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Abstract:

This document describes and summarizes the Internal Tests done by 6QM project during the first year. It describes the targets of each test, the partners involved, the specific components and the test-bed scenario used and the final results. Conclusions and future work to be done are included also in the document.

Keywords:

IPv6 Test-bed, QoS Measurement, Test Components, Test Scenarios.

Revision History

The following table describes the main changes done in the document since created.

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v1.9	21/02/2004	Final Review	Jordi Palet (Consulintel)

Executive Summary

This document describes and summarizes the Internal Tests done by the partners during the first year of 6QM project.

The internal tests during the first year were mainly intended to prepare the real trials that will be shown later within the project, along to prepare the evaluation of the probes that are been developed by partners.

The document describes the targets of each test, the partners and components involved, the specific scenario/test-bed used and the final results, as well conclusions and future work to be done.

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1. INTRODUCTION

The components of 6QM systems need to be evaluated in terms of performance, functionality and interoperability. For this, the 6QM A4.2 “Internal Testing” activity, structured in two yearly tests, aims to integrate, validate and demonstrate the characteristics of the different elements coming from the different work packages (network infrastructure, devices, applications and services).

This D4.3 deliverable describes the status of the A4.2 activity during the first year of the 6QM project giving a description of works carried out during this period.

The internal tests during the first year were mainly intended to prepare the real trials that will be shown later within the project, and to prepare the evaluation of the probes that are been developed by partners.

2. SUMMARY OF TESTS

In this section follows a brief description of the different internal tests done by the 6QM partners during the first year.

These tests were mainly made for getting experience with IPv6 QoS measurements and for obtaining a deeper knowledge of QoS measure commercial products that can be useful in further stages on the project, all for count with tools for checking the behavior of the developed devices within the project.

HEL has been working in an internal 6QM test-bed within its premises in Sophia Antipolis, France. The goal of the test-bed is to get hands-on experience with IPv6 and QoS measurement systems, with focus on trials involving the 6QM passive measurement prototype being developed by HIT within WP3. HEL 6QM test-bed consists of six Linux-based PCs: two used as passive measurement points, one as data source, one as data sink, one as router, and the last one as management station for data storage, processing, analysis, and display. HEL plans to interconnect its test-bed to the other 6QM partner's sites, through a native IPv6 connection as soon as such connection becomes available. After that, other experiments in collaboration with related EU projects can also be envisaged.

FT has deployed an active measurement system between FT/VTDHv6 (with two probes, one in Lannion and one in Paris) and Consulintel (one probe in Madrid). The main goals of FT tests are to provide a distribute measurement system to generate real IPv6 services traffic to calibrate the passive probes developed by partners. Also, the tests aim to get operational constraints usable for active or passive measurement systems. Finally, FT is working for coupling the QoSmetrix active measurement system with flows information exported by routers IPFIX meters.

Consulintel has been working in an internal test-bed so as to get information, procedures and know-how that will be used for evaluate the systems that have been developed within 6QM. The test-bed includes the investigation and use of QoS functionalities in Hitachi routers, and the use of Spirent systems (mainly SmartBits equipment and software) for analysis and monitoring on latency, packet loss and jitter of IPv6 traffic.

Fokus has been performed, along with other internal tests, non-intrusive measurements of IPv6 traffic. As preparation of a public demonstration on "Content Delivery and Measurements in Satellite Networks" Fokus has transmitted a video/audio stream encapsulated in IPv6 on multicast addresses on the receiving side of a satellite link. The traffic of this audio/video application can be used to perform and demonstrate passive measurements in presence of existing application traffic.

Finally, we can state that these internal trials are helping to gather important information for the future work of design and develop within WP4 evaluations.

3. DETAILED DESCRIPTION OF THE TESTS

This section contains a detailed description of the internal tests done during the first year of 6QM.

3.1 HEL Test-bed

HEL is building an internal 6QM test-bed within its premises in Sophia Antipolis, France (HSAL: Hitachi Sophia Antipolis Laboratory).

Partners involved

Hitachi Europe Ltd.

