



**VIDEO OVER DSL
INTEROPERABILITY TEST EVENT
November 17-21, 2003**

**PUBLIC TEST REPORT
FINAL VERSION**

Organized by:



In cooperation with:



Introduction

In November 2003, the European Telecommunication Standards Institute (ETSI) organized a Video over DSL interoperability test event in Saarbruecken, Germany, with support from the European Advanced Networking Test Center (EANTC).

The one-week test under non-disclosure agreement targeted interoperability of voice and video services rather than the physical DSL infrastructure; it was co-located with the 2nd joint physical layer xDSL Plugtests event. This test addressed manufacturers of

- **DSLAMs** and **DSL modems**, for IP multicast and QoS transport interoperability
- **Set-top boxes** and **headends / video content servers**, for video services interoperability

The goal was to set up and test a multi-vendor Video over DSL infrastructure with components of different equipment manufacturers, complemented by emulators to show scalable interworking and reliability between DSLAMs, DSL modems, set-top boxes and video content servers. The test scenarios evaluated transport and service aspects of Video over DSL. The test plan was defined by EANTC, based in part on the work of the FS-VDSL and the ITU (H.610 / H.611).

Background

In 2003, there has been a clear trend in the convergence of voice, video and data networks for consumer applications. The majority of deployments (especially in Europe and Asia) will use DSL to the home. Since there are 40+ million ADSL subscribers already it is also important to take into consideration existing infrastructure.

Our survey of more than 20 vendors at CeBIT exhibition (Germany, March 2003) showed that the market is ready and the equipment is nearly fully developed: A lot of implementations are available for Video over DSL. Some of these were shown live at CeBIT. All European carriers and content providers we talked with agreed that interoperability of Video over DSL solutions is currently a very hot topic — that created the idea of this Video over DSL interoperability test.

Participants and Devices

The following companies and devices demonstrated their interoperability in the test event:

Vendor	Devices	Device Type
Arescom	NDS 860 KUE NDS 1061 KE	DSL Modem (bridge) DSL Modem (router)
Ericsson	EDA 1.2 ESN310	DSLAM Ethernet Switch
Net To Net Technologies	IP D 4000	DSLAM
Spirent Communications	AX4000 SmartBits 6000B	Protocol Emulator Load Generator

Test Goals

The event focused DSL carrier requirements, specifically but not exclusively for the European market. The primary goals were:

- To demonstrate to carriers, service providers and content providers that the technology as a complete end-to-end solution is viable;
- To evaluate in how far Video over DSL (TV Broadcasting, Video on Demand) is ready for deployment in multi-vendor environments now.

Participants benefited in the following ways:

- Ensured that their solution provides exactly the features in a multi-vendor end-to-end environment which the carriers and content providers deem important;
- Improved their devices' interoperability capabilities.

