Technical Report
TR-012

Broadband Service Architecture for Access to Legacy Data Networks over ADSL Issue 1

June 1998

Abstract:

This Technical Report specifies an interoperable end-to-end architecture to support broadband service over ADSL systems. This architecture is based on the PPP over ATM (over ADSL) model. It satisfies many broadband service requirements that are important for ADSL deployment.

Table of Contents

1. Statement of the project.

1.1 Scope

This document is the first in a series of technical recommendations to emerge from the Network Architecture sub-Group of the ADSL Forum ATM Working Group. The focus of this document is a specific recommendation as to the user plane protocol that will be carried over ATM over ADSL independent of transmission layer line code at what is commonly known as the "U reference point" for the application of "access to legacy data networks". This series of recommendations will be dependent upon existing standards.

Future versions of this document will be expanded to encompass options for premises architecture (S and T reference points) and access network architecture (V reference point) and service interworking in the access consistent with the original recommendation.

1.2 Terminology of Requirements

In this document, several words are used to signify the requirements of the specification. If these words are capitalized, their meaning is as follows:

MUST	This word, or the adjective ÒREQUIRED Ó means that the definition is an absolute requirement of the specification
MUST NOT	This phrase means that the definition is an absolute prohibition of the specification.
SHOULD	This word, or the adjective ÒRECOMMENDEDÓ means that there may exist valid reasons in particular circumstances to ignore this item, but the full implications must be understood and carefully weighted before choosing a different course.
MAY	This word, or the adjective ÒOPTIONAL Ó means that this item is one of an allowed set of alternatives. An implementation that does not include this option MUST be prepared to inter-operate with another implementation that does include the option.

2. End-to-end Service Interoperability model over ADSL systems

2.1 Specific Reference model

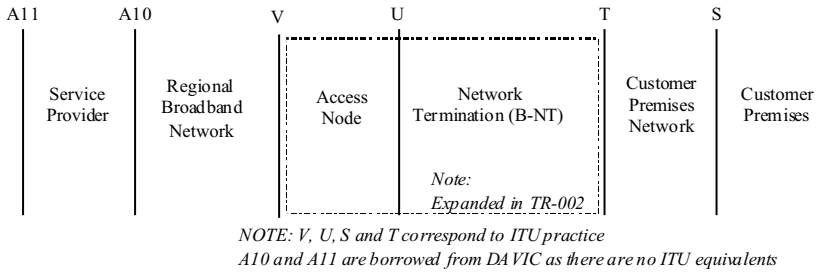

Figure 1. Architectural reference model

The end-to-end ADSL-based network architecture for convenience can be decomposed into the following subnetworks: the customer premise network, the access network, the regional broadband network and the service provider networks. They are shown in Figure 2.

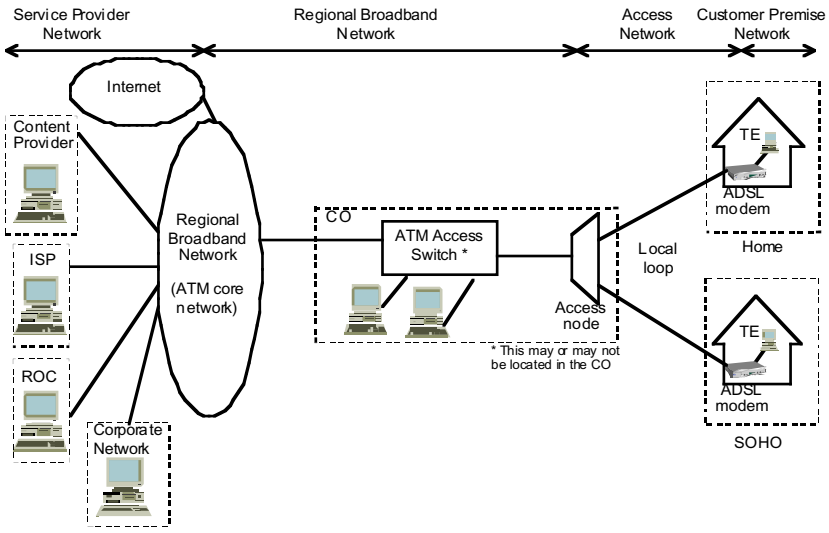

Figure 2. Example of an end-to-end ADSL-based Broadband Network Architecture

2.2 Customer Premise

The customer premise includes residences, home offices and small business offices. Each will contain one or more terminal equipment devices (TEs such as PCs, workstations, set-tops, etc.) possibly interconnected by a customer premises network. The ADSL modem on the customer premise is called the ÒB-NTÓ(B-ISDN network termination). A more detailed discussion of premises protocol architectures will reside in an annex of the next release of this document.

