

# **IPv6 over xDSL**

## List of Abbreviations

[illegible]

Table 1: Revisions

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## **1.1 Introduction**

The services provided in the Internet are becoming more and more comprehensive and user-friendly. At the same time, the demands on the bandwidth of the Internet access are increasing, so that even with an ISDN access surfing on the Internet requires a lot of patience. Therefore it is not amazing that more and more people are demanding a faster Internet access.

DSL technology allows to use the existing telephone lines. The data are modulated in such a way that they are in a range above the telephone signal so that the same line can still be used for telephone calls. Therefore, DSL can be offered at a comparatively reasonable rate

A further step to make the Internet more attractive for the user would be to allocate a permanent IP address to each subscriber. Thus, the user could better use the possibilities provided by the Internet. In view of the scarce stock of addresses under IPv4, this will inevitably lead to problems. An elegant solution would be IPv6, which is gaining more and more importance and providing considerably more addresses.

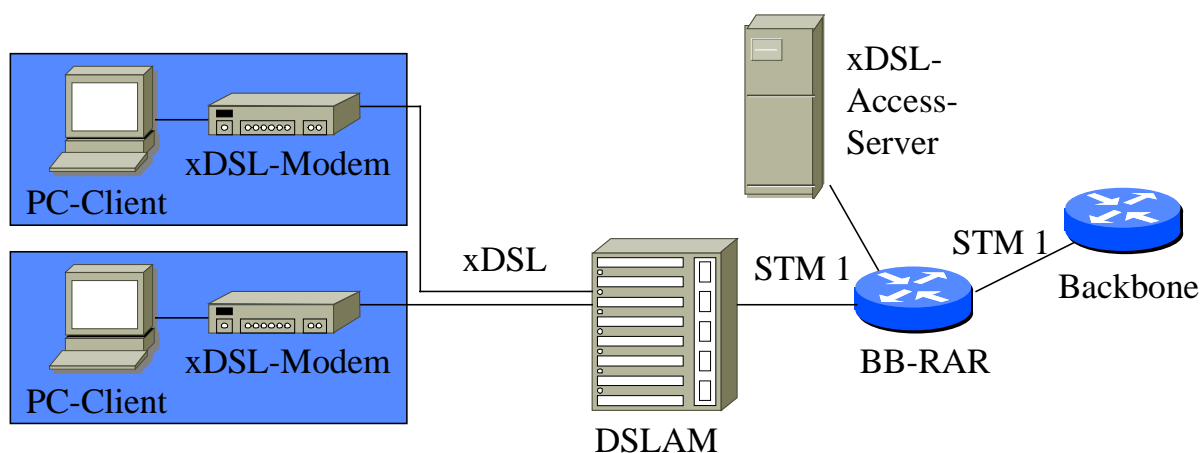
In order to realise a DSL connection on the basis of IPv6, various requirements as to the used hard- and software have to be fulfilled. This report should examine where exactly problems can arise and how they can be solved. Finally, it should be examined which companies are already offering solutions for the realisation of xDSL connections.

## 1.2 Examination of xDSL

In this chapter we focus on the structure of a xDSL connection as well as the involved components, in order to subsequently examine in chapter 1.3 the critical points regarding the realisation of IPv6.

### 1.2.1 The xDSL Structure

A xDSL connection mainly consists of the four components PC (of the xDSL user), xDSL-modem, DSL Access Multiplexer (DSLAM) and Broadband Remote Access Router (BB-RAR). A physical connection is established between the PC and the xDSL modem (see Figure 1). The actual xDSL connection exists between the xDSL modem and the DSLAM via a twisted pair copper cable. The DSLAM (or Access Concentrator) can administrate several xDSL modems in parallel and forwards the data to the BB-RAR in bundles. The BB-RAR establishes the connection to the backbone and generally to the Internet.



