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Abstract

This document provides detailed information about the integration process and laboratory tests of all SUIT components. These tests are used to detect integration problems and to verify the system performance. They were also very useful to minimise the risks associated with the trial fields since part of the test bed will be deployed into two sites in Aveiro city. This report outlines the results of the work done, modifications and all the tests. It also reports all partners components and contributions for the test bed

Keyword list: Tests bed, play-out, gateway, field trials, integration, SUIT components.

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Test bed report

SUIT_438

31 January 2008

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1 Introduction

1.1 Scope

This document is part of WP6 – Integration, performance evaluation and validation - and is related with Activity 6.3 ”Integration and test-bed/field trials”.

A laboratory work has been conducted before the field trials, integrating all SUIT components. Exhaustive tests according to SUIT propose has been performed. These tests have consisted in, simulating in the laboratory conditions that we will expect to find in the field. The test bed is a previous step towards the field trials. It is used to detect and address integration issues, confirm the operation of the “end to end” SUIT chain and minimise the problems that could be faced in the fieldwork. This deliverable follows all measurement procedures described in document SUIT_437_WP6_D6.1_Performance_metrics_definition.

In Section 2, we describe the tests plans. Section 3 describes all tests performed according to the tests plans. Section 4 lists all partners’ contributions to the test bed and obviously to the future field demonstrations. Finally, some conclusions are drawn in Section 5.

1.2 Objective and aims

The basic main objectives that we intended to achieve in laboratory were:

- Test the whole SUIT chain.
- Check the implementation constraints of SUIT solution;
- Make the necessary corrections to guarantee the expected performance;
- Assure that the field trials risks are minimised.

2 Test bed design and operations

In order to obtain the best results, a work plan with detailed and systematic test bed design was drawn. The laboratory tests were split into several steps. The whole process was divided into four phases. In the first phase we plan integrating the real-time SVC encoder in the SUIT system. In all phases where we want to test the end-to-end chain, throughput measurements should be used to evaluate the performance of the SUIT solution. In the phase 2, video streams and Internet traffic will be sent from the play-out to the gateway and from the Playout to the Terminal without the RF elements of the chain. For this, an Ethernet cable will be used to connect the play-out to the gateway in place of the RF elements.

In phase 3, the RF components should be added progressively. The tests will be carried out step-by-step, starting on the simplest configuration and moving toward to the most complex. All the SUIT profiles will be tested (except the mobile profile) according to the following draws.

Finally, an ENG test should be conducted in order to verify the WiMAX uplink video quality.

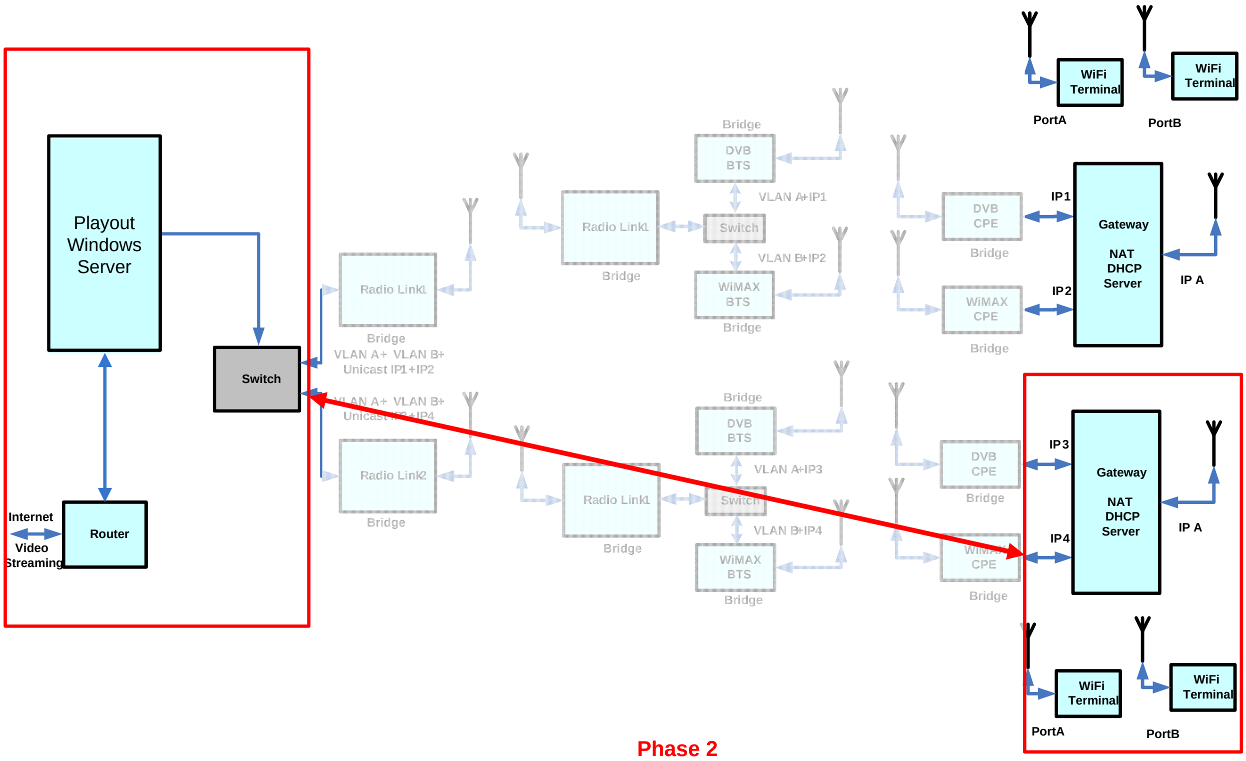

Figure 2-1: Suit platform - Phase 2 tests

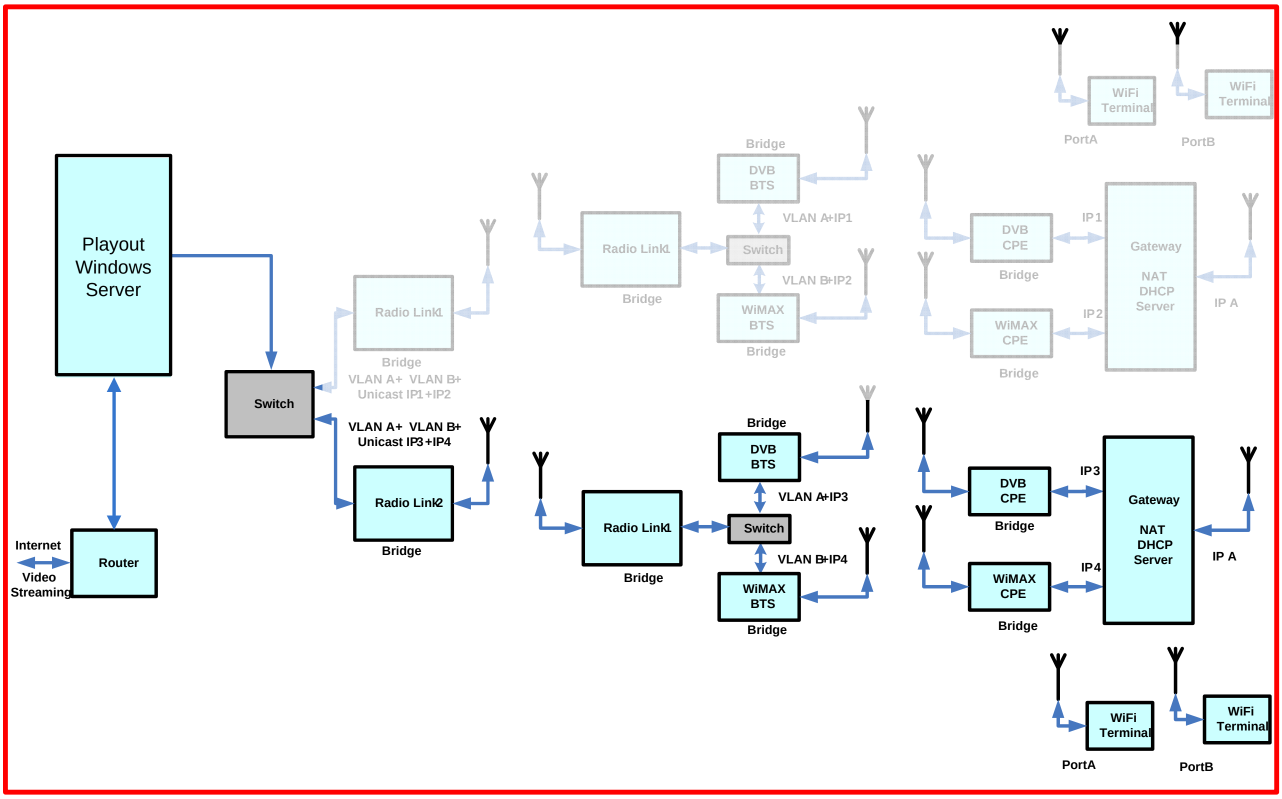

Figure 2-2: Suit platform - Phase 3 tests

2.1 *SVC real-time codec integration (Phase1)*

We will start SUIT tests by integrating the SVC real-time codec in the play-out, gateway and SUIT terminal.

These are the possibilities of the SVC CODEC considering RTP streaming in a basic application example i.e., a SVC encoder (server) sending a RTP stream to a SVC decoder/terminal (client).

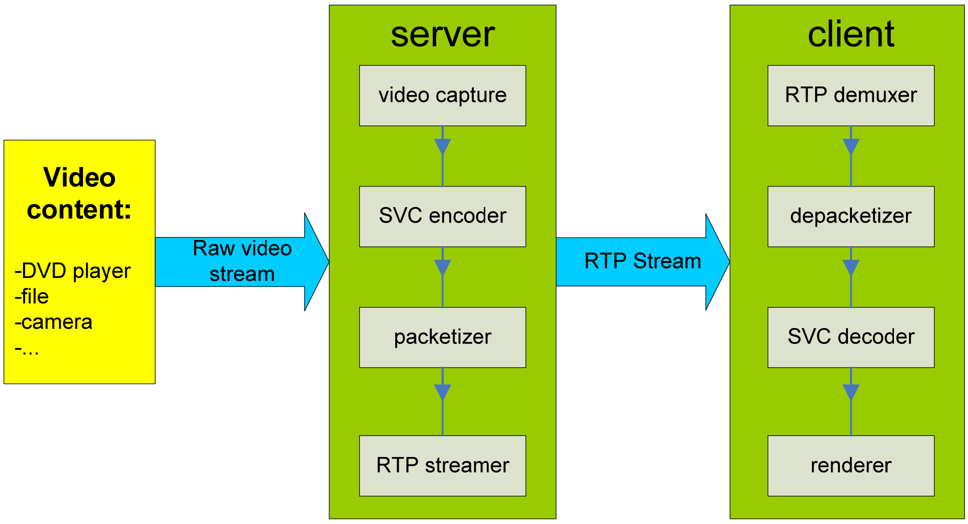

Figure 2-3: Basic RTP server/client application

In the SUIT integration scheme, the client is actually the Playout, receiving live video from the server, i.e., the real time video encoder.

