SIXTH FRAMEWORK PROGRAMME

Information Society Technologies

MORYNE

D7.2 : *MOBILE WIMAX MEASUREMENT SCENARIOS AND CONCEPT*

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II. Abstract

This document presents the Mobile WiMAX measurement scenarios and the concept to obtain the performance of Mobile WiMAX at the network layer. The requirements and the measurement setup will be defined. The measurements are planned in the fourth quarter of 2007 in a WiMAX testbed of Portugal Telecom Inovação at Aveiro in Portugal. The results of the measurement will be used as input for the Mobile WiMAX emulator.

III. Definitions

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IV. Acronyms

BS	base station
IEEE	Institute of Electrical and Electronics Engineers
IETF	Internet Engineering Task Force
IP	internet protocol
LOS	line-of-sight
MAC	medium access control layer
MS	mobile station
NLOS	non-line-of-sight
PHY	physical layer
PT	Portugal Telecom
QoS	quality of service
UMTS	universal mobile telecommunication system
WEIRD	WiMAX Extension to Isolated Research Data networks
WiFi	wireless fidelity
WiMAX	worldwide interoperability for microwave access

1 Introduction

The MORYNE project aims to contribute to better transport efficiency, increased transport safety and more environmental friendly transport by improving traffic management in an urban and sub-urban area [3]. MORYNE will provide a system by using public transport vehicles as elements of a network of mobile sensors communicating with the infrastructure. The public transport vehicles shall be buses. They shall be equipped with sensors and processing devices that collect data on the vehicle environment.

One technical objective is to capture and to understand public transport vehicle surrounding scenes with an appropriate video camera moving with the vehicle and providing real-time video analysis. At important events the control management centre can request a real-time video. The compressed video is streamed over the WiMAX, WiFi mesh or UMTS radio communication network. Snapshots can also be necessary for better traffic understanding and appropriate management decisions. Another innovative aspect of MORYNE is to transmit traffic-focused scene analyses results in real-time to the traffic control centre.

At the end of the MORYNE project the following demonstration is planned: A bus with mobile sensors is driving on the road or standing at a bus stop. From the bus it must be possible to transfer a video stream using one of the available radio communication networks. The maximum driving speed of the bus is 50 km/h. Most bus routes are along urban roads, where buildings, trees or other obstacles are in close vicinity. Consequently the radio communication from the bus to the base station is subject to reflection, scattering or diffraction. Usually there is no direct path to the antenna of the base station. Initially it was planned to use a life WiMAX network in the final demonstration of the MORYNE project based on the IEEE standard 802.16e [1,2], because it seemed to be suitable for this situation and the higher data rates required. However, in the early project phase it became clear that no Mobile WiMAX equipment was expected to be available before end of 2007. Another problem is that Mobile WiMAX can only be operated in licensed frequency bands and there will be no license available for MORYNE in Berlin, where the demonstration shall take place.

To solve the problem, a new real-time Mobile WiMAX emulator instead of the life WiMAX network will be used. It intends to show the performance of the MORYNE demonstrator using a Mobile WiMAX connection. The emulator will work at the IP network layer. To fit the emulator to the behaviour of a real Mobile WiMAX network, several measurements of the IP performance in a life Mobile WiMAX system are necessary. The measurements will be done in an available Mobile WiMAX testbed.

In the document “Report on Mobile WiMAX analysis in MORYNE scenario” [4] the characteristics of Mobile WiMAX and the impact on the MORYNE scenario were pointed out. Based on this requirements for the measurements are extracted.

In this document the concept and the scenarios to do the measurements of the Mobile WiMAX performance are specified. Important aspects include the speed of the mobile terminal and the type of area, e.g. urban or suburban areas. After this the measurement concept is presented, where the details of the measurement setup are explained.

2 Mobile WiMAX measurement scenarios

For performing the measurement, a car is used as means of transport. The car is equipped with a Mobile WiMAX client and moving on a road, Figure 1.

