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Abstract

The main objective of this report is to present the SUIT gateway. This document also shows some gateway tests. It starts by evaluating two operating systems in terms of networking capability. Then it assesses the Gateway CPU usage under different environments.

Keyword list: Gateway, Throughput, UDP, IGMP, Multicast

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Gateway prototype

SUIT_433

31-November-2007

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1 Introduction

1.1 Scope

This document is part of the WP5 – “Components for the Test-bed/Field Trials”, responsible for designing some required components not yet available in the market but required by the play-out infrastructure, in order to adequately serve scalable contents to user terminals through the two last mile wireless networks. Specifically, this document is the prototype dealing with the SUIT gateway. In accordance with the specifications and architecture addressed in D5.1 – “Gateway Specifications”, D5.4 – “Gateway report – preliminary version” and D5.7 – “Gateway report”, this document shows the gateway prototype.

1.2 Objective

The aim of this document is to report about the implementation in small PC based systems and the execution performance using Windows and Linux operating systems. It also shows the WLAN behaviour under multicasting.

2 Gateway

2.1 Introduction

A gateway prototype has been implemented. The platform in use is Mini-ITX Jetway. It is a compact PC based on VIA CN700 Chipset for VIA C7 processor family. In this document, we report some results of the throughput operating in Windows XP and Linux Ubuntu 7. We also show the performance for executing the gateway MDCs software in Windows XP.

2.2 Gateway diagram

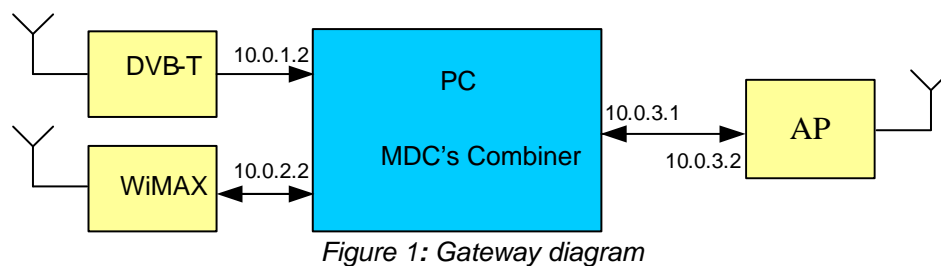


Figure 1 shows a block diagram of the gateway components as well as all IP addresses. Other IP addresses at home network are 192.168.0.1 for the AP and 192.168.0.198 for the terminal.

2.3 Gateway components

2.3.1 DVB-T Receiver

It is a Runcom's DVRCT SoC module described in D5.6.

2.3.2 WiMAX Transceiver

It is a Runcom's WiMAX SOC module described in D5.6.

2.3.3 Computer (PC)

As shown in Figure 2, the SUIT gateway is based on a small PC to permit making a gateway prototype very compact. This motherboard is designed for the VIA C7 processor family, which uses the VIA CN700 chipset supporting 400MHz/ 533MHz System Bus in data transfer rate.

Specifications:

- PCB size 17.0x17.0cm
- CPU Embedded VIA CN700 EBGA (1500MHz)
- Memory 1GB DDR2
- LAN four ports 10/100 BASE-T Transfer rate

We can observe in (Figure 2) the motherboard of the Gateway coupled with a three port Ethernet card.

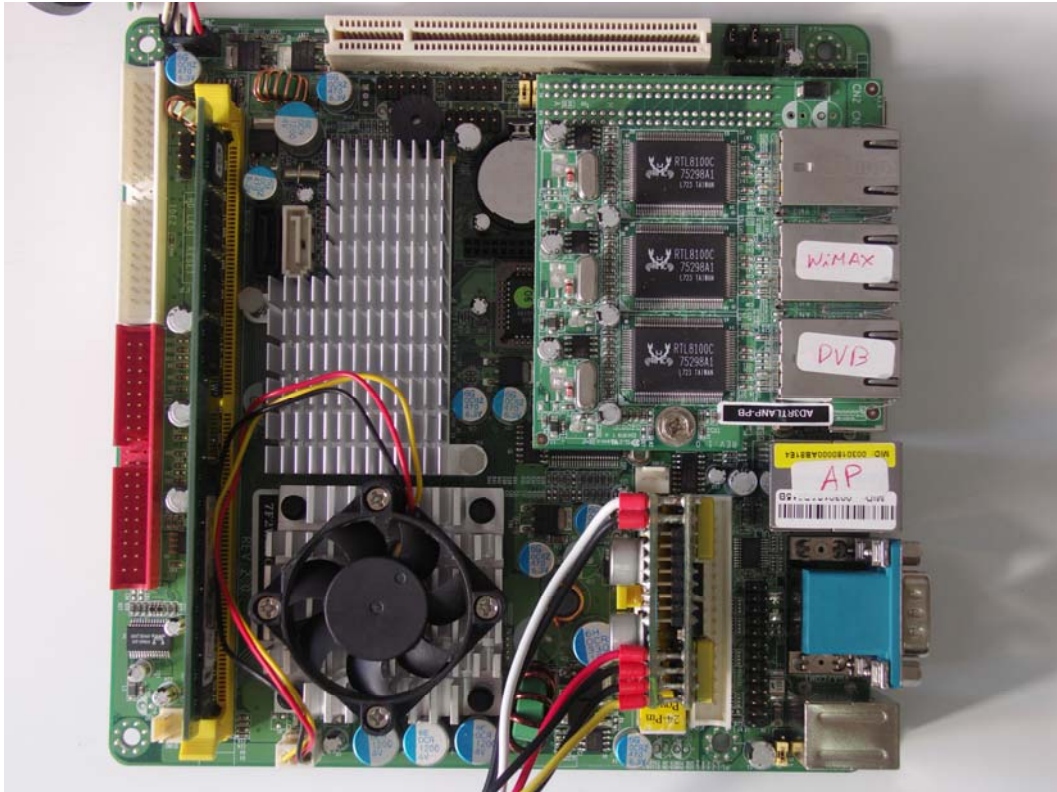


Figure 2: Gateway System (PC)

2.3.4 Access Point (AP)

The access point in use is a D-Link model DIR-655. This is a router with Wireless N (802.11n) and IGMP server to filter traffic multicast. This AP was selected due to its support for multicast as well as its high error robustness.



Figure 3: Access point D-Link DIR-655

3 Gateway Tests

3.1 Throughput

3.1.1 Introduction

To execute the Ethernet throughput tests, we have used J-Perf tool for Windows and I-Perf for Linux. We have executed two tests. In one, the Gateway (client) sends UDP packets. In the other, the Gateway sends and receives UDP packets. The following figures demonstrate these tests.

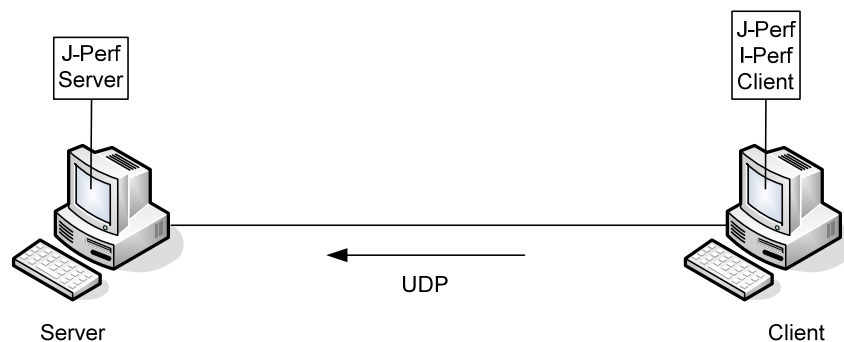


Figure 4: Test UDP unidirectional

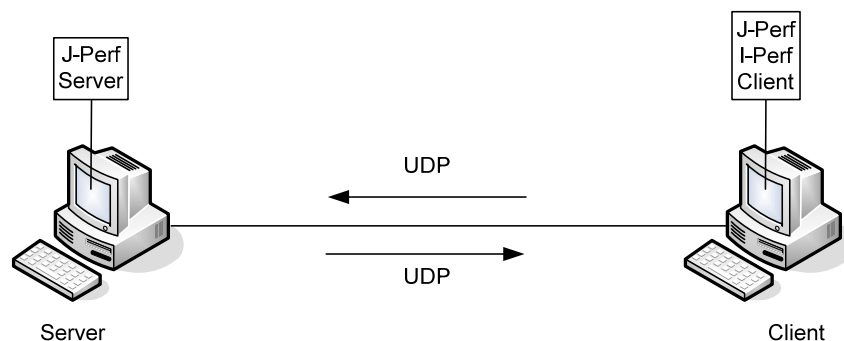


Figure 5: Test UDP bidirectional

3.1.2 Windows UDP throughput

The UDP unidirectional traffic throughput is approximately 74.8Mbit/sec (See Figure 6). For traffic UDP bidirectional, the throughput is approximately 75Mbit/sec. The input traffic is somewhere around 72Mbit/sec (See Figure 7).

