DSL Forum

Working Text
WT-101
Revision 1

Migration to Ethernet Based DSL Aggregation

For
Architecture and Transport Working Group

May 2004

Abstract:

This working text outlines how an ATM aggregation network can be migrated to an Ethernet based aggregation network in the context of TR-25 and TR-59 based architectures. This document provides an architectural/topological model of such an Ethernet based aggregation network. It describes the interworking function that should be provided by the access node, encompassing protocol translation, QoS, security and OAM issues and the corresponding functional modifications to the BRAS.

Revision History	Date	Reason for Update
Version 1	May, 2004	First version, based on DSL2004.086 and Brussels meeting conclusions.

Table of Contents

Table of Figures

1. Introduction and Purpose

1.1 ATM Based Architectures

DSL deployments today follow the architectural guidelines of TR-025 or the more advanced TR-059 (reference models are depicted in Figure 1 and Figure 2 respectively). Both architectures use ATM to aggregate the access networks into the regional broadband network. In such deployments the access node functions as an ATM aggregator and cross-connect, multiplexing user ATM PVCs from the U interface onto the V interface and de-multiplexing them back on the opposite direction (see Figure 1).

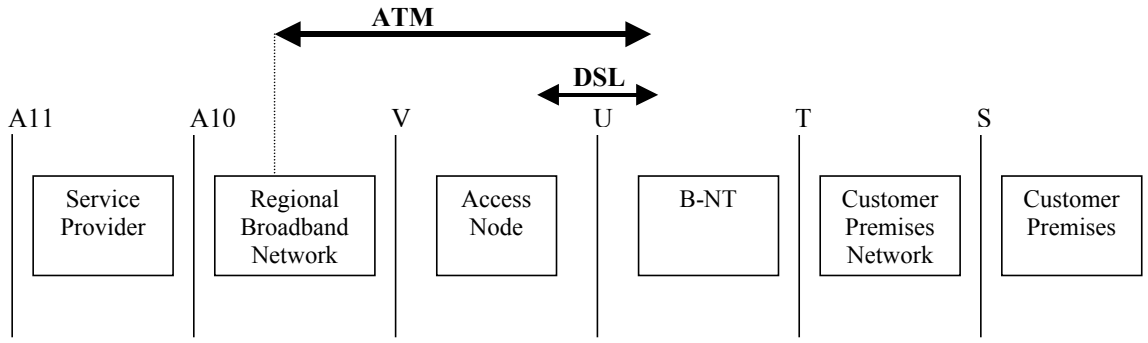

Figure 1 – TR-025 High Level Architectural Reference Model

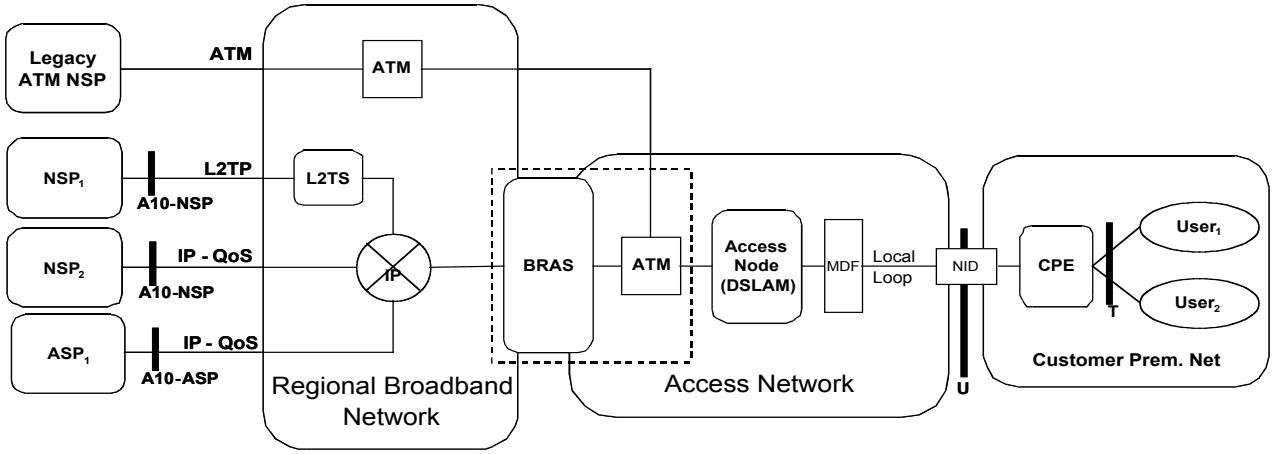

Figure 2- TR-059 High Level Architectural Reference Model

The traffic aggregated from the access nodes is steered to an IP node, the BRAS. In TR-025 the BRAS can be physically located either in the regional network or in the service provider network and is mainly engaged in PPP termination and tunneling. In TR-059 the BRAS is located on the edge of the regional network and its functionality is enhanced to include subscriber management, advanced IP processing, including IP QoS, and enhanced traffic management capabilities, e.g. 5-layer hierarchical shaping.

For the purpose of clarity if this document we define the term *'aggregation network'* as the part of the network connecting the access nodes to the BRAS (i.e. this is the edge of the regional network according to TR-025 and part of the access network according to TR-059). In Both TR-025 and TR-059 the aggregation network is ATM based.

1.2 Scope of this Document

This document addresses network architectures where the aggregation network is Ethernet based while the DSL access network is still ATM over DSL based (see Figure 3). The migration of the aggregation network from ATM based transport to an Ethernet based transport imposes several new requirements on the DSLAM and BRAS functions:

DSLAM:

- The DSLAM must be able terminate the subscriber ATM layer.
- The DSLAM must have an Ethernet uplink providing connectivity to the regional network.