The server/client application can run on a single PC with several clients onto it showing the different SVC layers (different video resolution and qualities).

Integration of Vitec's Realtime SVC encoder inside the SUIT architecture is described in figure 2-4: MDC-1 component and the SVC encoder are now communicating through an RTP stream.

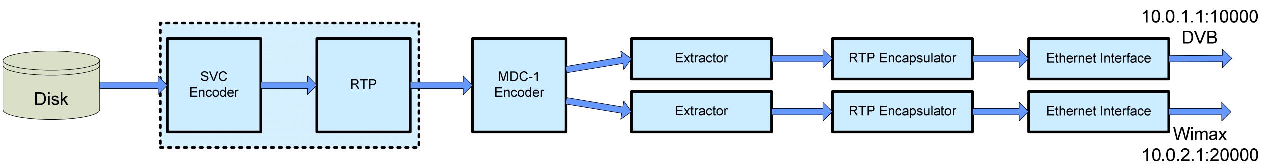

Figure 2-4: Play-out Architecture

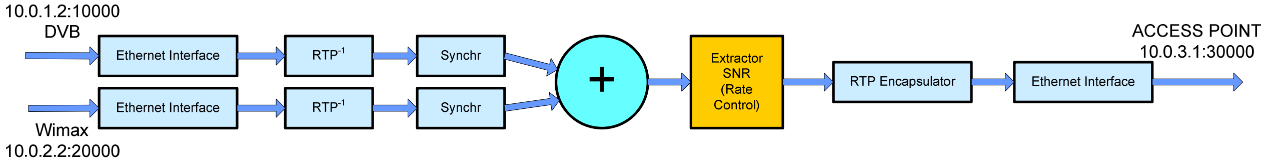

Figure 2-5: Gateway Architecture

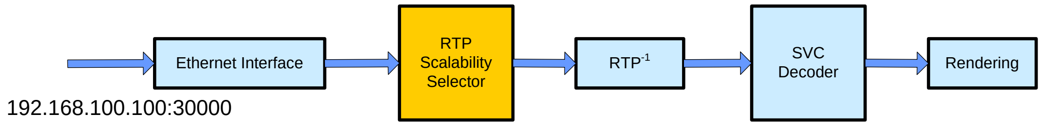

Figure 2-6: Terminal Architecture

2.2 *Without RF chain (Phase 2)*

This will be the first stage. In this phase, we plan to test the integration of all elements of the play-out, the gateway and terminal according to Figure 2-7.

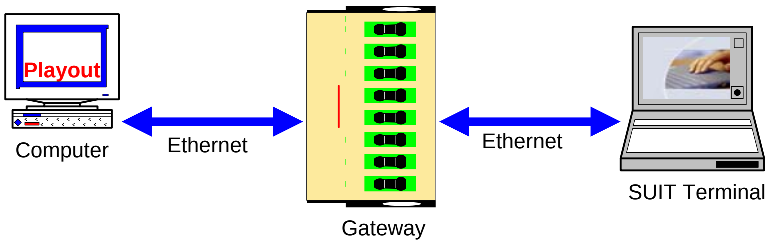

Figure 2-7: Play-out, Gateway and terminal test

2.3 *With RF chain (Phase 3)*

In this phase, the RF elements will be added to the chain, according to the SUIT platform. With the DVB-T tests the rural profile will be used. On the last stage (all chain), we should test the rest of the SUIT profiles (building and STB). To simulate the field environment and ensure the correct RF levels according to the technical characteristics of the equipments, the required attenuators were used.

2.3.1 DVB-T/RCT

We will start this phase by testing SUIT performance with only the DVB-T components inserted. For this test we will use the rural profile (a CPE with an access point).

2.3.1.1 DVB-T/RCT set up without Power Amplifier

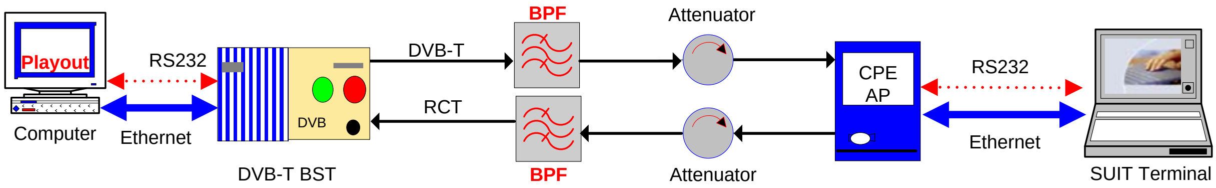

Figure 2-8: DVB-T/RCT test

The UHF BPF filters should be tuned for the chosen channels and the link should be established. After, the throughput tests will be conducted.

2.3.1.2 DVB-T/RCT set up with Power Amplifier

The DVB-T power amplifier should be inserted and throughput tests should be carried out

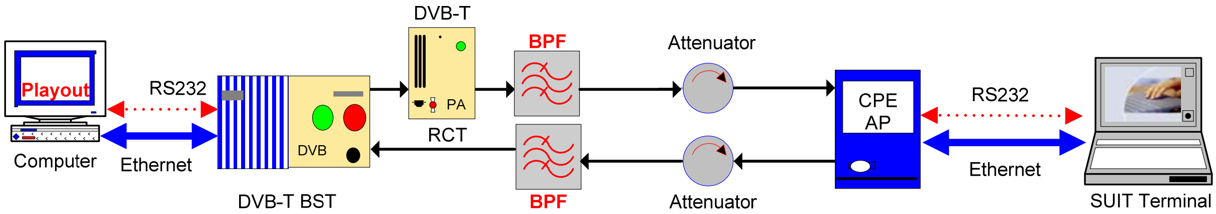

Figure 2-9: DVB-T/RCT with PA test

2.3.1.3 DVB-T/RCT set up with Power Amplifier and Radio Links

In this stage, a radio link will be inserted between the play-out and the DVB-T base station.

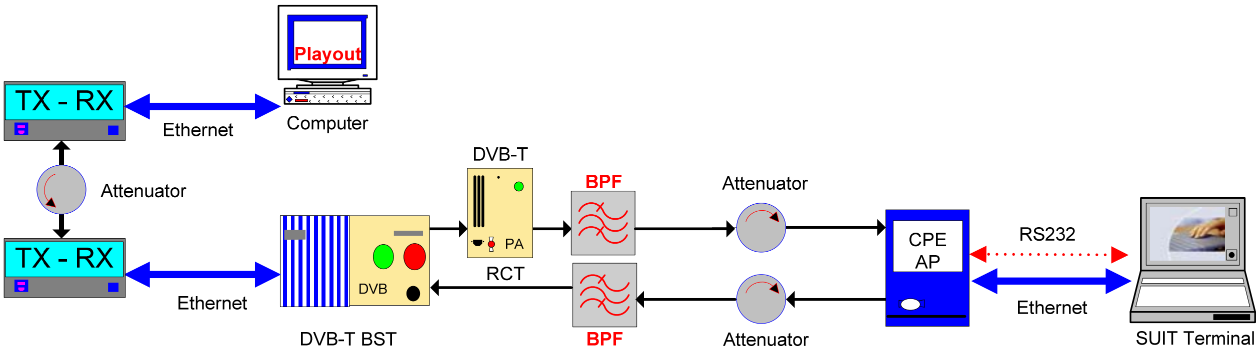

Figure 2-10: DVB-T/RCT with RL test

2.3.2 WiMAX

In this point we will conducted the tests replacing the DVB-T equipment by WiMAX base station and WiMAX power amplifier. The rural profile will be replaced, as well, by the building profile.

2.3.2.1 WiMAX set up without Power Amplifier

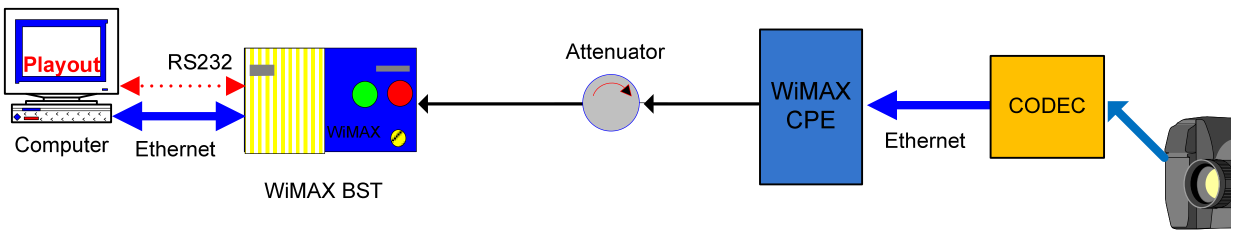

Figure 2-11: WiMAX test

The link should be established and throughput tests should be conducted.

2.3.2.2 WiMAX set up with Power Amplifier

A WiMAX Power Amplifier will be added to the chain.

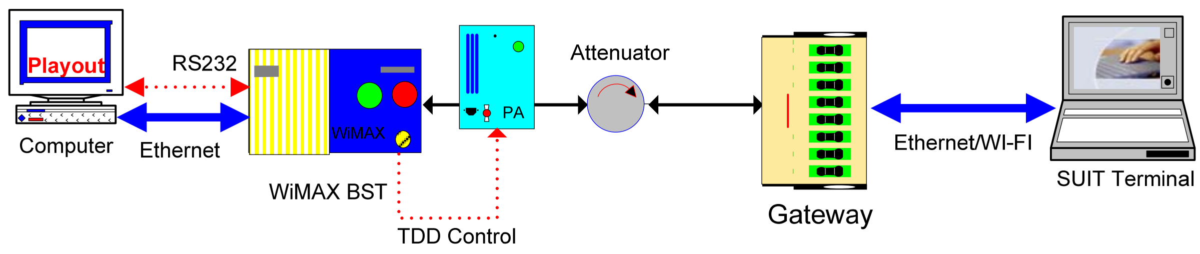

Figure 2-12: WiMAX with PA test

2.3.2.3 WiMAX set up with Power Amplifier and Radio Links

In this stage, a radio link will be inserted between the play-out and the WiMAX base station.

