6

ATM Access

For many years, ATM has been the networking technology of choice for service delivery with end-to-end quality. Today, while service providers are gradually starting to migrate to Carrier Ethernet and other alternative technologies, ATM access networks are still widely deployed – supporting, for example, the majority of First Mile DSL connections – and will remain operational for some time to come. Carriers and service providers are therefore looking for reliable solutions to leverage their large ATM installed base for both LAN-to-LAN connectivity and legacy traffic transport.

RAD's ATM integrated access devices, network termination units and corporate concentrators allow carriers and service providers to simultaneously transport voice, legacy data and LAN traffic over ATM backbones with various levels of service guarantees. Supporting a wide range of data rates from E1/T1 up to STM-4/OC-12, these devices feature sophisticated traffic engineering attributes with performance monitoring and diagnostic capabilities. Additionally, they enable the use of widely available DSL links for ATM access. RAD's ATM products can also be used for smart demarcation between ATM networks or between ATM and IP networks.

Multiple services over ATM

RAD's ATM access devices converge leased line and transparent LAN services, together with legacy Frame Relay and ISDN traffic delivery. This improves network utilization and eliminates the need to invest in dedicated infrastructure. Extending carrier control to the user premises, they support circuit emulation for voice and TDM connectivity, as well as for dedicated Internet access (DIA) and LAN bridging. This provides a single solution for service integration over ATM with quality of service (QoS) performance guarantees that meet diverse application requirements.

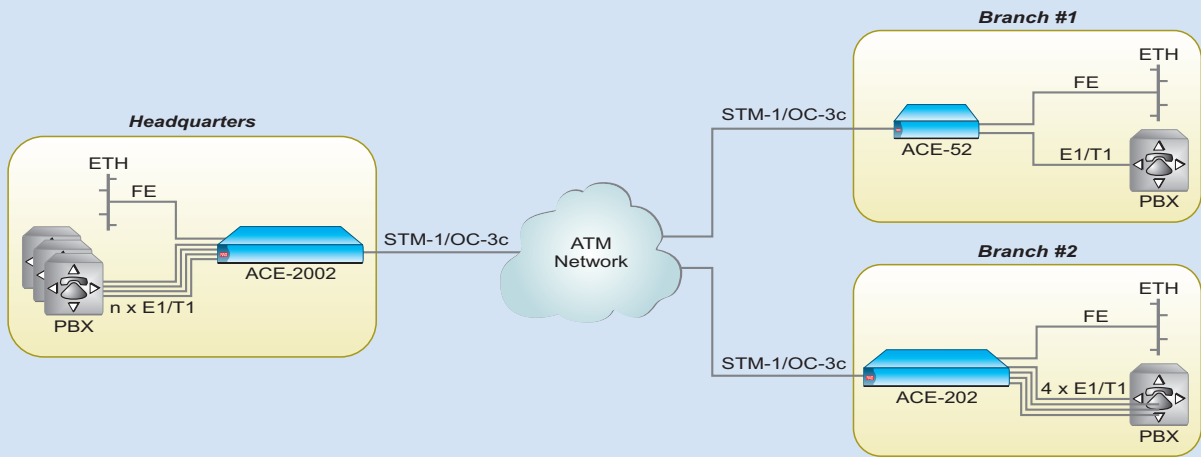## ATM traffic management and SLA differentiation

The ACE and LA ATM access devices allow service providers to offer different SLAs and control the total bandwidth provided to their users, right off the customer premises. Supporting CBR, VBR, UBR, and UBR+ service classes, they also enable hierarchical traffic scheduling, with QoS parameters assigned per virtual connection (VC), per VP (virtual path), per VP tunnel, or per network interface. This ensures fair bandwidth sharing between different users and services to avoid congestion while preserving individual connection requirements. Furthermore, increased statistical efficiency allows users to pass more traffic over their links when the network is free.