- The DSLAM has to provide an interworking function (denoted IWF in Figure 3) between the ATM layer on the user side and the Ethernet layer on the network side, encompassing protocol translation, DSL line identification, QoS, security and OAM issues. This may require the DSLAM awareness of protocol layers above the AAL.

BRAS:

- The BRAS must be able to terminate the Ethernet layer and corresponding encapsulation protocols
- The BRAS must be able to implement the counterpart of most of the functions added to the DSLAM (e.g. DSL line identification, Ethernet-based QoS, security and OAM).
- Following TR-059 QoS principles, the BRAS must be able to extend its IP QoS and congestion management logic (e.g. hierarchical scheduler) to address over-subscribed Ethernet-based topologies.

The Ethernet based aggregation network must provide capabilities matching those of the previously used ATM network.

- The aggregation network must be able to provide separation of the traffic flows according to the originating (or destination) UNI (i.e. DSL port)
- The aggregation network must provide means for traffic aggregation, e.g. similar to VP/VC.
- The aggregation network must provide means to prioritize in order to handle congestion at points of over-subscription.

This document aims to provide a detailed specification of all above-mentioned functions and capabilities. The principle guiding this specification work is that the resulting DSLAM and BRAS functions should enable as smooth as possible migration process from an ATM based aggregation network to an Ethernet based aggregation network. Therefore, the following requirements focus on the aggregation network itself and are not imposing any new requirements on the end user at the U interface or beyond. Furthermore, the functions specified in this document are designed to be compatible with all access protocols that were recommended by the DSL Forum for usage over the U interface, i.e. TR-043. In addition to the access protocols, the specified functions are designed to allow service levels (e.g. QoS, privacy, security etc.) that are same or better than those offered by an ATM based aggregation network. Several OAM and provisioning issues that are affected by replacing the ATM aggregation network to an Ethernet one are also addressed by this specification.

This current specification is limited to AAL5 based services only (i.e. over the U-interface).

Editor's note: Should be emphasized and agreed

Although the requirements described in this document add certain networking capabilities to the access node, this specification does not intend to import to the access node any networking capabilities that are not directly derived from the need to interwork between the ATM and Ethernet networks or to provide compatibility with current deployment scenarios. For example, this specification does not require BRAS functionalities such as LAC or PTA to be imported into the access node.

