1

Carrier Ethernet Access

In recent years, new industry standards have transformed Ethernet into a high speed transport method over metro and wide area networks and a widely-accepted, carrier-grade service suite. Layer 2 Ethernet services have become an attractive alternative to legacy leased lines and ATM or Frame Relay VPNs. This new breed of services enables simplified operations, higher throughput and better economics. At the same time, it requires clear demarcation at the customer premises to monitor and enforce SLA agreements, and to provide adequate service control using OAM capabilities.

RAD's EtherAccess strategy

RAD's EtherAccess® strategy aims to provide REAL (Reliable, Economical, Accountable, and Limitless) Carrier Ethernet access, enabling easy Ethernet service deployment and ensuring a consistent customer experience, regardless of the available access technology. RAD's EtherAccess product suite is designed to help service providers meet customer expectations for SLA accountability and verifiable performance for Carrier Ethernet services. This is achieved with built-in intelligent demarcation capabilities, including end-to-end network visibility with Ethernet OAM (operations, administration and maintenance) functionality, proactive performance measurement, granular QoS (quality of service), and advanced traffic management.

By deploying the EtherAccess devices, carriers can optimize their Ethernet business and wholesale services portfolio, cost-effectively extending their network's reach to as many customers as possible, while enhancing their offering with multiservice support, guaranteed priority per user and per service, and increased availability – over any available infrastructure.

Ethernet over PDH/SDH/SONET

RAD offers a comprehensive line of Ethernet access devices for extension, demarcation and concentration of Ethernet services over TDM networks. With rate versatility ranging from E1/T1 and bonded E1/T1 to STM-4/OC-12, RAD's sophisticated EtherAccess product suite delivers seamless mid-band Ethernet, Fast Ethernet (FE) and Gigabit Ethernet (GbE) connectivity over PDH access circuits and SDH/SONET transport networks.

Ethernet over fiber

RAD enables carrier-grade Ethernet service delivery over fiber access with a variety of Ethernet network termination units (E-NTUs), media converters and Ethernet aggregators. The ETX and ETX-A Carrier Ethernet demarcation devices enable advanced rate policing and shaping, and perform class of service differentiation through VLAN editing. MEF-9 and MEF-14 certified for Ethernet Private Line and Ethernet Virtual Private Line services, the ETX and ETX-A devices ensure five nines (99.999%) service reliability and exact service level agreement (SLA) management. Their automatic fault localization capabilities also help carriers and service providers to reduce operational costs and minimize expensive truck rolls.

The ETX-A Carrier Ethernet demarcation devices also feature advanced Timing over Packet capabilities, allowing for clock synchronization over packet switched networks. These clocking mechanisms include Precision Time Protocol (IEEE 1588-2008), Synchronous Ethernet and adaptive clock recovery (SAToP and CESoPSN). These Timing over Packet features, combined with powerful Carrier Ethernet service delivery attributes, make the ETX an ideal solution for LTE mobile backhaul applications.

Ethernet over DSL

RAD's Ethernet over xDSL copper access solutions leverage widely deployed IP DSLAMs to deliver mid-band Ethernet services, with access rates of up to 22 Mbps using standard EFM bonding over symmetrical SHDSL.bis links. Carrier-grade Ethernet demarcation attributes include proactive performance monitoring with Ethernet

OAM, SLA enforcement from the service hand-off points, and end-to-end QoS control per user port, per Ethernet flow and per CoS. Additionally, multi-standard pseudowire emulation (PWE) capabilities and advanced synchronization schemes allow transparent delivery of legacy TDM services over packet switched networks, to support existing revenue-generating services, such as TDM voice trunks or other legacy TDM or analog services.

Ethernet over ATM

The ACE product line can be used to provide Ethernet service over an ATM access network. For further information, please refer to Chapter 2, Cellular Backhaul and Chapter 6, ATM Access.

