliverable is the evaluation of the WiFi equipment used in UMA for the CARLINK project.

Goals:

1. Outline of the equipment.
2. Description of the experiments.
3. Performance analysis and evaluation of the WiFi devices used in UMA. The analysis contains:
   - One-hop communications.
   - Ad-hoc operation mode.
   - Static nodes.

Conclusions:

1. The analyzed hardware is able to transfer data at reasonable speeds being the static devices separated up to 100m in a line of sight (LOS) scenario.
2. The presence of obstacles decreases the performance noticeably. In these cases, the 802.11 standard does not incorporate an specific operation mode (unlike WiMax).

D2.2.1 - WiFi card performance evaluation using one-hop communications (STATIC tests in the CARLINK-UMA scenario)

CARLINK::UMA

November 20, 2007

1 Introduction

The CARLINK project aims for providing protocols and applications in order to establish wireless ad-hoc interconnection between cars constituting VANETs. 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 this deliverable, the equipment used in CARLINK is evaluated. In the technical report [5], we discussed about the most appropriated communication technology to be used in the project. The WiFi technology (considered in [2]) was selected because of its free band and easy availability, among other reasons. This way, the devices used here are based on the 802.11(b/g) standard.

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

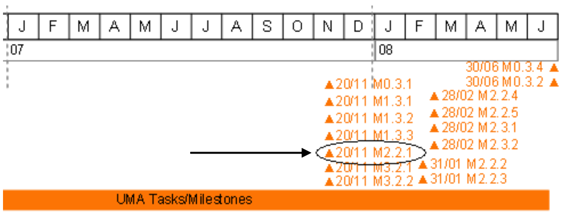

Figure 1: UMA time tabling scheduling

This document is structured as follows: Section 2 is dedicated to describe the hardware. In Section 3, we report all the experimental results, and finally, the conclusions of this work are drawn in Section 4.

2 Hardware Description

This section describes the hardware used for the communications. Specifically, two devices have been tested: a wireless card and an antenna. Both devices are connected to laptops. Table 1 shows their main characteristics.

The **Orinoco Card** [1] is 802.11b/g compliant. We identify as main features: 54Mbps of data rate and the possibility of working in the ad-hoc manner. We also use an **antenna** connected to the Orinoco card for increasing the coverage range. This antenna can be fixed to the car surface by a magnetic base.

Table 1: Hardware Characteristics

Device	Characteristics
Orinoco Wireless Card 	• IEEE 802.11b/g compliant: – 54Mbps – Ad-hoc networking • Possibility of adding an auxiliary antenna for increasing the signal range
Antenna 	• 7dBi of gain • Magnetic base

3 Experiments

The experiments carried out here consist basically of transmitting files between two laptops (equipped with the Orinoco and the range extender antenna) placed in fixed positions. We only consider an ad-hoc communication between the two terminals in a static environment (we can see in [3] a discussion about the use of the WiFi ad-hoc as an alternative for MEUs communication).

Three types of files with different dimensions were used to test the transference between (cars) devices: 1Mb, 5Mb and 10Mb. We are interested in measuring the data rates in two different scenarios (see Figure 2):

- **Laboratory**: an example of scenario where the laptops are exposed to interferences (other computers, different WiFi networks...) or obstacles (i.e. walls or cupboards when the distance between the devices is higher than 10m).
- **Parking**: an example of scenario without interferences and obstacles. A line of sight exists (LOS) between the terminals.

Table 2 shows the parameterization of the tests. We compare the obtained results by transferring 30 times the files in each scenario. Two different distances are considered: 2m and 20m. In the laboratory, at 20m distance, the devices are placed in different rooms. The selected software for carrying out the experiments is the Finding and Sharing Files (FSF) [6] application. This program has been developed by CARLINK UMA members and provides methods for sharing files in an ad-hoc network. FSF gathers statistical data (i.e. transmission time, number of send packets, number of lost packets, etc)

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

Laboratory **Parking**

Figure 2: The selected scenarios for carrying out the experiments: laboratory and parking

after each file transmission. The communication protocol used by this application (VDPT [4]) splits the file into chunks of 25Kb (this parameter is also configurable).

Table 2: Test parameterization

Equipped network hardware	Oricono card with extender antenna
Speed of the devices	0 Km/h (static tests)
Wireless Ad hoc Application	FSF [6]
WiFi Standard	802.11g
File sizes	1Mb 5Mb 10Mb
Distances	2m 20m 100m (only parking)
Chunk size	25KB
Number of trials	30

Table 3 shows the results of the tests. We present two values for each configuration (scenario, file size and distance): the best download rate among all the file transfers (Best column) and the average download rate (Avg column) in MB/s.