The specification focus on a qualitative approach rather than on a quantitative approach, namely, it describes a required function but does not specify how many instances of this function must be simultaneously supported. For example, it specifies that the DSLAM must provide ATM AAL5 SAR and CPCS functions for ATM PVCs but does not specify for how many PVCs.

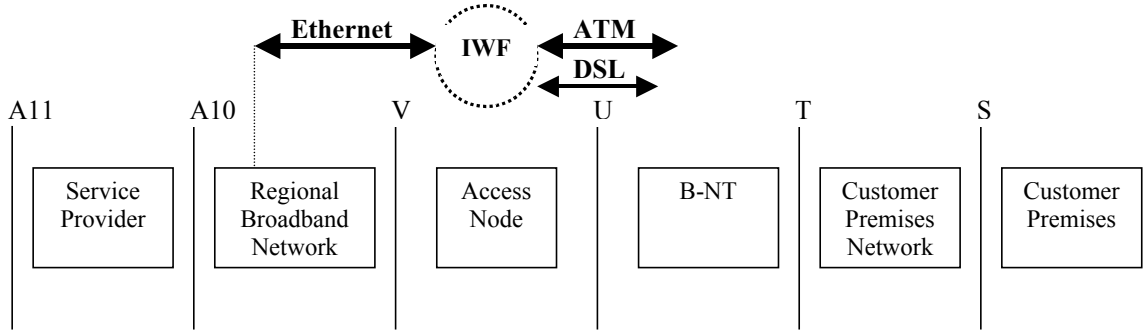

Figure 3 – ATM to Ethernet via Inter-Working Function

1.3 Additional Clarifications to the Scope

The following table further refines the scope by summarizing some high-level functions being 'in' or 'out of' the scope for this document.

	In scope	Out of scope	Appendix
Ethernet aggregation architecture derived from TR-25 principles	**X**		
Support for access protocols defined in TR-043 with Ethernet based aggregation network	**X**		
Ethernet aggregation architecture derived from TR-59 principles	**X**		
Aggregation architecture with subscriber traffic steered to a single edge (e.g. BRAS)	**X**		
Aggregation architecture with subscriber traffic potentially distributed to multiple edges		**X**	
Additional service/subscriber management mechanism at the DSLAM level		**X**	
Ethernet/DSL direct encapsulation at the U-interface		**X**	
Ethernet QoS (e.g. 802.1p) on the aggregation network	**X**		
Multicast services with multicast support at the DSLAM level		**Probably**	**Discuss motivation**
Business services (e.g. Transparent LAN, Layer 2 VPN)		**Probably**	**Discuss motivation**

1.4 Motivation for Migration to Ethernet Based DSL Aggregation

Editor's note: This section should elaborate on the drivers for such a migration

1.5 Requirements

In this document, several words are used to signify the requirements of the specification. These words are often capitalized.

MUST This word, or the adjective "REQUIRED", 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 "RECOMMENDED", 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 “OPTIONAL”, 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.

1.6 Key Terminology

The following definitions apply for the purposes of this document:

Access Network The access network encompasses the elements of the DSL network from the B-NT at the customer premises to (and including) the access node[1].

Access Node The access node may implement the ATU-C function (DSL signal termination), may physically aggregate other ATM nodes implementing ATU-C functionality, or may perform both functions at the same time. Can be CO based or non-CO based equipment. In the scope of this specification, this node contains at least one standard Ethernet interface that serves as its northbound interface into which it aggregates traffic from several ATM-based southbound interfaces. In the context of this specification the term DSLAM signifies the exact same function and is therefore used indistinctively.

Aggregation Network The part of the network stretching from the access nodes to the BRAS. In the context of this document the aggregation network is considered to be Ethernet based, providing standard Ethernet interfaces at the edges, for connecting the access nodes and the BRAS, and some transport for Ethernet frames (e.g. Ethernet over SONET, RPR, etc.) at the core.

