An Interoperable End-to-End Broadband Service Architecture over ADSL Systems

Version 1.0

June 3rd, 1997

I. EXECUTIVE SUMMARY

ADSL technologies are a new platform for delivering broadband services to homes and small businesses. ADSL can support a wide variety of high bandwidth applications, such as high-speed Internet access, telecommuting, virtual private networking and streaming multimedia content. These services were either not possible to support or were ineffectively supported by conventional dial-up data delivery technologies. Many vendors have either begun shipping or have announced plans to ship ADSL solutions soon.

The key to successful ADSL deployment is end-to-end interoperability. With interoperability, a competitive multi-vendor environment can exist, which leads to more affordable solutions. Through the standard bodies, significant progress has been made in establishing physical layer ADSL interoperability. In contrast, the number of end-to-end service models for ADSL has expanded as early trials have adapted to market and technical conditions.

The goal of this white paper is to specify a *single* end-to-end service architecture for ADSL that can serve as the baseline for interoperability among vendors. To facilitate rapid deployment, this architecture is based on existing standards: namely, PPP over ATM (using VC multiplexing over AAL 5 with null encapsulation). These standards were chosen because they satisfy the following key service requirements:

- Access to the Internet, corporate network, local content and peer-to-peer communications
- Easy migration from existing ISP infrastructure
- Simultaneous connectivity to multiple services
- Multi-protocol support
- Security
- Multicast support
- Multiple service classes support
- Quality of service support

In this paper, we first discuss the business opportunities created by ADSL-based broadband networks. Next, we discuss the service requirements in detail. In section IV, we present the end-to-end broadband service architecture and the interoperability model in detail (readers who are familiar with ADSL services and requirements can go directly to this section). This is followed by a discussion on how PVCs and SVCs are supported in this model. Lastly, we discuss the key criteria to providing user-friendly service for mass deployment of ADSL.

II. BUSINESS OPPORTUNITIES FOR ADSL-BASED BROADBAND NETWORKS

High-speed connectivity to homes, small businesses and remote offices enabled through ADSL will create many new business opportunities for service providers. We discuss a number of key opportunities below to illustrate the breadth of services enabled by ADSL.

Internet Connectivity Services

The explosion of interest in the Internet has created a clear opportunity to provide high-speed Internet access to homes and small businesses. ADSL can deliver not only higher speed, but also an “always on” service that does not risk call blocking in the telephone network. The service provider can also offer Web hosting services for the content providers and consumers, as well as the tools needed for them to author and maintain Web pages.

Branch Office Connectivity

ADSL lends itself to branch office connectivity, effectively replacing leased lines. Most business PC applications (file access, e-mail, terminal emulation, etc.) perform asymmetric communication, making ADSL an appropriate technology to connect a remote office to the enterprise.

Interconnecting remote offices as peers is a variation of leased-line replacement. If the remote offices have similar computing assets (LANs with servers and similar user populations) the communications between them may have balanced network traffic. These applications may be better suited to symmetric DSL technologies such as HDSL and SDSL.

Telecommuting Services

Telecommuting is another ripe opportunity for ADSL technology. With high-speed connectivity to employees' homes, the network operator can offer a "virtual office" experience to telecommuters. This is attractive because more and more corporations are embracing telecommuting as an effective means of reducing facility expenses and complying with environmental quality regulations. This has increased their willingness to invest in ADSL network services. In addition, the network operator can provide nationwide or even worldwide access to business networks, either through the Internet or through wide area broadband networks.

Business-to-Business Services

Today's connected information society is creating new types of business relationships, and providing new opportunities in more traditional business contexts. Businesses that have a common bond may want to share a private and secure network infrastructure. The network operator can create a virtual private network using ADSL in conjunction with existing backbone networks to interconnect businesses. Businesses outside the operator's service area can be connected through the Internet by using secured tunneling protocols such as PPTP, L2F, or L2TP.

Content Delivery Services

Although a high-bandwidth network connection is by itself attractive to the consumer, it can be made even more compelling by enhancing the quality and quantity of content accessed. Content can take many forms: shopping catalogs, reference materials, real estate listings, yellow pages, travel services, games, music, video, etc. The combination of high-speed networks and enriched content presents an attractive offering to business and residential consumers. The network operator will also be able to such content locally, in addition to serving as the conduit for content providers.

III. END-TO-END SERVICE REQUIREMENTS

The service requirements for enabling the new opportunities described above can be classified in two categories: access configurations and functional requirements. Access configurations address the types of destinations to which the network provides connectivity. Functional requirements are specific capabilities provided by the network to support applications.