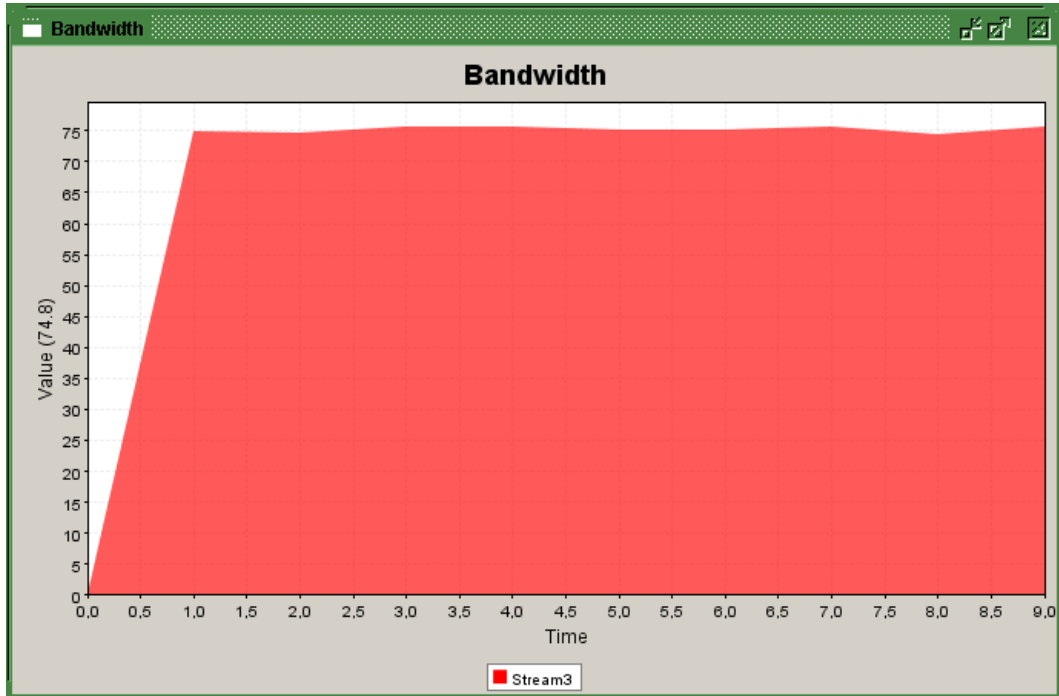


Figure 6: Results of the test UDP unidirectional (Windows)

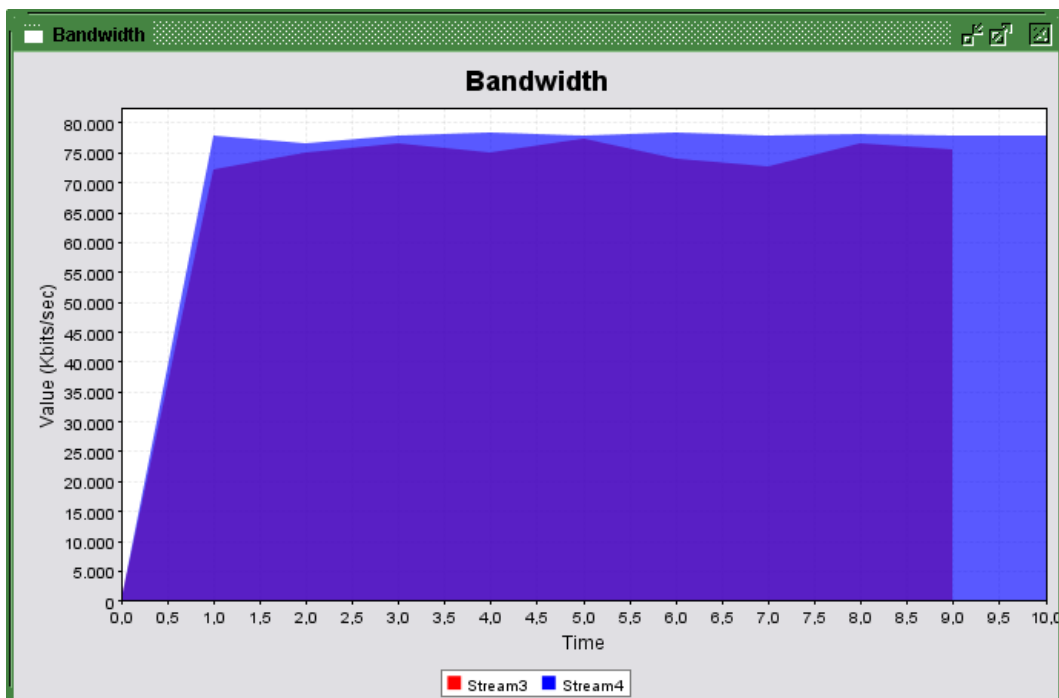


Figure 7: Results of the test UDP bidirectional (Windows)

3.1.3 Linux UDP throughput

The UDP unidirectional traffic throughput is approximately 86Mbit/sec (See Figure 8). In the case of UDP bidirectional traffic, the throughput (output) traffic is approximately 83.5Mbit/sec and the input traffic is around 71.4Mbit/sec (See Figure 9).

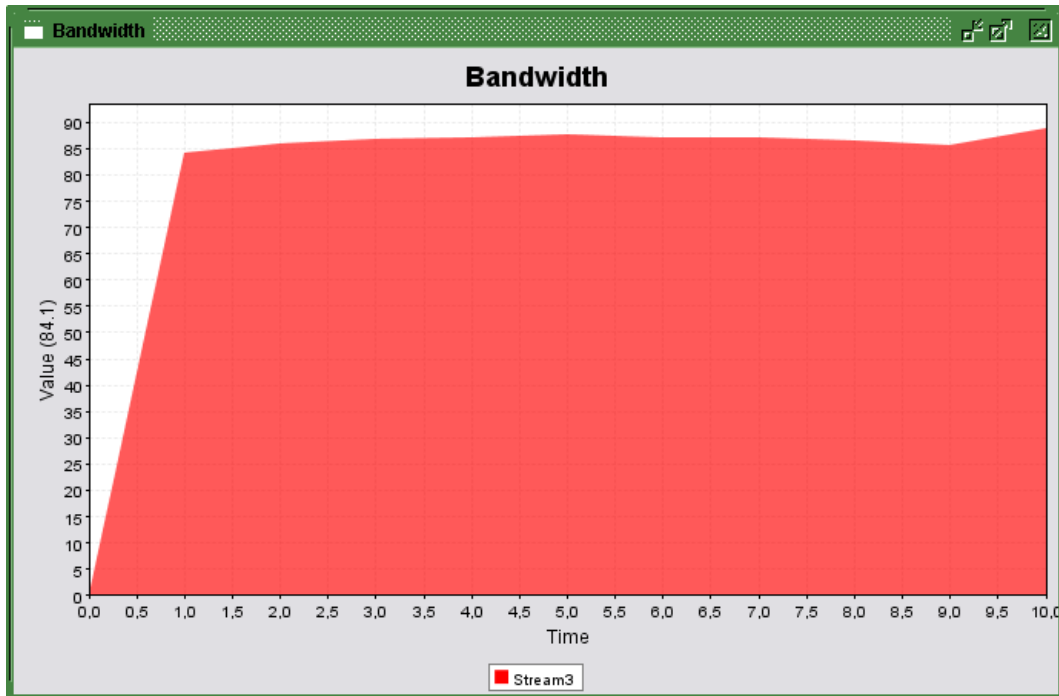


Figure 8: Results of the test UDP unidirectional (Linux)