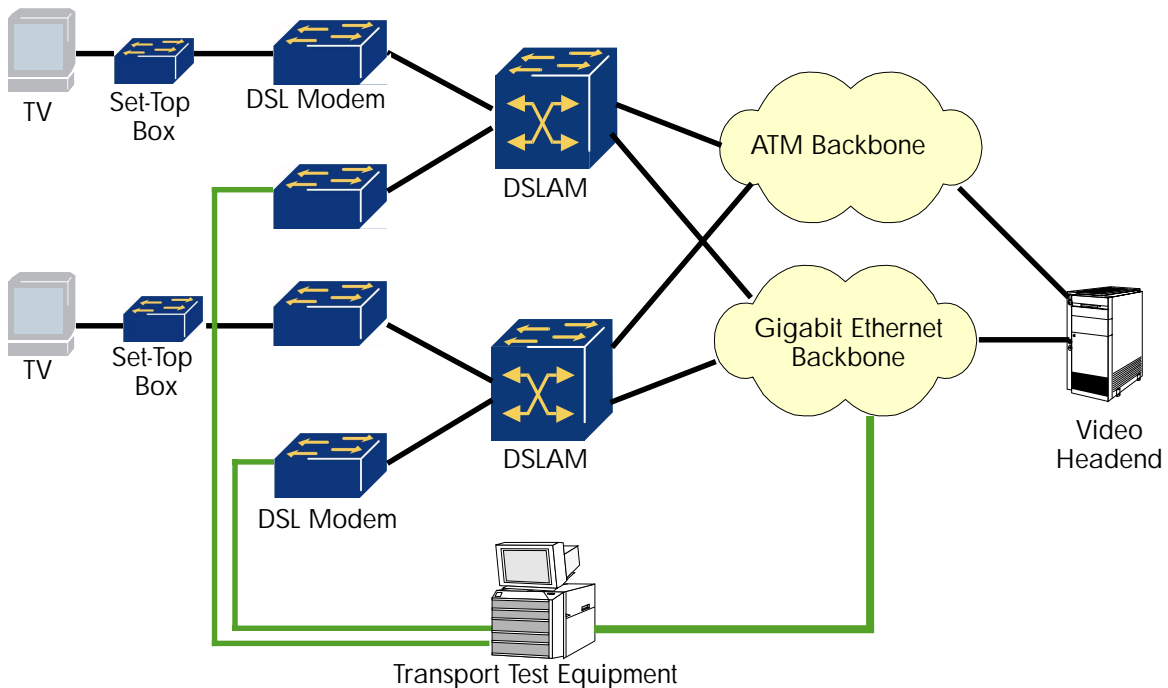
An end-to-end network with real Voice over DSL and Video over DSL solutions of different vendors, complemented by emulators, was used to perform interoperability test scenarios, check and improve test methodologies, and finally globally demonstrate advantages and capabilities of this technology.

Test Areas

The test plan covered the following topics of interoperability:

Video over DSL Transport (DSLAMs, DSL Modems)	Video over DSL Service (Set-top boxes, content servers)
<ul style="list-style-type: none"> • Multicast Transmission over DSL and backbone (ATM and Gigabit Ethernet, IGMP-based) • Scalability of DSLAMs: Number of simultaneous video channels Number of multicast subscribers Zapping Time under load • Quality of service Prioritization, latency issues at DSLAM ATM traffic management, shaping xDSL single VC / multiple VC solutions 	<ul style="list-style-type: none"> • End-to-end multicast transmission • Video quality between encoder, network and decoder (set-top box) • Channel Provisioning at headend / content server • Service Management Platform interoperability between Set-top boxes and headends (Program guide, set top box SW management)

Test Plan



TVoDSL Interoperability Test Bed

We distinguished transport tests applicable to DSL modems and DSLAMs from service tests applicable to video headends and set-top boxes.

Service Tests

1. Video Quality: End-to-end quality of service

To demonstrate the ability to maintain quality of service from the head-end to the modem through the backbone, showing interoperability with Ethernet or ATM based networks. (ITU-T H.610 14.1.1 and 14.1.2)

By generating traffic from both the backbone and the modem we verified that Quality of Service can be provided on the ADSL/SHDSL link between the modem and the DSLAM as well as in the backbone network all the way to the head-end.

2. Channel Provisioning: Video encapsulation at head-end

To demonstrate the interoperability of head-end solutions to multiple Set-top boxes to display video streams. (ITU-T H.610 14.1)

By having different types of head-end solutions and different types of set-top boxes connected to the same network we demonstrated video interoperability.

3. Service Management: Set-top to head-end interoperability

To demonstrate the ability of each head-end solution to manage different set-top boxes.

By connecting head-end solutions to set-top boxes from different vendors we showed interoperability of program guides, set-top software updates and channel control.

Transport Tests

1. Multicast Transmission over DSL

To demonstrate the capability to transmit an IP multicast stream from the DSLAM to the modem, including the ability to use IGMPv2 for a channel switchover at the DSLAM.

Using test equipment attached to both the DSLAM and one or more modems we distributed several IP multicast streams to a DSLAM, and verified correct subscription and forwarding activities at the DSL modems. We also initiated a channel switchover from the modem side to insure that the modem and the DSLAM process the IGMPv2 packets correctly.

2. Multicast Transmission over the backbone (ATM and Ethernet/IP)

To demonstrate the ability for a DSLAM to receive and forward multiple IP multicast streams in parallel. In the case of ATM, demonstrating the ability for DSM-CC to IGMP conversion and the ability for the CPE to send IGMPv2 messages to switch multicast streams.

