Connectivity tests in ADSL links

In order to check that the ADSL service, which mainly uses ATM technology, is operating correctly, an advanced ATM generator/analyzer is needed that can be easily transported to allow the user the greater mobility to go anywhere that the DSLAMs are located.

Application Note NAVAATM_ADLS30e

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TrendCommunications

The growth in popularity of the Internet has brought about a sizeable increase in the bandwidth needed for users to access the network, and as new services come on the scene, this need could grow still further. In order to satisfy these demands with the current local subscriber loop infrastructure, xDSL technologies have appeared that offer bandwidths of a few Mbit/s, like ADSL (Asymmetric Digital Subscriber Loop), to up to dozens of Mbit/s in the case of VDSL.

INTRODUCTION

ADSL is a technology that uses modems to achieve high transmission rates over the current twisted-pair telephone lines. As its name suggests, ADSL is aimed primarily at asymmetric switching, i.e. with different rates in each direction. This makes it suitable for all applications with asymmetric traffic where the bandwidth requirement from the network to the user (downstream) is much greater than that from the user to the network (upstream): Internet access, video on demand, etc.

Capacity

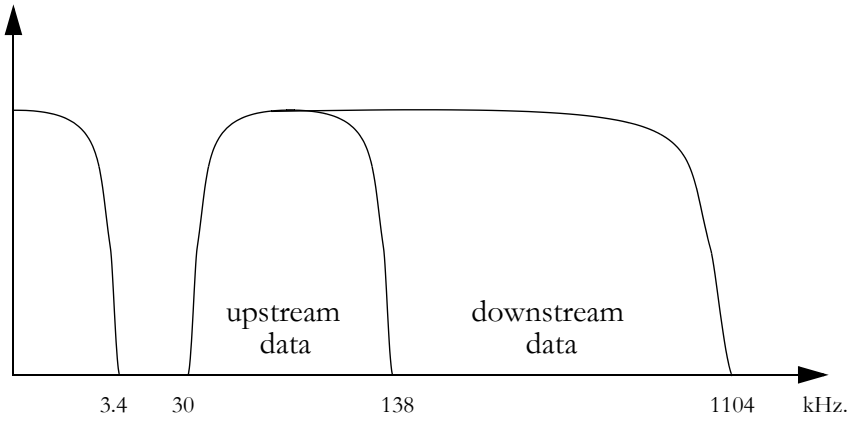
Different types of ADSL services have been defined according to the rates they offer, reaching capacities of up to 6.1 Mbit/s in the direction network-user and up to 640 kbit/s in the direction user-network. Most of the current installations allow up to 1.5 or 2 Mbit/s downstream and around 128, 256 kbit/s upstream. The maximum possible rates depend on a number of factors related to the properties and physical parameters of the local subscriber loop: length of copper wire, gauge of the wire (AWG), presence of bridged taps, far end crosstalk (FEXT) and attenuation. The attenuation increases together with the length of the line and the frequency, and decreases when the diameter of the wire is augmented.

Technology

ADSL as a transmission technology is based on the latest developments in the processing of digital signals and modulation techniques. The ADSL signal takes up the band of frequencies from approximately 25 kHz to 1.1 MHz. This allows the ADSL service to operate simultaneously with the telephone service, which takes up the band up to 4 kHz.

ADSL is based on a system of FDM (Frequency Division Multiplexing) in which the bandwidth available in the subscriber loop is divided into three parts. The base band is taken up by the telephone service, and the

other two zones are dedicated to data in the direction user-network (≈ 30 kHz. - 138 kHz.) and data in the direction network-user (≈ 138kHz. - 1104 kHz.). The capacity in the direction network-user can be divided into one or several high speed channels by means of time division multiplexing (TDM). Similarly, the user-network capacity can also be divided into one or several low speed channels using TDM.



In order to take fuller advantage of the bandwidth, some ADSL systems use echo cancellation techniques by overlapping part of the upstream and downstream data in frequency.