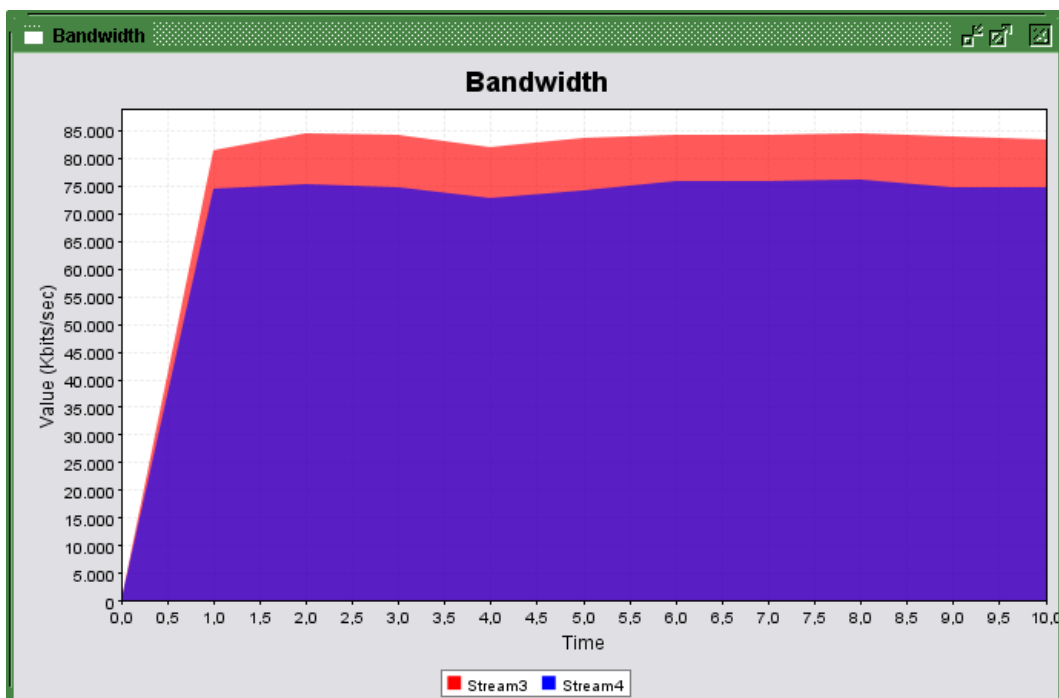


Figure 9: Results of the test UDP bidirectional (Linux)

3.2 Operating MDCs software

3.2.1 Combiner MDC1 Software

The first test consist in executed in the Playout MDC1 Extractor (release 9-March-2007) and in the Gateway MDC1 Combiner (release 9-March-2007). In this test, the CPU usage was 100% (See Figure 10), but the combiner worked well and the terminal received and decoded. In the second test, we have executed in the Playout Live555 (release 5-October-2007) and in the Gateway MDC-1 Combiner (release 9-March-2007). The results are equal (See Figure 11). We have used the same descriptions in both tests.

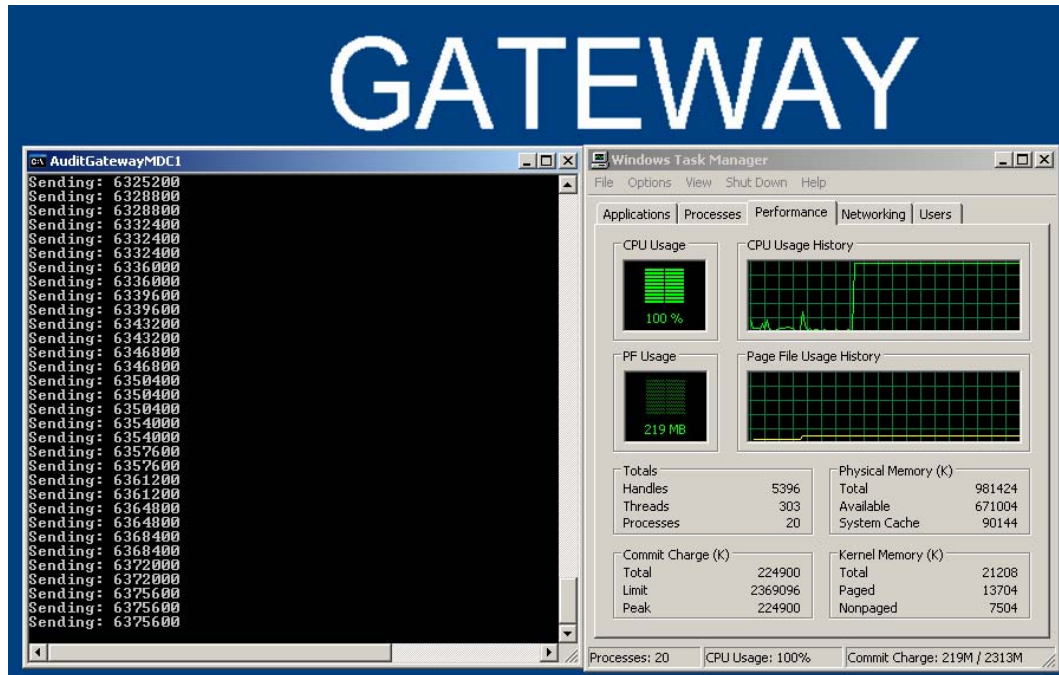


Figure 10: CPU usage first test

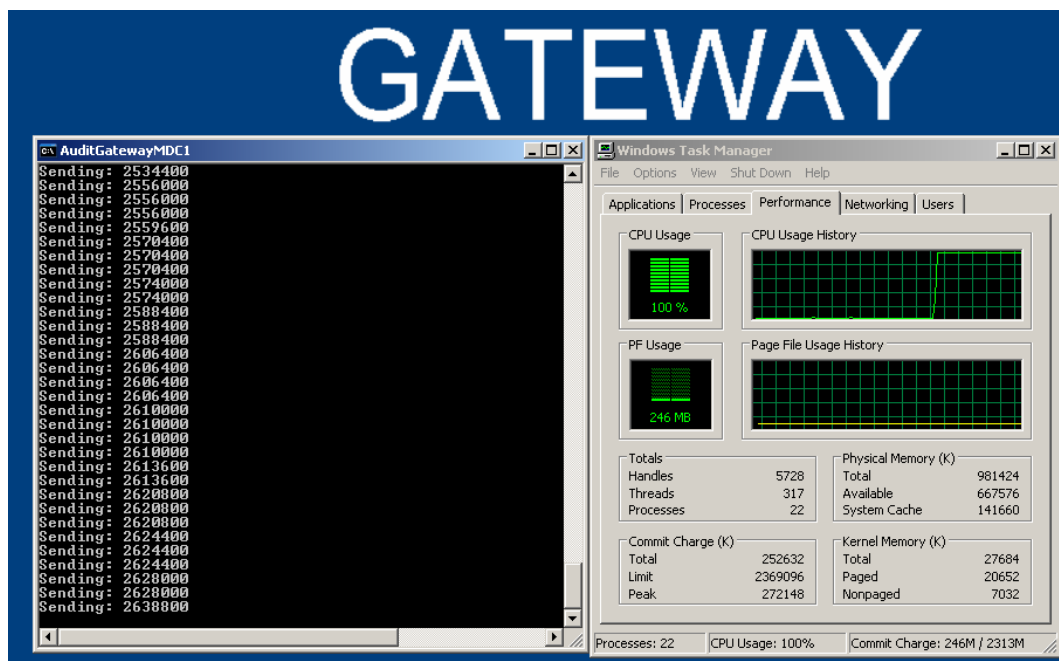


Figure 11: CPU usage second test

3.2.2 Combiner MDC2 Software

The first test consist in executed in the Playout MDC2 Extractor (release 9-March-2007) and in the Gateway MDC2 Combiner (release 20-Julie-2007). In this test the CPU usage was 80% (See Figure 12), the combiner worked well and the terminal received and decoded video. In the second test we have executed in the Playout Live555 (release 5-October-2007) and in the Gateway MDC2 Combiner (release 20-Julie-2007). In the second case the CPU usage was 50% (See Figure 13). We have used the same descriptions in both tests.