Targets

The goals of the test-bed are to:

- Help familiarize with IPv6 in practice, such as address autoconfiguration, DNS and router configuration, multihoming, IPv4-IPv6 coexistence and interoperability, etc.
- Test other related software dealing with QoS measurement systems, and IPv6 components, in order to evaluate useful features, possibilities to reuse components, and so on.
- Serve as initial test platform for software developed in WP3, with focus on the 6QM passive measurement prototype.
- Further interconnect the test-bed with other 6QM partners for initial WP4 trials, and in a later stage to participate in joint trials in collaboration with relevant related projects such as those participating in related IST projects including IPv6 Cluster projects, INTERMON, etc.

Components

The HEL internal 6QM test-bed consists of the following components:

- Source PC: Generates measured traffic to sink PC.
- Sink PC: Passive receiver of measured traffic in case of one-way measurements. In case of full-duplex measurements Sink PC can also be used as traffic source (destination is Source PC).
- Router PC: Used to separate measured traffic coming from the source PC from measured traffic going to the sink PC. Can also be used to simulate performance problems such as delaying packets, losing packets, etc.
- Meter PCs: Used passive measurement points, they capture packets and send measurement data to the Server PC.
- GPS receivers: To synchronize the clocks of meter PCs.
- Server PC: Management station for data storage, processing, analysis, and display. Calculates measurement parameters and displays them on the screen, or stores them in a database or in files. Also acts as a gateway to the outside world (Intranet or Internet, in IPv4 and IPv6).
- Hubs: Broadcast traffic from source PCs to router and to meter PCs.

- Switch: For Ethernet communication between Server and Meter PCs

Test-bed scenario

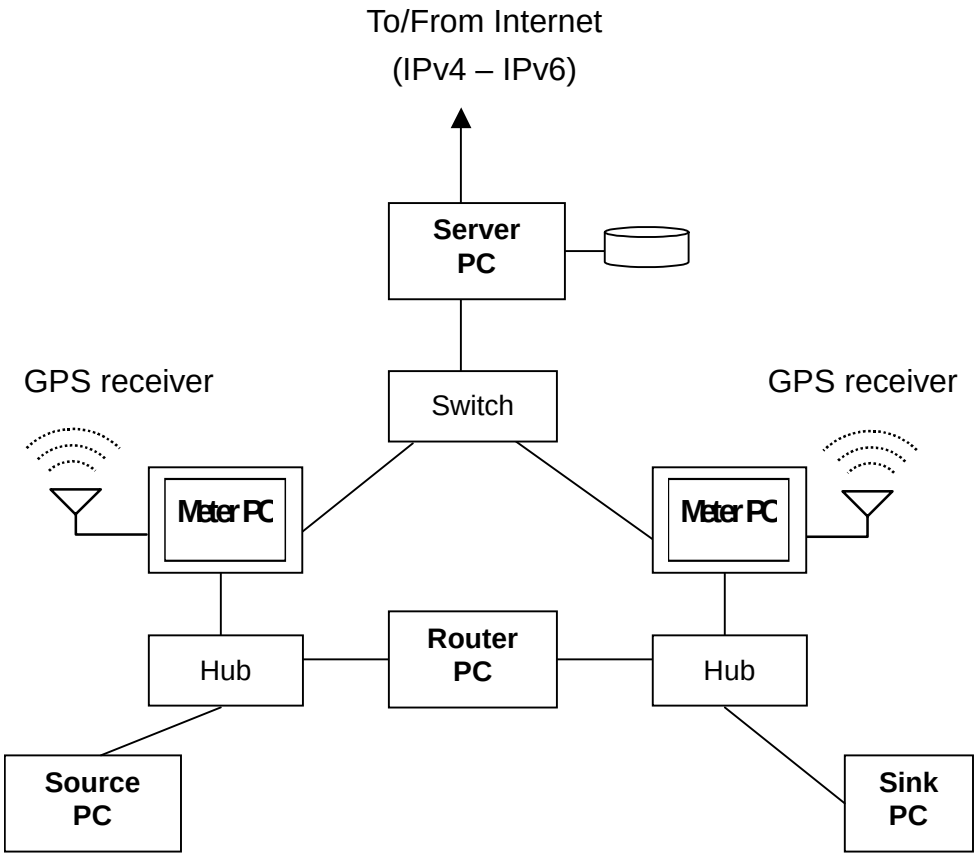

Figure 3-1: HEL Internal Test-bed Configuration

The complete test-bed is double-stack IPv4-IPv6. It is almost complete except for the GPS receivers, which still must be purchased.