Ethernet over wireless

RAD's managed Ethernet demarcation devices can connect to any wireless base station to support end-to-end service assurance for Ethernet and IP radio links, as well as in WiMAX deployments. Together with the stand-alone Airmux wireless device, they support point-to-point and point-to-multipoint topologies, over a wide range of licensed and licensed-exempt frequencies. This enables fast rollout of backhaul and broadband services in First Mile loops, in remote locations or where wire lines are not available.
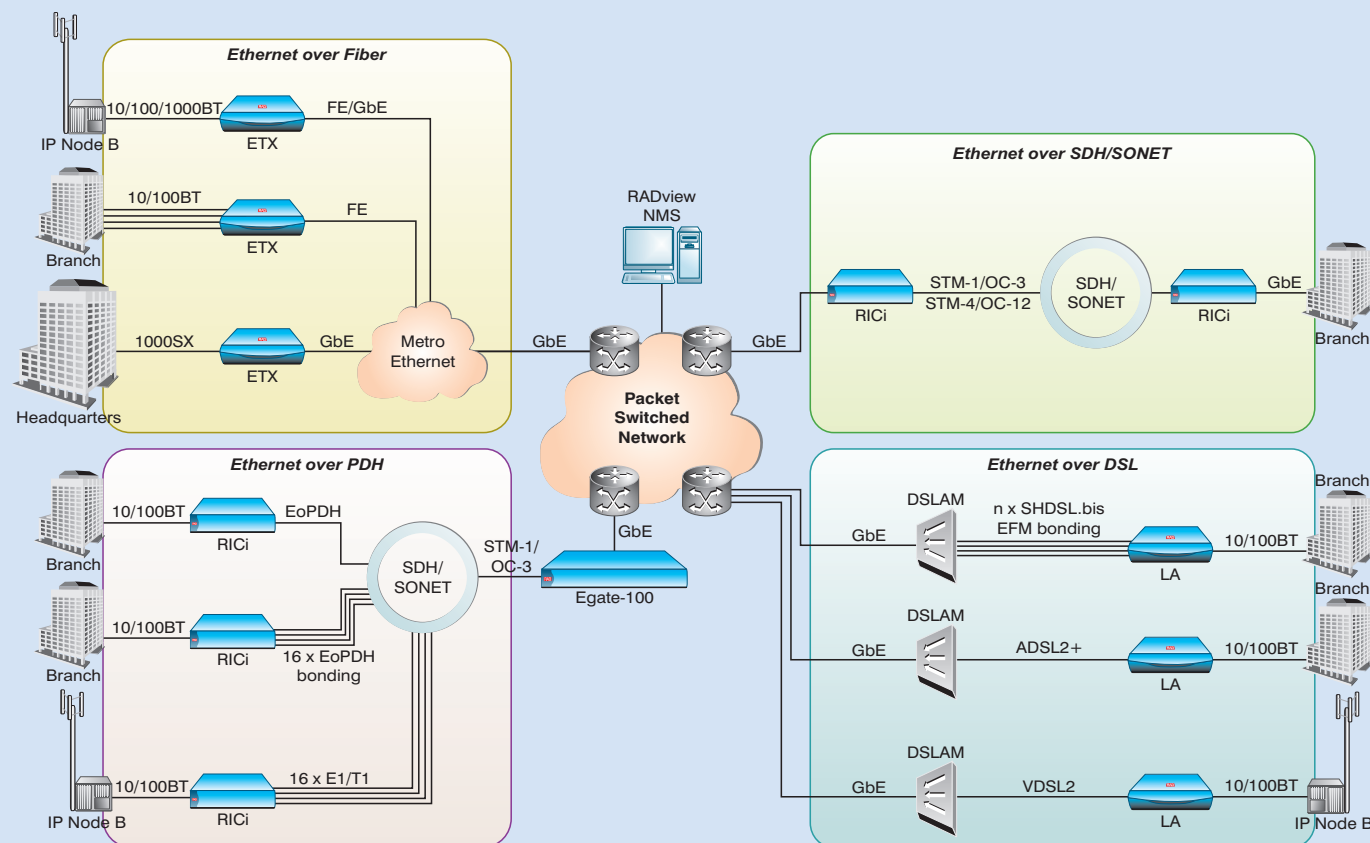
Carrier Ethernet access over any transport