**Figure 1: Structure of a DSL connection**

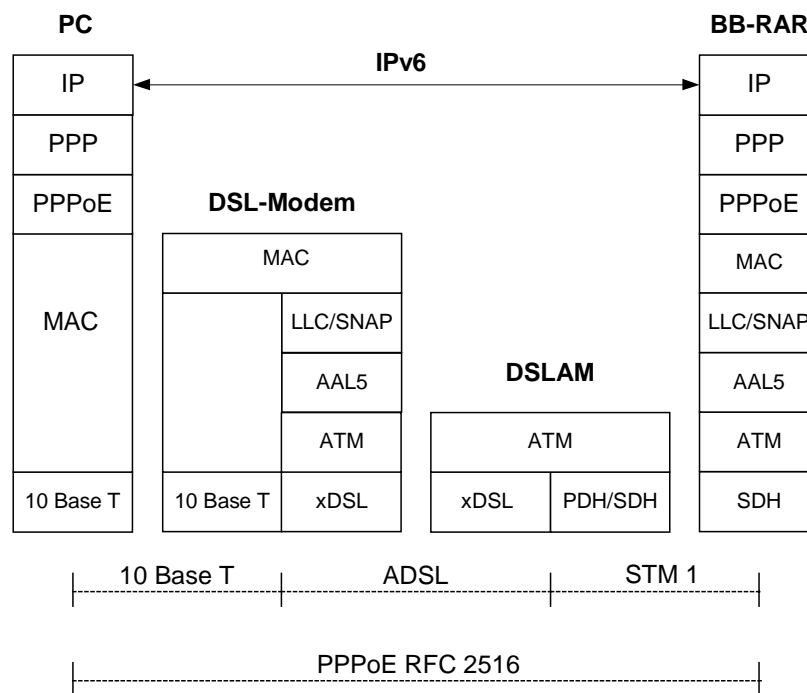
For the authentication of the subscribers and the subsequent cost calculation, an access server can be connected to the BB-RAR, which e.g. is employed for user administration on the basis of RADIUS. The access server is not important for the examination of an IPv6 connection via xDSL. Even if for example RADIUS is not executable via IPv6, it could be still operated with IPv4 without interfering with the IPv6 connection to the DSL subscriber. Therefore, the xDSL access server shall here not be examined any further.

For the connection between PC and xDSL modem, mainly ATM (25Mbit) and Ethernet are being used. The choice of the protocol does not have any direct consequences on the examination of IPv6 over xDSL, so that it is sufficient here to examine only the variant with an Ethernet connection.

The xDSL modem can be operated as a bridge or a router. In the bridge mode a Point-to-Point Protocol (PPP) connection is established between the PC and the BB-RAR, whereas in the router mode however the xDSL modem establishes a direct IP connection.

### 1.2.2 Bridge-Mode

In the bridge mode the DSL modem forwards the data packets – after a corresponding transformation – from the DSL interface to the Ethernet interface. Since several PCs can be connected on the Ethernet side, a direct Point-to-Point connection is established between the corresponding user PC and the BB-RAR. For that the IP packets are packed up according to RFC 1548 in the Point-to-Point Protocol (PPP). At first, the PPP had been conceived for serial connections and thus it does not provide for addressing, as it is necessary for the Ethernet. Therefore, the packets are encapsulated in PPP over Ethernet (PPPoE), and are forwarded via the Ethernet connection. As can be seen in Figure 2, the PPPoE packets are not examined further neither by the xDSL modem nor the DSLAM.

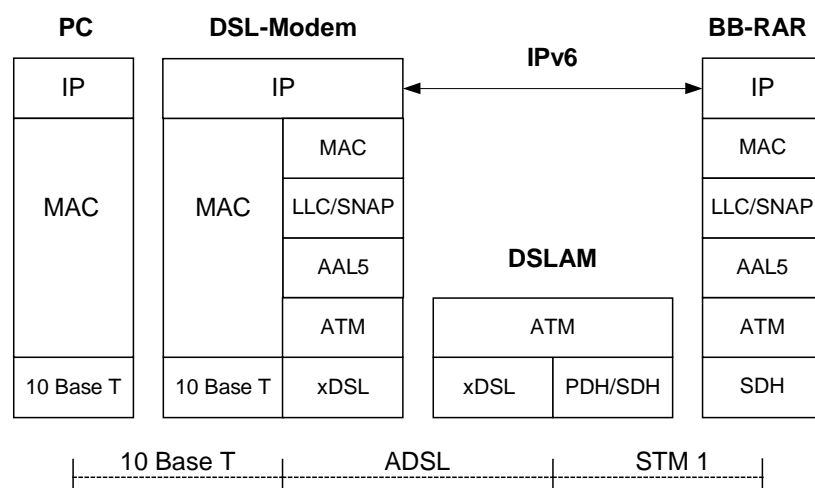


**Figure 2: Modelled Protocol Stack in the Bridge Mode**

An IP address is allocated to the user PC via the PPP and further configuration data are handed over. The connection to the backbone is established via the BB-RAR. It shall not be examined further if this connection is established via ATM or IP, since it does not directly concern the DSL connection.

