IP Access Service Provision for Broadband Customers

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Broadband Internet access architectures for residential, SOHO and small business are being developed largely in the ADSL Forum, where two architectures have been proposed for the service provider access. The ADSL Forum still has some work to do in this area to define the architectures fully, but the solutions are becoming available and practical through the reuse of many aspects of the existing dial–in solution. The two architectures proposed are the PTA – PPP Termination Aggregation Architecture, and the LAA – L2TP Aggregation Architecture, which are discussed in ADSL Forum working text WT-033 [1]. These IP access architectures can also be applied to cable modem deployments. The PTA model uses BAS [Broadband Access Server] technology to terminate PPP sessions from the user and the LAA model uses the LAC [L2TP Access Server] to transport PPP sessions from the LAC to a LNS [L2TP Network Server] which performs tunnel termination and AAA proxy at the ingress to a Service Provider [SP]. Optionally a L2TP Tunnel Switch (LTS) can be used in the transport network to perform the grooming of traffic between tunnels. These two models of IP access are shown in figures 1 and 3.

Use of these architectures provides a means for an access network provider to provide open access mechanisms based on the use of the structured user name (provided by the subscriber in CHAP/PAP interaction) for service provider selection, and secondly to provide a transport architecture solution based on virtual private IP network technology. The transport alternatives available in these architectures are based on IP in IP encapsulation schemes (e.g. GRE [2]) from a BAS, or L2TP (layer 2, PPP session transport) over UDP/IP [3], ATM [4] or Frame Relay [5]. These solutions are discussed later in this paper and are briefly compared.

The ADSL Forum is also looking to standardise the protocols to be used between the CPE and the ATU-R [ADSL Termination Unit – remote i.e. the NTE]. There are a number of different proposals that are being considered seriously, and there have been over a dozen proposals in total. The solutions are based on the use of PPP over ATM, the use of PPTP [Point to Point Tunnelling Protocol] for local multiplexing, PPP proxy using NAT and routing, and the use of PPP with PPPoE [PPP over Ethernet] which provides a server discovery, encapsulation and multiplexing mechanism used between the CPE and the BAS/LAC]. The choice of customer premises networking solutions support, NTE protocols and the transport architecture need to be carefully made in order to minimise the operational costs (through minimising configuration requirements in the Operators network, minimise configuration complexity which minimises the number of potential fault conditions, and also to minimise reconfiguration with respect to customer churn between service providers). Secondly to optimise transport resources and capital costs, e.g. to minimise the number of boxes needed to be installed and use packet multiplexing gain effectively. This paper looks at some of the options and briefly outlines optimal choices.

The PTA Solution

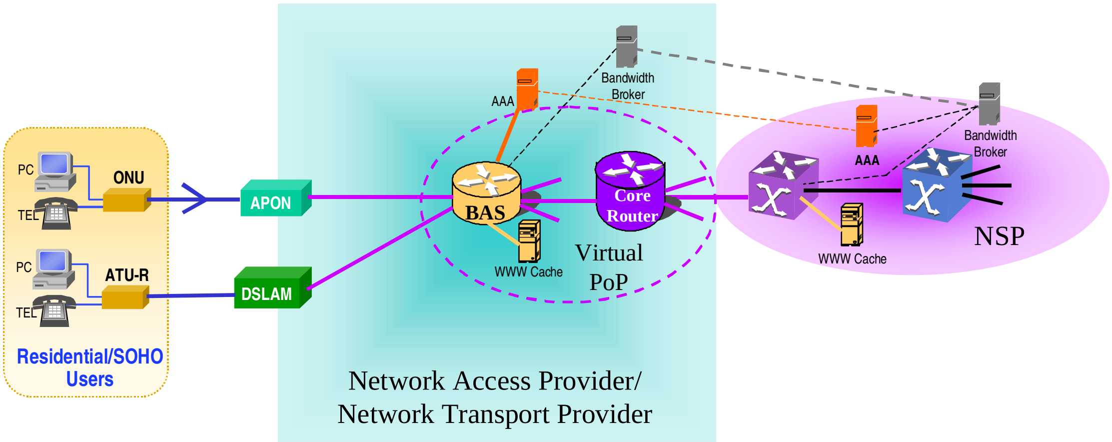

Figure 1 The PTA IP Access Service Model

Figure 1 shows the PTA architecture, applied to the virtual POP concept. In the virtual POP concept an access network provider provisions an IP access service used by a NSP to provide IP connectivity, in this case the Operator leases a BAS to a NSP. The actual BAS hardware can be shared by multiple NSPs using the virtual router concept. Figure 2 shows the typical protocol stack, where the transport from the ATU-R, through the DSLAM to the BAS is PPP over ATM, using RFC 1483 encapsulation and AAL5 as defined in [6].