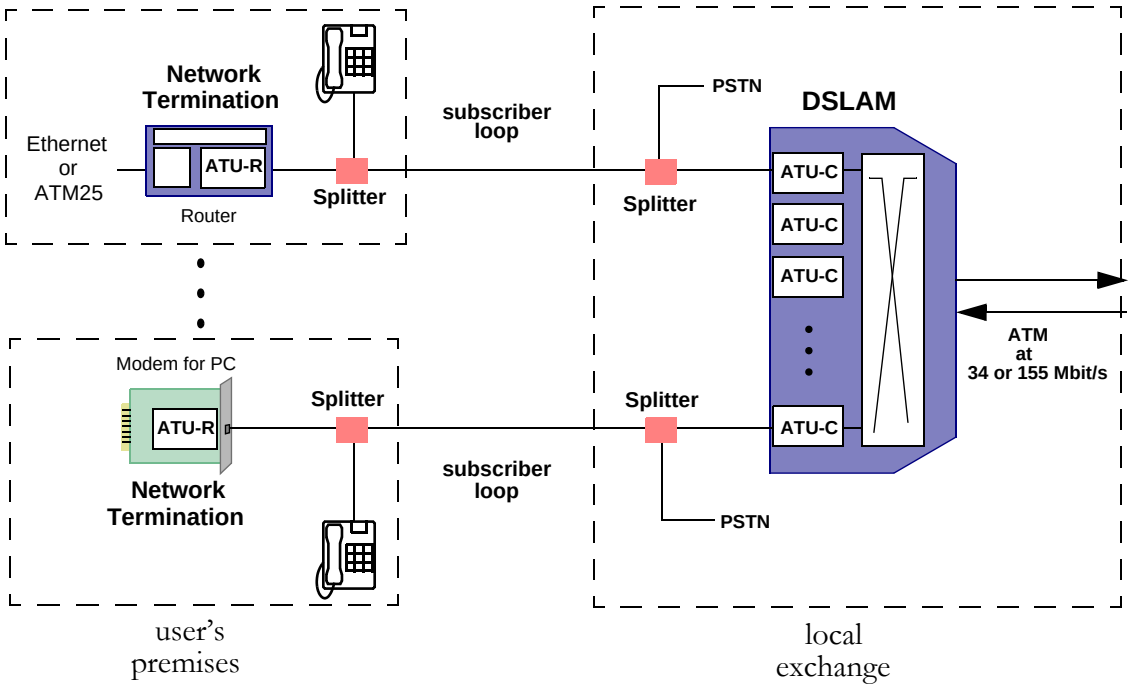
In order to obtain high transmission rates, ADSL uses a modulation technique known as DMT (*discrete multitone*) in which the available bandwidth is divided into bands of 4 kHz. The downstream data takes up 256 subbands while the upstream data takes up 32. In each band a QAM modulation is used to transmit a different number of bits depending on the S/N characteristic of the band in question. This way the use of the available bandwidth is optimized and the maximum transmission rates can be obtained.

Architecture

ATM transmission is the solution that has been most widely adopted for ADSL systems. In this case there is usually a single upstream channel and a single downstream channel, without the time division multiplexing of several channels. Instead, the function of multiplexing several services is delegated to the ATM layer where several connections are established. The data transported in each channel therefore consists of a flow of ATM cells.

The architecture and elements that form part of an ADSL are illustrated in the figure below.

The reference model for the ADSL itself would only include the ATU-R (ADSL Transceiver Unit, Remote terminal end), the user's splitter,