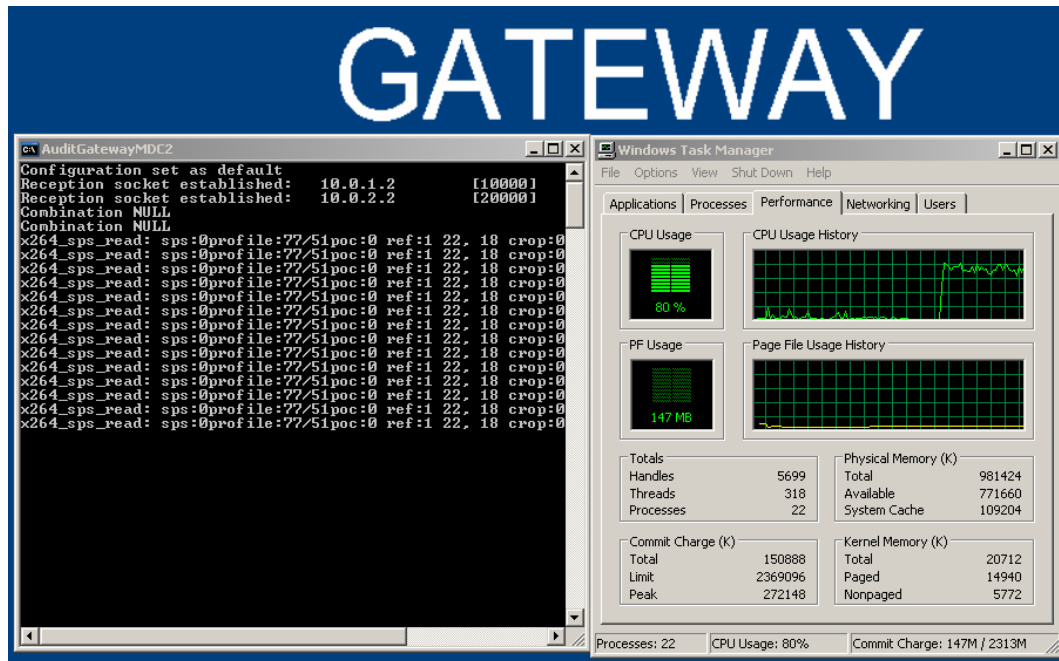


Figure 12: CPU usage first test

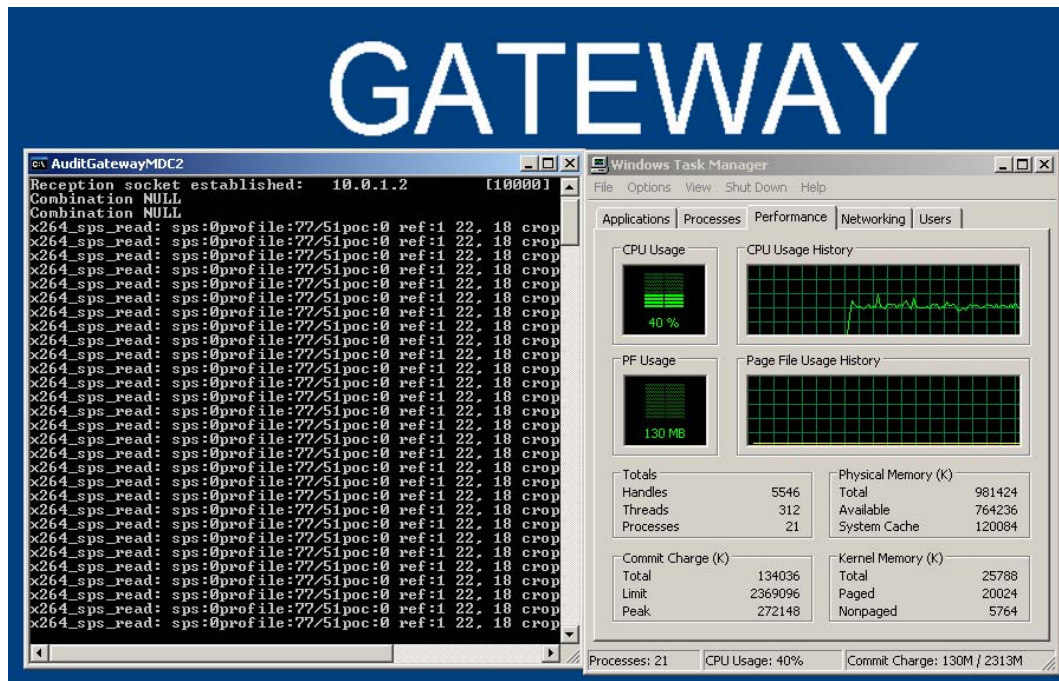


Figure 13: CPU usage second test

3.2.3 Gateway for both MDCs (Release 6_November_07)

In this section, we have made four tests, using in the Gateway the last Combiner (release 6-November-2007). This software works well with MDC1 and MDC2.

The first test consisted in executing in the Playout MDC1 Extractor (release 9-March-2007). In this case, the CPU usage was 2% (See Figure 14), the combiner worked well and the terminal received and decoded the videos. The second test consisted in executing in the Playout the MDC2 Extractor (release 9-March-2007). In this case the combiner did not work. In the third test we have executed in the Playout Live555 (release 5-October-2007) with MDC1 descriptions and in this case the CPU usage was 4% (See Figure 15). In the last test we have executed in the Playout Live555 (release 5-October-2007) with MDC2 descriptions and in this case the combiner does run.