Access Configurations

To successfully deploy ADSL, the public network operator must provide support for some combination of the following four access configurations: the Internet, corporate networks, local content and peer-to-peer connectivity.

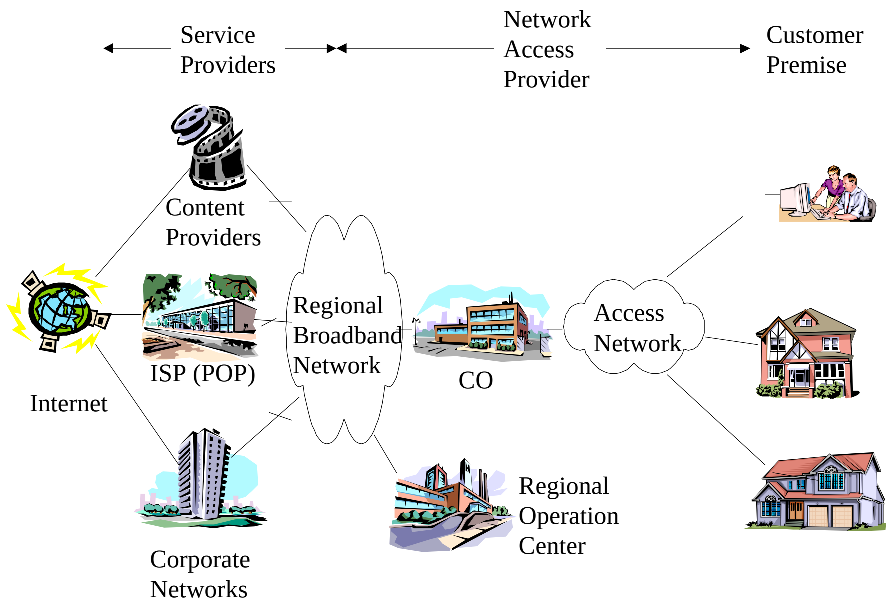


Figure 1. Access Configurations: Internet, Corporate networks, Local Content and Peer-to-Peer Communications

The Internet

Providing high-speed Internet access is a key value for both home users and small businesses. The Internet is accessed through one or more ISPs connected with high-speed links from the telephone company (telco)'s Central Office (CO). These high-speed links are part of the regional network of the telco, which can be a combination of SONET, ATM and Frame Relay.

Corporate Networks

There are two ways to access corporate networks. One is to use an IP tunneling mechanism through the Internet (using PPTP, L2F, or L2TP) to reach the corporate network. This design obviates the need for dial-up modems at the corporation while leveraging the Internet as the virtual private network. This, however, also means the connectivity may be limited by the bandwidth of the Internet. A second method is to use the network operator's own regional broadband network, as shown in Figure 1, to provide direct high-speed connectivity to the corporate network. This has the advantages of higher speed and greater security.

Local Content

Locally hosted content can be delivered at high speed without going through the Internet. Local content may be stored at the POPs (points of presence) of the ISPs, content providers or the COs and regional operation centers (ROCs) of the telco. Local content can be created locally (such as merchant services for retailing) or generated remotely (Web content from the Internet cached in local servers).

Peer-to-peer Communication

The ability to interconnect consumers at high speed enables high quality peer-to-peer communication applications such as video telephony or interactive gaming. Demand for this connectivity may ramp up more slowly than the services described above, but aggressive pricing could materially accelerate this consumer use of ADSL.

Functional Requirements

The following seven key functional requirements must be addressed to enable a mass market for ADSL.

Easy Migration from Existing ISP Access Infrastructure

Since ISPs already have an infrastructure to support dial-up access based on PPP, any new broadband Internet access solution must take into account this architecture. Ideally, the broadband service model for accessing ISP service can re-use most of the networking, management and administration infrastructure (such as IP address and domain name administration) and will not require a paradigm shift for the ISP.

Simultaneous Connectivity: Internet and Corporate network

A telecommuter working from home may need to access the Internet while connected to the corporate network. There are two ways to allow such simultaneous connectivity. One way is to access the Internet through the corporate network's own Internet gateway. The other way is to support a separate Internet connection simultaneously with the corporate connection. In many cases, the second way is more appropriate because it allows the telecommuter to access the Internet directly for non-work related reasons (such as entertainment) without using the corporate network resources. However, some corporations may not trust the simultaneous connections because this may open a back door to the corporate network from the Internet through the telecommuter's PC.

Multi-Protocol Support

Since not all corporations run IP exclusively, providing corporate connectivity requires interconnecting non-IP networks over the ADSL access network. Hence, such connectivity involves protocol negotiation and address assignment.