RICi-16
Ethernet over Bonded PDH NTU

- **Fast Ethernet/GbE over up to 16 framed or unframed E1/T1 circuits or two bonded T3 links**
- **Circuit bonding using MLPPP or standard Ethernet over NG-PDH with multi-VCG support**
- **Metro Ethernet Forum certified (MEF-9, MEF-14) for EPL, EVPL services**
- **Up to four 10/100BaseT user ports or a combination of two GbE and two Fast Ethernet ports**
- **Hierarchical QoS with configurable Strict Priority and WFQ (weighted fair queuing) scheduling, EVC shaping**
- **Color-sensitive P-bit re-marking**
- **Ethernet OAM per 802.3-2005 (formerly 802.3ah), 802.1ag and performance monitoring per ITU Y.1731 for end-to-end SLA control**
- **Secure Telnet and Web applications; SNMPv3 and RADIUS**

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RICi-16 is a network termination unit (NTU) connecting Fast Ethernet or Gigabit Ethernet LANs over multiple bonded PDH links, enabling service providers to extend high capacity Ethernet–based services to remote locations. RICi-16 is also used to backhaul Ethernet traffic from HSDPA IP Node Bs, IP DSLAMs and WiMAX base stations over copper-based or microwave PDH connections.

The RICi-16 features up to four Fast Ethernet user ports, or two Gigabit Ethernet and two Fast Ethernet ports, with three different uplink configuration options:

- Up to 16 framed/unframed E1/T1 ports
- Two bonded clear channel T3 ports
- Single channelized T3 port. When selecting this option, the 16 T1 interfaces serve as user ports and are multiplexed into the T3 link together with Ethernet traffic.

The RICi-16 is MEF-9 and MEF-14 certified for Ethernet Private Line and Ethernet Virtual Private Line services.

Ethernet over NG-PDH encapsulation and bonding

RAD's RICi-16 supports MLPPP bonding as well standard Ethernet over NG-PDH protocols, including GFP (G.8040, G.7041), VCAT (G.7043) and LCAS (G.7042).

These protocols allow service providers to dynamically allocate bandwidth to their customers by simply changing the number of links bonded to the virtual group, without the need to change the NTU device or stop the service. In addition, the RICi-16 supports up to 16 GFP VCAT groups (VCG), allowing the connection of up to 16 different customers per site.

Enhanced service delivery capabilities

The RICi-16 is equipped with advanced, software-based capabilities for handling multi-priority traffic, ensuring latency, jitter and packet delivery performance on a per-flow basis. The device supports traffic classification according to any user-defined criteria, including VLAN ID, VLAN priority (P-bit), DSCP/ ToS, subscriber port, and others, as well as their combinations. In addition, metering, policing and shaping functionalities help carriers rate-limit user traffic according to pre-defined CIR (committed information rate) and EIR (excess information rate) profiles, thereby supporting customized service packages and enabling carriers to introduce new revenue generators. These capabilities enable service differentiation and SLA guarantees.