HEL plans to obtain a native IPv6 connection for it as soon as possible. Negotiations are in progress with available network access providers. After that, external experiments can be envisaged. Meanwhile, internal experiments will be performed, with focus on WP3 developments.

Results

Current state and results achieved so far:

- The elements have been configured in double stack mode (IPv4-IPv6) with address autoconfiguration and site-local prefixes. Since HEL has still no native IPv6 access, no global prefixes are assigned yet.
- An IPv4 version of the passive meter prototype is available for internal testing, and is currently being ported to IPv6. Part of the porting has been successfully compiled and tested within the HEL test-bed. Current tests have involved single-point measurements only (packet count in unicast and multicast).

- HEL developed a prototype IPv6-IPv4 generic C library, which was implemented and tested in both IPv4 and IPv6 using the internal test-bed. This library provides network functions to facilitate migration from IPv4 to IPv6 and the development of double-stack applications. The current version of the source code has been uploaded to the 6QM ftp site in order to be used and integrated within upcoming WP3 developments.

3.2 FT Test-bed

FT has deployed and tested a Distribute Active Measurement system between FT/VTDHv6 and Consulintel. The system has 3 QoSmetrix points of measurement located in Lannion (FT), Paris (FT) and Madrid (Consulintel).

Partners involved

France Telecom, Consulintel

Targets

The goals of this system are to:

- Provide a distribute measurement system to generate real IPv6 services traffic to calibrate the passive probes developed by partners.
- Get operational constraints usable for active or passive measurement systems.
- Work toward coupling the QoSmetrix active measurement system with flows information exported by routers IPFIX meters.

Components

This active measurement system consists of the following main components:

- 3 QoSmetrix NetWarrior (IPPM and RTP probe).
- 1 QoSmetrix NetAdvisor (Management software for NetWarrior.
- IPPM Proxy and SNMP agent.

Test-bed scenario

The main components of the distributed active measurement system are shown in the following figure.

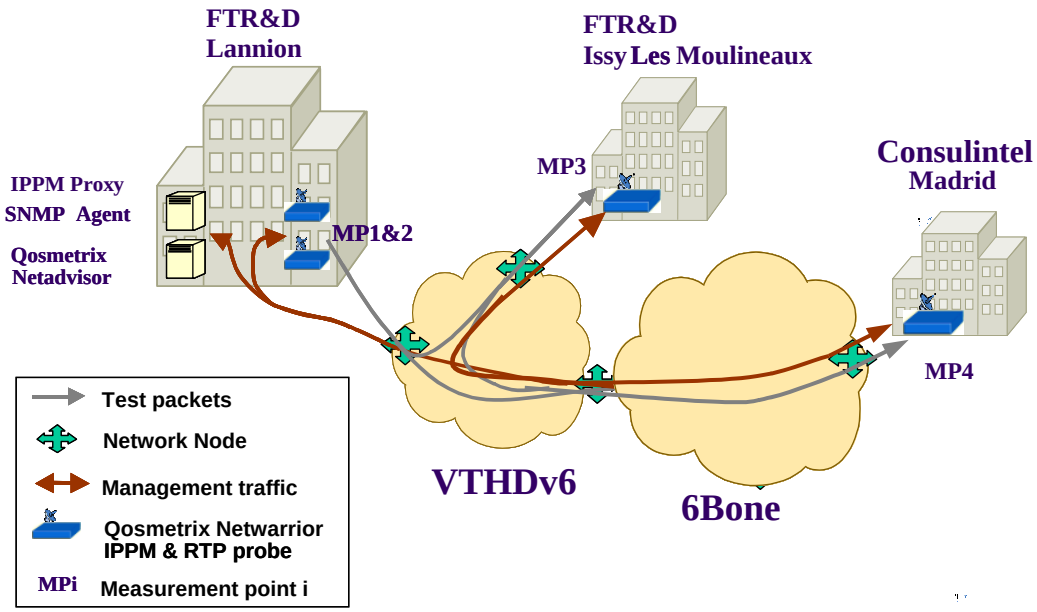

Figure 3-2: FT Distributed Test-bed Scenario

Results

The above tests is producing information for calibrate the passive probes that will developed by partners, and initial work for coupling the QoSmetrix active measurement system with flows information exported by routers IPFIX meters.