3. Number of simultaneous IP multicast streams (video channels)

To demonstrate the total number of Multicast streams a DSLAM can accept without frame loss.

4. Number of simultaneous IP multicast subscribers

To verify that the DSLAM can replicate a Multicast stream to all ports

Connecting as many modems to the DSLAM as possible, see if the DSLAM can forward one Multicast stream to all modems.

5. Zapping time under load

To demonstrate the time taken for a CPE device to join/leave multicast streams while the DSLAM is fully populated with incoming streams and subscribers.

6. Verify Quality of Service on the xDSL link using either a single virtual channel (VC) for all applications or multiple VCs for different applications

Test Results

In this section, we summarize the results and observations collected during the interoperability test. In general, functionality test goals in the multi-vendor TVoDSL environment were reached. Some interoperability issues and future test areas were identified.

Results of Service Tests

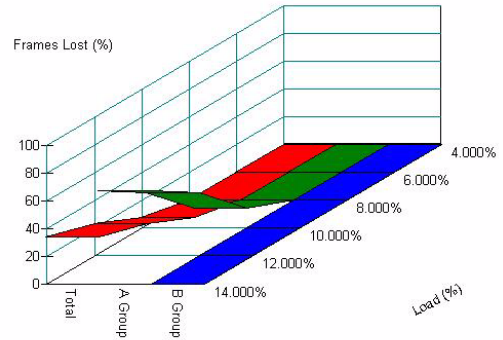
The end-to-end quality of service (QoS) test verified if video quality (multicast traffic stream) was maintained with high priority even when the link between DSLAM and DSL modem was saturated and further oversubscribed with emulated unicast Internet traffic.

All devices involved in the test ultimately passed it, but surprisingly we faced initial configuration issues in all cases. In one case, there was additional configuration necessary to tag multicast IP packets in order to prioritize them; in another case, the ATM traffic management configuration of the systems under test was incorrect. Clearly, the technology is available but from our point of view it is important to verify correct QoS configuration in triple play networks today.

During the interoperability test, all configuration was done manually and via CLIs / GUIs. The issues emphasize that it is important to use an efficient management system for triple play service provisioning.

When these issues had been sorted out, the devices showed correct oversubscription behavior. To evaluate if prioritization works as expected, we generated a prioritized multicast stream of 1518 Byte packets with the load generator. The test showed the expected results: only unicast frames were dropped in the overload situation while multicast TV packets were prioritized.

The results of link oversubscription tests with two parallel multicast streams were as expected, no stream was prioritized over the other and so packets from both streams were discarded.

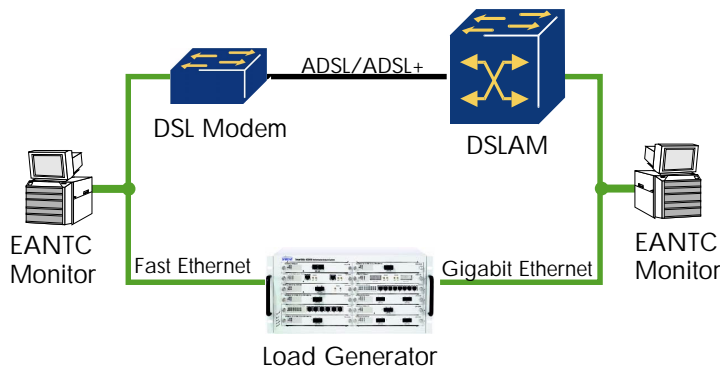


Oversubscription Test Result: PASS
 (blue: multicast TV — no loss,
 green: unicast Internet — loss,
 red: total)

Results of Transport Tests

In this section, the vendors verified the functionality, interoperability and scalability of their Ethernet/IP multicast implementations. At first, basic IP multicast stream transport from the DSLAM to the modem was evaluated, including the test of IGMPv2 for a channel switchover at the DSLAM.

This basic test worked well in some combinations, but uncovered an IGMP interoperability issue with one of the Annex B modems. The modem vendor accepted the issue and planned to solve it in the next software release. It appears that multicast transmission was not an initial design goal for all modem vendors.