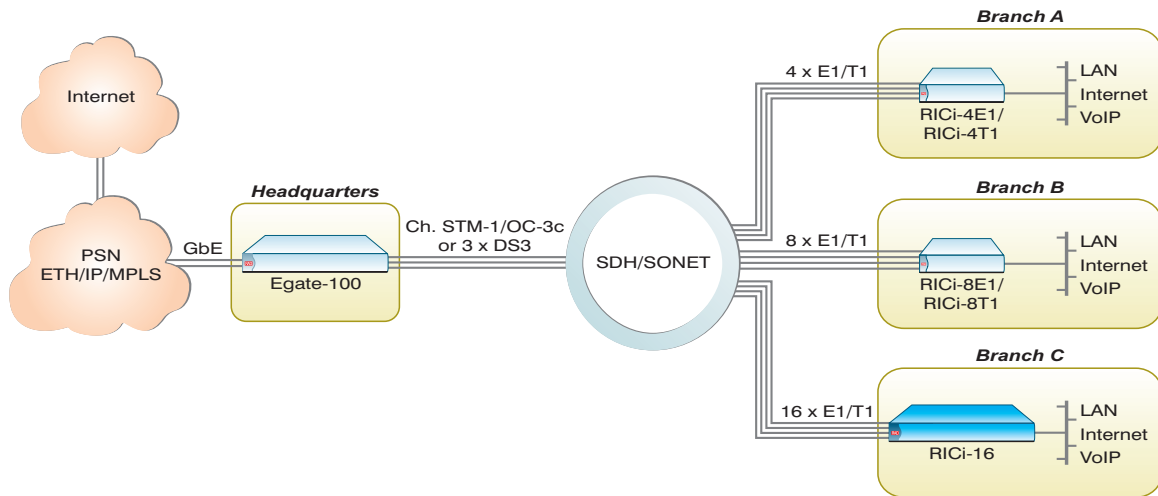### VLAN stacking and color-sensitive P-bit re-marking

By supporting VLAN stacking (Q-in-Q), the RICi-16 enables service providers to ensure transparent delivery of user traffic, while minimizing the number of required VLAN IDs in the network. In addition, the RICi-16 features unique P-bit re-marking capabilities, which assign color-specific P-bit values to Ethernet frames at the network ingress to ensure metering continuity across the Metro Ethernet network. User traffic that was marked "yellow" according to the CIR/EIR parameters by the device's QoS engine is assigned a new P-bit value to signal its status and priority, so that it is dropped first by 802.1Q and 802.1ad network elements in the event of congestion. This is especially useful in color-blind as well as in color-aware networks with no "discard eligible" ("yellow") marking.
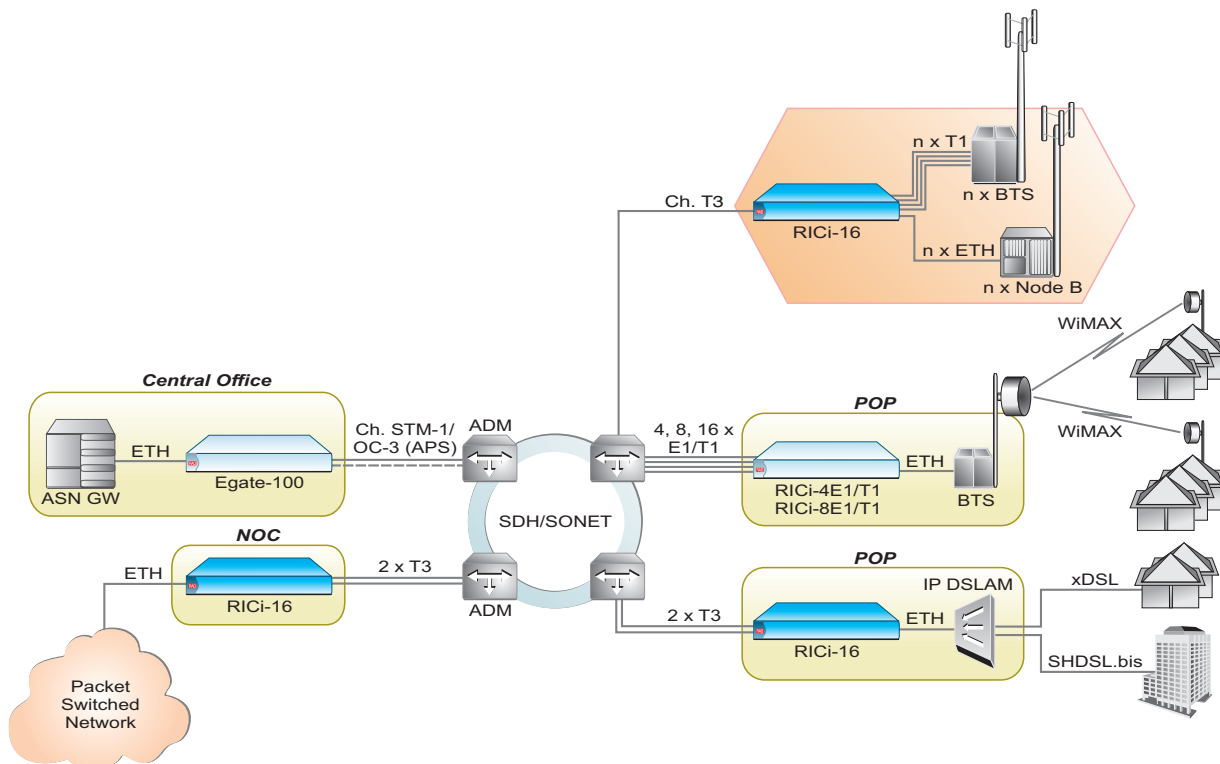
SNMP management