Table 3: Transfer rates using Orinoco Card

	Laboratory				Parking					
	2m		20m		2m		20m		100m	
File size	Avg	Best	Avg	Best	Avg	Best	Avg	Best	Avg	Best
1Mb	1.16	1.42	0.55	0.91	0.91	1.01	0.67	0.71	0.45	0.52
5Mb	1.01	1.39	0.53	0.74	0.86	0.96	0.59	0.7	0.46	0.54
10Mb	0.83	1.15	0.48	0.88	0.7	0.84	0.53	0.63	0.45	0.51

The average download rate is between 0.45 MB/s and 1.16 MB/s. The highest values appear when the laptops are separated by 2m in both scenarios. This is an expected result since the received signal level is 40dBm, being the percentage of lost packets close to 0%. In these conditions (2m) the best and average download rate are higher in the laboratory than in the parking scenario.

When we increase the distance between the laptops, the average download rate decreases notoriously (see Figure 3). This fact is clearer in the laboratory, where the appearance of obstacles shows that the WiFi 802.11b/g standard was not designed for working in non line of sight (NLOS) scenarios (unlike the Wimax one).

Additionally, we have transferred files in the parking scenario separating the terminals by 100m. There is not significant difference between 20m and 100m values (mainly transferring the 10mb file). According to the received signal level at 100m (20bBm), we can reach a maximum distance of 150m approximately.

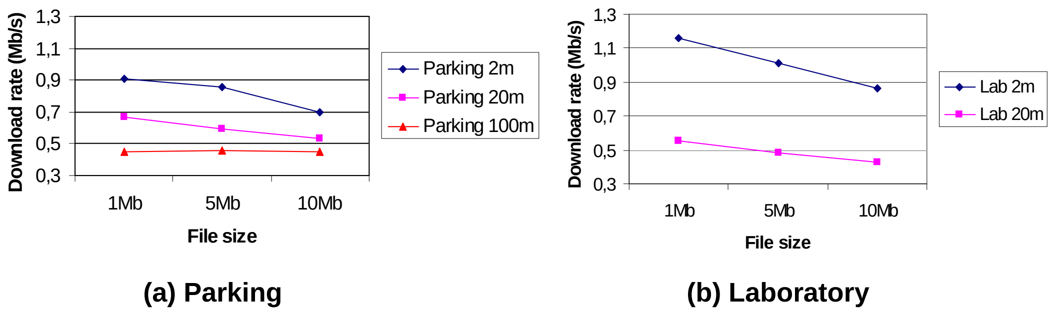

Figure 3: Average download rates considering different distances and file sizes in the Parking(a) and Laboratory(b) scenarios

Figure 4 shows the average number of lost packets in each scenario. We can observe that the number of lost packages increases with the file size and the distance between the laptops. Once again, the worst results are produced in the laboratory because of the obstacles. This fact is very important because we have to take into account that the average download speed is very penalized for each lost packet, depending on the timeout value defined by the application (2 seconds in FSF).

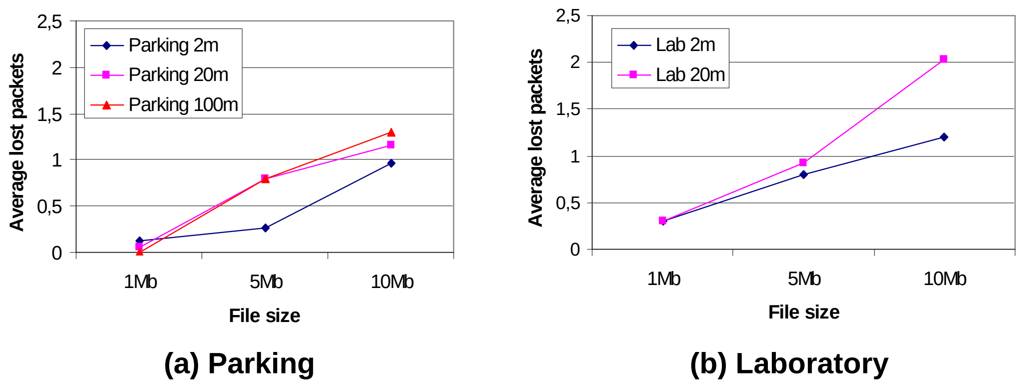

Figure 4: Average of lost packets considering different distances between the devices and file sizes in the Parking(a) and Laboratory(b) scenarios

4 Conclusions

In this deliverable we describe the static experiments of the WiFi equipment at UMA. All the communications have used the ad-hoc of the 802.11g protocol, and the terminals were placed in fixed positions. This technology is considered in CARLINK [1], mainly when transmitting critical car to car data between two MEUs. The tests reveal that it is possible to transfer files between two static terminals separated up to 100m without obstacles. The speed of download obtained values are enough for transmitting low amounts of data (shorter than 1Mb) in reasonable times. In a scenario with obstacles, it is more probable to lose packets, so the download speed decreases notoriously.

References

[1] CARLINK. CARLINK D2.1 - Architecture definition. Chapter 1: Pysical platform overview. CARLINK consortium, September 2007.

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

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

[4] CARLINK::UMA. D2006/10 - VDTP: A File Transfer Protocol for Vehicular Ad hoc Network.

[5] CARLINK::UMA. D2006/9 communications hardware. University of Malaga, February 2006.

[6] CARLINK::UMA. D3.2.2- Design and implmentation of CARLINK (wireless ad-hoc applications): Finding and Sharing Files (FSF). University of Malaga, October 2007.