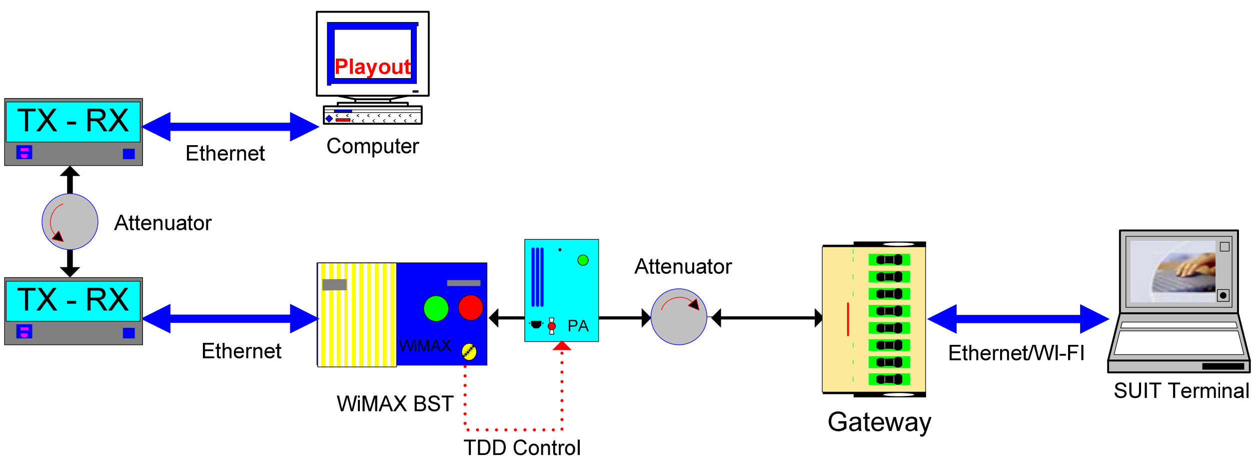

Figure 2-13: WiMAX with RL test

2.3.2.4 WiMAX hand over set up

In this point a horizontal hand over test will be performed. Acting on the attenuators, we will vary the level of the attenuation on each channel, simulating the real conditions for the WiMAX hand over tests.

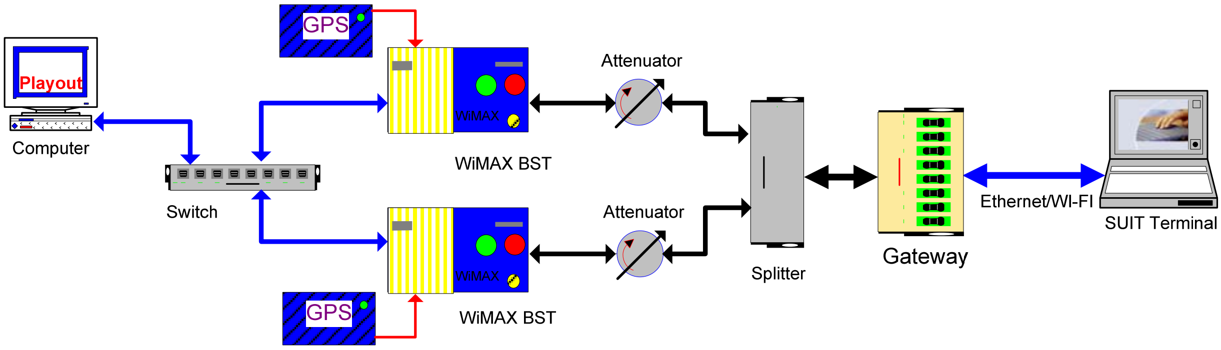

Figure 2-14: WiMAX HO test

2.3.3 All Chain (DVB-T/RCT and WiMAX) set up

In this stage, the most complex test will be carried out. All SUIT components should be integrated to evaluate the performance of the SUIT platform. All the SUIT profiles (except vehicular profile) will be exhaustively tested.

2.3.3.1 Building profile

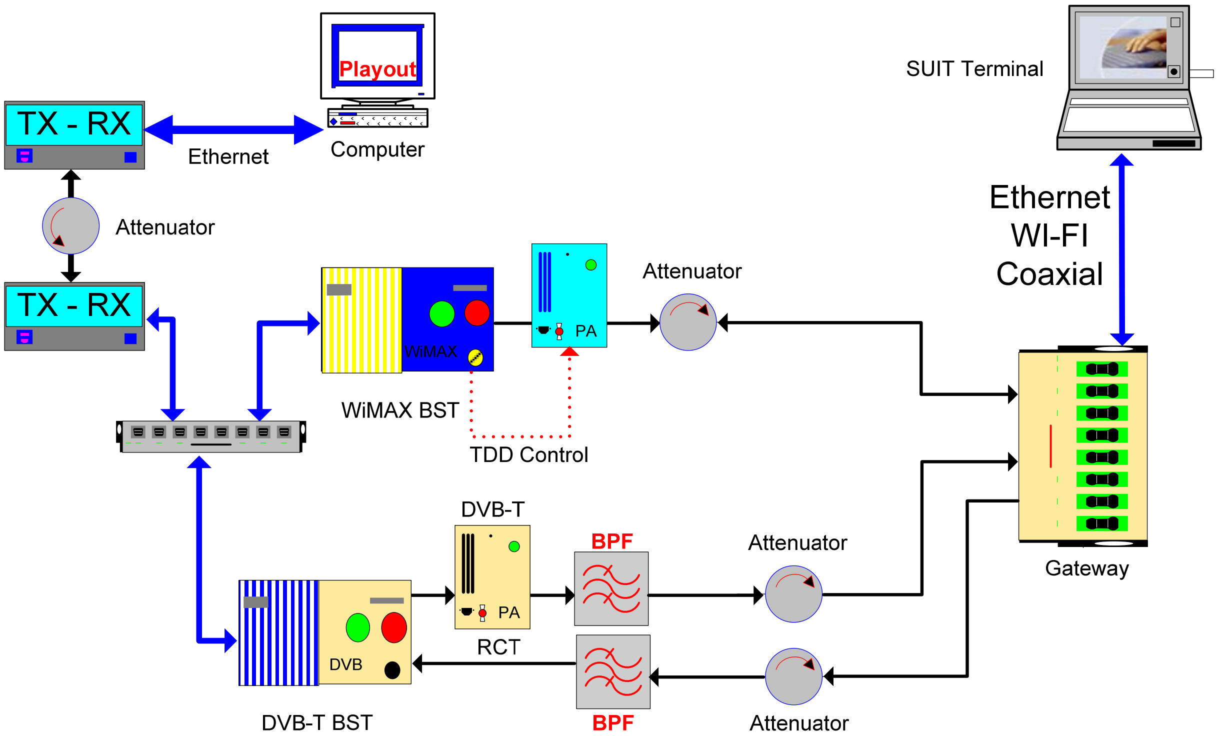

Figure 2-15: Building profile test

2.3.3.2 STB profile

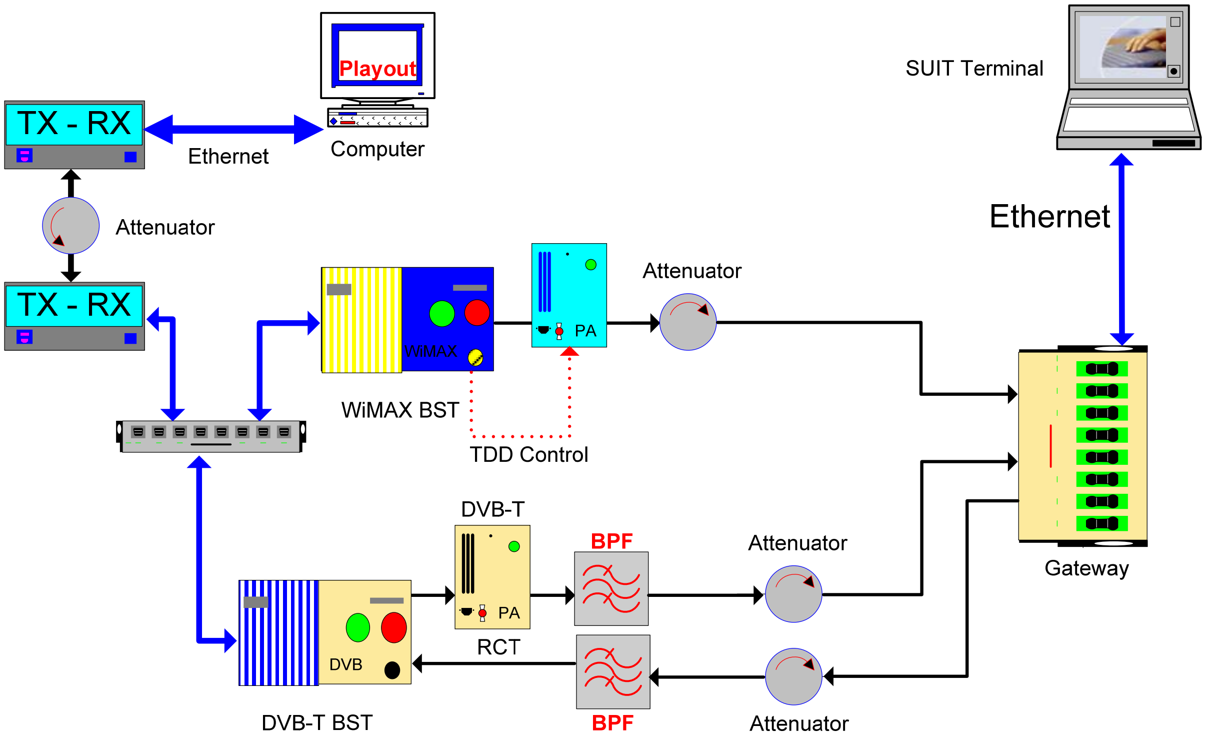

Figure 2-16: STB profile test

2.4 ENG setup (Phase 4)

In this stage a real-time video stream will be send over the WiMAX uplink into the play-out. Some measurement tests will be carried out.

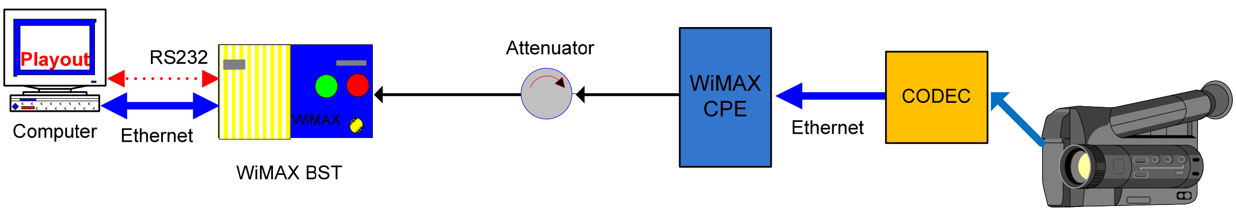

Figure 2-17: ENG test lay-out

3 Operations and results

We started the integration and the test beds in 10Th of the December and it lasted five days. People from UPM, URL, IBBT, IT, UniS and MCT attended this Aveiro meeting. We followed the plan previously defined according to the section 2. During this meeting, we made some important integration progresses. However, we realized that some work should be done in some components and after we should join again in another integration meeting. This new meeting took place again in Aveiro, Portugal, between 21 and 25 of January 2008. People from UPM, URL, IBBT, IT, UniS, MCT, IRT and WAVECOM attended this integration meeting.

Figure 3-1: Lab tests work in IT

The work described here has been performed collaboratively among the members of the SUIT partners who attended the meetings.

3.1 Tests characterization

To verify the correct operation of the whole SUIT chain, a throughput test was performed. SD and HD video streams were delivered from the play-out to the terminal over the SUIT network. The video streams received in the terminal were analyzed and compared with the source video streams. To help us finding packet losses, latency and other network constraints, a Network Protocol Analyzer tool was inserted in crucial points of the path (see Deliverable D6.1-Metrics), namely in the different interfaces along the SUIT chain. IP unicast and IP multicast tests have been carried out, as well.