In addition, these tests have been used as base and preparation for the public demonstration done by 6QM during the Madrid 2003 Global IPv6 Summit. Further description of this will be included in D4.4 “First Year Public Trial and Evaluation Report”.

3.3 Consulintel Test-bed

Consulintel has been working in an internal test-bed in order to get information, procedures and know-how that will be used for evaluated the systems that are been developed within 6QM project.

Partners involved

Consulintel

Targets

The goals of the test-bed are to:

- Investigate and evaluate the DiffServ QoS functionalities in Hitachi routers.
- Investigate and evaluate Spirent systems (mainly SmartBits – SMB equipment and software) for IPv6 QoS performance tests.
- Gain experience and know-how on measurement of Packet loss, Latency and Jitter for IPv6 traffic.
- Cooperate with other IPv6 related projects for using the 6QM system in their own networks and developments.

Components

The Consulintel internal test-bed consists of the following components:

- Hardware
  - Tester:
    - SmartBits 6000B and Terametrics 10/100 cards.
  - Devices under test (DUT)
    - Hitachi GR2000-10H and 10/100 Ethernet ports.
    - Hitachi GR2000-2B and 10/100 Ethernet ports.
- Software
  - Tester:
    - SmartFlow 2.20.005.1.
  - (DUT)
    - SW S-9181-61X 07-01 for Hitachi GR2000-10H.
    - SW S-9181-6B 06-05-/C for Hitachi GR2000-2B.

Test-bed scenario

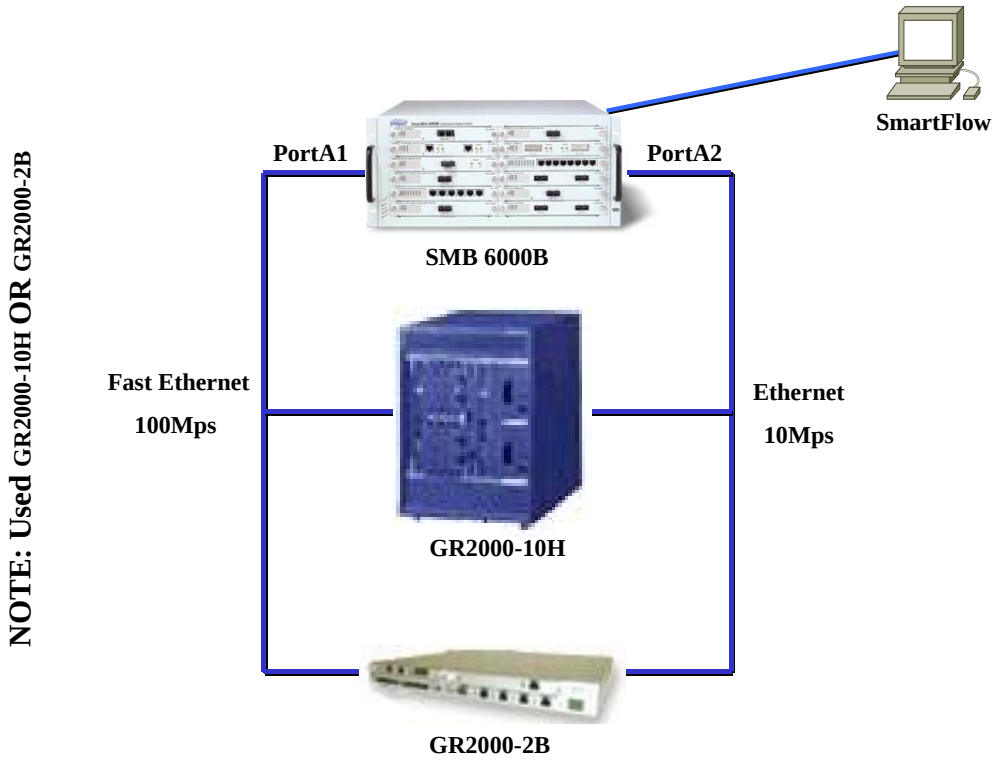

Figure 3-3: Consulintel Internal IPv6 QoS Test-bed

Several tests were done on IPv6 QoS functionalities in Hitachi routers and SmartBits systems using the topology shown in the above figure. The link from PortA1 was configured for Fast Ethernet full-duplex and the link from PortA2 was configured for Ethernet full-duplex in order to create a bottleneck and obtain packet losses.