In addition, link diagnostics, including alarm indication, continuity check and loopback testing, promote substantial savings in operational and maintenance costs, by minimizing technician truck rolls for on-site inspections to localize and repair network faults.
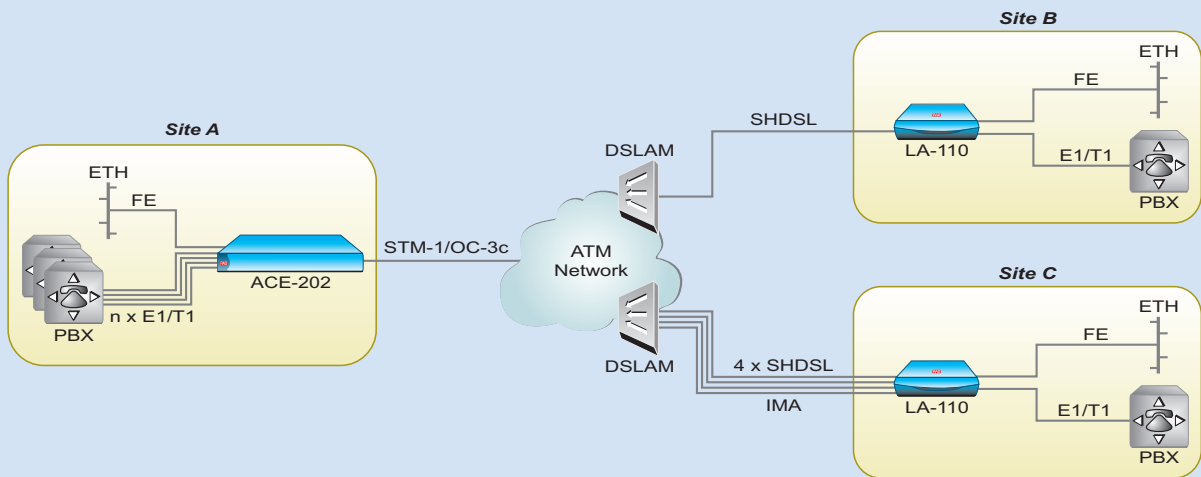
Leveraging DSLAM deployments for ATM access

RAD's LA-110 integrated access device enables service providers to leverage existing DSLAM infrastructure for ATM access and to reduce First Mile costs by using ADSL2+ or IMA-bonded SHDSL links instead of expensive leased lines. In addition, its comprehensive pseudowire encapsulation features support transparent delivery of ATM, TDM, HDLC, and Frame Relay traffic over new packet switched networks (PSNs).

Branch #1

ETH

FE

STM-1/OC-3c

ACE-52

E1/T1

PBX

Headquarters

ETH

FE

STM-1/OC-3c

ATM
Network

ACE-2002

n x E1/T1

PBX

STM-1/OC-3c

Branch #2

ETH

FE

STM-1/OC-3c

ACE-202

4 x E1/T1

PBX

Multiservice ATM access with end-to-end QoS

Site B

ETH

FE

SHDSL

DSLAM

LA-110

E1/T1

PBX

Site A

ETH

FE

STM-1/OC-3c

ATM
Network

ACE-202

n x E1/T1

PBX

DSLAM

Site C

ETH

FE

4 x SHDSL

IMA

LA-110

E1/T1

PBX

Low speed (DSL) and high speed (fiber) Ethernet services over ATM

ACE-52
Multiservice Network Termination Unit

Ace

- **Delivers LAN and voice/TDM services over ATM networks**
- **Network interface: single STM-1/OC-3c or 25.6 Mbps UTP**
- **User interfaces: one or two 10/100BaseT ports and one optional E1/T1 CES port**
- **RFC 1483/2684 LAN/ATM interworking, with up to 32 VCs**
- **ATM QoS according to CBR, VBR, UBR**
- **End-to-end control based on ITU-T I.610 OAM standard**
- **VLAN-transparent and VLAN-aware bridging (802.1D, 802.1Q)**
- **Ethernet QoS based on IP ToS or 802.1p**
- **Remote device configuration**

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The economical ACE-52 multiservice network termination unit serves as a demarcation device that is owned and managed by the service provider and installed at the customer premises. The ACE-52 allows service providers to take advantage of their existing ATM infrastructure in providing transparent LAN services, as well as integrated voice and data, over an ATM network. It monitors and controls traffic entering and exiting the network, thus enabling the service provider to maintain QoS commitments to its customers end-to-end.

Multiple services over ATM

Service providers are looking for ways to cost-effectively run more services over their ATM backbones, to leverage their widespread deployment of ATM equipment. RAD's ACE-52 is ideal for delivering transparent LAN services (TLS) and circuit emulation services (CES) over the ATM network.