3.2 SVC real-time codec integration (Phase 1)

It was intended to integrate two SVC real-time encoders (see Deliverables 5.8 and 5.10), one SD-SVC-MDC-1 and another HD-SVC-MDC-1 into the SUIT platform according to the test bed work plan. We integrated the two SVC encoders within SUIT chain and after some minor corrections in software, we verified the acceptable performance of the encoders. In first tests, the quality of the encoded video in HD, was not good. Vitec updated the software and solved this problem.

End to end tests have been performed, sending H.264 video sequences from the play-out over the SUIT Network to the terminal. This video was received with the expectable quality on the terminal.

3.3 Without RF chain (Phase 2)

In this stage, SD video streams were delivered over the SUIT system with success. All the SUIT components have behaved properly with IP unicast and IP multicast. Internet traffic was tested also with success (traffic shaping and proxy worked properly).

With HD video streams, we have experienced some trouble. HD with IP unicast was tested with relative success. Some work was done to optimize HD VoD and now the HD VoD is working properly.

After some difficulties in software SUIT components, HD video streams with IP multicast have been tested with success.

3.4 With RF chain (Phase 3)

In this phase the RF elements were added progressively to the chain, according to the SUIT platform and as planned.

The last wireless component in the SUIT chain is the Access Point. Our tests using a D-Link AP with reference DIR-655 showed that it does not worked properly in multicast. However, by changing the AP firmware, the AP worked properly in multicast but it did not show a good performance in unicast. We have updated the firmware with some tuning work and now it working properly.

3.4.1 DVB-T/RCT tests

We started this phase, testing SUIT performance with only the DVB-T components inserted. For this test the rural profile was used (a CPE with an access point).

Following the plan, the UHF BPF filters were tuned for the chosen channels.

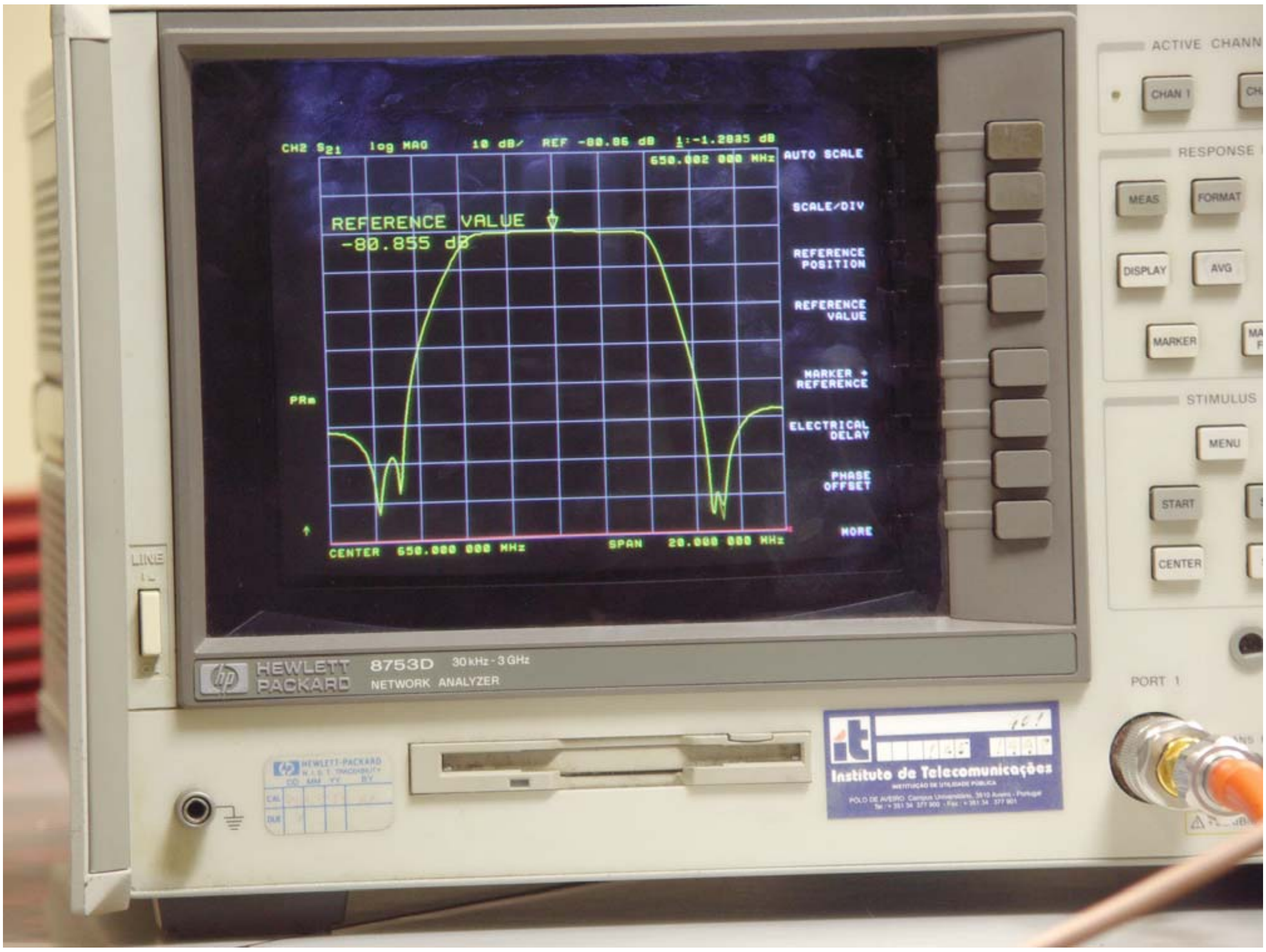

Figure 3-2: Filter curve

Then, the link between the DVBT BST and the CPE was established.

DVBTRCT – DVBTCPE Integration summary:

- Base station DVBRCT was configured to output power 0dBm (Using gdb

browser);

- CPE received level: -67dBm (after 60db attenuators);

- CPE transmit level (PWR REF)= -26dBm (PWR REF should be more than -30dBm and less than 0 dBm);

- Link was established (Ping traffic was operated).

Afterwards, a throughput measurement has been made with a professional tool names IxChariot, which is the Industry’s leading test tool for simulating real world applications to predict device and system performance by simulating hundreds of protocols across of network endpoints. The BST was configured with 64QAM Modulation and ½ code rate. We did the tests with RTP protocol and we only achieve 7.5 Mbit/s down link throughput maximum.

IxChariot

Summary - C:\Dokumente und Einstellungen\ixia\Desktop\SUIT\DVBT-RCT-RTP-Down8M.tst

Console version	6.50
Console build level	60
Console product type	IxChariot
Filename	C:\Dokumente und Einstellungen\ixia\Desktop\SUIT\DVBT-RCT-RTP-Down8M.tst
Run start time	Freitag, 25. Januar 2008, 13:10:21
Run end time	Freitag, 25. Januar 2008, 13:10:58
Elapsed time	00:00:37
How the test ended	Ran to completion
Number of pairs	1

Run Options

End type	Run until any pair ends
Reporting type	Real-time
Automatically poll endpoints	Yes
Polling interval (minutes)	1
Stop run upon initialization failure	Yes
Connect timeout during test (minutes)	0
Stop test after this many running pairs fail	1
Collect endpoint CPU utilization	No
Collect TCP statistics	No
Allow pair reinitialization for setup	No
Maximum number of setup reinitializations	3
Setup reinitialization wait interval (milliseconds)	10
Allow pair reinitialization at runtime	No
Maximum number of runtime reinitializations	3
Runtime reinitialization wait interval (milliseconds)	10
Validate data upon receipt	No
Use a new seed for random variables on every run	Yes
Datagram window size (bytes)	1500
Datagram retransmission timeout (milliseconds)	200
Datagram number of retransmits before aborting	50
Receive Timeout (milliseconds)	10000
Time To Live (Hops)	32
Enable Ixia hardware timestamps	Yes
Clock synchronization	'Endpoint'
Use RTP extended headers	No

Figure 3-3: DVBT-RCT DL throughput test configuration

Test Setup (Console to Endpoint 1)

Group/ Pair	Console Knows Endpoint 1	Console Protocol	Console Service Quality	Pair Comment
All Pairs				
Pair 1	10.0.1.52	TCP	n/a	

Test Setup (Endpoint 1 to Endpoint 2)

Group/ Pair	Endpoint 1 Knows Endpoint 2 (Setup)	Endpoint 2 Setup Protocol	UDP compliant with RFC768
All Pairs			
Pair 1	10.0.1.50	TCP	n/a

Test Execution (Endpoint 1 to Endpoint 2)

Group/ Pair	Endpoint 1	Endpoint 2	Network Protocol	Service Quality	Script/Stream Name
All Pairs					
Pair 1	10.0.1.52	10.0.1.50	RTP		IPTVv.scr

Throughput

Group/ Pair	Average (Mbps)	Minimum (Mbps)	Maximum (Mbps)	Throughput 95% Confidence Interval	Measured Time (secs)	Relative Precision
All Pairs	**7,884**	**4,166**	**9,012**			
Pair 1	7,895	4,166	9,012	0,060	36,774	0,759
Totals:	**7,884**	**4,166**	**9,012**			