The RICi-16 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, while maintaining separation between management and user traffic via the use of VLANs. Advanced FCAPS (Fault, Configuration, Administration, Performance, Security) and diagnostic tools are provided by RADview-EMS, RAD's carrier-class element management system, via an SNMP-based GUI.

The RICi-16 also supports a variety of access protocols, including CLI over Telnet, SNMP, Web server, and TFTP. Incorporated security features include Secure Shell (SSH), Web-based Secure Socket Layer (SSL), SNMPv3, and RADIUS, as well as management access control list (ACL).

Internet

PSN ETH/IP/MPLS

Headquarters

GbE

Egate-100

Ch. STM-1/OC-3c or 3 x DS3

SDH/SONET

Branch A

4 x E1/T1

RICi-4E1/ RICi-4T1

LAN
Internet
VoIP

Branch B

8 x E1/T1

RICi-8E1/ RICi-8T1

LAN
Internet
VoIP

Branch C

16 x E1/T1

RICi-16

LAN
Internet
VoIP

Differentiated business Ethernet services over bonded PDH

n x T1

n x BTS

Ch. T3

RICi-16

n x ETH

n x Node B

WiMAX

WiMAX

Central Office

ASN GW

ETH

Egate-100

Ch. STM-1/ OC-3 (APS)

ADM

SDH/SONET

4, 8, 16 x E1/T1

POP

RICi-4E1/T1 RICi-8E1/T1

ETH

BTS

NOC

ETH

RICi-16

2 x T3

ADM

POP

IP DSLAM

xDSL

RICi-16

ETH

SHDSL.bis

2 x T3

Packet Switched Network

Backhaul services over bonded PDH links

RICi-4E1, RICi-4T1, RICi-8E1, RICi-8T1

Ethernet over Four or Eight E1 or T1 NTUs

- **Fast Ethernet/GbE over four/eight framed or unframed E1/T1 circuits**
- **Circuit bonding using MLPPP or standard Ethernet over NG-PDH with multi-VCG support**
- **Metro Ethernet Forum certified (MEF-9, MEF-14) for EPL, EVPL services**
- **Up to four 10/100BaseT user ports or a combination of two GbE and two Fast Ethernet ports**
- **Hierarchical QoS with configurable Strict Priority and WFQ (weighted fair queuing) scheduling, EVC shaping**
- **Color-sensitive P-bit re-marking**
- **Ethernet OAM per 802.3-2005 (formerly 802.3ah), 802.1ag and performance monitoring per ITU Y.1731**
- **Secure Telnet and Web applications; SNMPv3 and RADIUS**

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The RICi-4E1, RICi-4T1, RICi-8E1, and RICi-8T1 are network termination units (NTUs) connecting Fast Ethernet or Gigabit Ethernet LANs over multiple bonded PDH links, enabling service providers to extend high capacity Ethernet–based services to remote locations. The devices are also used to backhaul Ethernet traffic from HSDPA IP Node Bs, IP DSLAMs and WiMAX base stations over copper-based or microwave PDH connections.