The ACE-52 uses up to two 10/100BaseT ports for LAN/VLAN connectivity, supporting untagged, priority-tagged and VLAN-tagged frames. It provides L2 VPN services, achieving total traffic separation between users by assigning VLAN IDs to virtual connections (VCs). Different priority levels can be defined within each VPN by mapping VLANs to different VCs with appropriate QoS parameters.

An optional CES port supports structured and unstructured circuit emulation to allow PBXs, TDM multiplexers and video conferencing equipment to be interconnected over an ATM network. The ACE-52 offers flexible timing modes to ensure accurate synchronization.

OAM functionality reduces OpEx

The ACE-52 supports ATM OAM functionality, complying with ITU-T I.610. This reduces operational costs by providing end-to-end traffic management and fault localization. The device enables link diagnostics, including alarm indication, continuity check and loopback testing.

SLA differentiation

The ACE-52 enables service providers to assign QoS parameters per virtual connection (VC), allowing them to generate additional revenues by offering different levels of service.

ACE-52 supports four service classes: CBR, VBR, UBR, and UBR+, to ensure that each VC is granted its guaranteed data rate.

Sophisticated traffic management capabilities, such as traffic shaping and monitoring, help carriers avoid congestion and anticipate problems before they affect the service. They also make sure that users do not exceed their allocated bandwidth, while increased statistical efficiency allows the customer to pass more traffic over the link when the network is free.

Remote management, easy installation

Plug-and-play installation, automatic IP address learning and remote configuration simplify ACE-52 deployment and minimize system downtime.

The ACE-52 features flexible management capabilities, including local management via an ASCII terminal (RS-232). In addition, remote management can be performed inband, using the network ports. Advanced FCAPS (Fault, Configuration, Accounting, Performance, Security) and diagnostic tools are provided by RADview-EMS, RAD's carrier-class element management system, via an SNMP-based GUI.

The ACE-52 also supports a variety of configuration access channels, including Telnet, SNMP, Web server, and TFTP.
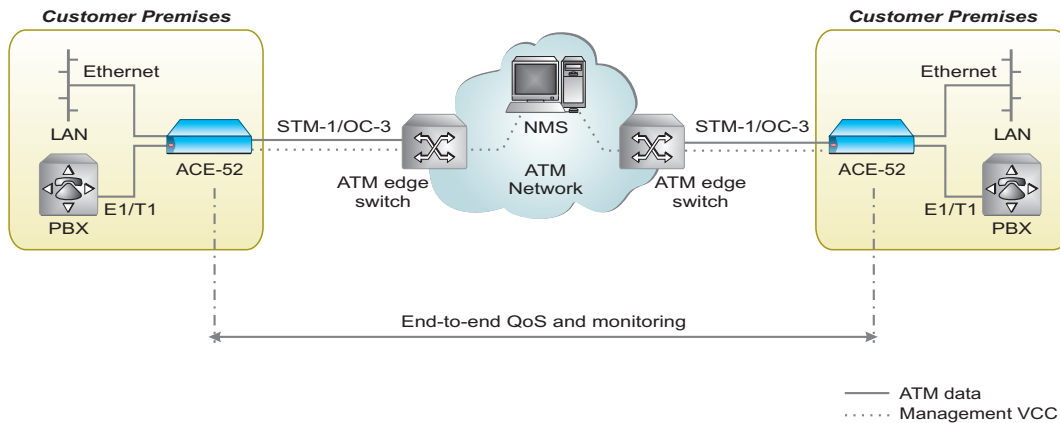
LAN and E1/T1 services over ATM

ACE-201
Multiservice Network Termination Unit

ACE-201 is customer-located equipment (CLE) dedicated to provisioning Ethernet services over an ATM network. Used as a network termination unit (NTU), the ACE-201 defines a demarcation point between the provider's network and the customer premises, thus providing end-to-end traffic and network management control.

SLA differentiation

The ACE-201 enables service providers to offer different service level agreements (SLA) with traffic classification and prioritization schemes, right off the customer premises, to generate more revenues from their existing infrastructure.