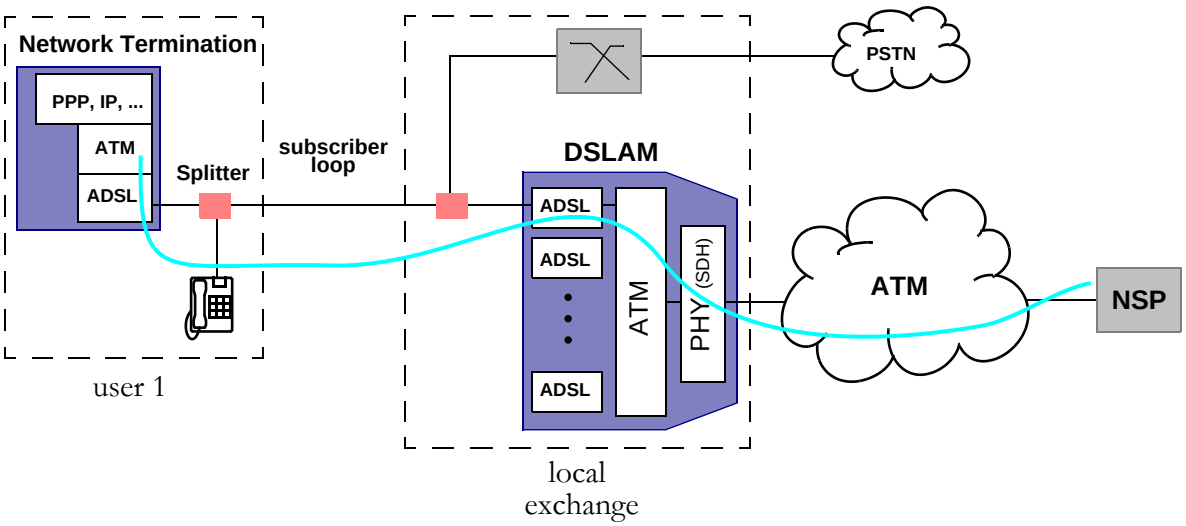


the subscriber loop, the splitter in the local exchange and the ATU-C (ADSL Transceiver Unit, Central office end). On the user's premises the ATU-R is located inside the network termination device, which may be a modem or card connected to a PC, an access device, a router ... The network element DSLAM (DSL access multiplexer) is found in the local exchange and contains the terminations of the ADSL circuits for all the users (ATU-Cs), concentrating the ATM connections of each of them into one single ATM link at 34 or 155 Mbit/s.

From the point of view of the ATM layer, the DSLAM usually only implements the functions of a concentrator: It multiplexes the ATM flows received from each user into a single output link and demultiplexes the flow of ATM cells received from the network by sending the ATM cells to their intended recipients. For this reason, switching functions are not usually found in the DSLAM. The DSLAM will be connected to an ATM network that provides access to the different services. To begin with, the connection between each user and a specific service (often an ISP) will be performed by PVCs.

MEASUREMENTS

High-speed Internet access is the service that will initially be offered using ADSL, with other services such as VoD (video on demand) perhaps following in the future. Access to the Internet via a PVC requires that both the termination device of the ADSL link and the



PVC: connection between user 1 and service provider NSP

PVC connection on the user's premises implement the IP protocol above the ADSL and ATM layer.

Once the ADSL service has been installed, the DSLAM configured and the ATM connections established, the overall operation of the ADSL service must be analyzed.

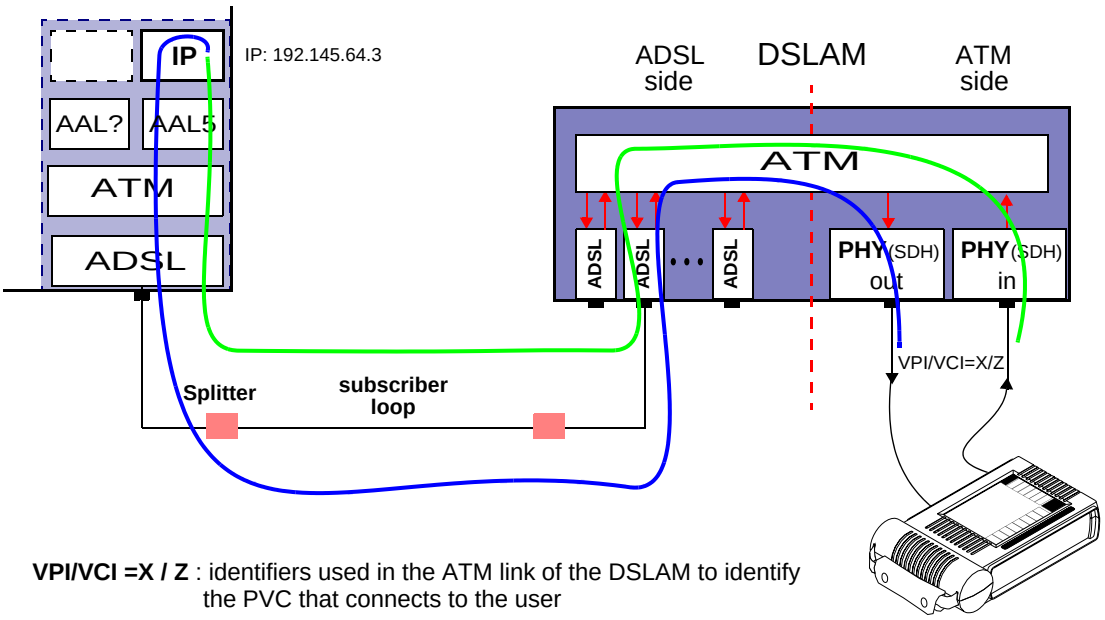
Checking the connection (OOS)