2.3 Access Network

The ADSL access network encompasses the ADSL modems at customer premise and the access multiplexer system at the CO connected via the local loop.The ADSL Forum TR-002 [2] (and WT-021 [3]) addresses the layer 2 protocols and specifically describes the

implementation of ATM transport over ADSL links. TR-002 identifies and defines the functional blocks of ATM-based ADSL access network which are formally referred to as B-ISDN Network Termination (B-NT) for ADSL modem and Access Node (AN) for access multiplexer system.The access node is frequently referred to as the ÒDSLAMÓ(DSL Access Multiplexer). TR-002 also addresses the control and management planes related to supporting ATM in user plane. It includes the ATM PVC support, signalling for SVC support and operations and maintenance functionality to support ATM over ADSL. 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 co-located. The function of the access node and access switch is to:

- provide physical port concentration
- provide bandwidth concentration in the form of statistical multiplexing of non-CBR traffic classes
- to possibly provide logical port concentration when a service interworking function is co-located in the access network
- support the ability to offer differentiated services in the network.

2.4 Regional Broadband Network

A regional broadband network, interconnects the central offices in a geographical area. The function of the regional broadband network is a combination of transport and possibly switching.

2.5 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.

3. End-to-end Service Requirements

The broadband service requirements for enabling the new opportunities 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.

Some deployment scenarios will see the access network provider as a different entity from the service provider. This is reflected in the end-to-end interoperability model.

3.1 Access Configurations

To successfully deploy ADSL, the access provider will typically provide support for some combination of the following four access configurations: the Internet, corporate networks, local content and peer-to-peer connectivity. These are typically pre-existing networks utilizing LAN/packet technology which require network layer interworking at the point of ingress from the access network.

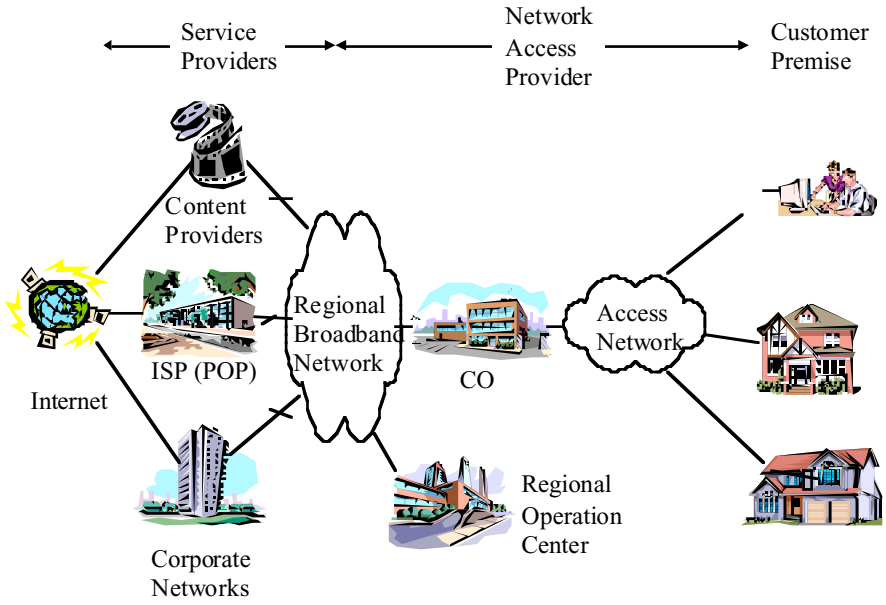

Figure 3. Access Configurations: Internet, Corporate networks, Local Content and Peer-to-Peer Communications

3.1.1 The Internet

The Internet is accessed through one or more ISPs connected with high-speed links from the access provider's Central Office (CO) equipment (either telco or co-located). These high-speed links are part of the regional network of the access provider, which can be a combination of, e.g., SONET/SDH, ATM and Frame Relay.

3.1.2 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 3, to provide direct high-speed connectivity to the corporate network. This may have the advantages of higher speed, QoS guarantees and greater security.

3.1.3 Local Content

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

3.1.4 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.

3.2 Functional Requirements

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.