Ethernet over NG-PDH encapsulation and bonding

RAD's RICi NTUs support MLPPP bonding as well as standard Ethernet over NG-PDH protocols, including GFP (G.8040, G.7041), VCAT (G.7043) and LCAS (G.7042).

These protocols allow service providers to dynamically allocate bandwidth to their customers by simply changing the number of links bonded to the virtual group, without the need to change the NTU device or stop the service. In addition, the devices support up to four or eight GFP VCAT groups (VCG), allowing the connection of up to four or eight different customers per site.

Enhanced service delivery capabilities

The RICi-4E1, RICi-4T1, RICi-8E1, and RICi-8T1 can operate in either bridge or flow modes. When working in flow mode, advanced, software-based capabilities enable the handling of multi-priority traffic to ensure latency, jitter and packet delivery performance on a per-flow basis. The devices support traffic classification according to any user-defined criteria, including VLAN ID, VLAN priority (P-bit), DSCP/ ToS, subscriber port, and others, as well as their combinations. In addition, metering, policing and shaping functionalities help carriers rate-limit user traffic according to pre-defined CIR (committed information rate) and EIR (excess information rate) profiles, thereby supporting customized service packages for additional revenue generation.

### VLAN stacking and color-sensitive P-bit re-marking

By supporting VLAN stacking (Q-in-Q), the RICi demarcation devices enable service providers to ensure transparent delivery of user traffic, while minimizing the number of required VLAN IDs in the network. In addition, they feature unique P-bit re-marking capabilities, which assign color-specific P-bit values to Ethernet frames at the network ingress to ensure metering continuity across the Metro Ethernet network. User traffic that was marked "yellow" according to the CIR/EIR parameters by the device's QoS engine is assigned a new P-bit value to signal its status and priority, so that it is dropped first by 802.1Q and 802.1ad network elements in the event of congestion. This is especially useful in color-blind, as well as in color-aware networks with no "discard eligible" ("yellow") marking.

SNMP management

The RICi-4E1, RICi-4T1, RICi-8E1, and RICi-8T1 feature 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, while maintaining separation between management and user traffic via the use of VLANs. Advanced FCAPS (Fault, Configuration, Administration, Performance, Security) and diagnostic tools are provided by RADview-EMS, RAD's carrier-class element management system, via an SNMP-based GUI.

All four devices also support a variety of access protocols, including CLI over Telnet, SNMP, Web server, and TFTP. Incorporated security features include Secure Shell (SSH), Web-based Secure Socket Layer (SSL), SNMPv3, and RADIUS, as well as management access control list (ACL).
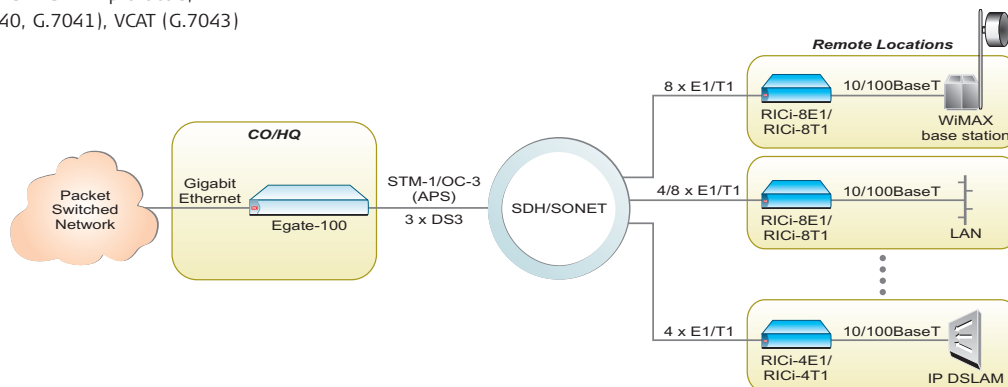
Backhauling IP DSLAM and WiMAX base station traffic over n x E1 or T1 circuits