Figure 3-4: DVBT-RCT DL throughput values

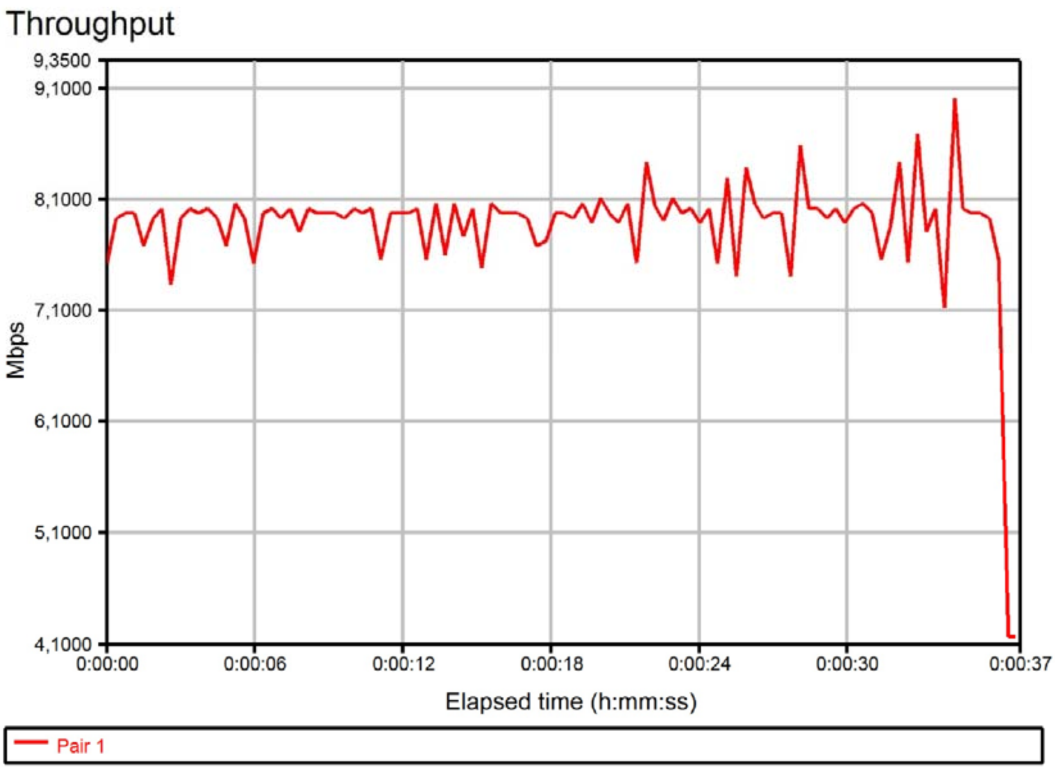

Figure 3-5: DVBT-RCT DL throughput measurements

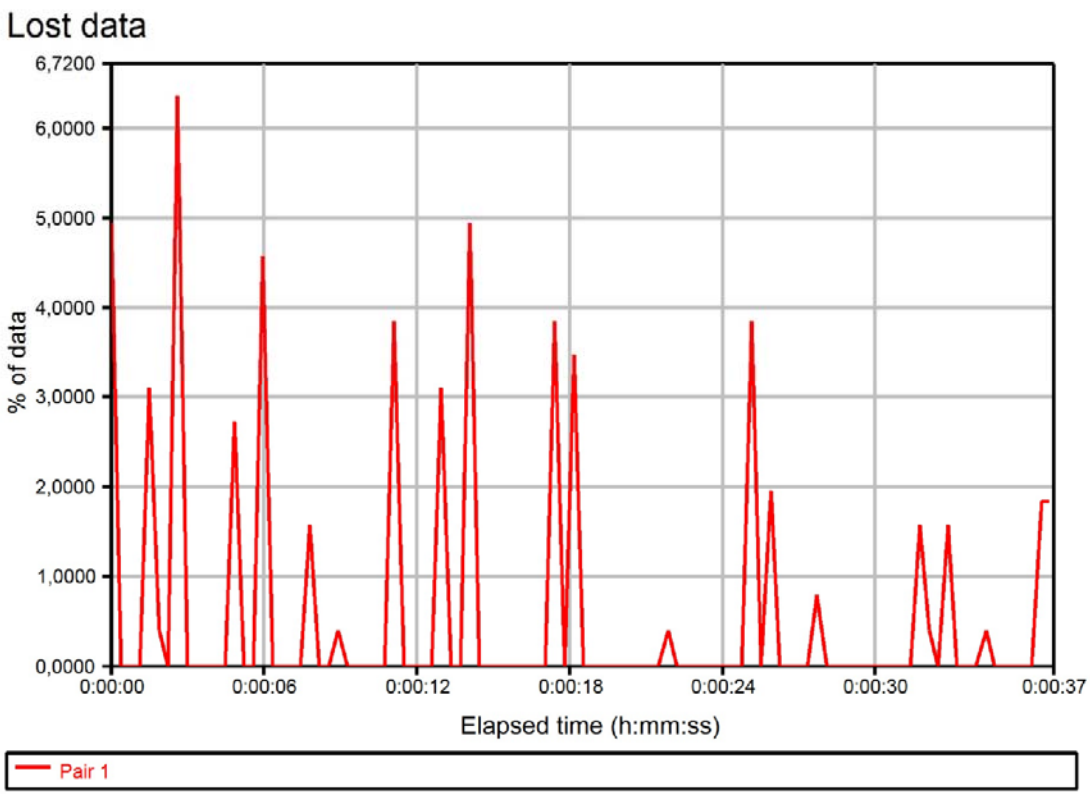

Figure 3-6: DVBT-RCT Lost data measurement

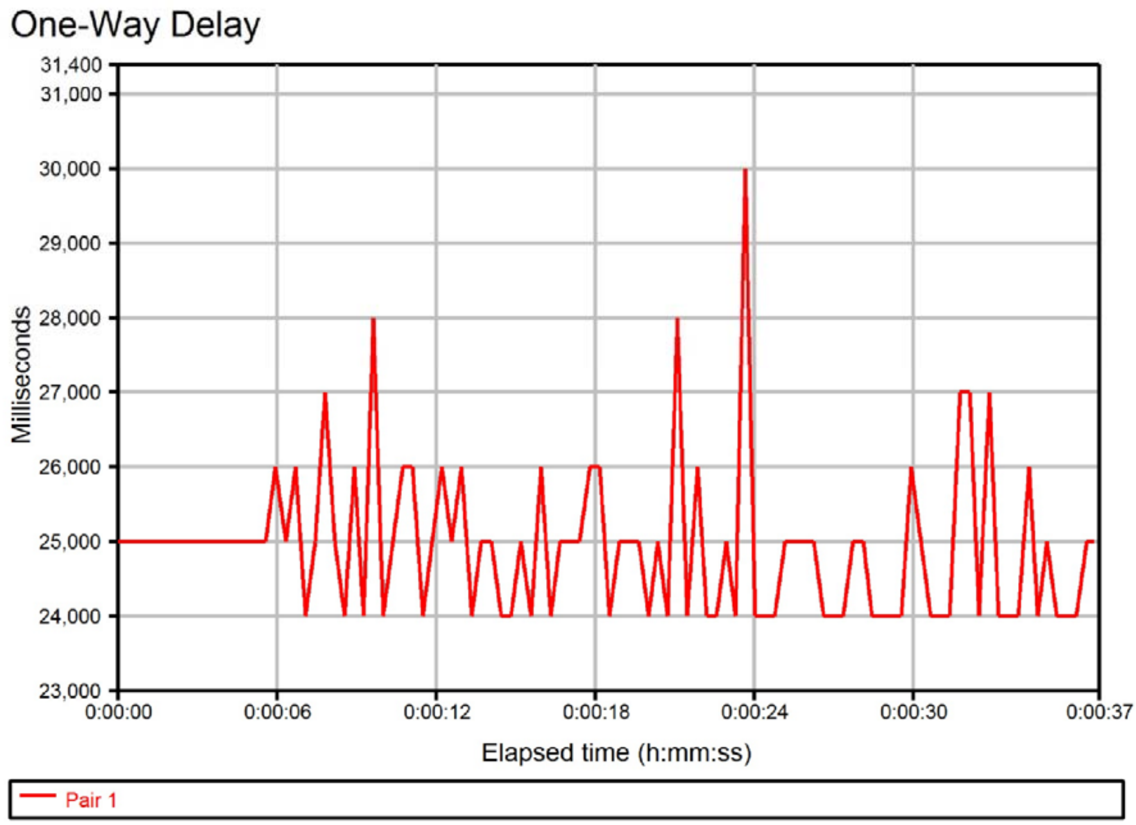

Figure 3-7: DVBT-RCT delay measurement

We sent an SD video stream with IP unicast and worked well. After, a video stream was sent, in IP multicast, over the link. We found that the DVBT BST was blocking IP multicast traffic. This problem was reported to the RUNCOM staff.

3.4.2 DVB-T/RCT tests with Power Amplifier and Radio Links

We started with the PA integration in the chain.

DVBTRCT – DVBTCPE with PA Integration summary:

- Power Amplifier gain =40dB
- Power Amplifier was configured to output power of +40dBm (10Watt), with 0dBm input from DVBRCT BST
- Output Power of Power Amplifier was measured with spectrum analyzer: -30dBm (after 70dB attenuators);
- CPE received level: -67dBm (after 100db attenuators)
- CPE transmit level (PWR REF)= -26dBm (PWR REF should be more than -30dBm and less than 0 dBm)
- Link was established (Ping traffic was operated).

With the DVB-T power amplifier inserted in the chain and with the radio links, the results of the tests were the same as without the power amplifier.

3.4.3 WiMAX tests without Power Amplifier

We began this test linking the BST and the WiMAX CPE.

WiMAX BST – WiMAX CPE Integration summary:

- Base station DVBRCT was configured to output power 0dBm ;

- CPE received level: -61,9 dBm (after 55db attenuators);

- CPE transmit level (PWR REF)= -33dBm (The level REF received on the BST should be more than -96 dBm and less than -60 dBm. In our case, -33 dBm plus -55 dBm equal -88 dBm wich is inside the range);

- Link was established (Ping traffic was operated).

We decided that we will measure the DL a UL throughput during the ENG tests (see 3.5 section below)

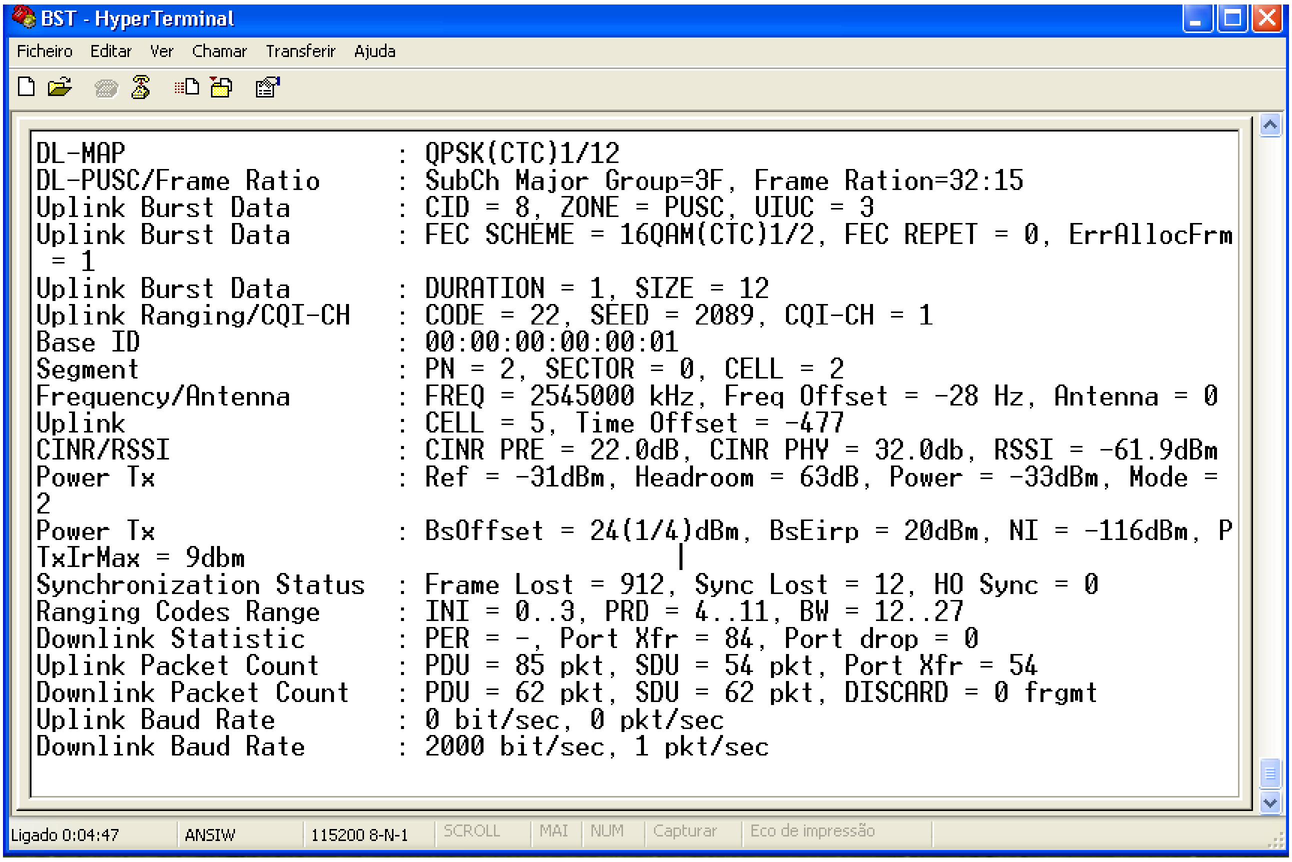

Figure 3-8: WiMAX link values

After, the BST was configured to allow IP multicast traffic.