Security

Telecommuters and branch offices must be able to communicate to the enterprise in a fashion that supports authentication, authorization and privacy. Security is also important for connecting to the Internet since the ISP already authenticates all user access. The ISP must identify users and provide them with the contracted level of service.

Multicast

There has been an explosion of interest in IP multicast service. For example, during recent elections, most Internet sites carrying real-time results were jammed with users trying to log in.

If it had been possible for this information to be pushed out using multicast, there would have been no congestion. Live events are now commonly offered in audio and video on the Internet, and multicast is the preferred delivery mechanism. A first-order requirement for the ADSL access network is to deliver IP multicast service to homes and small businesses.

Multiple Service Class Support

It has become very clear that many services, including Internet access, cannot depend solely on a "one size fits all" paradigm. Different classes of service are required to satisfy the different needs of, for example, power users versus occasional users. Such differences in service class can be based on a variety of attributes, such as maximum, average or minimum bandwidth.

Quality of Service Support

Real-time streaming audio and video applications have become increasingly popular, especially over the Internet. These applications, and other real-time applications, require QoS to ensure their performance [1]. Quality of service also implies that the network can prevent aggressive or rogue users from consuming network bandwidth and degrading the performance of other users.

IV. END-TO-END SERVICE INTEROPERABILITY MODEL

We first describe the end-to-end ADSL-based service network architecture. This is followed by a discussion of the end-to-end service interoperability architecture and the motivations behind it. We also explain how this model satisfies the service requirements discussed in Section III.

ADSL-based Broadband Service Architecture

The end-to-end ADSL-based network architecture consists of the following subnetworks: the customer premise network, the access network, the regional network and the service provider networks. They are shown in Figure 2.

Customer Premise

The customer premise includes residences, home offices and small business offices. Each may contain one or more PCs (or workstations). Where there are multiple PCs, they reside on a LAN. The gateway to the external network can be dedicated hardware (such as a router) or a PC server (acting as a router or proxy server). In the latter case, the PC server has two network interface cards (NICs), one for connecting to an ADSL modem (or serving as the ADSL modem in the case of an internal ADSL modem card) and the other for the LAN. The ADSL modem on the customer premise is called the "ATU-R" (ADSL Termination Unit-Remote).

Access Network

The ADSL access network encompasses the ADSL modems and the access multiplexer system at the central site and the ADSL modems at customer premise connected via the local loop. The central site ADSL modem is also called the ATU-C (ADSL Terminal Unit-Central). The access multiplexer system and the central site modems are usually combined into a single unit called the access node (using the ADSL Forum terminology) and also referred to as the "DSLAM" (DSL Access Multiplexer). When the backbone network is ATM, the access node is connected to an ATM access switch. The ADSL access node and ATM access switch may or may not be colocated. The function of the ATM access switch is to concentrate and switch traffic from a number of access nodes onto the regional broadband network.

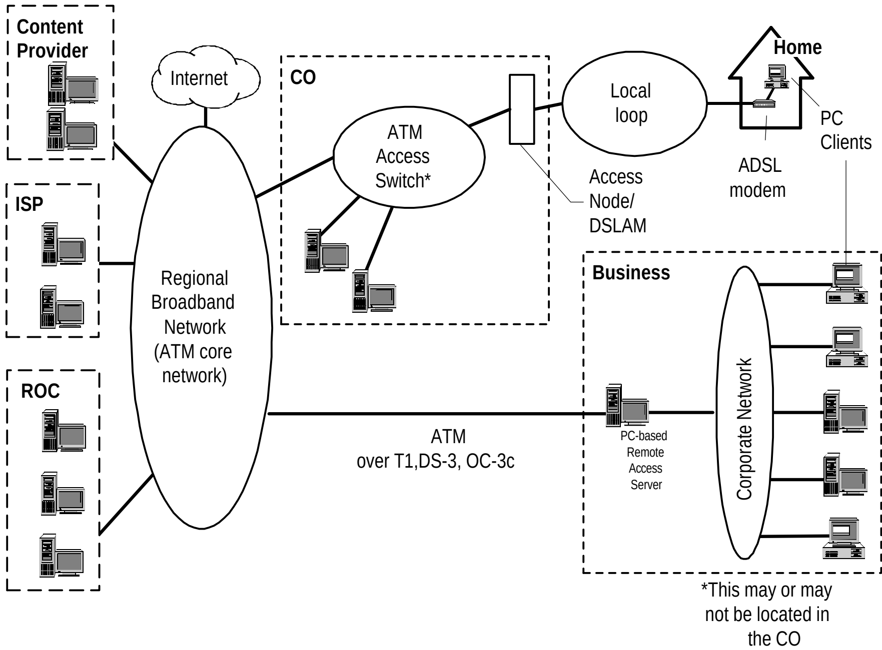


Figure 2. End-to-end ADSL-based Broadband Network Architecture

ATU-R

The functionality of the ATU-R is twofold:

- The Network Termination of the ADSL subscriber line at the customer premise.
- The adaptation to the data interfaces from ADSL to the CPE side, which can be a LAN interface or a NIC in a PC.