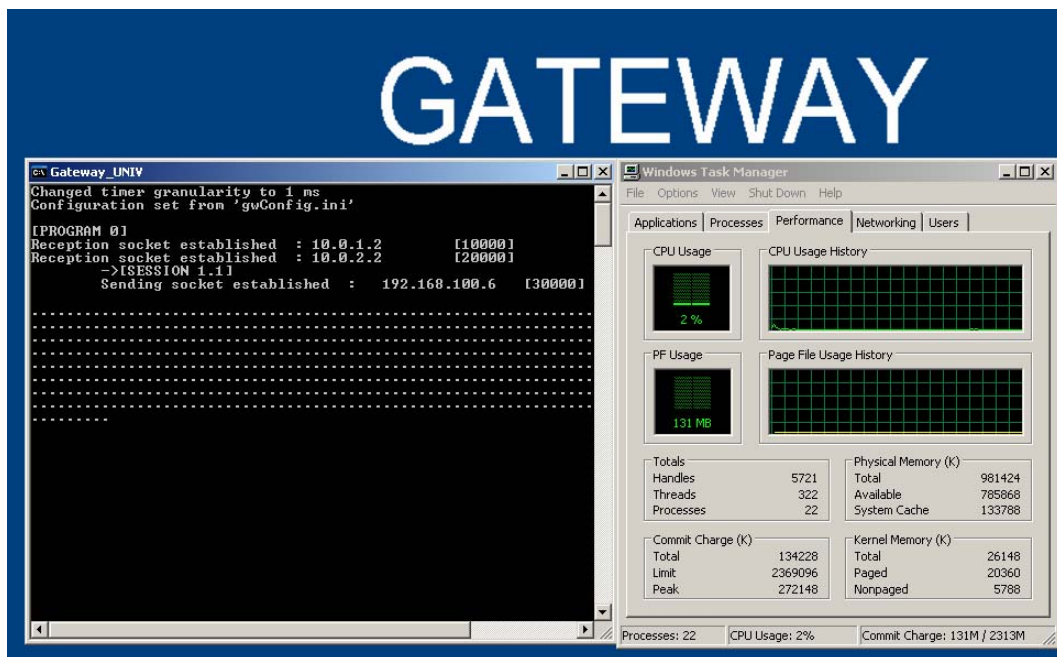


Figure 14: CPU usage first test

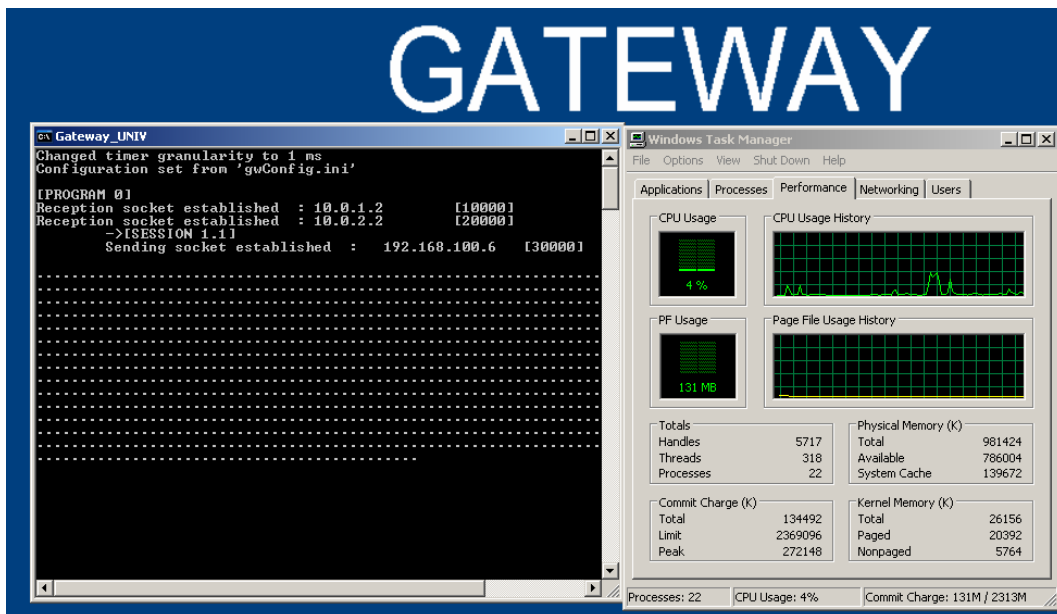


Figure 15: CPU usage third test

3.3 Multicast test in access point

3.3.1 Introduction

The software used to make the captures during the tests was a Wireshark (Version 0.99.6a). This software captures and analyzes the packets that arrive at the port of the computer, provides a data type, condition and quantity of packets and information for bit rate.

We have used VLC in the Terminal and SUIT Live555 in the Server.

In order to execute this test we have used two computers, one as a server (SUIT Payout) and another for receiving a multicast stream. The computers are:

Server (Suit Server):

IP – 10.0.1.1

MAC – 00:0E:0C:9C:51:C4

Multicast IP - 224.255.255.3

Port - 1234

MAC Multicast – 01:00:5E:7F:FF:03

Receiver (Terminal computer with wireless .11b card):

IP – 192.168.0.173

MAC – 00:0E:0C:9C:53:3B

Access point (D-Link DIR-655, wireless .11n):

WAN IP - 10.0.1.2

LAN IP - 192.168.0.1

MAC – 00:1B:11:E6:92:0B

3.3.2 Results of tests

In the Figure 16, we can see the first packet being exchanged which corresponds to the IGMP request of the Terminal to join to the multicast group (Destination IP: 224.255.255.3).

No. -	Time	Source	Destination	Protocol	Info
1	0.000000	fe80::1203:2fff:fe28:9	ff02::1	ICMPv6	Router advertisement
2	0.119336	192.168.0.173	224.255.255.3	IGMP	V2 Membership Report
3	0.134657	10.0.1.1	224.255.255.3	UDP	Source port: 1234 Destination port: 1234
4	0.135203	10.0.1.1	224.255.255.3	IP	Fragmented IP protocol (proto=UDP 0x11, off=0)
5	0.135298	10.0.1.1	224.255.255.3	UDP	Source port: 1234 Destination port: 1234
6	0.137404	10.0.1.1	224.255.255.3	IP	Fragmented IP protocol (proto=UDP 0x11, off=0)
7	0.137506	10.0.1.1	224.255.255.3	UDP	Source port: 1234 Destination port: 1234
8	0.137631	10.0.1.1	224.255.255.3	IP	Fragmented IP protocol (proto=UDP 0x11, off=0)
9	0.137653	10.0.1.1	224.255.255.3	UDP	Source port: 1234 Destination port: 1234
10	0.137800	10.0.1.1	224.255.255.3	IP	Fragmented IP protocol (proto=UDP 0x11, off=0)
11	0.137887	10.0.1.1	224.255.255.3	UDP	Source port: 1234 Destination port: 1234
12	0.138010	10.0.1.1	224.255.255.3	IP	Fragmented IP protocol (proto=UDP 0x11, off=0)
13	0.138058	10.0.1.1	224.255.255.3	UDP	Source port: 1234 Destination port: 1234
14	0.138179	10.0.1.1	224.255.255.3	UDP	Source port: 1234 Destination port: 1234
15	0.175924	10.0.1.1	224.255.255.3	UDP	Source port: 1234 Destination port: 1234

Frame 2 (46 bytes on wire, 46 bytes captured)

Ethernet II, Src: Intel_9c:53:3b (00:0e:0c:9c:53:3b), Dst: 01:00:5e:7f:ff:03 (01:00:5e:7f:ff:03)

- Destination: 01:00:5e:7f:ff:03 (01:00:5e:7f:ff:03)
 - Address: 01:00:5e:7f:ff:03 (01:00:5e:7f:ff:03)
 -1 ... = IG bit: Group address (multicast/broadcast)
 -0 ... = LG bit: Globally unique address (factory default)
- Source: Intel_9c:53:3b (00:0e:0c:9c:53:3b)
 - Address: Intel_9c:53:3b (00:0e:0c:9c:53:3b)
 -0 ... = IG bit: Individual address (unicast)
 -0 ... = LG bit: Globally unique address (factory default)
 - Type: IP (0x0800)
- Internet Protocol, Src: 192.168.0.173 (192.168.0.173), Dst: 224.255.255.3 (224.255.255.3)
 - Version: 4
 - Header length: 24 bytes
 - Differentiated Services Field: 0x00 (DSCP 0x00: Default; ECN: 0x00)
 - Total Length: 32
 - Identification: 0x3f7d (16253)
 - Flags: 0x00
 - Fragment offset: 0
 - Time to live: 1
 - Protocol: IGMP (0x02)
 - Header checksum: 0x4402 [correct]
 - Source: 192.168.0.173 (192.168.0.173)
 - Destination: 224.255.255.3 (224.255.255.3)
 - Options: (4 bytes)
- Internet Group Management Protocol
 - IGMP Version: 2
 - Type: Membership Report (0x16)
 - Max Response Time: 0,0 sec (0x00)
 - Header checksum: 0x09fc [correct]
 - Multicast Address: 224.255.255.3 (224.255.255.3)

Figure 16: Request to join a multicast group

After IGMP first packet, the receiver begins to receive UDP packets from the server (see Figure 17). These packets are stamped with IP origin of the server and the destination IP as IP Multicast (224.255.255.3). At the MAC address level, the packets have as origin the router (AP) and destination the multicast address (01:00:5e:7f:ff:03).