Using Spirent' SmartFlow application, 8 IPv6 bi-directional flows were defined between PortA1 to PortA2 of the SMB-6000B passing through the Hitachi router. These flows, from "DS_0 –

DIFF0" to "DS7 – DIFF7" have different values in theirs IP Precedence bits, and then in theirs equivalent Traffic Class and DSCP fields as shown in the following equivalent values table.

SMB-6000B Flows	IP Precedence (Decimal)	IP Precedence (Binary)	Traffic Class (Binary)	Traffic Class (Decimal)	DSCP (Binary)	DSCP (Decimal)
DS_0 – DIFF0	0	**000**	**000**00000	0	**000**000	0
DS_1 – DIFF1	1	**001**	**001**00000	32	**001**000	8
DS_2 – DIFF2	2	**010**	**010**00000	64	**010**000	16
DS_3 – DIFF3	3	**011**	**011**00000	96	**011**000	24
DS_4 – DIFF4	4	**100**	**100**00000	128	**100**000	32
DS_5 – DIFF5	5	**101**	**101**00000	160	**101**000	40
DS_6 – DIFF6	6	**110**	**110**00000	192	**110**000	48
DS_7 – DIFF7	7	**111**	**111**00000	224	**111**000	56

Figure 3-4: Equivalent Values for QoS Fields

Results

Several tests were done obtaining number of tables and graphs for Packet losses, Latency and Jitter measurements for both GR2000-10H and GR2000-2B Hitachi routers. Some examples depicted in the following sections.

Results for Hitachi GR2000-2B configured with different output priorities

The GR2000-2B was configured as follow in order to give to the generated flows a different output priority according theirs DSCP values. Hitachi routers make a flow control function effective by specifying the output priority and queuing priority. For output priority, can be use values from 1 to 1000, and the greater the value of the output priority, the more preferentially the packet is issued.

```
flow yes {
      qos eth01 out {
            list 40021 ip any any dscp 8 action priority 1;
            list 40022 ip any any dscp 16 action priority 2;
            list 40023 ip any any dscp 24 action priority 3;
            list 40024 ip any any dscp 32 action priority 4;
            list 40025 ip any any dscp 40 action priority 5;
            list 40026 ip any any dscp 48 action priority 6;
            list 40027 ip any any dscp 56 action priority 7;
      };
};

Note that there is no action for DSCP=0

File: 2b_DiffServ_test_01
```

Figure 3-5: GR2000-2B Configuration for Different Output Priorities

The following graphic show the different behaviors on Packet Losses for the flows according to different output priorities in router acting over the different DSCP values in the IPv6 traffic. As it can be seen, there is a better performance for DS_7 rather than the others DS_n.