Access Node (DSLAM)

The access node performs the following functions:

- **Line Termination of the ADSL subscriber lines.** The ATU-C modules of the access node perform this function.
- **Concentration/multiplexing of the ADSL subscriber lines towards regional broadband network.** WAN interfaces such as an OC-3c are regulated and therefore are expensive resources for a telco operator. It is important to concentrate as many subscriber lines as possible onto a single network interface. A multiplexing scheme that provides high concentration while guaranteeing the individually negotiated QoS will be an important asset for network operators, because it will allow them to offer differentiated services at a reasonable cost.

Regional Broadband Network

A regional broadband network, typically based on a SONET infrastructure, interconnects the central offices in a geographical area. Increasingly, ATM is being deployed over this SONET infrastructure to provide broadband connectivity among the COs.

Service Provider Networks

The service provider networks include the ISP POPs, content provider networks, corporate networks and regional operation center (ROC). An ISP POP is for connecting to the Internet and provides ISP services such as e-mail and Web hosting. A content provider network consists of a server farm for distributing content. The corporate networks are connected to the regional broadband network to allow remote access from a home (telecommuting) or from branch offices. The ROC is operated by the access network operator to manage the entire access network, and possibly to provide value-added services.

End-to-end Interoperable ADSL Network Architecture

Two Levels of Providers

Deployment of ADSL closely involves the telco. In some deployments the telcos may restrict their operating scope to the access network or the backbone network. In such cases, explicit agreement on the interactions between different levels of providers is mandatory. For remote corporate access, the division of responsibility is equally critical since the corporation is almost acting as a service provider. Hence, we need to distinguish between an access network provider and a service network provider in the end-to-end service interoperability model.

It is reasonable to assume that the network model for ADSL will not drastically deviate from the dial-in model. This is essentially a layered model in which connectivity is explicitly established at several levels: the call level (dial-up), the link level and the network level. Note that both the setup and the explicit release of the session at each layer are essential for usage metering and billing by the providers involved at the different layers.

PPP over ATM over ADSL

ATM End-to-end

The proposed ADSL end-to-end service interoperability model is based on an end-to-end ATM network between the customer premise networks and the service provider networks (ISP, content provider and corporate networks). The ATM endpoints include all the devices at the customer premise (such as a PC or router) and the service provider network (an access server or a router) that terminate this end-to-end ATM network. The ATM over ADSL architecture preserves the high-speed characteristics and guarantees QoS in the ADSL environments without changing protocols.

The ATM endpoints must support UNI 3.1 signaling [2]; support of UNI signaling 4.0 [3] is optional. All ATM endpoints must support traffic shaping (including unspecified bit rate, UBR, service) and honor the peak cell rate (and sustained cell rate, if appropriate) agreed on during connection setup. This is to avoid overloading the ADSL link.

With ATM over ADSL, the residential and small business office customers have access to broadband Internet environments. ATM over ADSL provides seamless connections from remote users to any ATM distribution network, to any ATM backbone, to any corporate intranets, or to the Internet. In addition, ATM provides direct connection to Internet/intranet servers, such as a security server, an Internet content caching server, or a video server. This enhances Internet services, in terms of performance, load sharing, and redundancy.

Furthermore, the use of ATM as the layer 2 protocol over the ADSL access network offers some distinct advantages.

Protocol transparency: The network is independent of the layer 3 protocol (IP, IPX, etc.) used. In some countries, protocol transparency is also required by regulatory constraints.

Support of multiple QoS classes and capability to guarantee levels of QoS: ATM delivers the capability for the network operator to differentiate the network services based on QoS classes mapped to user profiles or applications.

The fine-grained bandwidth scalability of ATM: The scalability of ATM matches the rate adaptiveness of ADSL, hence allowing optimal use of each copper loop.

Evolution to different xDSL members: Using ATM with ADSL is an opportunity to pave the way for evolving access technologies, such as VDSL.

PPP over ATM

Once ATM layer connectivity is established between the customer premise and the service provider network, the session setup and release phases at the link level and network level can be established using PPP.