The ACE-201 NTU offers the following benefits:
- Ensuring that the user does not over-utilize the allocated bandwidth
- Improving link efficiency over the same backbone equipment
- Enabling the service provider to anticipate problems and make the required changes

Traffic management

ACE-201 supports four different service classes: CBR, VBR, UBR, and UBR+. Using the ACE-201, service providers can control the total bandwidth provided to their users, by assigning QoS parameters per virtual connection (VC) or per outbound traffic port.

The device also enables link diagnostics, including alarm indication, continuity check and loopback testing.

Transparent LAN services over ATM

ACE-201 is the perfect device for providing transparent LAN services (TLS) over an ATM network. It allows both transparent and VLAN-aware bridging and point-to-point or point-to-multipoint LAN connectivity.

L2 VPN can be easily implemented with the ACE-201. Total traffic separation between VPNs can be achieved starting from the customer premises by assigning VLAN IDs to VCs. Optionally, different QoS can be defined for different types of traffic within each VPN by mapping the VLAN priority to different VCs with appropriate QoS parameters. The ACE-201 also supports VLAN stacking, or Q-in-Q.

Management

The ACE-201 features flexible management capabilities, including local management via an ASCII terminal (RS-232). In addition, remote management can be performed either inband or out-of-band, using the network or user ports. Advanced FCAPS (Fault, Configuration, Accounting, Performance, Security) and diagnostic tools are provided by RADview-EMS, RAD's carrier-class element management system, via an SNMP-based GUI.

The ACE-201 also supports a variety of configuration access channels, including Telnet, SNMP, Web server, and TFTP.

- **Delivers LAN and voice/TDM services over ATM networks**
- **Network interface: STM-1/OC-3c or STM-4/OC-12**
- **User interface: Gigabit Ethernet**
- **RFC 1483/2684 LAN/ATM interworking, with up to 512 VCs**
- **ATM QoS according to CBR, VBR, UBR, and UBR+ traffic classes**
- **End-to-end control based on ITU-T I.610 OAM standard**
- **VLAN-transparent and VLAN-aware bridging (802.1D, 802.1Q)**
- **Ethernet QoS based on IP ToS or 802.1p**
- **Remote device configuration**

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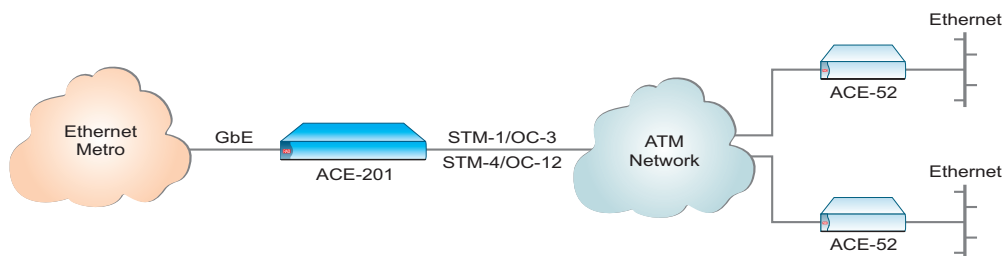
ACE-201 as a junction point between ATM and Ethernet networks

ACE-202
Multiservice Access Concentrator and NTU

- **Carrier-owned dedicated multiservice concentrator/ATM demarcation device**
- **Supports LAN, ATM, voice/TDM services over ATM networks**
- **Supports CBR, VBR (rt and nrt), ABR, UBR, and UBR+ QoS**
- **ATM interfaces: STM-1/OC-3, E3/T3, IMA, E1/T1 UNI**
- **User interfaces: Ethernet/Fast Ethernet, E1/T1 (built-in/plug-in), E3/T3 CES**
- **Fault, delay and performance monitoring based on ITU-T I.610 OAM standard**
- **Inband SNMP management**
- **Optional redundant power supply**

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The ACE-202 can be used as a carrier-owned demarcation device or as a corporate concentrator connected to the public ATM network.

Extend carrier control to the user premises

As a demarcation device, the ACE-202 enables carriers and service providers to define the boundary between their ATM-based public services and the customer private network. A clear demarcation point at the customer premises increases service reliability, improves network efficiency and ensures end-to-end QoS.