RICi-E1, RICi-T1, RICi-E3, RICi-T3

Fast Ethernet over E1/T1 or E3/T3 NTUs

The RICi-E1, RICi-T1, RICi-E3 and RICi-T3 are network termination units (NTUs) connecting Fast Ethernet over unframed/framed E1/T1 or T3 circuits, or a single unframed E3 circuit.

Typical applications include:
- Ethernet Private Line services
- Layer 2 VPN services
- Backhauling of network management traffic
- IP DSLAM and WiMAX base station backhaul
- Inter-office or enterprise LAN connection

The devices can interoperate with third-party devices using standard protocols: HDLC framing, GFP (RICi-E1/RICi-T1) and X.86/LAPS (RICi-E3/RICi-T3).

The devices support VLAN priority (802.1p) and IP Precedence (RICi-E1/RICi-T1), enabling users to define different levels of quality of service (QoS) according to application requirements.

VLAN capabilities

The VLAN tagging, stacking and stripping option enables transparent delivery of user traffic, keeping all user VLAN settings intact.

The built-in Fast Ethernet bridge can work in filter mode, where it learns MAC addresses and filters local traffic, or in transparent mode, where any received packet will be forwarded to the other interface. The device can also operate in VLAN-aware mode, switching traffic according to VLAN tags and MAC address (IVL mode).

SNMP management

The RICi-E1, RICi-T1, RICi-E3 and RICi-T3 feature 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, while maintaining separation between management and user traffic via the use of VLANs. Advanced FCAPS (Fault, Configuration, Administration, Performance, Security) and diagnostic tools are provided by RADview-EMS, RAD's carrier-class element management system, via a Web browser.

The RICi-E1, RICi-T1, RICi-E3 and RICi-T3 also support a variety of access protocols, including Telnet, SNMP, Web server, and TFTP. DHCP client support is employed to automatically obtain IP address, IP mask and default gateway, saving precious installation time. All four devices support diagnostic tools for TDM and Ethernet

- **Connects Fast Ethernet over E1/T1 or E3/T3 circuits**
- **10/100BaseT user port**
- **PDH to Ethernet fault propagation and TDM loop detection**
- **Interoperable with third-party devices:**
  - **RICi-E1/T1 supports GFP (G.8040) and HDLC**
  - **RICi-E3/T3 supports X.86 (LAPS)**
- **QoS priority queues**

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networks, for fast isolation of network problems, saving time and costs. Remote and local loopbacks are used to isolate problems on the physical layer, while ping, trace-route and ICMP messages enable diagnostics of the Ethernet layer.