The definition of a standard for PPP over ATM will increase the utility of ATM as an access technology. The important players in the computing and networking industries are driving progress towards that standard. Other connection models for ATM (such as Classical IP over ATM, LANE, and MPOA) target campus environments and lack the security, session, and autoconfiguration functionality that high-speed remote access networks will demand.

Essential operational functions can be delivered over ATM using features well established in PPP:

- Authentication (PAP, CHAP, token-based systems)
- Layer 3 address autoconfiguration (e.g., domain name autoconfiguration, IP address assignment by the destination network)
- Multiple concurrent destinations (i.e., multiple PPP sessions)
- Layer 3 transparency (e.g. both IP and IPX are currently supported on PPP)
- Encryption
- Compression
- Billing, usage metering, and interaction with RADIUS servers

Adapting the PPP suite to ADSL can happen with little or no extra effort and will accelerate delivery of an interoperable service architecture. PPP over ATM is even more valuable because it adheres to the narrowband service model currently driving the ISP business.

Null Encapsulation and VC multiplexing of PPP over ATM

More specifically, this interoperability architecture specifies that PPP is carried over ATM using AAL5 based on VC multiplexing [4]. This means that each VC carrying the PPP session only carries a PPP session: i.e., no multiplexing with other protocols in parallel with PPP. Since PPP itself supports protocol multiplexing, running IP and other protocols occurs above the PPP layer. This also means that the mapping of PPP over AAL5 uses null encapsulation. (The delineation and checksum components that typically come with PPP in an HDLC-like framing are not needed on top of AAL5, which already addresses these aspects.)

For Permanent Virtual Connections (PVCs), carrying PPP over ATM using null encapsulation is required. For Switched Virtual Connections (SVCs), the use of PPP over AAL5 (over ATM) using null encapsulation is specified during the UNI 3.1 call setup using the B-LLI information element user information layer 3 protocol field. This field is required to select ISO/IEC TR 9577

[5] in octet 7, and explicitly specify PPP (IPI value 0xCF) in the extension octets. This model of PPP over ATM complies with the recent IETF draft for PPP over AAL5 [6].

There are many reasons for choosing VC multiplexing. The key reasons are listed below:

Per VC or session QoS: Since each ATM VC is dedicated to a particular PPP session, its bandwidth and QoS requirements can be directly specified for the ATM VC. This is consistent with the ATM paradigm to set each VC with the proper traffic and QoS characteristics for the application it supports.

Security: Since each ATM VC carries only PPP, the authentication and authorization functions of PPP apply to all the traffic carried over the ATM VC. In other words, the PPP security attributes directly apply to the entire ATM connection. This is an important time-to-market advantage, as we do not need to wait for the availability of the ATM security standards.

Lower overhead: If an ATM VC is dedicated to PPP only, there is no need to add an additional multiplexing layer between AAL5 and PPP to demultiplex for other protocols. Since ATM endpoints know a priori that it is carrying only PPP, they save the per-AAL5 frame processing used to detect the protocol (and avoid the additional overhead bytes for indicating the proper protocol). Reduction of processing overhead is particularly important to residential PC clients. Again, since PPP itself is a multiplexing layer that supports multiple layer 3 protocols, it is redundant to have additional protocol multiplexing beneath PPP trying to solve the same problem.

PPP over ATM Model Addresses the Service Requirements

This end-to-end service architecture based on PPP over ATM discussed above satisfies the service requirements defined in Section III.

Easy migration from existing ISP Access Infrastructure: Since we are only replacing the underlying layer for carrying the PPP session: the majority of the ISP infrastructure is maintained, which include IP address and domain name autoconfiguration. The only key changes needed are using ATM interfaces instead of dial-up modem bank. This could represent a significant cost saving because it reduces the need to support dial-up modem banks and their associated blocking problems.

Simultaneous Connectivity to the Internet and Corporate network: The PPP over ATM model supports multiple ATM VCs carrying independent PPP sessions to the ISP and the corporate network.

Multi-Protocol Support: Again, PPP supports multiple layer 3 protocols.

Security: Security is enabled by the connection-oriented nature of ATM plus PPP's encryption and authentication mechanisms. Again, since each ATM VC only carries a PPP session, the security provided by PPP applies to the entire ATM connection.

Multicast: The router/server at the service provider network that terminates the ATM connection and PPP session can provide IP multicast forwarding. In addition, IP multicast can be supported over an ATM network using existing IETF standards (RFC 2022 [7]) to provide more efficient IP multicast distribution over the ATM network.