The ACE-202 delivers native ATM traffic with advanced capabilities for traffic management (policing, scheduling and shaping) and full OAM (operation, administration and maintenance) flow support. In addition, the wide range of ATM modules further enhances the flexibility of service offerings, with network interfaces including STM-1/OC-3, E3/T3, IMA (4 x E1/T1), and E1/T1 UNI.

When used as an interworking device, the ACE-202 connects legacy PBXs and LANs over ATM networks. The unit enables the most efficient utilization of public ATM services for transporting different types of corporate traffic including ATM. User interfaces featured as plug-in modules include Ethernet/Fast Ethernet, E1/T1, 4 x E1/T1, and E3/T3 CES. Optional built-in user interfaces include Ethernet/Fast Ethernet and E1/T1 CES.

ATM capabilities

ACE-202 supports both NNI and UNI addressing with full bit range of VPI/VCI fields. ACE-202 can support up to 256 connections (VPC and/or VCC). In addition, full switching capability is available between each VC or VP (from either the user or the network) to obtain maximum flexibility in connection assignment.

To enhance carriers' service offerings, ACE-202 supports VP tunneling. This enables bundling multiple VCCs into a single VPC while maintaining all the VCC QoS characteristics and

OAM capabilities at F4 and F5 layers. Each tunnel can be shaped as a CBR connection. It can be defined with end-to-end OAM flows and act as a regular VP connection in the public network.

Traffic management

Both users and network operators benefit from spacing bursty traffic. For the user, more traffic can pass through the link at no additional cost.

For the operator, spacing enables better statistical efficiency while keeping the same backbone equipment and QoS.

In addition, ACE-202 supports hierarchical traffic scheduling. The layers are set per VC, per VP or VP tunnel, or per network interface. In these cases, ACE-202 schedules the traffic to meet pre-defined traffic thresholds. This ensures fair bandwidth sharing between different connections while preserving the requirements of the individual connections.

ACE-202 can be equipped with two plug-in ACE-M modules for network and user interfaces, and two optional built-in user interfaces. The LAN module performs bridging and routing (RFC 1483/2684) with IP ToS and 802.1p priority support. In addition, multiple VLANs can be configured, optimizing ACE-202 for IP access applications.

The ACE-202 comes in a 1U-high enclosure suitable for mounting in a 19-inch rack.
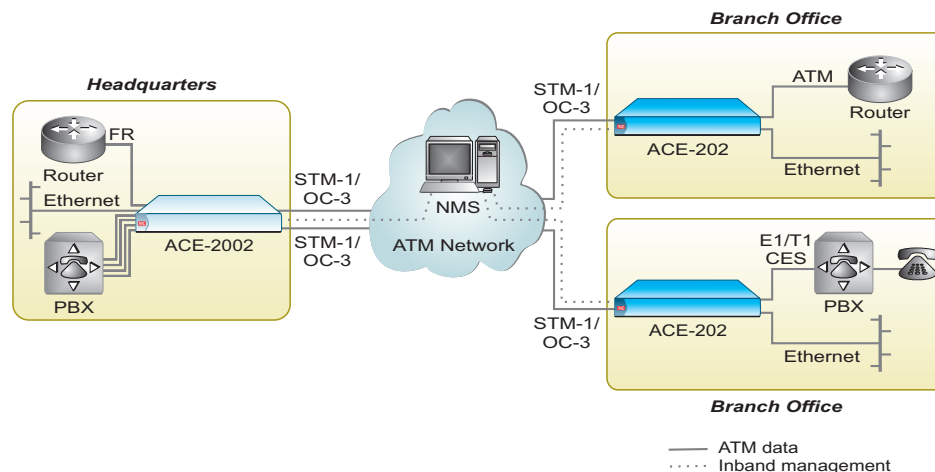
ACE-202 as an access device for the small and medium-sized enterprise (SME) market

ACE-2002, ACE-2002E
Multiservice Access Concentrators and ATM NTUs

The ACE-2002 can be used as a carrier-owned demarcation device or as a corporate concentrator connected to the public ATM network.

The ACE-2002E is an enhanced version of the ACE-2002 that can accommodate additional E1/ T1 interfaces. Information about ACE-2002 also pertains to ACE-2002E unless otherwise specified.