BRAS The BRAS is the aggregation point for the subscriber traffic. It provides aggregation capabilities (e.g. IP, PPP, Ethernet) between the access network and the NSP or ASP. Beyond aggregation, it is also the injection point for policy management and IP QoS in the access network.

Downstream The direction of transmission from the regional network to the access node and from the access node towards the end user.

End User A DSL subscriber using standard ATM over ADSL xTU-R.

Interworking Function (IWF) The set of functions required for interconnecting two networks of different technologies. These functions include conversion of

[1] The definition of ‘Access Network’ differs from the one in TR-059 in order create distinction between the ATM part, which is named here the access network and the Ethernet part which is named here the aggregation network. The concatenation of the latter two forms the ‘access network’ as defined in TR-059.

	PDU framing, addressing schemes, priority mapping, security mechanisms, OAM flows and more.
Regional Broadband Network	The regional broadband network (‘regional network’ for short) interconnects between the Network Service Provider's networks and the access networks. Typically more than one access network is connected to a common regional network.
Upstream	The direction of transmission from the end user to the access node and from the access node towards the regional network.

Editor’s note: initial list - will grow as we go.

2. General Requirements

Editor's note: This section should include requirements that are independent of the networking approach(es) presented in the following sections. Several such issues are additional ATM layer requirements for the access node (like AAL5 SAR and CPCS, RFC 2684 support) and general requirements from the physical/MAC layer of the DSLAM's and BRAS links (e.g. 802.3,flow control etc.).

3. Fundamental Architectural and Topological Aspects

Editor's note: this section should describe the chosen networking approach and the way it addresses the following fundamental issues on the Ethernet based aggregation network:

1. *Aggregation of flows*
2. *Prioritization scheme*
3. *Customer Separation (i.e. the ability of the network to identify and handle traffic coming to/from a certain DSL subscriber as single flow)*
4. *The ability to perform translation at the V-interface of the U-interface protocols described in TR-043 (without a change to the U-interface).*

A reference protocol stack should be provided. Considerations about security and broadcast should be included in this discussion. Recommended practices for over-subscription points (e.g. DSLAM and first Ethernet switch) should be explained, and made consistent with TR-59 5-levels hierarchical scheduling principles.

One possible solution is to use VLAN tags (IEEE 802.1Q & P). VLAN tagging can be used for aggregation of flows by:

- *Using one VLAN id per (DSLAM, BRAS) pair.*
- *Using one VLAN id per a group of subscribers or PVCs*

Priority mechanism can be realized by the VLAN priority field providing priority indicating per frame.

Customer separation can be provided by using one dedicated (DSLAM, BRAS) VLAN id per subscriber, hence an ATM Virtual Circuit equivalent, or by a combination of VLAN ids, customized learning bridge and relay-id insertion. The latter two are described in the following.

The following sections include some issues that are solution independent, and some that are solution dependent. The latter assume the above VLAN approach is taken.

Other technical solutions (to VLANs) should be proposed and evaluated. The evaluation should take into account scenarios of different size POP configurations, since this might have an affect on the customer separation techniques.

4. Networking and Interworking Functions

4.1 Customer Separation

4.1.1 VLANs

Editor's note: this section describes the required VLAN assignment capabilities (DSLAM, network and BRAS), e.g. VLAN id per DSLAM, PVC, subscriber, group of….

4.2 DSLAM Forwarding Principles

Editor's note: Following the VLAN approach, 2 basic schemes are offered. Each VLAN me may be assigned one forwarding scheme.