Multiple Service Classes: Multiple service classes are enabled by the nature of ATM to support different service classes. Individual user profiles can be defined as part of policy management in the network.

Quality of Service Support: Since ATM supports QoS, this architecture lends itself to supporting QoS for each PPP session.

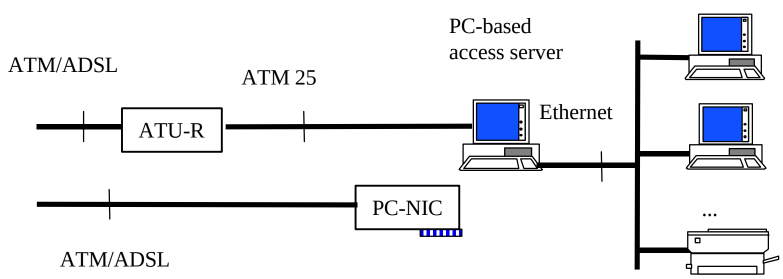
Customer Premise Configurations

The interoperability model of ATU-R in the customer premise network initially focuses on the following interfaces:

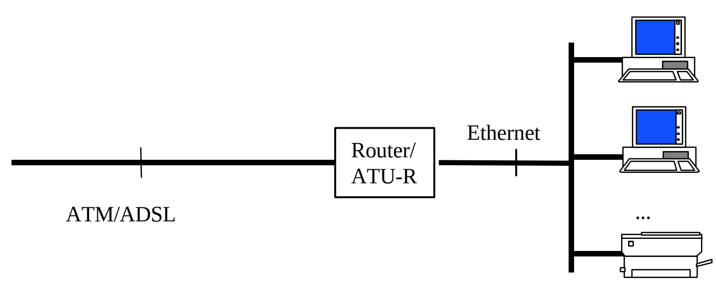
- **ATMF-25** For an external ATU-R, this interface provides service transparency and supports consistent ATM end-to-end internetworking.
- **ADSL plug-in card (PC-NIC)** This is a cost effective solution for single PC environments. It also simplifies the management of the ATU-R because it can take advantage of the operating system support on the PC.

Since the ATU-R is operating in an ATM-to-the-desktop paradigm, it inherits the complete service transparency inherent to ATM. As such, these products can be kept fully service agnostic as they will be able to benefit from evolutions currently taking place at the desktop with minimum cost of ownership.

Even for multiple-PC environments, the ATM end-to-end solution has functional appeal. A sufficiently powerful PC attached via either an ATMF-25 interface or an ADSL PC-NIC can serve as access server (or gateway) on behalf of the CPE LAN. Such an access server can provide firewall, proxy and caching services (using today's PC operating systems, such as Windows NT™) to the LAN segment. Such customer premise architecture is illustrated in Figure 3 (a). Alternatively, a stand-alone ATU-R with routing functions can be used to connect to the CPE LAN, as shown in Figure 3 (b).



(a) PC-based Access Server: external or internal ATU-R



(b) Stand-alone router with internal ATU-R

Figure 3. Customer Premise Network Configurations to Support Multiple-PC environments

Ethernet Interface Support

Although the support of Ethernet interfaces for the client PC is important, there is a protocol complexity involved in supporting Ethernet on the external ATM-based ADSL modem. The reason is that ATM protocols are terminated in the ADSL modem and converted to Ethernet. Although we do not specify the Ethernet support model in this white paper, this will be addressed in the future. (Note that for multiple-PC environments, the Ethernet interface support is addressed through the PC-based access server as discussed above.)

V. STATIC AND DYNAMIC CONNECTIONS

PVC Support

The most straightforward way of establishing an end-to-end connection is in the management plane: an administrative action provisioning a set of PVCs throughout the network for an end user at subscription time. The traffic profile and QoS class can also be configured at the same time throughout the network elements involved.

However, for large-scale deployment the operational burden of manually creating PVCs between each subscriber and the service providers becomes unwieldy. Consequently, the establishment of connections at the ATM layer should be performed in the control plane (i.e., SVCs), with signaling initiated at the customer premise. Nevertheless, PVC support is required now because most current public ATM networks have not yet enabled SVC support.

The PVC connection architecture supports today's DSLAM products and ADSL broadband service. Again, PPP over ATM with null encapsulation (PPP directly over AAL5) is implemented to provide an end-to-end protocol for utilizing existing PPP services such as authentication and IP allocation. Multiple PVCs can be set up per PC client to different destination networks. (To facilitate PVC provisioning and management, soft-PVC can be used within the ATM network.)