We sent SD video streams with IP unicast and IP multicast with success. Internet traffic was tested as well with success. We did not test HD video streams during the first tests. Before setting up the Sites for the field trials, we tested the WiMAX downlink with one HD sequence and it worked well.

3.4.4 WiMAX tests with Power Amplifier and Radio Links

We inserted the Power Amplifier and established the link between the BST and the CPE. After, we added the Radio Links to the chain.

WiMAX BST – WiMAX CPE with PA Integration summary:

- Power Amplifier (10 Watts maximum output power with 10 dB back off) was configured to output power of +30dBm (1Watt), with 0dBm input from WiMAX BST

- Output Power of Power Amplifier was measured with spectrum analyzer: -30dBm (after 60dB attenuators);

- CPE received level: -61,9dBm (after 65db attenuators)

- CPE transmit level (PWR REF)= -23dBm (The level REF received on the BST should be more than -96 dBm and less than -60 dBm. In our case, -23 dBm plus -65 dBm equal -88 dBm wich is inside the range);

- Link was established (Ping traffic was operated).

We done the same tests we have done before without the PA and we got the same results.

3.4.5 WiMAX hand over tests

We performed these HO tests in lab according to the test bed plan. Everything run well and minor adjusts in BST parameters were made.

3.4.6 All Chain (DVB-T/RCT and WiMAX) tests

In the first integration meeting we have realized that the DVBT-RCT BST was not working properly with IP multicast. Runcom fixed this issue and after, the tests with the RF chain, in laboratory, have occurred with success.

3.5 ENG (Electronic News Gathering) tests

Electronic news gathering is about to transmit current events to the Play-out Centre.

The equipment that we have built is mobile and fully battery operated. It is consist of DV-Camera, H264/AAC Encoder, WiMAX CPE and a Battery pack.

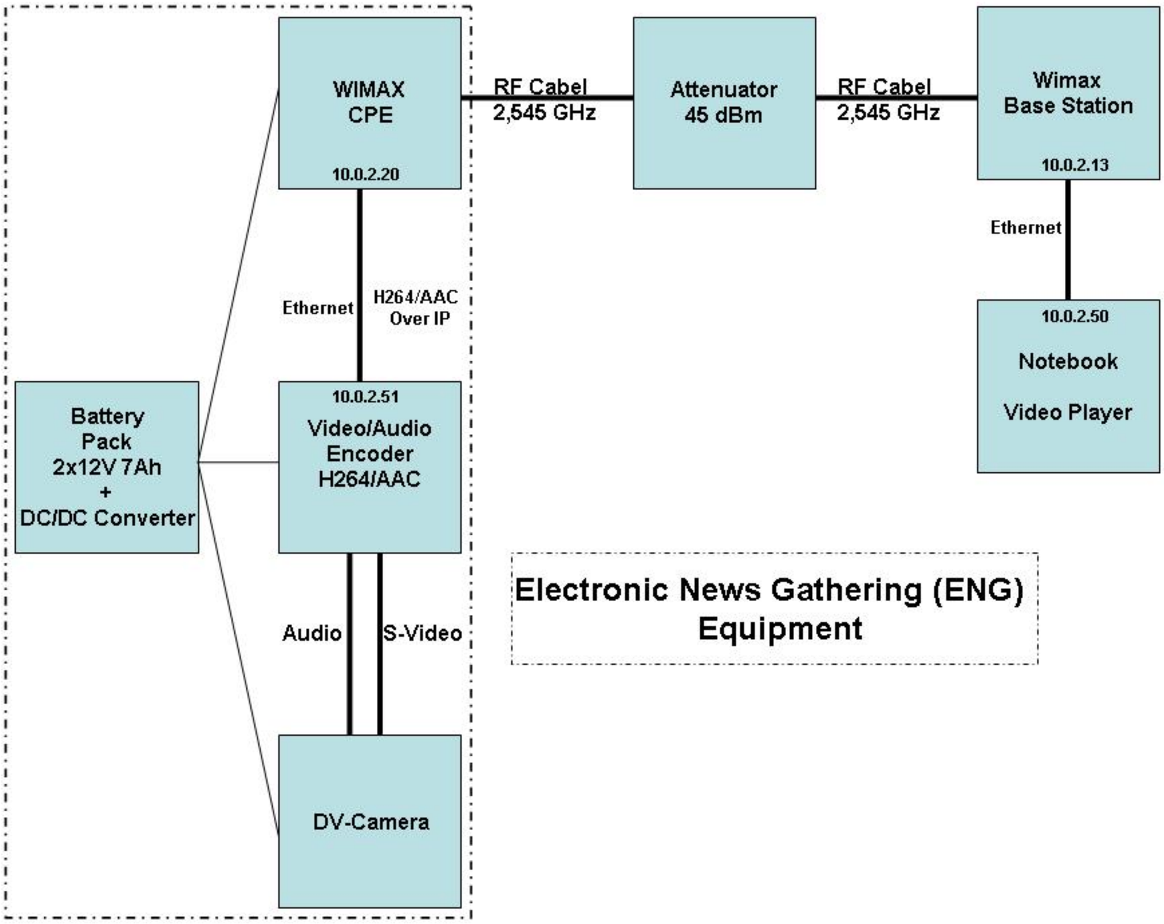

Figure 3-9: ENG lay-out test

The Battery pack has a volume of 7Ah and it is sufficient to operate the ENG equipment for about 7 hours. The DV-Camera delivers the captured Video/Audio Signal to the encoder to be encoded in H264 for Video and AAC for Audio. The encoder transmits the encoded Signal over IP through the Ethernet Interface to the WiMAX CPE.

The first ENG Tests was done in the Lab. we have connected the WiMAX CPE with the Base Station over a cable with attenuators. The CPE has a transmit Power of 20dBm and the BST can take Max -10dBm at the input. Therefore, a 45 dB attenuator has been inserted to decrease the received signal level at the CPE input. The BST transmit power can be varied between -20 dBm until 30dBm.

To decode the received Signal we have connected a Notebook to the BST over the Ethernet Interface. On the Notebook is a H264/AAC Decoder Software installed to monitor the received signal.

The first tests indicated some trouble with the throughput of the BST. We were not able to transmit Video/Audio Streams that have more then 1.3Mb/s of data rate in the Uplink (RSSI -51 dBm CNIR 35 dB Modulation 16QAM). That is why it was necessary to do some throughput measurement of the system. The throughput measurement has been made with a professional tool names IxChariot, which is the Industry’s leading test tool for simulating real world applications to predict device and system performance by simulating hundreds of protocols across of network endpoints.

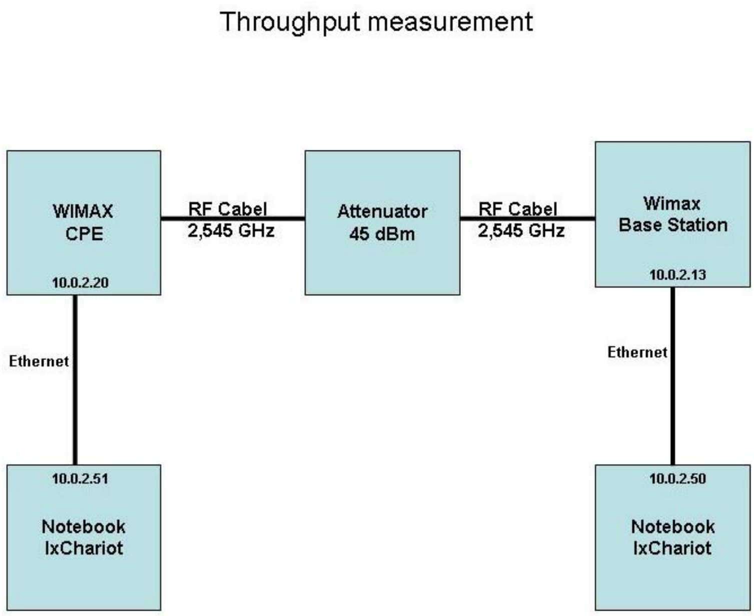

Figure 3-10: Throughput test

At first, the Uplink throughput has been measured by emulating RTP traffic over the network by different data rate. The measurement proved that the maximal possible RTP data rate in the Uplink was about 1.4 Mb/s. Increasing the RTP data rate above 1.4 Mb/s caused high lost of data and delays as we can see in the pictures below.