Each User session corresponds to a single PPP session, and each PPP session requires a PVC from the ATU-R to the BAS, unless PPPoE or L2TP are used to multiplex several PPP sessions onto a single PVC. The current ATM networks do not offer SVC capabilities therefore the number of PVCs required by a subscriber need to be provisioned at day one, from the ATU-R to the BAS. A solution which required provisioning a single PVC and sharing this between the number of users at the subscriber premises minimises the Operator provisioning overheads and minimises the transport resources, which is important in order to minimise the cost of providing broadband IP access services.

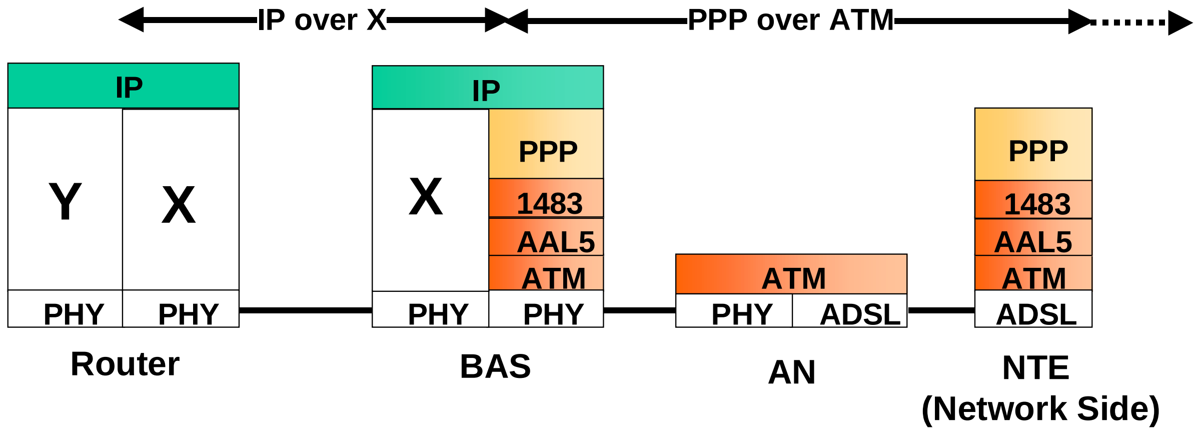

Figure 2 PTA Protocol Architecture

The transport from the BAS to an NSP ingress router can be accomplished in a number of ways. If an ATM network is provided between BAS and NSP ingress router then IP over ATM can be used directly, similarly if frame relay is used. If an IP network is used, then GRE (Generic Router Encapsulation - RFC 1701/1702, or another VPN mechanism) can be used to transport the NSP IP traffic over the access network provider IP transport network in order to ensure end to end IP address transparency.

Complexity arises with the PTA solution because the BAS, if provided by an Operator as a virtual POP to a NSP, requires management by two entities. The BAS may be provided in a virtual router mechanism, shared by a number of NSPs, which could present some further security risk. The use of overlapping, or private address spaces by NSPs means that the access network provider needs to be concerned with layer 3 issues of the NSPs in order to provision end to end services, which adds provisioning complexity to this solution.