No. -	Time	Source	Destination	Protocol	Info
1	0.000000	fe80::203:2fff:fe28:9	ff02::1	ICMPv6	Router advertisement
2	0.110936	192.168.0.173	224.255.255.3	IGMP	V2 Membership Report
3	0.134357	10.0.1.1	224.255.255.3	UDP	Source port: 1234 Destination port: 1234
4	0.135203	10.0.1.1	224.255.255.3	IP	Fragmented IP protocol (proto=UDP 0x11, off=0)
5	0.135298	10.0.1.1	224.255.255.3	UDP	Source port: 1234 Destination port: 1234
6	0.137404	10.0.1.1	224.255.255.3	IP	Fragmented IP protocol (proto=UDP 0x11, off=0)
7	0.137506	10.0.1.1	224.255.255.3	UDP	Source port: 1234 Destination port: 1234
8	0.137631	10.0.1.1	224.255.255.3	IP	Fragmented IP protocol (proto=UDP 0x11, off=0)
9	0.137653	10.0.1.1	224.255.255.3	UDP	Source port: 1234 Destination port: 1234
10	0.137800	10.0.1.1	224.255.255.3	IP	Fragmented IP protocol (proto=UDP 0x11, off=0)
11	0.137887	10.0.1.1	224.255.255.3	UDP	Source port: 1234 Destination port: 1234
12	0.138010	10.0.1.1	224.255.255.3	IP	Fragmented IP protocol (proto=UDP 0x11, off=0)
13	0.138058	10.0.1.1	224.255.255.3	UDP	Source port: 1234 Destination port: 1234
14	0.138179	10.0.1.1	224.255.255.3	UDP	Source port: 1234 Destination port: 1234
15	0.175924	10.0.1.1	224.255.255.3	UDP	Source port: 1234 Destination port: 1234

* Frame 13 (655 bytes on wire, 655 bytes captured)
 * Ethernet II, Src: D-Link_e6:92:0b (00:1b:11:e6:92:0b), Dst: 01:00:5e:7f:ff:03 (01:00:5e:7f:ff:03)
 Destination: 01:00:5e:7f:ff:03 (01:00:5e:7f:ff:03)
 Address: 01:00:5e:7f:ff:03 (01:00:5e:7f:ff:03)
 = IG bit: Group address (multicast/broadcast)
 = LG bit: Globally unique address (factory default)
 Source: D-Link_e6:92:0b (00:1b:11:e6:92:0b)
 Address: D-Link_e6:92:0b (00:1b:11:e6:92:0b)
 = IG bit: Individual address (unicast)
 = LG bit: Globally unique address (factory default)
 Type: IP (0x0800)
 * Internet Protocol, Src: 10.0.1.1 (10.0.1.1), Dst: 224.255.255.3 (224.255.255.3)
 Version: 4
 Header length: 20 bytes
 Differentiated Services Field: 0x00 (DSCP 0x00: Default; ECN: 0x00)
 Total Length: 641
 Identification: 0x3e17 (15895)
 Flags: 0x00
 Fragment offset: 1480
 Time to live: 254
 Protocol: UDP (0x11)
 Header checksum: 0x9097 [correct]
 Source: 10.0.1.1 (10.0.1.1)
 Destination: 224.255.255.3 (224.255.255.3)
 * IP Fragments (2101 bytes): #12(1480), #13(621)]
 * User Datagram Protocol, Src Port: 1234 (1234), Dst Port: 1234 (1234)
 Data (2093 bytes)

Figure 17: UDP Packet

In the Figure 18 we can see the relationship between erroneous and correct received packets. It is evident there are no packets errors (neither physical nor protocol errors).

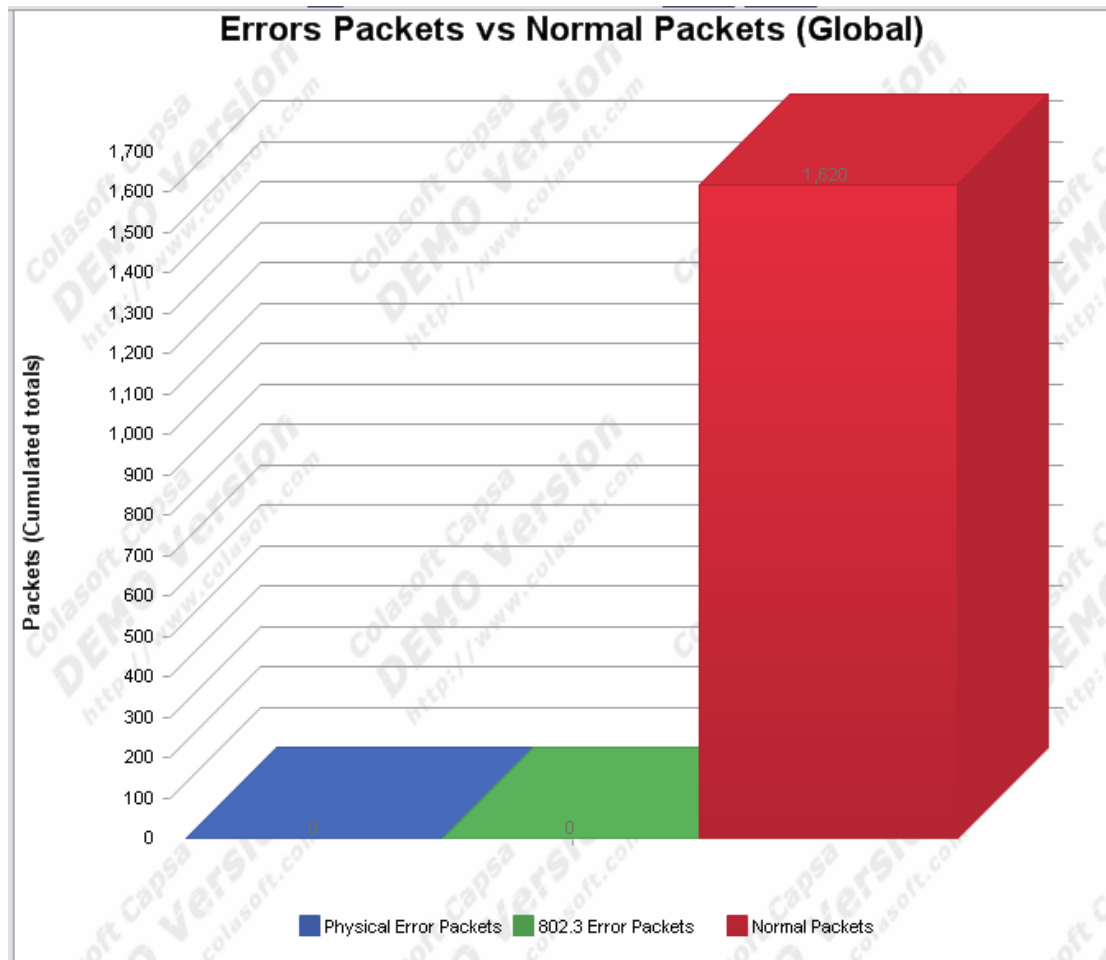


Figure 18: Errors Packets vs Normal Packets

In the Figure 19 we can see the bit rate at the input of the SUIT terminal.