Initially, the DSLAM performs VP crossconnect and is transparent to VCI values, as discussed in UNI signaling 4.0's Annex on virtual UNI [3]. PVCs from each subscriber are tunneled through the DSLAM to the ATM access switch, as shown in Figure 4. Additional DSLAM capabilities are for further study.

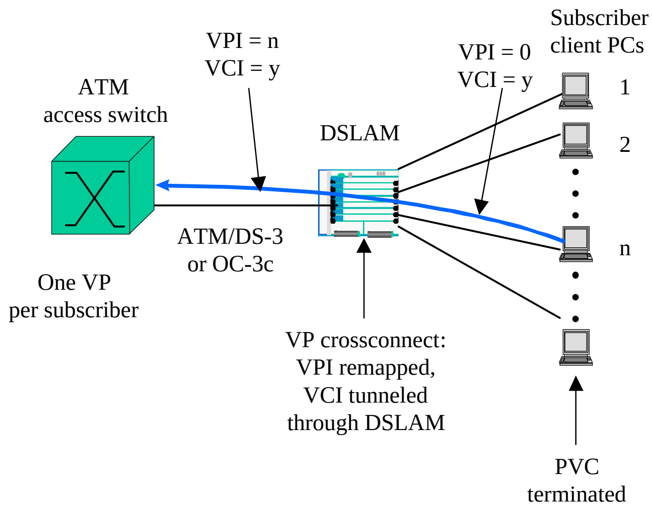


Figure 4. PPP over ATM using PVCs

The operating attributes of the PPP over ATM using PVCs are:

- ATM over ADSL to the home with a PVC tunneled through the DSLAM

- One unique VPI assigned to each (DSLAM-connected) subscriber on the link to ATM access switch
- Equal access provided to ISPs and local content services by the access network provider
- Concurrent connections to several ISPs and corporate intranets through multiple PVCs enabled
- PPP over ATM PVC session established between subscriber (PPP client) and remote access router (PPP server, such as at the ISP or corporate network)

SVC Support

In the SVC environment, a signaling tunneling approach based on the virtual UNI concept discussed in UNI signaling 4.0 [3] is used for the interoperability model. In this configuration, the management plane establishes VP crossconnect in the DSLAM and associates a set of VPCIs at the interface to the ATM access switch network to a VPI for each user, as in Figure 4. Each subscriber is represented by a VPI at the ATM access switch (on the interface to the DSLAM). The UNI signaling protocol is terminated at the ATM access switch. The signaling between the home PC client and the ATM access switch is transparent to the DSLAM, because the DSLAM functions as a VP crossconnect. Although the ATM access switch has to implement UNI signaling 4.0's virtual UNI concept to support multiple signaling channels (one from each subscriber), the home client PCs need to support only UNI signaling 3.1; the virtual UNI concept is transparent to the home client PCs. This is shown in Figure 5.

The main attributes of the PPP over ATM model in the SVC environment are:

- One unique VPI assigned to each (DSLAM-connected) subscriber
- ATM access switch provides the virtual UNI to the DSLAM (subscribers) and terminates the UNI signaling and ILMI protocols to the customer premise clients
- Equal access provided to ISPs and local content services by the access network provider
- Concurrent connections to several ISPs and corporate Intranets through multiple PVCs enabled
- PPP over ATM SVC session established between subscriber (PPP client) and remote access router (PPP server, such as at the ISP or corporate network)

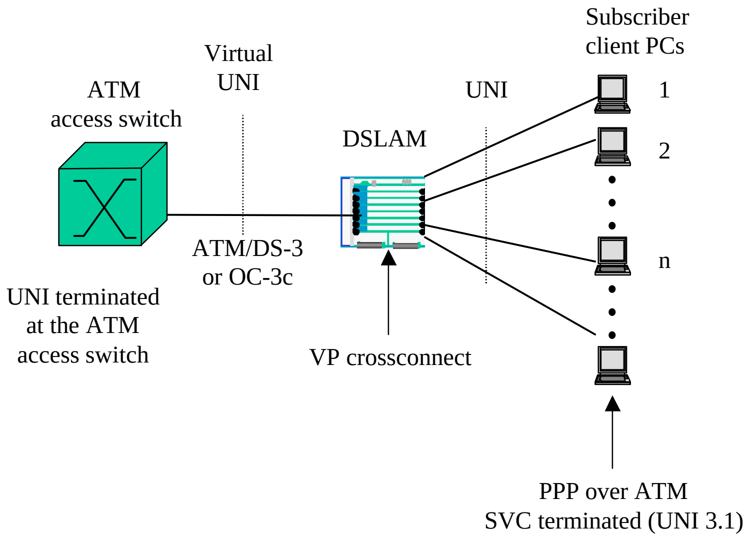


Figure 5. UNI Signaling Terminates at ATM Access Switch as Virtual UNI

It is clear that in this configuration the focus is on connectivity. However, this implies a choice between the attainable user concentration level at the WAN interface and the degree to which the QoS guarantees to the individual users can be met.