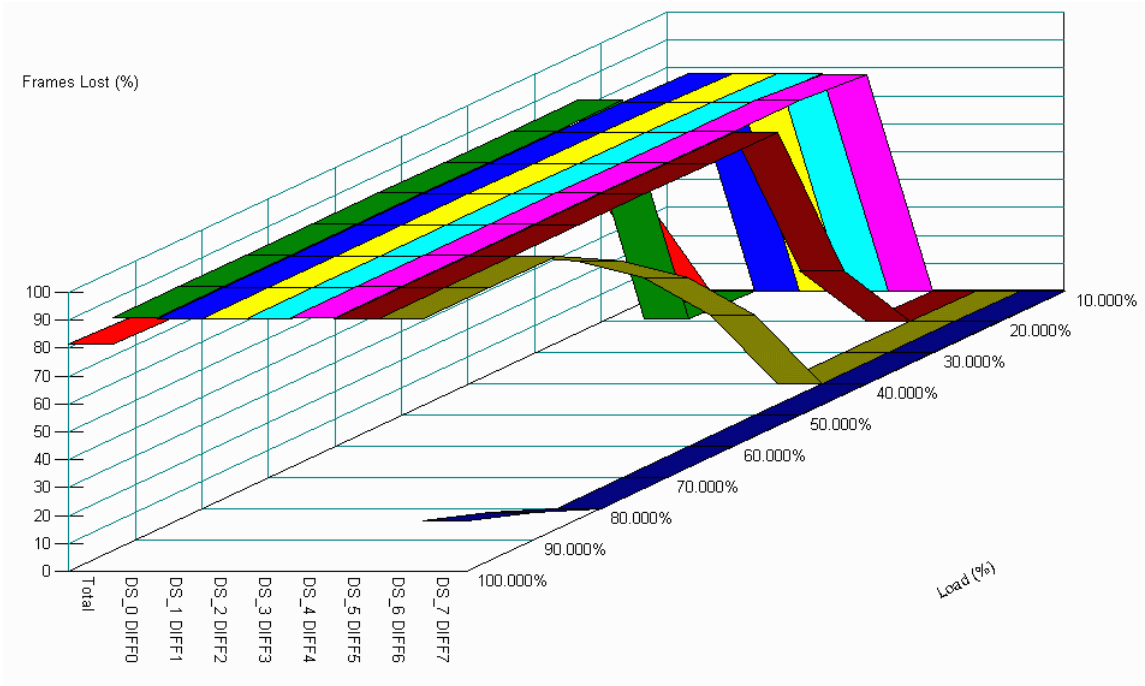

Figure 3-6: Packet Loss for Different Output Priorities Acting over DSCP Values

3.4 Fokus Test-bed

Fokus has been performed, along with other internal tests, trails for Non-intrusive Measurements of IPv6 traffic. As preparation of a future public demonstration on "Content Delivery and Measurements in Satellite Networks" Fokus has tested the transmission of video/audio streams encapsulated in IPv6 on multicast addresses on the receiving side of a satellite link.

Partners involved

Fokus

Targets

The goals of the test-bed are to:

- Setup and try non-intrusive measurements tool for IPv6 traffic.
- Investigate the use of audio/video application in order to perform and demonstrate passive measurements in presence of existing application traffic.
- Preparation of a future public demonstration on "Content Delivery and Measurements in Satellite Networks".

Components

The Fokus test-bed consists of the following main components:

- Two measurement points to perform non-intrusive measurements.
- Audio/video stream server.

- Live video and audio streams are transmitted to mobile devices using IPv6 multicast over satellite, terrestrial and WLAN networks.