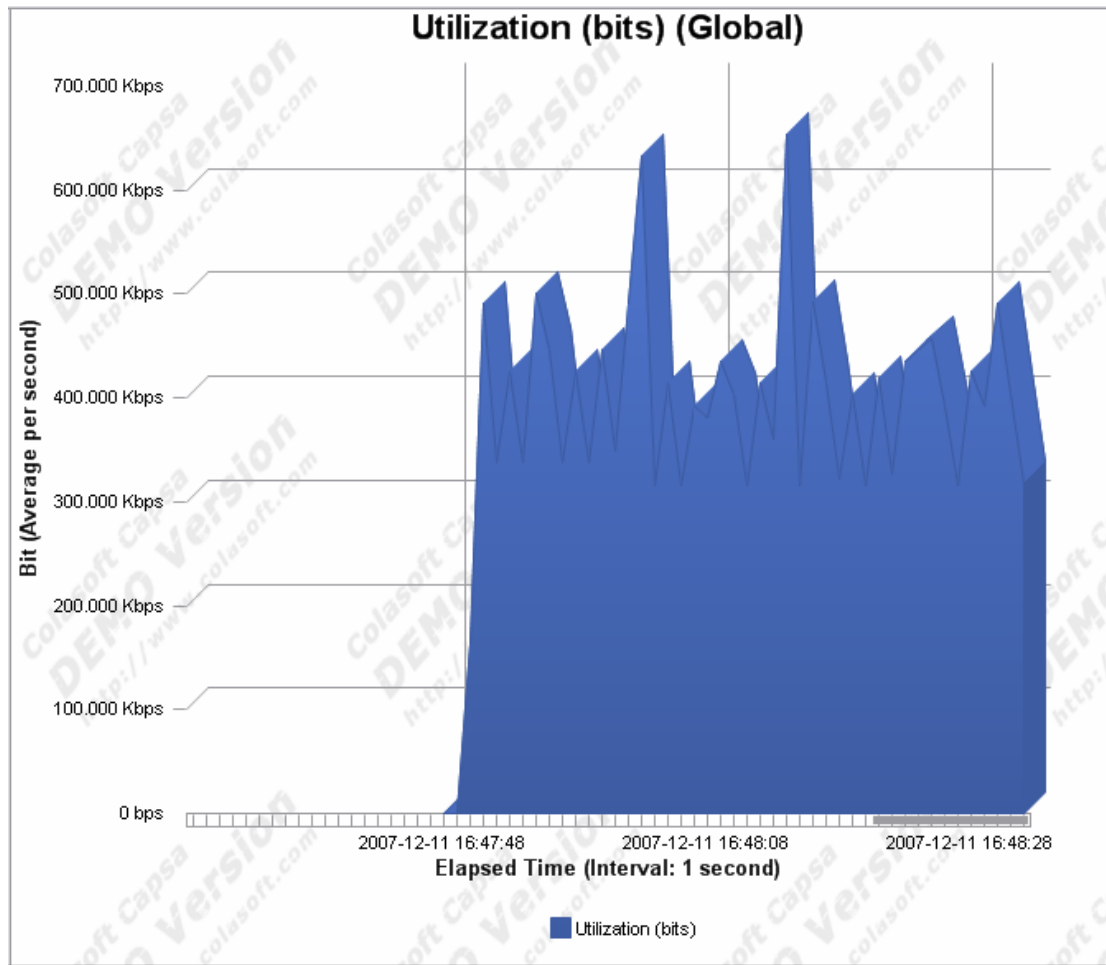


Figure 19: Bit rate in the receiver

In the Figure 20 we can see the packets captured on another computer apart from the SUIT Terminal. Its only function is to monitor the network traffic. However this computer is not attached to the multicast group. It did not request to join the multicast group. However there is another computer on the network, SUIT Terminal, attached to the multicast group and therefore the router (AP) replicates the multicast traffic to the WLAN. Thus, from instant of time that any Terminal/computer is attached to the multicast group, all computers in the same network receive multicast traffic.

We can see from the packets captured that the MAC address of destination corresponds to the multicast MAC Address.

No.	Time	Source	Destination	Protocol	Info
1213	11.416353	10.0.1.1	224.255.255.3	UDP	Source port: search-agent Destination port: search-agent
1214	11.429013	10.0.1.1	224.255.255.3	IP	Fragmented IP protocol (proto=UDP 0x11, off=0)
1215	11.432819	10.0.1.1	224.255.255.3	UDP	Source port: search-agent Destination port: search-agent
1216	11.438653	10.0.1.1	224.255.255.3	UDP	Source port: search-agent Destination port: search-agent
1217	11.451312	10.0.1.1	224.255.255.3	IP	Fragmented IP protocol (proto=UDP 0x11, off=0)
1218	11.462796	10.0.1.1	224.255.255.3	UDP	Source port: search-agent Destination port: search-agent
1219	11.474335	10.0.1.1	224.255.255.3	UDP	Source port: search-agent Destination port: search-agent
1220	11.479877	10.0.1.1	224.255.255.3	UDP	Source port: search-agent Destination port: search-agent
1221	11.488885	10.0.1.1	224.255.255.3	UDP	Source port: search-agent Destination port: search-agent
1222	11.501492	10.0.1.1	224.255.255.3	IP	Fragmented IP protocol (proto=UDP 0x11, off=0)
1223	11.502331	10.0.1.1	224.255.255.3	UDP	Source port: search-agent Destination port: search-agent
1224	11.506542	10.0.1.1	224.255.255.3	UDP	Source port: search-agent Destination port: search-agent
1225	11.512435	10.0.1.1	224.255.255.3	UDP	Source port: search-agent Destination port: search-agent
1226	11.526348	10.0.1.1	224.255.255.3	IP	Fragmented IP protocol (proto=UDP 0x11, off=0)
1227	11.538909	10.0.1.1	224.255.255.3	IP	Fragmented IP protocol (proto=UDP 0x11, off=1480)
1228	11.544256	10.0.1.1	224.255.255.3	UDP	Source port: search-agent Destination port: search-agent

+	Frame 1219 (1390 bytes on wire, 1390 bytes captured)
+	Ethernet II, Src: D-Link_e6:92:0b (00:1b:11:e6:92:0b), Dst: UscInfor_7f:ff:03 (01:00:5e:7f:ff:03)
+	Destination: UscInfor_7f:ff:03 (01:00:5e:7f:ff:03)
+	Address: UscInfor_7f:ff:03 (01:00:5e:7f:ff:03)
+1..... = IG bit: Group address (multicast/broadcast)
+0..... = LG bit: Globally unique address (factory default)
+	Source: D-Link_e6:92:0b (00:1b:11:e6:92:0b)
+	Address: D-Link_e6:92:0b (00:1b:11:e6:92:0b)
+0..... = IG bit: Individual address (unicast)
+0..... = LG bit: Globally unique address (factory default)
+	Type: IP (0x0800)
+	Internet Protocol, Src: 10.0.1.1 (10.0.1.1), Dst: 224.255.255.3 (224.255.255.3)
+	User Datagram Protocol, Src Port: search-agent (1234), Dst Port: search-agent (1234)
+	Data (1348 bytes)

Figure 20: Packets UDP (multicast group 224.1.1.10)

In the Table 1, we can see the summary of one capture (3min 36sec), during which the SUIT Terminal was attached to the multicast group and accessed to the Internet. One important parameter in this table is the value of the physical errors and protocol errors (802.3).