A system fullfilling the functional requirements of this document MUST comply with [1]. Those functional requirements of a system that are endorsed in this document are listed below:

- It MUST have the ability to transport and distinguish one or more data protocols
- It MAY have multiple simultaneous service provider connections
- It SHOULD have simultaneous multiple class of service/QoS support

4. End-to-end Interoperable ADSL Network Architecture

4.1 PPP over ATM over ADSL

The core of this recommendation is the use of PPP over ATM at the U reference point, identified in Figure 1, to meet the requirements outlined above.

4.1.1 ATM End-to-end

The 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). This model is independent of but does not preclude service interworking in the regional network core. 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 service may be SVC or PVC. For ATM SVC service, use of UNI 3.1 [4] is mandatory and UNI 4.0 [5] MAY be required and is strongly recommended[1]. Furthermore, the use of ATM as the layer 2 protocol over the ADSL access network offers some distinct advantages.

- Protocol transparency
- Support of multiple QoS classes and capability to guarantee levels of QoS
- The fine-grained bandwidth scalability of ATM
- Evolution to different xDSL members

4.1.2 PPP over ATM

PPP over ATM MUST be implemented as specified in the IETF proposed standard for PPP over ATM [6] with the caveat that for PVCs the use of null encapsulation is REQUIRED to be the default.

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.

PPP over ATM [6] increases the utility of ATM as an access technology. Essential operational functions can be delivered over ATM using features well established in PPP:

- Authentication (PAP, CHAP, token-based systems)
- Layer 3 address auto-configuration (e.g., domain name auto-configuration, 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

[1] UNI 4.0 provides several DSL friendly features such as ability to specify a peak cell rate for the UBR traffic class, allows rate negotiation and is aligned with many desirable features in ILMI 4.0.

5. References

[1] ADSL Forum WT-014v8.0 - Requirements & Reference Models for ADSL Access Networks: The "SNAG" Document

[2] ADSL Forum TR-002 — ATM over ADSL Recommendations

[3] ADSL Forum WT-021 — Working Text for ATM over ADSL Recommendation v2[2]

[4] The ATM Forum, ATM User-Network Interface Specification V3.1, af-uni-0010.002, 1994.

[5] The ATM Forum, UNI Signaling, Version 4.0, af-sig-0061.000, July, 1996

[6] M. Kaycee, G. Gross, A. Lin, A. Malis, J. Stephens, "PPP over AAL5 ," IETF Draft <draft-ietf-pppext-aal5-06.txt>, May, 1998[3].

[2] This reference, developed by the Internet Engineering Task Force (http://www.ietf.org), has not reached formal standards status. Implementers should contact the Internet Engineering Task Force for the latest revision of draft-ietf-pppext-aal5-06.txt. The ADSL Forum reserves the right to alter or amend this document based on the evolution of draft-ietf-pppext-aal5-06.txt to the final standard.

[3] This reference, developed by the ADSL Forum (http://www.adsl.com), has not reached formal standards status. Implementers should contact the ADSL Forum for the latest revision of ADSL Forum WT-021. The ADSL Forum reserves the right to alter or amend this document based on the evolution of ADSL Forum WT-021 to the final standard.

6. Glossary

ADSL: Asymmetric Digital Subscriber Line
AN: Access Node
ATM: Asynchronous Transfer Mode
B-ISDN: Broadband ISDN (Broadband Integrated Services Digital Network)
B-NT: B-ISDN Network Termination
CBR: Constant Bit Rate
CHAP: Challenge Handshake Authentication Protocol
CO: Central Office
DAVIC: Digital Audio-Visual Council
DSLAM: DSL Access Multiplexer
IETF: Internet Engineering Task Force
IP: Internet Protocol
IPX: Novell protocol
ISDN: Integrated Services Digital Network
ISP: Internet Service Provider
L2F: Layer 2 Forwarding
L2TP: Layer 2 Tunneling Protocol
LAN: Local Area Network
NAP: Network Access Provider
NSP: Network Service Provider
NT: Network Termination
PAP: Password Authentication Protocol
PC: Personal Computer
POP: Point of Presence
PPP: Point to Point Protocol
PPTP: Point to Point Tunneling Protocol
PVC: Permanent Virtual Connection
QoS: Quality of Service
RADIUS: Remote Access Dial In User Services
ROC: Regional Operation Center
SDH: Synchronous Digital Hierarchy
SONET: Synchronous Optical Network
SOHO: Small Office — Home Office
STB: Set-Top-Box
TE: Terminal Equipment
UNI: User-Network Interface
xDSL: Acronym commonly used for all kinds of of DSL services, where x can be any of A, H, V, etc.