The LAA Solution

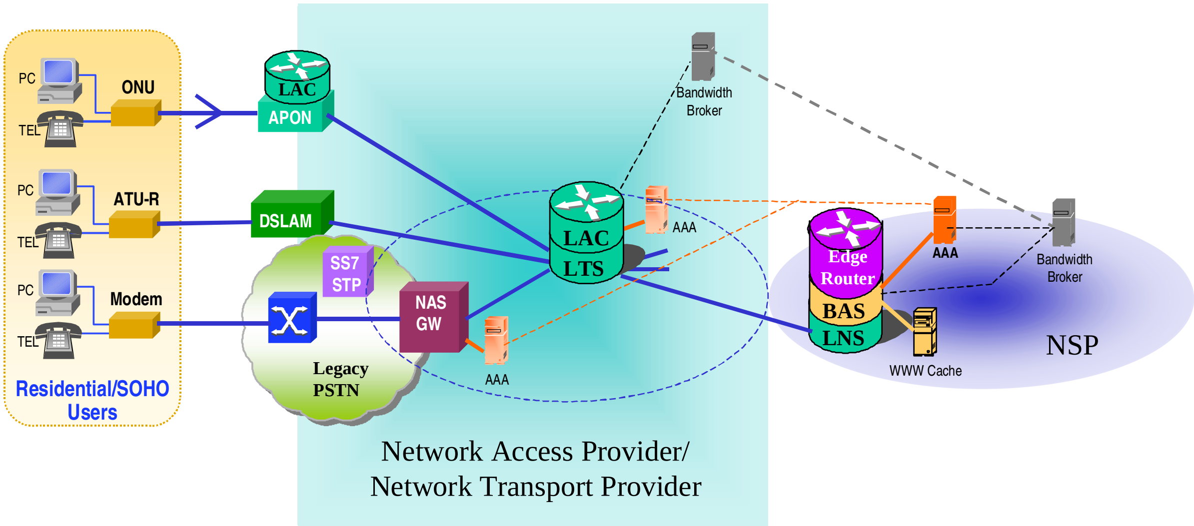

Figure 3 The LAA IP Access Service Model

In figure 3 the LAA model shows the three aspects of a L2TP solution. Firstly that PPP traffic ingress is through a LAC functional which can be provided in an Access Node [AN], such as an APON OLT [Optical Line Termination] device. This LAC function allows the concentration of local traffic into appropriate tunnels, which can terminate at tunnel servers (LTS) or terminate directly at the LNS located at the NSP. Access equipment may not provide LAC functionality so PPP over ATM sessions are transported over an ATM network to a LAC located further in the network hierarchy. Lastly existing narrowband services can be integrated with broadband PPP transport by providing L2TP support from a NAS [Network Access Server] to an LTS. At the LTS the PPP sessions from L2TP tunnels are switched from the ingress tunnel to appropriate egress tunnels. This switching is achieved through the use of the structured user name, which is provided through the L2TP session initiation messages.

Figure 4 shows the LAA protocol architecture. The architecture is very similar to the PTA model, except that PPP is not terminated at the LAC. The LAC provides the initial LCP interactions and performs a PAP/CHAP challenge – response in order to obtain the structured user name, which identifies the destination of the session. Based on this information the LAC initiates a session on an appropriate L2TP tunnel, this session initiation message contains the structured user name and the plain text password or hashed CHAP response. On successful authentication by the LNS (typically using RADIUS) the L2TP session is initiated and the PPP session PDUs are de-capsulated from the ATM PVC and placed in the L2TP tunnel with a session id based header. The full protocol interactions are defined in [3].