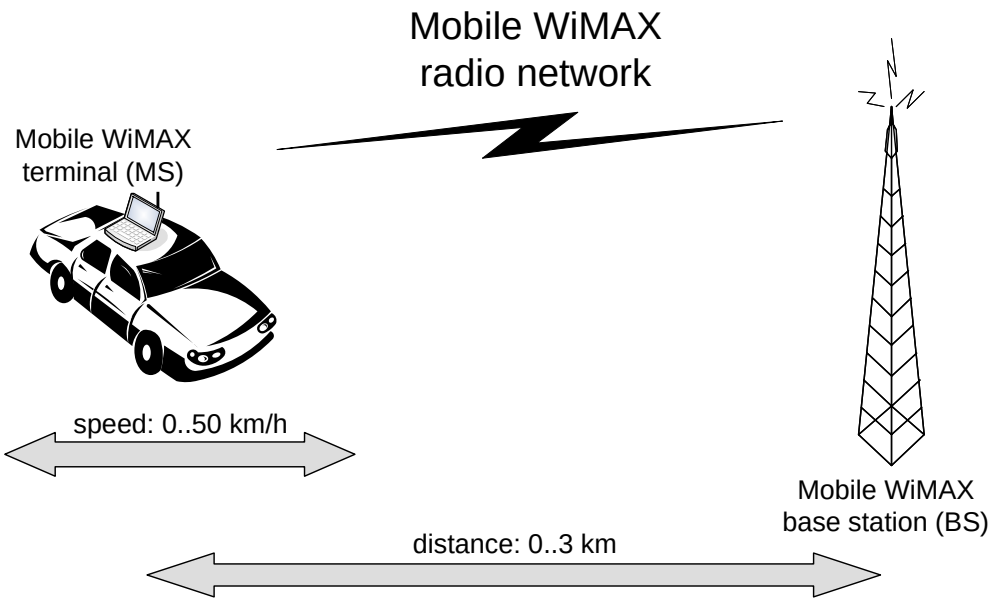

Figure 1: Mobile WiMAX measurement scenario

The Mobile WiMAX client is a Notebook with a connected WiMAX mobile station (MS). The MS is connected to the base station (BS) over a Mobile WiMAX radio link. The car is driving in the coverage area of the Mobile WiMAX network around the basestation. The car is varying the speed as well as the direction and the distance to the base station.

In this case four parameters are important:

- the type of area, where the car is driving,
- the speed of the car,
- the distance from the base station and
- the orientation with respect to the base station.

The type of area can be urban or suburban, the speed between 0 and 50 km/h, the distance between 0 and 3 km and the orientation varies between 0 and 180 degrees.

Different types of area are used to analyse the mobile-radio propagation behaviour [5]. It is expected that the effects of fading will be different as well as the reflection, diffraction, scattering and absorption mechanisms. Furthermore in urban environments the non-line-of-sight (NLOS) situation will be primary existent whereas in suburban environments line-of-sight (LOS) conditions are basically available.

By varying the speed the influence of mobility will be analysed. When a mobile station is moving, the radio channels become time-variant and this results in fading effects. Furthermore the Doppler shift of the carrier frequencies becomes important, which results in interferences and degradation of signal quality.

Also the orientation of the driving car has an influence to the Doppler shift. If the road is parallel to the direct radio path, the effect of the Doppler shift will be high.

The variation of the distance results in different signal strengths. With this the coverage area of the WiMAX radio cell can be determined as well as the sensitivity of the WiMAX receivers at low signal strengths. It can be expected that the available data rate of the WiMAX uplink channel will be decreased by increasing the distance from the basestation.

All effects described have to be compensated by the technology and features of the IEEE 802.16e Mobile WiMAX equipment.

2.1 Urban and suburban scenario

Urban and suburban environments are typically used to analyse the behaviour of mobile radio networks. The characterisation of the different environments is mainly done by the following parameters [5]:

- height of buildings
- width of roads
- building separation
- road orientation with respect to the direct radio path

In an urban environment there are many high buildings which are staying closely to each other. In a suburban environment there is more free space between the buildings and the most buildings are not as high.

To reach the required higher user capacity in a City, the density of base stations in a City is higher than in suburban or rural areas. Hence the BS-to-BS distance and the typical maximum distance of a mobile station to the base station is lower in an urban area.

In the urban environment, the characteristics of Mobile WiMAX radio network should be:

Mobile WiMAX system:	configured to urban values
cell radius:	1 km
MS-to-BS distance:	0..1 km

In the suburban environment, the characteristics of Mobile WiMAX radio network should be:

Mobile WiMAX system:	configured to suburban values
cell radius:	3 km
MS-to-BS distance:	0.5..3 km

2.2 Variation of distance

The cell range should be detected and the coverage area has to be determined. The measurements will be performed between the base station location and the cell edge in steps of 500 meters for the suburban and 200 meters for the urban scenario.

2.3 Variation of street orientation

In the city variation of roads with different orientations have to be used. One road should have the same orientation as the direct radio path, another orthogonal to it. On the road with the same orientation, the car has to drive in both directions, once in the direction to the base station and the other time in the opposite direction away from the base station. The values of the orientation should be:

- 0°
- 90°
- 180°

with a deviation of +/- 10°.

These measurements should be done in the middle of the radio cell area with the maximum speed of 50 km/h.

2.4 Variation of speed

Measurements should be done at three different speeds of the car:

- 0 km/h
- 30 km/h
- 50 km/h

with a deviation of +/- 5 km/h.

The measurements with the different speeds should be done in the vicinity of the base station, in the middle of the radio cell area, and at the edge of the radio cell.

3 Mobile WiMAX measurement concept

The goal of the measurements is to obtain the behaviour of a Mobile WiMAX system at the Internet Protocol (IP) layer. This is done to reduce the complexity of the parameters at the Physical Layer (PHY) and the Medium Access Control Layer (MAC) to some few parameters at the IP layer. Then this few parameters shall characterise the system behaviour of the Mobile WiMAX PHY and MAC together.

Please note that for the MORYNE scenario, transmitting video form a bus, the Uplink of Mobile WiMAX has to be measured.

In the emulator to be build the measured IP statistics will be used to drop and delay the IP packets of an application, e.g. video streaming, accordingly.