Extend carrier control to the user premises

As a demarcation device, the ACE-2002 enables carriers and service providers to define the boundary between their ATM-based public services and the customer private network. A clear demarcation point at the customer premises increases service reliability, improves network efficiency and ensures end-to-end QoS. The ACE-2002 delivers native ATM traffic with advanced capabilities for traffic management (policing, scheduling and shaping) and full I.610 OAM (operation, administration and maintenance) flow support. In addition, the wide range of ATM modules further enhances the flexibility of service offerings, with interfaces including STM-4/OC-12, STM-1/OC-3, E3/T3, IMA (4/8 x E1/T1), and E1/T1 UNI. When used as an interworking device, the ACE-2002 enables smooth migration of legacy voice, LAN and Frame Relay traffic to ATM networks. Featuring multiport, plug-in modules, the ACE-2002 can also be used as a concentrator for medium to large corporations, with user interfaces including Ethernet or Fast Ethernet, and up to eight E1/T1 CES.

ATM capabilities

ACE-2002 supports both NNI and UNI addressing with full bit range of VPI/VCI fields. ACE-2002 can support up to 1,024 connections (VPC and/or VCC). In addition, full switching capability is available between each VC or VP (from either the user or the network) to obtain maximum flexibility in connection assignment.

To enhance carriers' service offerings, ACE-2002 supports VP tunneling. This enables bundling multiple VCCs into a single VPC while maintaining all the VCC QoS characteristics and I.610 OAM capabilities at F4 and F5 layers. Each tunnel can be shaped as a CBR connection. It can be defined with end-to-end OAM flows and act as a regular VP connection in the public network.

Traffic management

Both users and network operators benefit from spacing bursty traffic. For the user, more traffic can pass through the link at no additional cost. For the operator, spacing enables better statistical efficiency while keeping the same backbone equipment and QoS. ACE-2002 offers a built-in mechanism that supports up to 983 spaced connections.

- **Carrier-owned multiservice concentrator/ATM demarcation device**
- **Delivers LAN, ATM and voice/TDM services over ATM networks**
- **STM-1, E1/T1 aggregation**
- **Supports CBR, VBR (rt and nrt), UBR, and UBR+ traffic shaping**
- **ATM OAM based on I.610**
- **Maps L2 VLAN/L3 CoS to ATM QoS**
- **Plug-and-play installation**
- **SNMP management**
- **Optional redundant hot-swappable interfaces and power supplies**

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In addition, ACE-2002 supports hierarchical traffic scheduling. The layers are set per VC, per VP or VP tunnel and per network interface. In these cases, ACE-2002 schedules the traffic to meet pre-defined traffic parameters. This ensures fair bandwidth sharing between different connections while preserving the requirements of the individual connections.

In order to improve service resiliency, ACE-2002 offers a protection mechanism on the user and network sides, which enables standard SDH/SONET protection of the last physical segment from the service exchange to the customer premises.

TDM aggregation and LAN bridging

ACE-2002E can combine up to 20 E1/T1 IMA/UNI ports, or up to 20 E1/T1 CES ports. The high E1/T1 port density is especially suitable for cellular applications.

ACE-2002 can be equipped with multiple LAN modules (up to six LAN ports in the ACE-2002E). The LAN module performs bridging and routing (RFC 1483/2684) with IP ToS and 802.1p priority support. In addition, multiple VLANs can be configured, optimizing ACE-2002 for LAN and IP access applications.

The ACE-2002 comes in a 1U-high enclosure suitable for mounting in a 19-inch rack. The ACE-2002E is 1.5U-high.
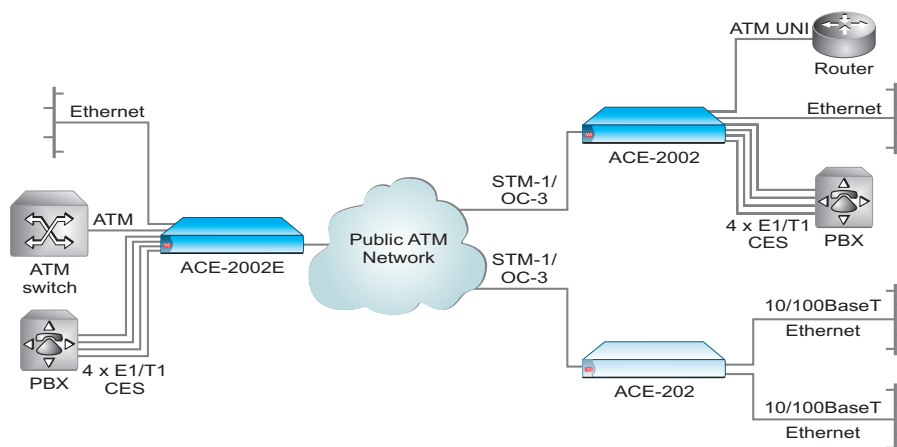
ACE-2002 as an interworking NTU