  Test-bed scenario

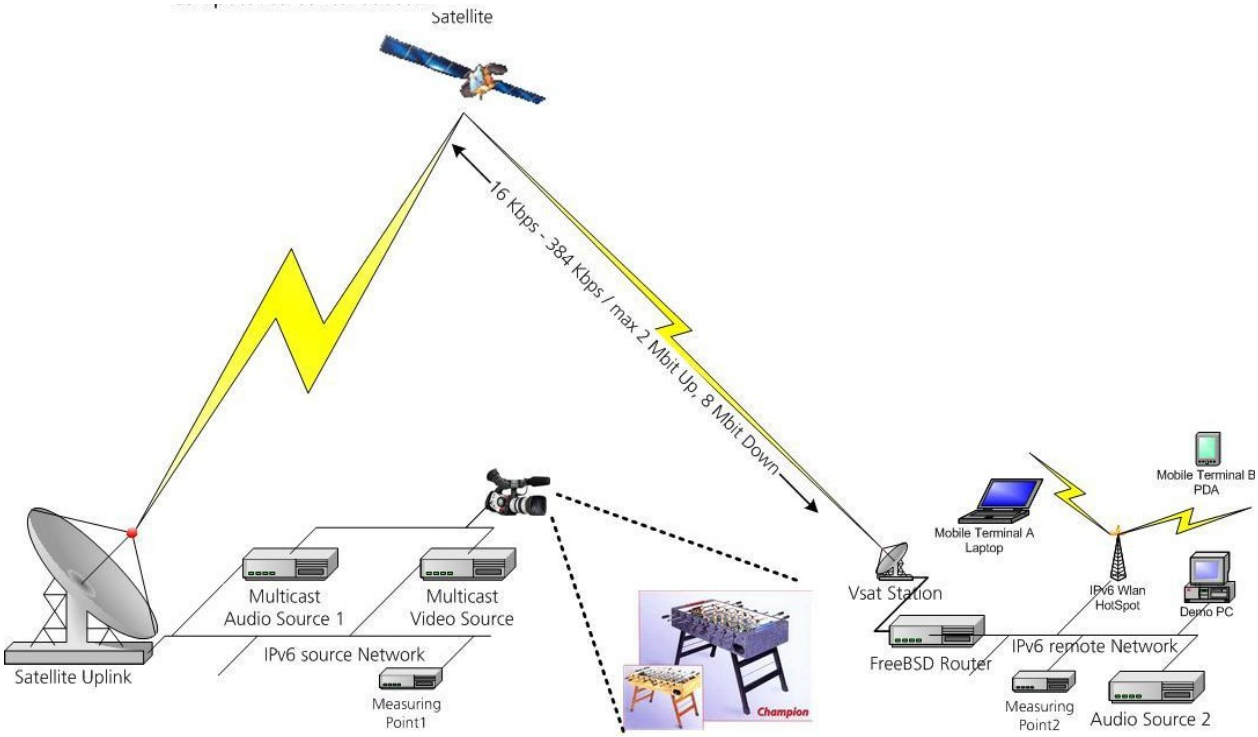

Figure 3-7: Test-bed for QoS Measurement of Streaming Video over IPv6 via Satellite

The general test-bed scenario is shown above. Two measurement points are installed to perform non-intrusive measurements of one-way delay for the audio and video streams. This enables investigation of the actual streaming quality. Based on the measurement results, validation of guarantees given in an SLA can thus be effected. Furthermore, the transmitted volume is metered, providing the basis for usage-based accounting.

3.5 Other Tests

HEL and Consulintel participated in the 1st ETSI Remote IPv6 Interoperability Plugtests event for IPv6 related tests within the tests session of 12th-14th of May 2003, during the Madrid 2003 Global IPv6 Summit. This Plugtests event interconnected the following sites in native IPv6.

- ETSI (Sophia Antipolis, France).
- IRISA (France).
- Madrid 2003 Global IPv6 Summit (Spain) http://www.ipv6-es.com.
- Université Libre de Bruxelles (Belgium).
- TAHI (Japan).
- ChungHwa Telecom (Taiwan).
- TTA (Korea).
- New Hampshire University (USA).

This was the first remote IPv6 interoperability event organized by ETSI in the framework of the Plugtests activity. Several tests were performed, including QoS, DNS, Mobile IPv6 and BGP4+. The test coordination was managed from ETSI using the ISABEL videoconferencing system.

4. FUTURE WORK

The goal is to use and exploit the knowledge acquired with these internal tests as a base and preparation for real public trials along with the evaluation of the probes that are been developed by 6QM.

In the future 6QM will increase the tests and evaluations of performance, interoperability and may be conformance for the component system developed by partners in order to assure the success of the 6QM outputs. Note that there are not foreseeing more internal solitude trials but inter-partner tests and collaborations that enforce the evaluation process of all the different elements taken into account within the 6QM project.

One of the main points in the next stage of the evaluation will be to install the prototype shipped by WP3 at partner premises. As a result the consortium will have a homogeneous system to perform consistent measurement tests on a world wide scale.

5. SUMMARY AND CONCLUSIONS

The components of 6QM systems need to be evaluated in terms of performance, functionality and interoperability. As parts of this activity, the present D4.3 deliverable describes the main internal tests done during the first year.

These tests were mainly made for getting experience with IPv6 QoS measurements and for obtaining a deeper knowledge of QoS measure commercial products that can be useful in further stages on the project, all this for count with tools for checking the behavior of the developed devices within the project.

Also, this set of tests is intended to prepare the real trials that will be shown later within the project. In fact, the early and current test-beds have produced outputs for external trails already done, for example there were successful external trails during IST 2002, October 2002, CeBIT, February 2003, and Madrid 2003 Global IPv6 Summit, May 2003. During those trials, important information for the future work of design and develop within WP4, has been gathered. Further description of this will be included in D4.4 deliverable “First Year Public Trial and Evaluation Report”.

Also is important to highlight that one of the main points in the next stage of the evaluation will be to install the prototype shipped by WP3 at partner premises. With this, 6QM will have a homogeneous system to perform consistent measurement tests on a wider scale.