3.1 Measurement location

The measurements will take place in Aveiro in Portugal, Figure 2. There Portugal Telecom (PT) Inovação is located. The PT Inovação is involved in the IST project WEIRD [6], focussing on Fixed and Mobile WiMAX testbeds. As agreed with PT Inovação, this testbed will be used to make the measurements for the envisioned MORYNE scenario. The testbed details are not defined yet.

Figure 2: Map of Aveiro in Portugal

3.2 Measurement concept

To define the characteristics of the Mobile WiMAX network at the IP level, the following quality of service (QoS) parameters have to be determined:

- unidirectional connectivity
- unidirectional maximal throughput (bandwidth)
- one-way delay
- one-way delay variation (jitter)
- one-way packet loss
- one- way bursty loss [7]
- packet reordering.

The measurements will be done by the following measurement setup, Figure 3:

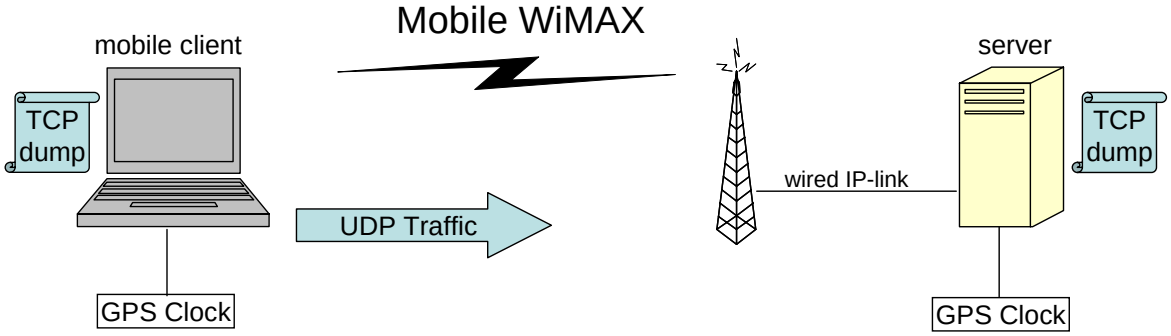

Figure 3: Mobile WiMAX measurement setup

A mobile client is connected to the base station by a Mobile WiMAX radio link. A server is connected to the base station via a cable and the Internet Protocol. Both system clocks are synchronised with the common time-normal of the GPS system, because a high time accuracy is needed. .

The client can send predefined data to the server. When sending the data, client and server will capture the packets and save them with a timestamp. After the measurement, a post-processing is performed by comparing the clients and the servers data to get the required QoS parameters.

Before a measurement is started, the following parameters must be predefined: the maximal data rate, packet size, number of sending packets and duration of the measurement. All parameters should be adapted to the video streaming planned in the MORYNE scenario.

When the client is starting, the measurement packets are generated and sent via UDP socket connections. The packets are prepared with defined areas in the data payload field. The special header in the data field is defined as:

| *sequence number* | *sending timestamp* | *packet length* | *random characters* |

The first header is provided with a sequence number, space for a timestamp, packet length and randomised user data, which is inserted until the specified, constant packet length is reached. Then the packet gets timestamp information and is sent to the socket. This sequence continues until the last packet is sent or the user has cancelled the measurement.

The server receives the incoming packets from the socket, appends a timestamp and an incoming sequence number to the packet header information and stores this information in a data field. The data field is defined as:

| *incoming seq.-no.* | *incoming timestamp* | *seq.-no.* | *sending timestamp* | *packet size* |

The user data payload is discarded, because it is not needed for the measurement information. If the computer is running out of memory, a signal is sent to the transmitter to stop the measurement. After each measurement sequence the received data and the sent data are written to a file. In addition the sender creates a logfile containing the configuration parameters and input of the user during each measurement. Also the filename consists of the name of the configuration, the current time and date.

Now the stored measurement data can be used for postprocessing and determination of the required values of the parameters to characterise the Mobile WiMAX behaviour. Furthermore these results will be the input for the Mobile WiMAX emulator, so that an emulation of the Mobile WiMAX can be done at the IP layer.

4 Literature

[1] IEEE Std 802.16-2004 – IEEE Standard for Local and Metropolitan Area Networks – Part 16: Air Interface for Fixed Broadband Wireless Access Systems, October 2004

[2] IEEE Std 802.16e-2005 – Amendment to IEEE Standard for Local and Metropolitan Area Networks – Part 16: Air Interface for Fixed and Mobile Broadband Wireless Access Systems – Physical and Medium Access Control Layers for Combined Fixed and Mobile Operations in Licensed Bands, February 2006

[3] MORYNE: Annex I - Description of work - V4.1, December 2006

[4] MORYNE: Report on Mobile WiMAX Analysis in MORYNE Scenario, June 2007

[5] COST Action 231: Digital mobile radio towards future generation systems, final report, European Communities, EUR 18957, 1999

[6] WEIRD – WiMAX Extension to Isolated Research Data networks, Integrated project IST-034622-IP, 2006-2008, http://www.ist-weird.eu

[7] R. Koodli, R. Ravikanth: One-way Loss Pattern Sample Metrics, RFC 3357, IETF, August 2002