This measurement checks that the system is correctly configured by analyzing the transparency of the communication over the link connecting the DSLAM to the ATM network and the user. Victoria is connected in terminal mode to the ATM link at the input/output of the DSLAM and an IP ping message is generated via the corresponding VPI/VCI to the PVC that connects to the user whose ADSL function is being tested. The destination of the IP ping message must be the IP address of the modem or router of the user that provides access to the ADSL link. If the configuration is correct, the response to the IP ping should be received in the opposite direction.

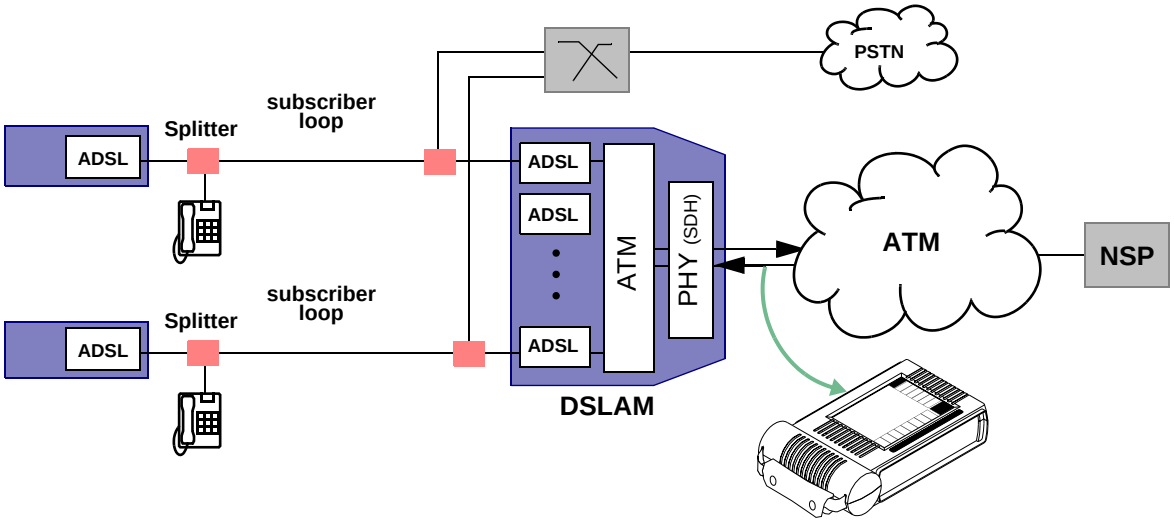
When generating the IP ping, bear in mind what type of embedding of IP datagrams via ATM is used and select the appropriate type in Victoria: IP+AAL5+ATM when VC multiplexing is used, otherwise IP+LLC/SNAP+AAL5+ATM.

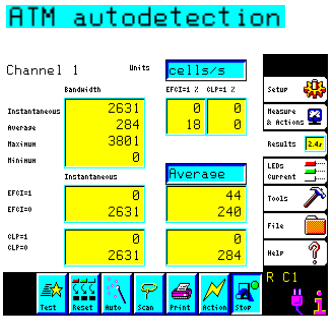
ISM: use of connections

With the ADSL service up and running with live traffic, the in-service monitoring of the ATM link provides information about the use of the connection by each user and possible defects that may appear.



VPI/VCI =X / Z : identifiers used in the ATM link of the DSLAM to identify the PVC that connects to the user



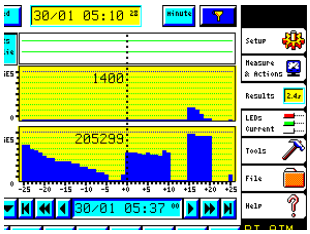


1. Check that the connections used (VPI/VCI values) are correct and not other values that may be reserved. This measurement should be carried out in both directions in the ATM link.