### 1.2.3 Router-Mode

In the router mode the xDSL modem moreover plays the role of a router. It is possible to connect several user PCs to the xDSL modem and to surf at the same time on the Internet. The packets have to be looked at in the modem up to the IP layer, so that the modem can allocate the packets to the individual user PC. By using a router this can be done without a Point-to-Point connection.



**Figure 3: Modelled Protocol Stack in the Router Mode**

It has to be taken into consideration that for each connected PC either an own IP address is applied for, or that the modem additionally carries out a NAT. At any rate, the allocation of IP addresses should be automated by a protocol (e.g. DHCP for the configuration of the connected PC and DSL modem).

## 1.3 Feasibility of IPv6

After the explanations made above, we will now examine the four individual components more closely as regards the feasibility to realise IPv6 and the necessary requirements for its realisation.

### 1.3.1 Connection between User PC and BB-RAR

A basic prerequisite for the operation of IPv6 is an existing IPv6 stack on the user PC as well as the BB-RAR. This should not be a major problem on the PC side, because all newer operating systems provide such an IPv6 stack. The platforms, on which the different BB-RARs are being realised, depend on the manufacturer. Therefore, the manufacturer has to provide an executable IPv6 stack.

If the xDSL modem is operated in the bridge mode, the IP packets have to be encapsulated in PPP and PPPoE for the transmission between PC and BB-RAR. The PPP carries out the configuration of both subscribers when establishing the connection. The corresponding IP addresses have to be transmitted. Since the IPv6 addresses with 128 Bit are considerably longer, the protocol has to be adapted to IPv6. In the RFC 2472 a method has been defined, which allows the transport of IPv6 packets via a PPP. According to this standard it is not difficult to adapt the PPP to IPv6. Under Linux, a PPP daemon for IPv6 has already been implemented since the kernel version 2.2/2.3. As regards the operating systems of Microsoft used much more often finished solutions have not been known so far. Due to the simple feasibility such a solution will be found soon.

PPPoE is not directly concerned by the effects of IPv6 and does not have to be adapted.

However, If the xDSL modem is operated in the router mode, the configuration is no longer carried out by PPP. A sensible alternative solution would be DHCP. The realisation of an IPv6-enabled DHCP daemon has reached so far the draft status and will soon be released as a standard.

### 1.3.2 xDSL-Modem

When examining the xDSL modem we have to distinguish whether the modem is operated in the bridge mode or the router mode.

In the bridge mode, the packets above the MAC layer are not examined further. Therefore the modem is transparent for IPv6 and does not have to be considered further. In the router mode, however, the modem has to determine the IP address so that an addressing can be done. Therefore, the xDSL modem has to be made IPv6- enabled.

Since more efforts have to be made for the operation of the router mode than the bridge mode, this first one is used more rarely. Regarding the router mode the change to IPv6 will consequently happen much later than as regards the bridge mode. This is due to the required adaptation of the xDSL modem as well as the present draft status of the IPv6 realisation of DHCP.