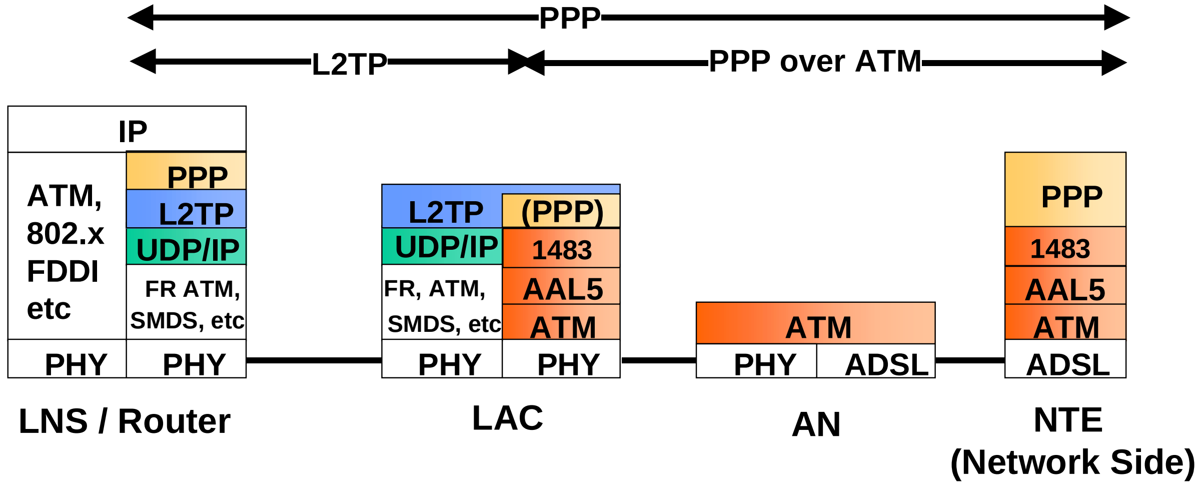

Figure 4 LAA Protocol Stack

Figure 5 shows the provision of LAC functions at an Access Node and the provision of an LTS. Because of the use of an LTS it is possible to share a tunnel by subscribers destined for different NSPs from an Access Node (or NAS) to an LTS because at the LTS PPP sessions are groomed into appropriate outbound tunnels based on the same structured user name information. This can make the LAC solution particularly transport efficient and because the PPP transport is entirely at layer 2 the transporting access network providers network is transparent to the end-to-end IP service, keeping overlapping address space concerns out of the Operator network. The Operator does not need to take part in any end-to-end layer 3 interactions, and because L2TP can be transported over ATM or Frame Relay directly the solution may require no IP network infrastructure in the access network provider at all.

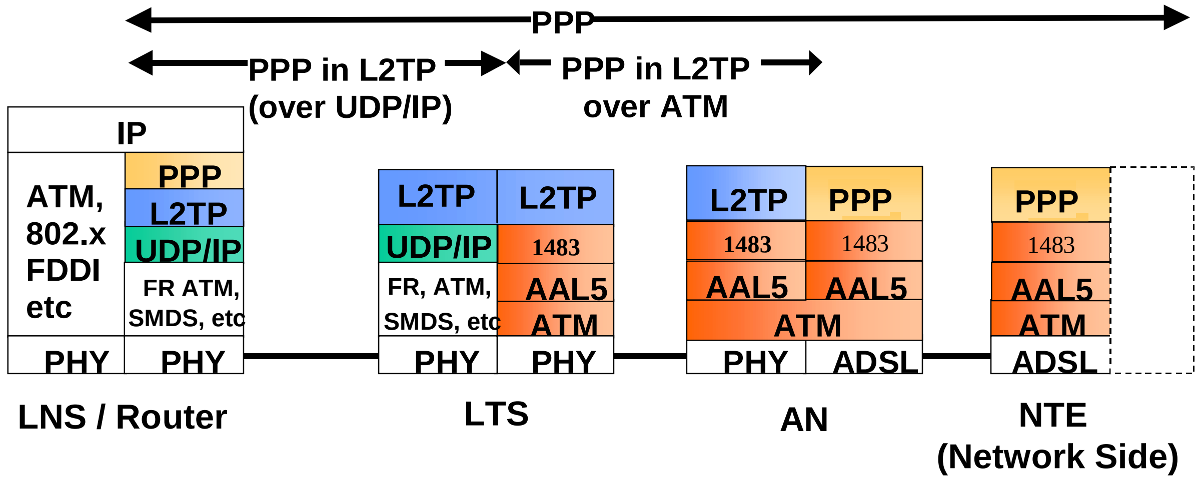

Figure 5 Typical LTS Protocol Stack

Broadband IP Access Solution Comparison

In this section I briefly want to introduce some of the options within the customer premises network [CPN], which can be used to provide efficient transport. In figure 6 the PPTP mechanism is used at the CPN to provide transport over Ethernet to the ATU-R, each PPP session needs to be mapped to a PVC. The number of PVCs to be provisioned needs to be determined based on the number of simultaneous subscriber sessions expected. If fewer PVCs are provisioned, there may be service access blocking at the ATU-R.
This is the solution which has had most implementation in the industry at this time, because of the support of PPTP (mainly in Microsoft operating systems) as a means for providing PPP session support across the

subscribers LAN. The disadvantage of this mechanism is that the CPN needs to be configured with a private IP address – which means that an Operator needs to gain knowledge of a subscribers IP network configuration. This solution imposes considerable configuration knowledge on the Operator and considerable provisioning effort to provide broadband IP access services.