   Running the detection of active connections, Victoria shows all those ATM connections, VPI/VCI values, through which traffic is being transmitted. (Bear in mind that a PVC may be configured, the switches have the VPI/VCI inputs in their tables, without any traffic passing through them; in these cases such a connection would not be detected unless the OAM continuity check cells generation function were activated).

2. Check the bandwidth of the users for management and planning purposes. With the traffic histogram supplied by Victoria for different connections you will discover the profiles of your users and will be able to make improvements in configuration and planning. In this case,

and also in the following point, the monitoring is carried out in the direction network-DSLAM of the ATM link, since this direction is the one with the greater bandwidth.

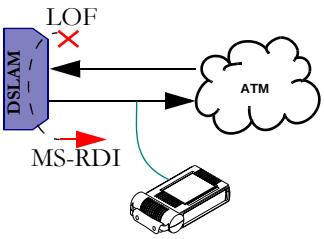


Current, average, maximum and minimum traffic values for a user for management and planning.

3. Check the bandwidth used in the link for planning and congestion control tasks. With the numerical data about the use of the DSLAM ATM output and the histogram showing the traffic over time, you will be able to see how your circuits are being used and make your calculations about adding new users or increasing the bandwidths supplied.

   Knowing about the traffic in the link and its evolution over time, as well as whether there is traffic with congestion, is essential if you are to plan the service and the number of users. With the histograms provided by Victoria you will see (with a resolution of as little as 1s) the busiest times of day, how long these periods last and the bandwidth used.

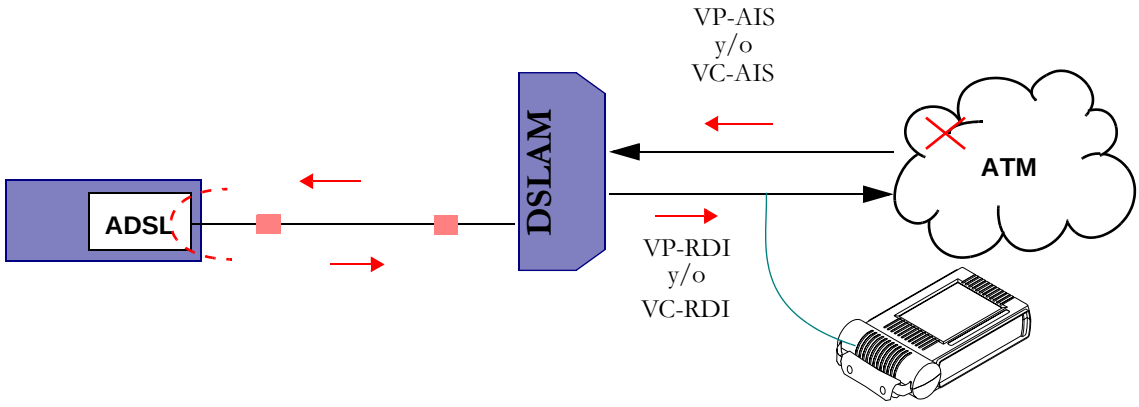
ISM: detecting errors and alarms



Victoria also carries out an analysis of all the errors and alarms on the physical layer and the ATM layer, detecting any problem that may affect the service to the users. Even when only one direction of the ATM link is being monitored, any problem in the opposite direction will also be detected via the backwards indications generated by the DSLAM.

Continuously checking the bytes that carry error detection codes, such as B1, B2 and B3 for ATM over STM-1, offers the possibility of detecting whether errors are produced in the transmission frame in the DLSAM ATM output. Generally speaking, the level of quality in this frame must be high since they are usually optical links at 155 Mbit/s.

Likewise, any problem inside the ATM network that leads to an interruption of the connection in the direction network-user can be detected by Victoria . This is done by analyzing the backwards remote defect indication OAM cells (VP-RDI or VC-RDI).



CONCLUSIONS

As ADSL becomes more popular as an access technology, the great variety of situations that affect transmission quality will require measurements that characterize the performance before commissioning the service and in-service monitoring to locate problems and poor transmission quality.

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