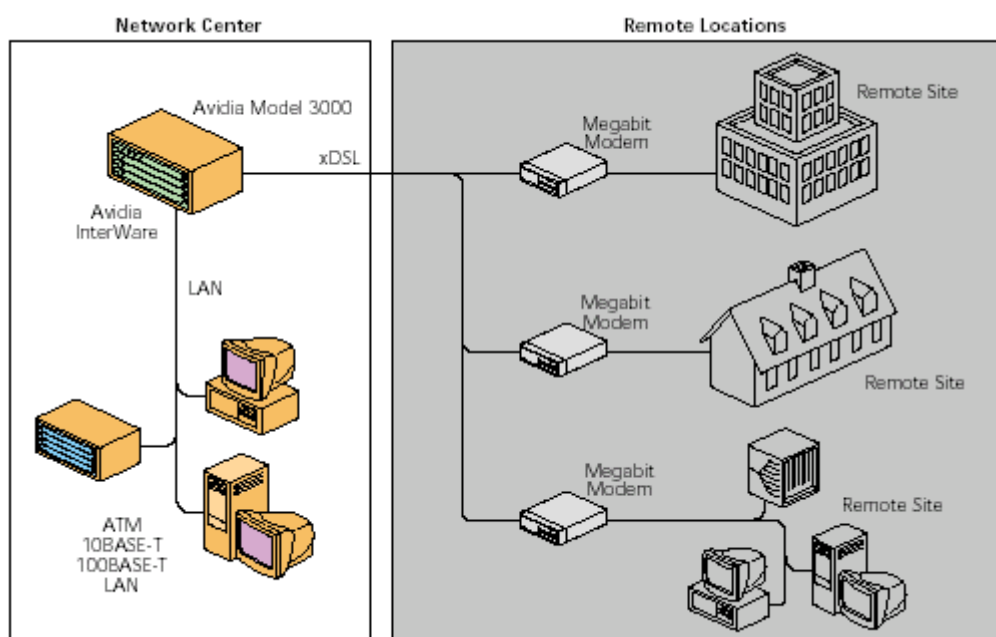
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### 1.3.3 DSLAM

With xDSL small ATM cells are transmitted. Therefore, in most cases the data behind the DSLAM are further transmitted in bundles via ATM. Since xDSL and ATM are below layer 3, such a DSLAM is transparent for IPv6.

The 'Avidia Platform' of ADC is a special case. It allows the realisation of the uplink via ATM as well as LAN. As can be seen in Figure 4 the uplink is realised via LAN in the Avidia Model 3000. According to ADC, the packets here are resolved up to the IP layer. An adaptation to IPv6 is thus required.



**Figure 4: Avidia As LAN Extension Concentrator**

The variant with the ATM uplink is especially suitable for Internet providers who have an ATM backbone whereas the variant with the LAN uplink is used in companies, which want to connect their smaller branches located a few kilometres away via xDSL to an existing LAN.

## 1.4 Result of the Survey

As has been shown in chapter 1.3, some components have to be adapted for IPv6. In order to get an overview which ones of the components do already support IPv6 or where an IPv6 support is being planned or developed, a total of 21 companies have been written to. The result of the survey has been shortly summarised in the following table.

Companies	Status of the Enquiry	Status regarding IPv6
ADC Telecommunications	Receipt of Response 17.01.2002	Planning IPv6 Adaptation.
Adtran	Receipt acknowledged 10.01.2002	
Advanced Fibre Communications	-	
Alcatel Telecom	Receipt of Response 01.02.2002	Stated that their modems only support bridge mode and are therefore transparent to upper layer protocols
Cisco Systems	-	
Copper Mountain	-	
ECI Telecom	-	
Ericsson	Receipt acknowledged 11.01.2002	
Fujitsu	-	
Lucent Technologies	Receipt of Response 29.01.2002-	Planning IPv6 Adaptation, no time plan provided
Marconi Communications	Receipt acknowledged 15.01.2002	
Next Level Communications	-	
Nokia	-	
Nortel Networks	Receipt of Response 22.01.2002	Nortel Networks in the meantime has left the DSL line of business.
Orckit Communications	-	
Paradyne	Receipt acknowledged 14.01.2002	
Samsung Electronics Co.	Receipt of Response 15.01.2002	Want to offer IPv6 products between 2004 and 2005 in the area of DSL.
Siemens AG	Internal Handling 14.01.2002	
WaiLAN Communications, Inc.	Receipt of Response 10.01.2002	Do not offer IPv6 products.

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Westell Inc.	-	
ZyXEL Communications, Inc	-	

There was only a weak response to the survey, which reflects the present small interest of the companies in the area of IPv6. The reason for that certainly is the small demand of the network providers for this technology. Even if an IPv6 boom would start, a realisation of a DSL connection with IPv6 could be expected in 2004 at the earliest. Furthermore, a change of the components to IPv6 will not require a lot of efforts and can be realised at relatively short notice. Therefore the manufacturers have not yet started large-scale production and are waiting how the market will develop.

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