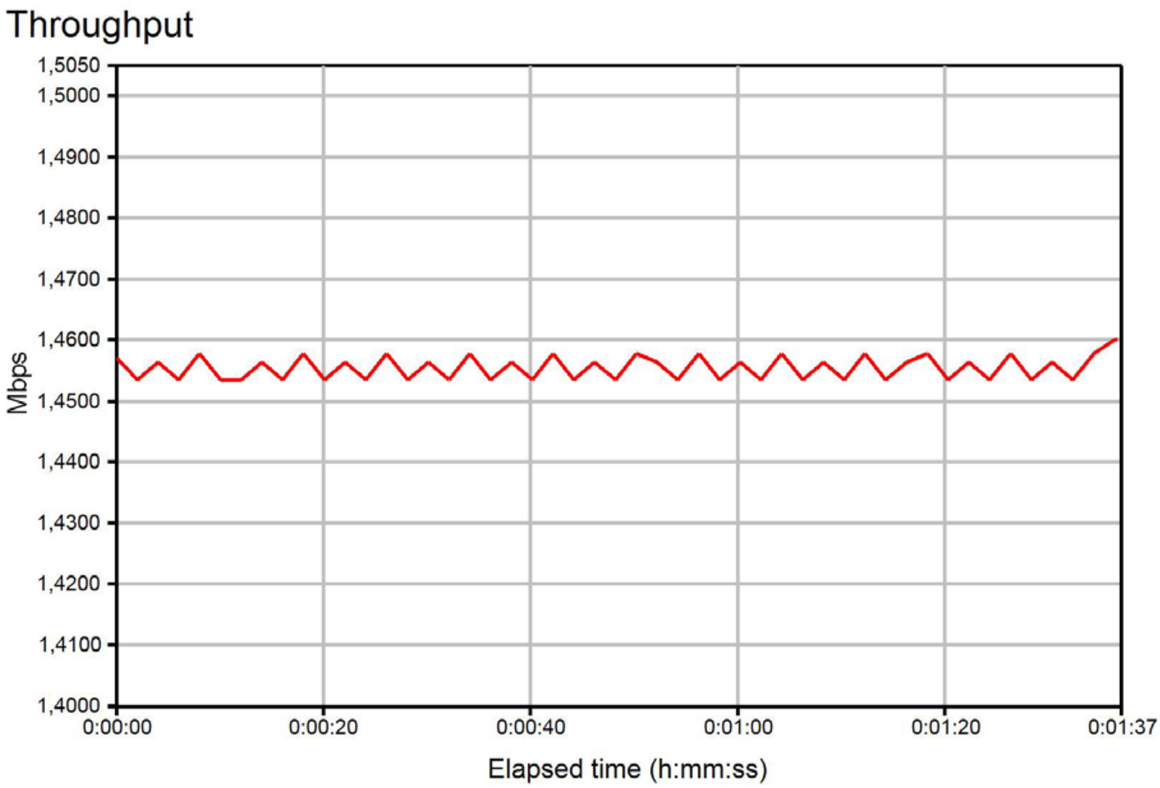

Figure 3-11: WiMAX Uplink throughput measurement

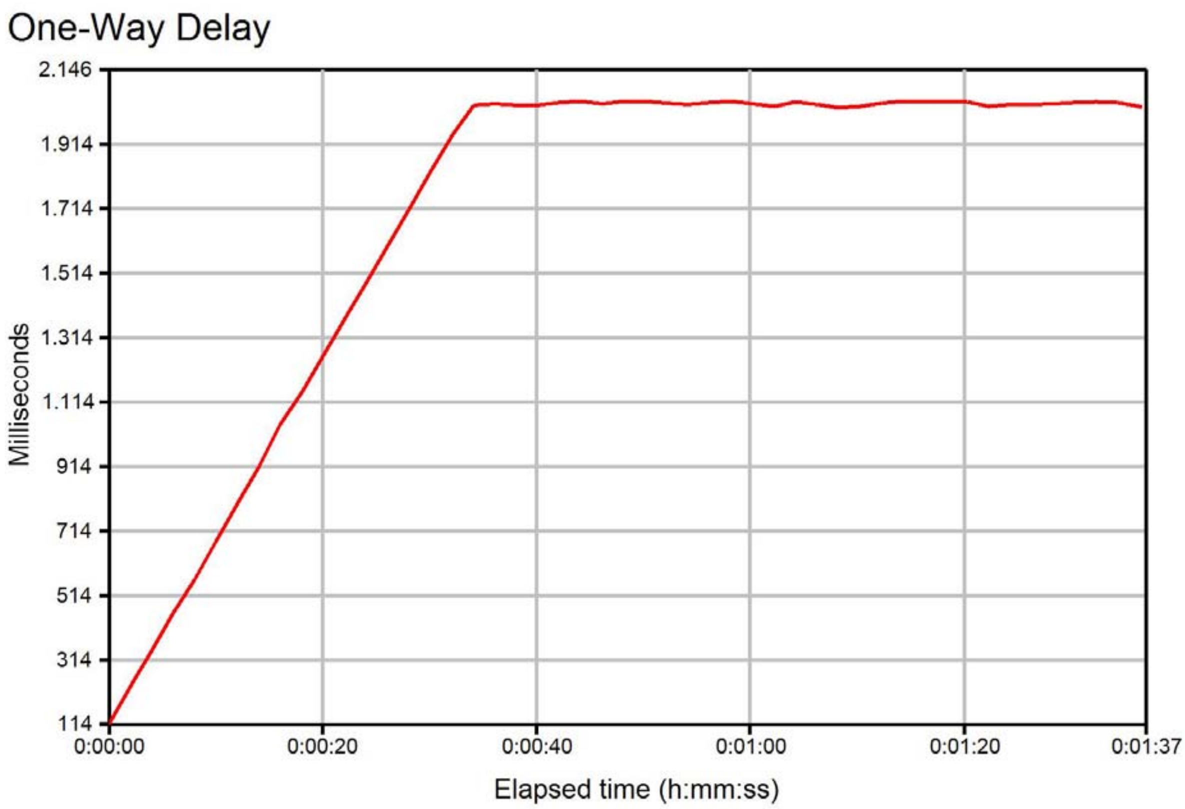

Figure 3-12:WiMAX Uplink delay measurement

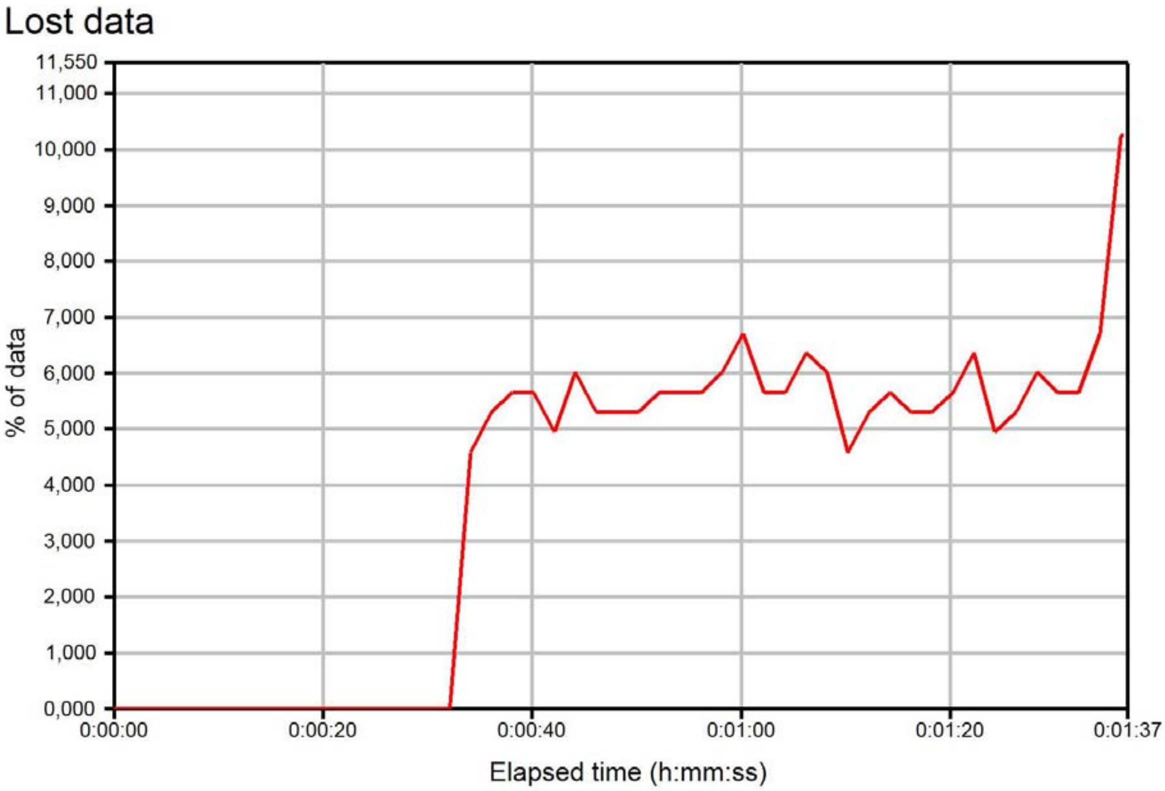

Figure 3-13: WiMAX Uplink lost data measurement

In the downlink the Maximal RTP data flow is by 3.6 Mb/s. Above this value IxChariot indicates a 40% of lost data.