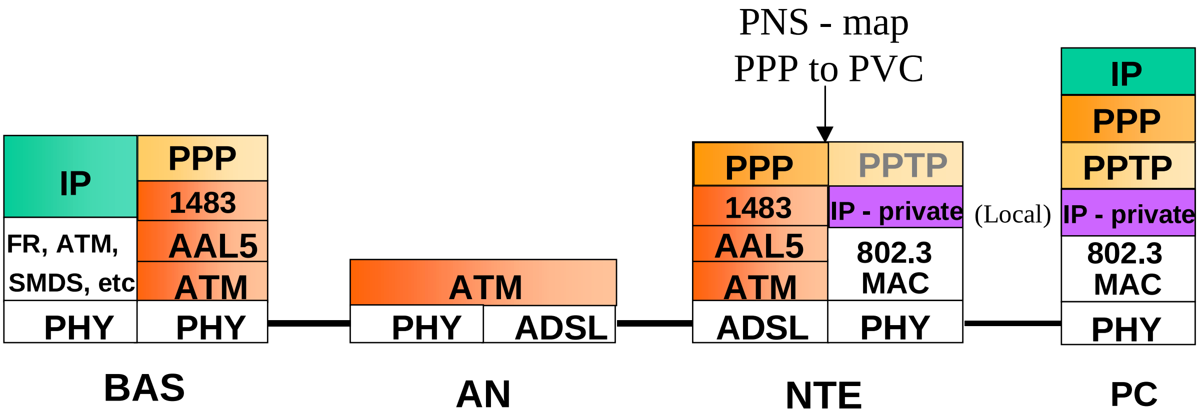

Figure 6 PPTP used in Customer Premises Network

In figure 7 a much simpler protocol stack is proposed which uses a single PVC for transport of many user sessions between the ATU-R and the BAS or LAC. Here PPPoE (which is defined in reference [7]) is used to multiplex a number of users onto the single PVC. This requires that the BAS or LAC provide IP traffic shaping mechanisms to ensure the fair sharing of the single PVC between multiple users (this functionality is becoming more widely available with policing and rate-limiting provision is BAS and LNS equipment).
PPPoE is particularly efficient at minimising the cost of the ATU-R because only simple Ethernet bridging needs to be supported, using RFC1483 bridging mode encapsulation between the ATU-R and the BAS/LAC. There is no need for configuration of local IP addresses and parameters etc. which makes the CPN requirements minimal and very simple to install. This should make PPPoE particularly efficient for the provision of broadband IP access services, from an access network provider perspective.

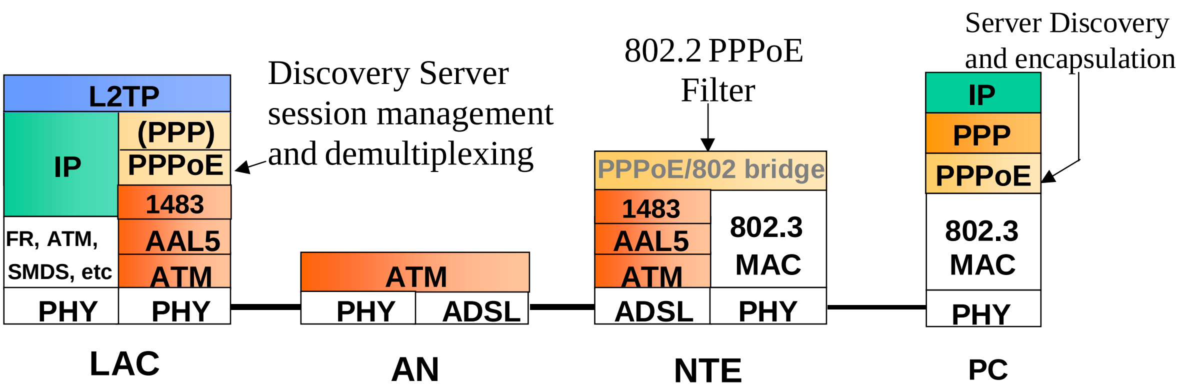

Figure 7 PPPoE Protocol Stack (from PC to LAC [or to a BAS])

Other mechanisms can be used to configure the ATU-R and the CPN, but these are outside the scope of this paper.

Conclusions

The use of the LAA model with PPPoE provides the most efficient mechanism for providing broadband IP access services as it minimises Operator provisioning at LAC, ATU-R and in the CPN. It also means that an Operator does not require any end-to-end IP knowledge to provide the service.

References

[1] WT-033v1.doc, Core Network Architecture for Access to Legacy Data Network over ADSL, revision 1, ADSL Forum, 1999.
[2] Generic Router Encapsulation, RFC 1701 and RFC 1702, IETF.
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[5] L2TP over Frame Relay, draft-ietf-pppext-l2tp-fr-01.txt, IETF.
[6] PPP over ATM, RFC 2364, IETF.
[7] PPPoE, RFC 2516, IETF.