LA-110
Integrated Access Device

- **Supports leased line, cellular backhaul, Frame Relay, and corporate IT applications**
- **Network ports: ADSL2+, SHDSL or E1**
- **Up to 9.2 Mbps, 8 km (5 miles) with IMA bonding over four × 2-wire SHDSL**
- **Built-in 10/100BaseT user interface**
- **Optional user ports:**
  - **E1/T1 TDM/ATM**
  - **ISDN BRI/PRI**
  - **Serial FR/X.21/V.35**
- **AAL1, AAL2, and AAL5 adaptation layers**
- **Up to 16 ATM virtual connections (VCs)**
- **Comprehensive pseudowire capabilities**
- **Advanced diagnostics and statistics per port, network layer and VC**
- **Bridge and router capabilities**

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RAD's LA-110 ATM IAD enables carriers to converge multiple services, such as voice, data, and Internet access, over DSL access lines and existing ATM or packet-based networks. This improves network utilization and eliminates the need to invest in new infrastructure, thereby achieving increased profitability. Typically used by small and medium-sized enterprises (SMEs) and in cellular backhaul, the LA-110 features a variety of network interface alternatives, including ADSL, SHDSL, IMA over SHDSL, and E1. User interfaces include 10/100BaseT and optional E1 (TDM or UNI), ISDN, or serial FR/X.21/V.35.

LA-110's multiservice support enables users to use widely-available, cost-effective DSL infrastructure to replace expensive legacy leased lines.

Pseudowire emulation

LA-110 transports TDM, ATM, HDLC, and Frame Relay data transparently over packet switched networks (PSNs). Payload encapsulation is performed using standard methods, including SAToP, CESoPSN, TDMoIP, ATMoPSN, HDLCoPSN, or FRoPSN. Pseudowire emulation enables carriers to provide high revenue leased line and cellular backhaul services over IP DSLAMs and PSN.

Frame Relay

The LA-110 supports Frame Relay services using network interworking (FRF.5) and service interworking (FRF.8) over ATM. This allows carriers to migrate their customers' services to the ATM or PSN network while preserving the existing Frame Relay architecture.

IMA bonding

To increase the bandwidth capacity of available SHDSL lines, the LA-110 features optional IMA (inverse multiplexing over ATM) bonding over four × 2-wire SHDSL lines. This allows carriers and service operators to cost-effectively fill the bandwidth gap between lower speed xDSL and higher speed fiber, providing up to 9.2 Mbps for distances of up to 8 kilometers (5 miles).

Traffic management over PSN

Traffic management enables carriers to better manage the end customer's application through prioritization of the data streams. Traffic classification is based on 802.1p, DSCP, ToS, or IP Precedence. Traffic can be mapped into three different connections or into different queues in a single connection.

IP functionality

The LA-110 incorporates a fully-featured, built-in bridge or IP router with integrated firewall. The integrated IP router saves the costs of an external router and provides an excellent solution for LAN-to-LAN or Internet access services. NAT functionality allows multiple users to share a single public IP address. Layer 2 VLAN mapping is also supported.
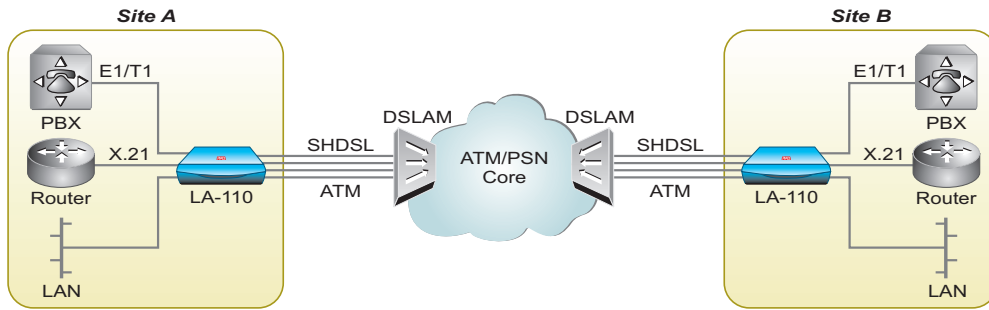
ATM quality of service and OAM