Summary Statistics

Statistics	Values				
Capture	Count				
Start Date	2007-12-12				
Start Time	19:55:00				
Duration	00:03:36				
Physical Errors	Count				
Total Errors	0				
CRC Errors	0				
Alignment Errors	0				
Overrun Errors	0				
Underrun Errors	0				
802.3 Errors	Count				
802.3 Total Errors	0				
802.3 One Collision	0				
802.3 More Collisions	0				
802.3 Max Collisions	0				
802.3 Deferrals	0				
Traffic	Bytes	Packets	Avg Utilization	Avg bps	Avg pps
Total Traffic	21.721 MB	17,074	7.669%	843.576 Kbps	79.046
Broadcast Traffic Sent	2.229 KB	15	0.001%	84.556 bps	0.069
Multicast Traffic Sent	21.344 MB	16,482	7.536%	828.933 Kbps	76.306
Packet Size Distribution	Bytes	Packets	Avg Utilization	Avg bps	Avg pps
<=64	12.875 KB	206	0.004%	488.296 bps	0.954
65-127	4.330 KB	59	0.001%	164.222 bps	0.273
128-255	3.223 KB	16	0.001%	122.222 bps	0.074
256-511	42.560 KB	104	0.015%	1.614 Kbps	0.481
512-1023	43.469 KB	68	0.015%	1.649 Kbps	0.315
1024-1517	21.332 MB	16,424	7.531%	828.463 Kbps	76.037
>=1518	292.037 KB	197	0.101%	11.076 Kbps	0.912
TCP Packets	Bytes	Packets	Avg Utilization	Avg bps	Avg pps
TCP SYN Packets	2.514 KB	39	0.001%	95.333 bps	0.181
TCP FIN Packets	0 B	0	0.000%	0.000 bps	0.000
TCP Reset Packets	64 B	1	0.000%	2.370 bps	0.005
TCP Connections	Count				
TCP Connection Initiated	18				
TCP Connection Established	7				
DNS Analysis	Count				
DNS Request	8				
DNS Correct Response	8				
DNS Error Response	0				
SMTP Analysis	Count				
SMTP Connections	0				
SMTP Messages Sent	0				
SMTP Messages with Attachment	0				
POP3 Analysis	Count				
POP3 Connections	0				
POP3 Messages Received	0				
POP3 Messages with Attachment	0				
HTTP Analysis	Count				
HTTP Connections	10				
HTTP Requests	61				
HTTP Servers Seen	1				

Table 1: Summary of packets receiving in test

During this capture 17074 packets were received correctly. Zero errors occurred for physical reasons and protocol errors.

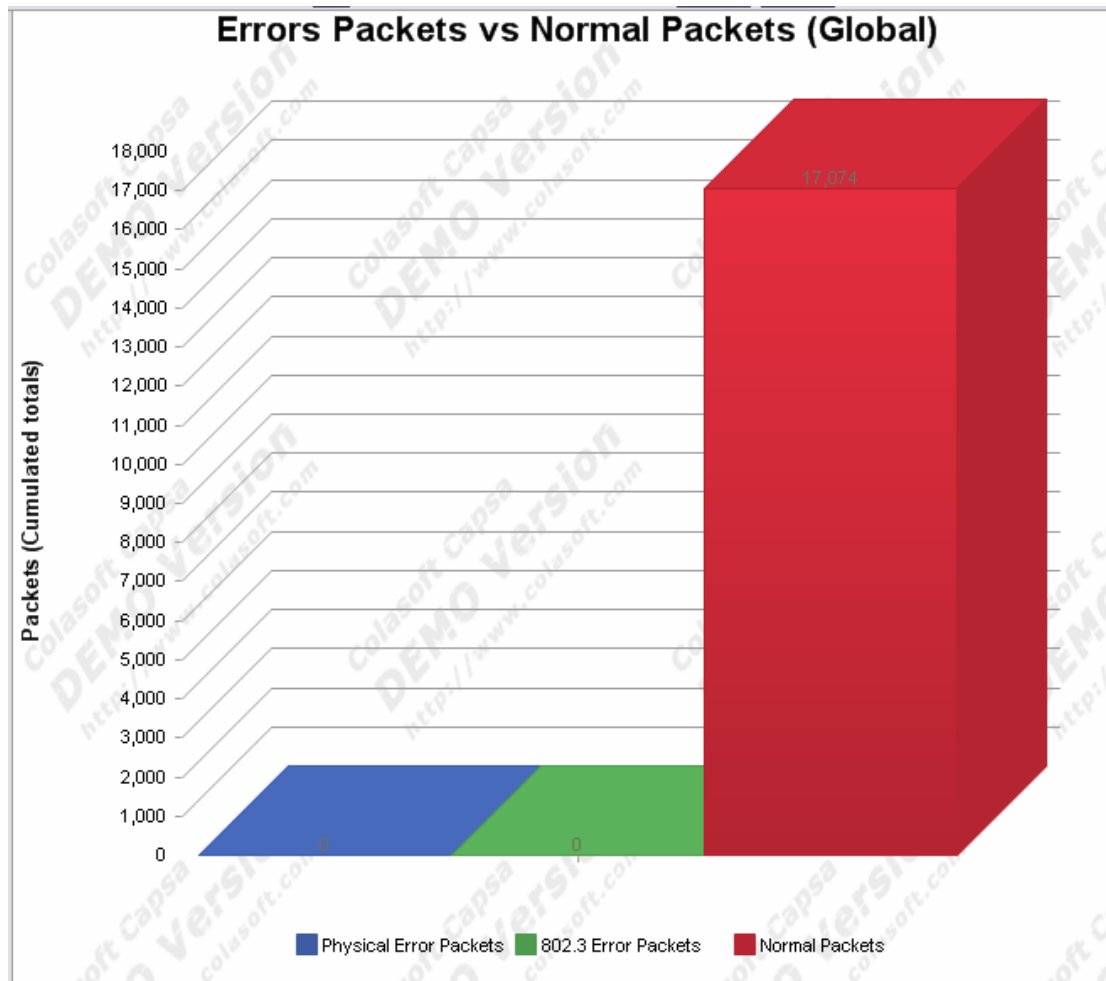


Figure 21: Errors Packets vs Normal Packets

4 Conclusions

Concerning the throughput, the Linux operating system presents slightly better results in relation to Windows. We can observe in Table 2: Relation bit rate (Mbit/sec) the differences the bit rate.

UDP		Windows	Linux	Difference
Unidirectional (Output)		74.8	86.0	11.2
Bidirectional	Output	75.0	83.5	8.5
	Input	72.0	71.4	-0.6

Table 2: Relation bit rate (Mbit/sec)

Besides, we can conclude that the processing unit works well with MDCs software. The last version of the MDCs combiner needs less resources but the MDC2 combiner does not work perfectly and therefore needs an update. The gateway prototype to be used in the SUIT demo is implemented in a PC stronger than the one shown in Figure 2.

The AP with firmware version 3 is an excellent choice because this model works very well with multicast traffic. We realised that later versions of the firmware do not permit Multicasting.

Let us assume each DVB-T/H multiplexer is delivering 25 Mbps. So, the building profile can accommodate 2 DVB-T/H and 2 WiMAX tuners $(25 \times 2 + 8 \times 2) = 68$ Mbps. However, all throughputs were measured with PCs which Ethernet cards have throughput limitations (in our case, the figures shown above in Table 2). As the coax modem manufacture mentions in the datasheet that the maximum throughput is 128 Mbps, we can conclude that the building profile can accommodate 4 DVB-T/H tuners and 3 WiMAX tuners.

5 Acronyms

AP	Access Point
BM	Bandwidth Manager
BW	Bandwidth
CATV	Cable Television Network
CMTS	Cable Modem Termination System
Copernicus	Communal name for the element manager (BARCO)
DVB	Digital Video Broadcasting
DVB-RCT	Digital Video Broadcasting – Return Chanel Terrestrial
DVB-T	Digital Video Broadcasting – Terrestrial
EMS	Element Management System
GK	Gatekeeper
HDSL	High bit rate Digital Subscriber Line
HFC	Hybrid Fibre Coax
ID	Identity
IGMP	Internet Group Management Protocol
IP	Internet Protocol
IT	Instituto de Telecomunicações
MDC	Multiple Description
Mbit/sec	10 ⁶ bit/s
MIB	Management Information Base
NE	Network Element
NMS	Network Management System
NMS	Network Management system
PC	Personal Computer
QoS	Quality of Service
RADIUS	Radius Server
RIC	Integrated Communication Network
ROSA	Communal name for the client monitoring programme (BARCO)
SMS	Service Management System
SNMP	Simple Network Management Protocol
TMN	Telecommunications Management Network
VCM	Video Call Manager
VxM	Video exchange Manager
WiMAX	Worldwide Interoperability for Microwave Access
UDP	User Datagram Protocol