By supporting the virtual UNI at the ATM access switch, it is necessary to support many signaling channels on the interface to the DSLAM (one per subscriber). If the DSLAM can terminate UNI signaling directly, this can reduce the signaling requirements on the ATM access switch because only one signaling channel is needed to support all the DSLAM-connected subscribers. This functionality tradeoff between the ATM access switch and the DSLAM requires for further study. In any case, whether signaling is terminated at the DSLAM or at the access switch does not affect end-to-end service interoperability based on the PPP over ATM model, because the precise termination point of the UNI signaling protocol within the network is transparent to the ATM endpoints.

VI. USER-FRIENDLY SERVICE REQUIREMENTS

While user friendly services do not ensure success, complex and hard to use services can ensure failure. On their own, ATM and ADSL are complex technologies. Combined as a service to the home or small business office user, ATM and ADSL present a difficult challenge to the objective of user friendliness. To be consider “user friendly,” the service provided by access network and service providers should meet the following goals. Approaches to achieve these goals are being studied.

- CPE (including ATU-R) can be installed with little or no networking knowledge or background, and without using a manual.
- CPE installation and setup requires little or no manual configuration (with no manual configuration as our ultimate goal) or information that must be manually acquired from the Access Network Operator.
- CPE installation and setup should be consistent across multiple access networks to insure portability of user devices. Variations must be avoided and must be isolated from the user.
- CPE and the Access Network must always maintain valid and compatible configurations.
- The access network can be rearranged without manual reconfiguration of the CPE.
- The customer premise can be rearranged without manual reconfiguration of the Access Network.
- Access network and service providers should not be required to contact the user for information about the user’s installed CPE.
- The CPE should be user friendly in all operational environments such as Internet access (IP), or corporate work-at-home (such as IPX and IP).
- User friendliness should not require the use or purchase of software or hardware that would not routinely be used for that application by a user.
- Use of standard applications, like a Web browser, should require no unusual or unnatural user operation (particularly a departure from standard operation on today’s PSTN or LAN’s).
- User friendly operation should be consistent across multiple access networks.
- User friendly operation must be designed for various regulatory environments.
- User friendly operation should not burden the network operator with additional operational expenses.

Further Information

This white paper is a result of the collaboration between Microsoft and industry leading companies Alcatel, Cisco Systems, FORE Systems, U.S. Robotics and Westell to accelerate ADSL deployments. Questions on this paper can be directed to:

Microsoft
Timothy Kwok
Phone: (425) 936-6755
E-mail: timkwok@microsoft.com

Alcatel
Ivan Verbesselt
Phone: +32-(0) 3-240-79-56
E-mail: Ivan.Verbesselt@alcatel.be

Cisco Systems, Inc.
David Veneski
Phone: (408) 527-7615
E-mail: dveneski@cisco.com

FORE Systems
Paul Y.B. Shieh
Phone: (412) 742-7819
E-mail: pshieh@fore.com

US Robotics
James Loehndorf
Phone: (847) 933-5684
E-mail: jloeh@usr.com

Westell Technologies
Rama Mwikalo
Phone: (630) 375-4469
E-mail: rmwikalo@westell.com

References

[1] T. Kwok, “Residential Broadband Internet Services and Applications Requirements,” *IEEE Communications Magazine*, June 1997.
[2] The ATM Forum, *ATM User-Network Interface Specification V3.1*, af-uni-0010.002, 1994.
[3] The ATM Forum, *UNI Signaling, Version 4.0*, af-sig-0061.000, July, 1996
[4] J. Heinanen, “Multiprotocol Encapsulation over ATM Adaptatio *IETF Request for Comments: 1483*, July 1993.
[5] ISO/IEC TR 9577:1990(E), “Information technology - Telecommunications and Information exchange between systems - Protocol Identification in the network layer,” 1990-10-15.
[6] M. Kaycee, G. Gross, A. Lin, A. Malis, J. Stephens, “PPP over AAL5 and FUNI,” IETF Draft <draft-ietf-pppext-aal5-funi-00.txt>, March, 1997.
[7] G. Armitage, “Support for Multicast over UNI 3.0/3.1 based ATM Networks,” *IETF Request for Comments: 2022*, November 1996.