Supporting ATM QoS, the LA-110 enables carriers to deliver voice, data and leased line services with performance guarantees. Traffic shaping per VC secures the priority of critical applications, with service classification per CBR, VBR, UBR, and UBR+ bandwidth profiles. Additionally, operation, administration and maintenance (OAM) cells provide complete end-to-end control of the network. They enable fault notification and performance and connectivity monitoring, including delay measurements. The LA-110's comprehensive diagnostics and statistics collection allow service providers to reduce their operational and maintenance costs, by minimizing technician truck rolls for on-site inspections to localize and repair network faults.
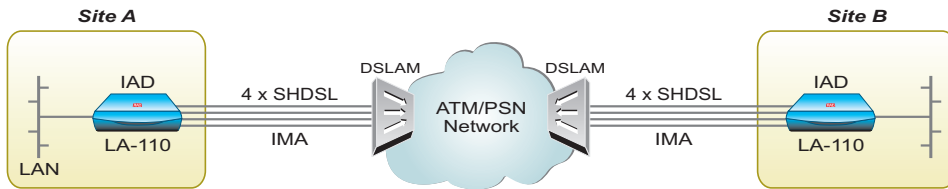
Network management

The LA-110 features flexible management capabilities, including local management via an ASCII terminal (RS-232). In addition, remote management can be performed either inband or out-of-band, using the network or user ports. Advanced FCAPS (Fault, Configuration, Accounting, Performance, Security) and diagnostic tools are provided by RADview-EMS, RAD's carrier-class element management system, via an SNMP-based GUI.

The LA-110 also supports a variety of configuration access channels, including Telnet, SNMP, Web server, and TFTP. Incorporated security features include Secure Shell (SSH), Web-based Secure Socket Layer (SSL), SNMPv3, and RADIUS.
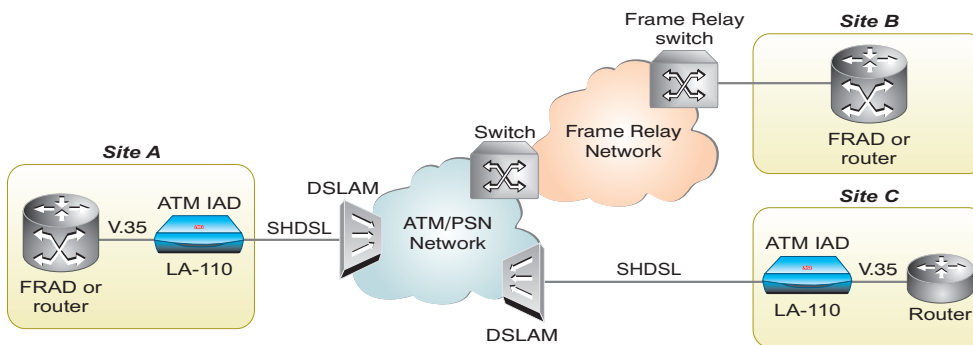
Site A

PBX
E1/T1

Router
X.21

LA-110

SHDSL

ATM

DSLAM

ATM/PSN
Core

DSLAM

SHDSL

ATM

LA-110

E1/T1
PBX

X.21
Router

LAN

Site B

LAN

Leased line service

Site A

IAD
LA-110

4 x SHDSL

IMA

DSLAM

ATM/PSN
Network

DSLAM

4 x SHDSL

IMA

IAD
LA-110

Site B

LAN

High speed LAN-to-LAN using IMA

Frame Relay
switch

Site B

FRAD or
router

Site A

FRAD or
router

V.35

ATM IAD
LA-110

SHDSL

DSLAM

Switch

ATM/PSN
Network

Frame Relay
Network

DSLAM

SHDSL

Site C

ATM IAD
LA-110

V.35

Router

Frame Relay-ATM interworking

6