Generic Test Setup For Transport Tests

We were unable to run the next test case dealing with multicast transmission over an ATM backbone, scalability for multiple IP multicast streams in parallel, and the ability for DSM-CC to IGMP conversion: The participating DSLAM vendors provided only Ethernet uplinks for the test. For this reason, the generic test setup for all following tests used Ethernet links only, as shown in the diagram on the left.

The DSLAMs showed outstanding scalability and robustness in the next test, verifying the maximum simultaneously active number of IP multicast streams (video channels). All DSLAMs under test scaled to their documented design goals without any issues, supporting a maximum of between 255 and 1024 multicast streams. Given the limited number of DSL modems available, the test ran all streams in parallel over a few modems only, each using a very low rate — making this test an IGMP signalling and multicast cache size test, not a data plane performance test for the DSLAMs.

For the same reason — number of available modems — the maximum number of simultaneous IP multicast subscribers for one stream could not be tested in practice. A very large number of modems would have been required to verify that the DSLAM can replicate a multicast stream to all ports simultaneously. To our knowledge, there is unfortunately no IP load generator in the industry attaching directly to the ADSL/ADSL+ lines of the DSLAMs. All DSLAM multicast scalability tests are still expensive to carry out and difficult to manage.

The next test we executed, showing the *zapping time under load*, will certainly remain one of the most critical DSLAM and DSL modem multicast performance tests in the foreseeable future. The time it takes a CPE device to join/leave multicast streams while the DSLAM is fully populated with incoming streams and subscribers, and running a large number of active IGMP instances, is an extremely important parameter for

customer satisfaction. During our test, we were able to measure join latencies only with a single active modem and one multicast stream. The join latencies were very promising, between 13 ms and 230 ms. However it is difficult to predict behavior at full load based on these figures.

Finally, we verified the Quality of Service on the xDSL link using either a single virtual channel (VC) for all applications or multiple VCs for different applications. One participating vendor ran the prioritization on the DSLAM uplink module based on IP TOS bits. On the ADSL link, the stream used only one ATM PVC. To realize QoS the packet need to be queued according to their traffic profile before being transmitted over the PVC. Another participating vendor classified the traffic based on VLAN or IP TOS information and mapped the traffic to different ATM PVCs with different service classes like UBR or VBR-rt for transport over the ADSL link. With both solutions we successfully verified that a prioritization of a multicast stream over a data stream was possible.

Conclusion

This event was a first step to probe TV over DSL service interoperability and multicast, QoS enabled DSL transport interoperability in an open multi-vendor end-to-end application environment. Many open interoperability test events have been conducted in the past focusing the physical layer of ADSL, S-HDSL and VDSL. To our knowledge, there were attempts by the Full Service VDSL focus group to organize video/voice/data over VDSL interoperability events in 2001, but no results have been communicated to the public. It seems that the market is getting ready for multi-vendor TVoDSL interoperability testing right now: Service providers request interoperability of set-top boxes, video server middleware, and of course DSL modems and DSLAMs because they want to select best-of-breed solutions and need to assure second source availability for critical and/or mass network components.

This interoperability event proved that the TVoDSL transport architecture is available and working between the participating vendors in most scenarios. The issues with basic IGMP interoperability and difficulties configuring the Quality of Service parameters showed that we are just at the beginning of TVoDSL interoperability testing, however. Although single-vendor or vendor-group solutions have been successfully tested in many service provider trials and are already deployed in a couple of production networks, it will still take some time to reach full multi-vendor interoperability — specifically regarding the video service components (set-top boxes and video on demand / video broadcasting middleware) and the provisioning, management, accounting and billing solutions.

References

- [H.610] ITU-T recommendation H.610 (07/2003), Broadband and triple play multimedia services — Broadband multimedia services over VDSL, Full-Service VDSL — System architecture and customer premises equipment (prepublished recommendation)
- [H.611] ITU-T recommendation H.611 (07/2003), Broadband and triple play multimedia services — Broadband multimedia services over VDSL, Operations, administration, maintenance & provision aspects of a full-service VDSL platform (prepublished recommendation)
- [H.Sup3] ITU-T recommendation H.611 (05/2003), Broadband and triple play multimedia services — Broadband multimedia services over VDSL, Operator requirements for full-service VDSL in ITU-T recommendations H.610 and H.611 (prepublished recommendation)



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