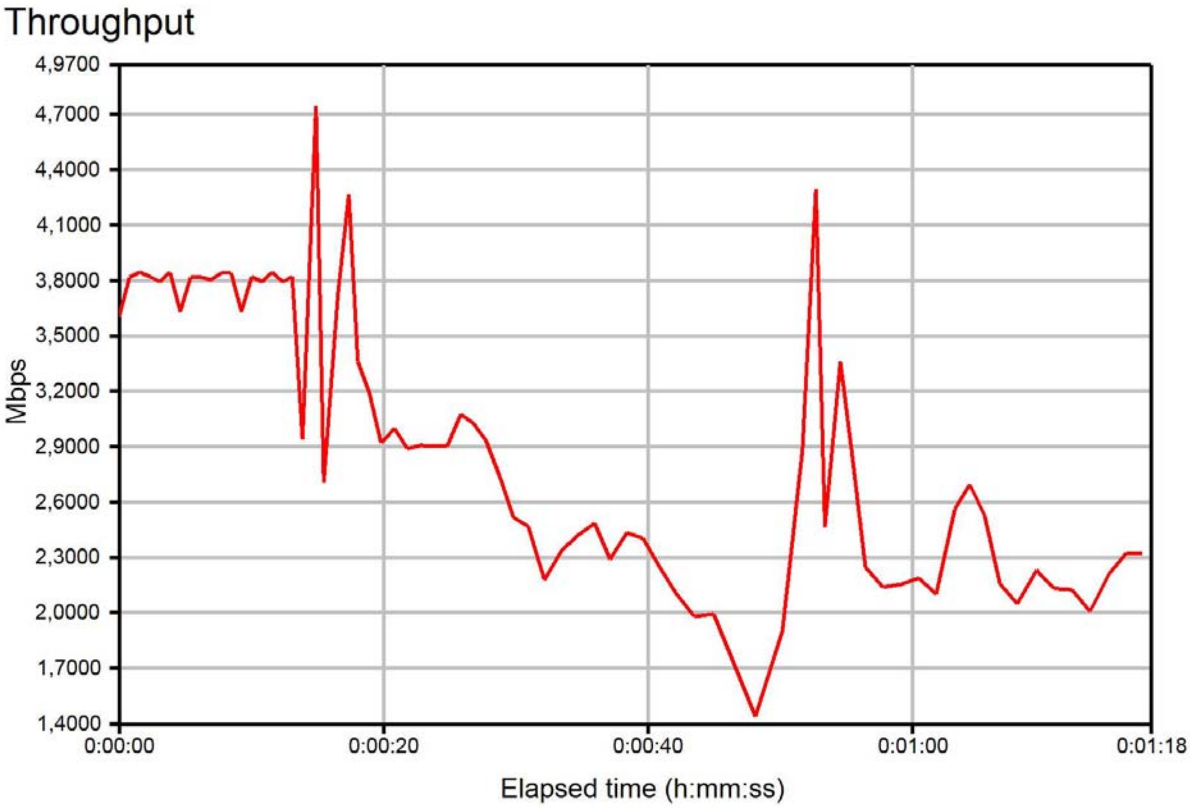

Figure 3-14:WiMAX Downlink throughput

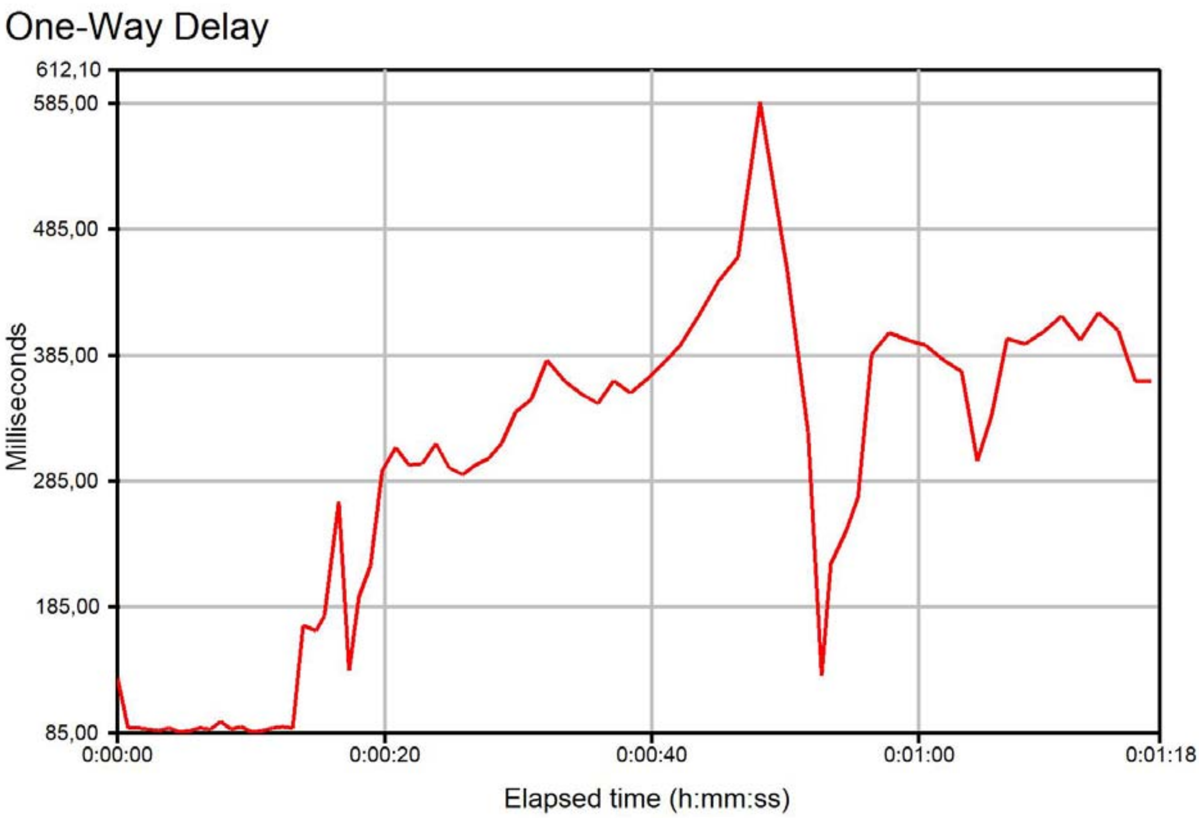

Figure 3-15: WiMAX Downlink delay measurement

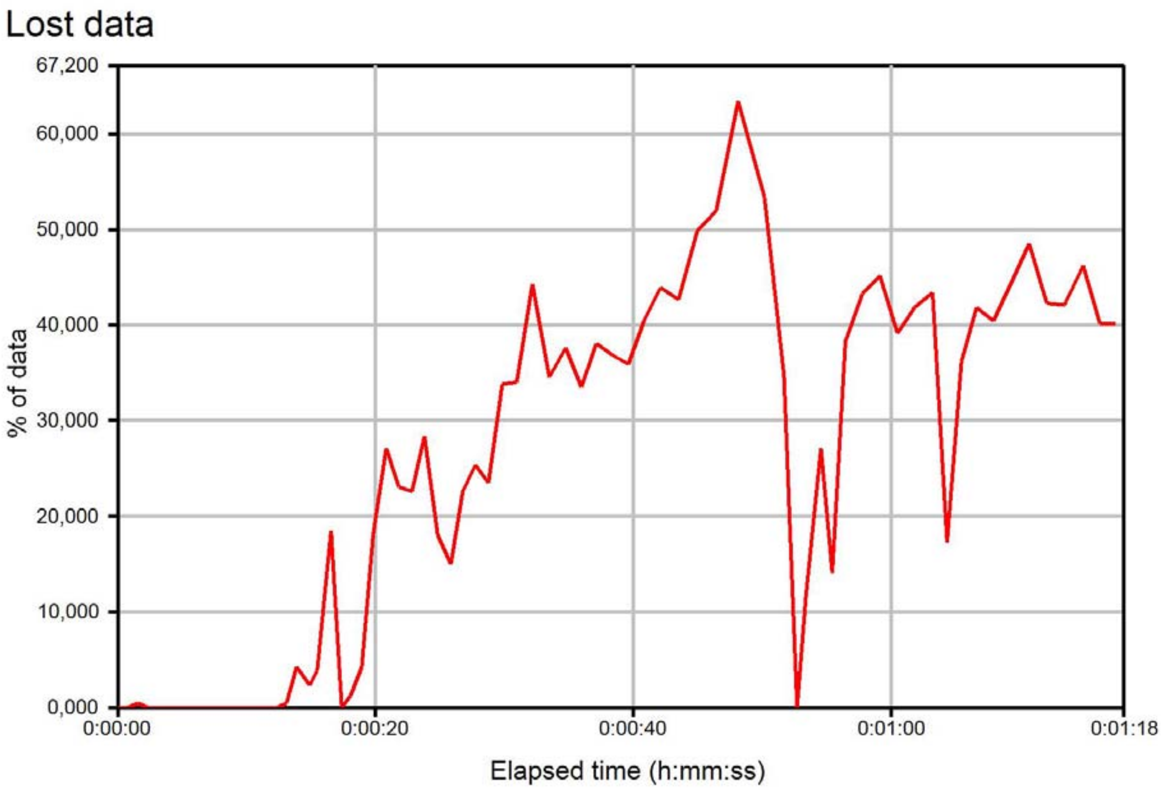

Figure 3-16: WiMAX Downlink lost data measurement

In the next step, as part of the field trials, we will deploy the WiMAX BSTs on Air and do some mobile ENG tests.

4 Partners' Contributions

4.1 – IT

4.1.1 - Contributions

The main contributions of IT to the tests bed are:

1. HD Video Camera
2. Building profile (with Wavecom)
3. Terminal (with Vitec, UPM and MCT)
4. One WLAN and another STB.
5. Two DVB-T power amplifiers
6. Real Time MDC-3
7. MDC-3 Combiner
8. One GPS
9. One power attenuator
10. One variable attenuator
11. Several low power attenuators

4.2 - IBBT

4.2.1 - Contributions

The main contributions of IBBT to the tests bed are:

1. Non-real time MDC-2 (CGS)
2. An Integrated Extractor (MDC-1+MDC-2 for CGS)

4.3 - URL

4.3.1 - Contributions

The main contributions of URL to the tests bed are:

1. Playout

4.4 - UniS

4.4.1 - Contributions

The main contributions of UniS to the tests bed are:

1. Audio SVC Codec
2. Audio MDC Codec

4.5 - Vitec

4.5.1 Contributions

The main contributions of VITEC to the tests bed are:

1. Codec software (CGS)
2. Terminal (with IT, UPM and MCT)

4.6 – RUNCOM

4.6.1 - Contributions

The main contributions of RUNCOM to the tests bed are:

1. One DVB-T/RCT Exciter
2. Two WiMAX BSTs
3. One DVB-RCT CPE
4. Three WiMAX CPE

4.7 – IRT

4.7.1 - Contributions

The main contributions of IRT to the tests bed are:

1. SD&S Server software
2. ENG System

4.8 – UPM

4.8.1 - Contributions

The main contributions of UPM to the tests bed are:

1. Gateway
2. Terminal (with IT, Vitec and MCT)

4.9 - Wavecom

4.9.1 - Contributions

The main contributions of Wavecom to the tests bed are:

1. Providing two RadioLinks
2. Providing three Gateways
3. Three Switches with VLAN features
4. One Router with traffic shaping features
5. Building profiles (with IT)
6. One variable attenuator
7. Several low power attenuators

4.10 - MCT

4.10.1 – Contributions

The main contributions of MCT to the test bed are:

1. Two WiMAX Power Amplifier with TDD control
2. One attenuator (300 W / 30dB)
3. Set up the equipment
4. Four Filters for UHF
5. One GPS receiver
6. Four WiMAX filters
7. Terminal (with IT, Vitec and UPM)

5 Conclusions

Due the difficulties that we could face in the fieldwork, integration issues and so on, a good and well-done laboratory was considered very important to address those critical issues. This was crucial to overcome the challenges posed by the complexity of the end-to-end SUIT chain. However, the laboratory work could only succeed if we had a good work plan. Doing the job systematically was seemed to be the best strategy to deal with this issue. As a matter fact, it has been proven that, it was the best way to detect potential defects or points of failure.

During this laboratory test bed, some integration problems have been found and some of them have been promptly solved. Constraints like IP multicast video flow in the DVBT-RCT BST and HD streaming, have been faced and have not completely solved.

Even with some WiMAX uplink throughput limitations, we were able to test the operation and prove the quality of the uplink video transmissions with SUIT ENG system tests.

After hard work and collaboratively efforts of all involved in the tests, we were not able to test and confirm the performance of all SUIT components integrated together. Further work has to be done urgently.

As of today, we have not tested in SUIT platform the SD and HD real time encoders (see Deliverables D1.4 and D7.1.3) because they were not delivered for integration.

6 Acronyms

AP	Access Point
BER	Bit Error Rate
BPF	Band Pass Filter
BST	Base Station
C/N	Carrier to noise ratio
CGS	Coarse Grain SNR Scalability
CIR	Committed Information rate
CPE	Customer Premises Equipment
DV	Digital Video
DVB	Digital Video Broadcasting
DVB-RCT	DVB Return Channel Terrestrial
DVB-T/H	DVB Terrestrial/ Handheld
EDCA	enhanced distributed channel access
ENG	Electronic news gathering
FGS	Fine Grain SNR Scalability
GPS	Global Position System
GW	Gateway
HO	Handover
HD	High Definition
IP	Internet Protocol
Kpbs	kilobit per second
Mbps	Megabit per second
MER	Modulation Error Ratio
MIR	Maximum Information Rate
PA	Power Amplifier
QoS	Quality of Service
RF	Radio Frequency
RL	Radio Link
RTP	Real-Time Transport Protocol
RS	Reed-Solomon
TDD	Time Division Duplex
TS	MPEG-2 Transport Stream
UHF	Ultra High Frequency
SD	Standard definition
STB	Set top box

SVC	Scalable Video Coding