1. *Customized learning bridge- one instance per VLAN. Customization is necessary (see section on security)*
2. *Direct mapping - direct mapping between VLAN and virtual port (no learning).*

4.3 QoS

4.3.1 Mapping between ATM and Ethernet CoS

Editor's note: DSLAM mapping between ATM PVCs and 802.1P

4.3.2 Queuing Scheduling and Shaping

Editor's note: two facets to this discussion:

- *Expected layer2 behavior in the DSLAM inter-working unit*
- *Expected layer3 behavior in the BRAS (hierarchical policing & scheduling)*
    - *VP-level scheduler node should probably be mapped to a "trunk" VLAN*
    - *VC-level scheduler node should probably mapped to a DSL local loop (identified as a "circuit" VLAN or via DSL2004.071 mechanisms)*

4.3.3 Policing

Editor's note: should discuss implications on Hierarchical Policing (TR-59) and any requirements on policing (if at all) when HS and HP are not used.

4.4 Protocol Translation Functions

Editor's note: the intention in this clause is to describe the access protocols of the U interface, described in TR-43, and how those are translated at the V interface.

Also this section should address the issue of layer 2.5/3 transparency, namely if the proposed solution does not offer this transparency, what are the possible mechanisms to overcome this problem (this may be informative)

4.4.1 PPPoE over ATM (U-interface)

Editor's note: protocol translation function

4.4.2 IPoE over ATM (U-interface)

Editor's note: protocol translation function

4.4.3 IP over ATM (U-interface)

Editor's note: protocol translation function

4.4.4 PPP over ATM (U-interface)

Editor's note: protocol translation function

4.5 Security Considerations

4.5.1 Broadcast Handling

Editor's note: How to forward broadcasts received from the network side. One possibility is to be able to block or allow broadcasts per VLAN.

4.5.2 L2 Peer to Peer ("hair-pin") Forwarding

Editor's note: If we want to allow the option of 2 ports exchanging traffic through the access node, we need to specify how it is done and controlled

4.5.3 Traffic Separation

Editor's note: it is required to be able to separate traffic coming from users, as if they where still on separate PVCs. Inherent when 'direct mapping forwarding' is used, in learning bridge forwarding this requires something like 'split horizon' or forced forwarding.

4.5.4 Source MAC Spoofing

Editor's note: Means to detect that 2 ports (on the same VLAN) using the same MAC address.

4.5.5 Source MAC Flooding

Editor's note: A ways to limit a user port to an upper limit of MAC addresses

4.5.6 Secure ARP

Editor's note: May be required if we are forwarding ARP requests coming from the network.

4.5.7 Filtering

Editor's note: any additional filtering that is required, for example making sure that a specific port uses a specific MAC address.

4.5.8 Source IP Spoofing

Editor's note: the corresponding BRAS function needs to be re-discussed in the context of cases where there is no VLAN per subscriber (then the scope of the BRAS anti-spoofing function induces some limitation which impact needs to be discussed).

4.6 DSL Line Identification and Traceability

Editor's note: this clause discusses the ways to maintain the id of originating DSL port when traffic is forwarded to the network after terminating ATM. Should import relevant parts of Dslf2004.071

4.7 OAM

Editor's note: This reflects the wish to maintain similar layer 2 end-to-end OAM capabilities that were available when the aggregation was ATM-based, via ATM OAM (I.610). Ongoing work in standard bodies like ITU SG13, IEEE and MEF should be reviewed, and a gap analysis (compared to the level of OAM obtained in an ATM aggregation network) should be provided. Discussion of impact on DSLAM, BRAS, but also aggregation Ethernet switches.

4.7.1 Ethernet OAM

4.7.2 Interworking between Ethernet and ATM OAM

5. Network Management

Editor's note: this clause discusses the ways impact on DSLAM and BRAS element and network management (e.g. Ethernet-related monitoring MIBs; relation with OAM mechanisms; Provisioning processes; coupling of DSL2004.071 with RADIUS/DHCP, etc).

6. Deployment and Migration Scenarios

Editor's note: this chapter discusses ATM/Ethernet migration stages where a mix of both technologies is needed.

Appendix A – Multicast Services Support

Editor's note: should discuss several ways to realize multicast services when using Ethernet based DSL aggregation