In cases of error conditions on the TDM port, a fault propagation feature disconnects the link on the Fast Ethernet port, and enables routers on both ends of the link to reroute the traffic.
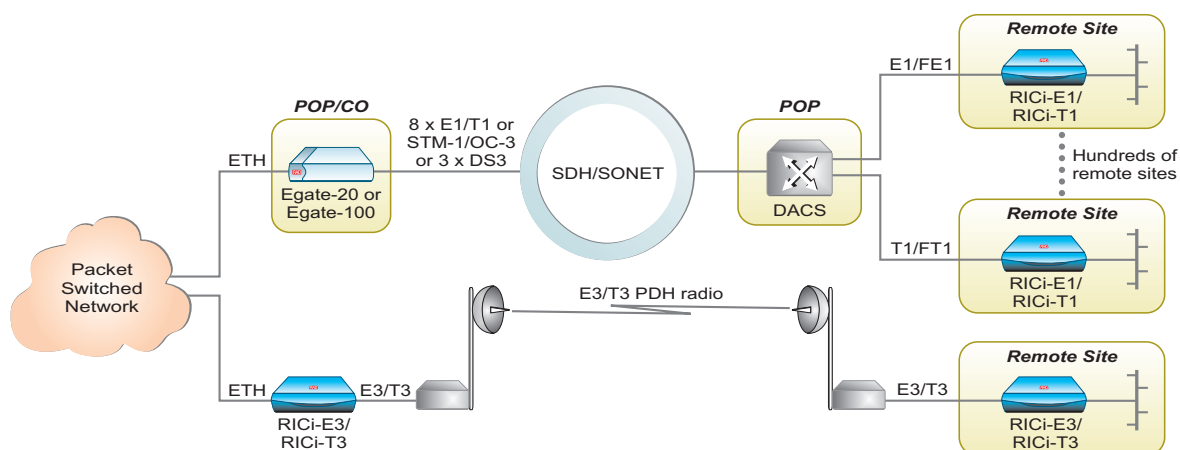
Transparent LAN services over E1/E3 or T1/T3 lines

RICi-622GE
Gigabit Ethernet over STM-4/OC-12 NTU

- **Delivers Gigabit Ethernet over two STM-4/OC-12 links**
- **Supports GFP (G.7041/Y.1303), VCAT (G.707/Y.1322) and LCAS (G.7042) standards**
- **MEF-9 and MEF-14, EPL and EVPL**
- **Supports APS (1+1), 802.3ad Link Aggregation**
- **Ethernet OAM per 802.3-2005 (formerly 802.3ah), 802.1ag and ITU Y.1731**
- **Marking and classification per EVC/EVC.CoS**
- **Secure Telnet and Web applicaitons, SNMPv3 and RADIUS**
- **Redundant hot-swappable power supplies**
- **NEBS-compliant**

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The RICi-622GE Ethernet network termination unit (NTU) provides simple, efficient and cost-effective Gigabit Ethernet (GbE) connectivity over two STM-4/OC-12 uplinks, supporting bundled access rates of 1.2 Gbps. It offers a migration path by connecting future-ready IP devices with 10/100/1000 Mbps interfaces to existing SONET/SDH networks, using standard GFP, VCAT and LCAS technology.

The RICi-622GE supports GFP or X.86 encapsulation with virtual concatenation, enabling Ethernet bandwidth to be configured in various increments for cost-effective adaptation of the SDH/SONET infrastructure. These increments are as follows:
- SDH: 2 Mbps (VC-12), 50 Mbps (VC-3) or 155 Mbps (VC-4)
- SONET: 1.5 Mbps (VT 1.5), 50 Mbps (STS-1) or 155 Mbps (STS-3)

This eliminates the rigid bandwidth restrictions usually imposed by SDH/SONET virtual containers and allows for scalable and efficient delivery of next-generation Ethernet services over TDM networks. In addition, the RICi-622GE supports up to 32 low-order VCAT groups (VCGs), allowing the connection of up to 32 different customers per site.

The RICi-622GE is MEF-9 and MEF-14 certified for Ethernet Private Line (EPL) and Ethernet Virtual Private Line (EVPL) services.

Typical applications include IP DSLAM and WiMAX base station backhaul, inter-POP connectivity or high bandwidth private line services.

Ethernet QoS and rate limitation

The device maps Ethernet frames into a flexible priority queuing mechanism. The traffic can be mapped according to several parameters, including ingress port number, VLAN priority, IP Precedence and DSCP. Rate limitation can be performed per Ethernet flow or per EVC.CoS at the ingress side, and per port at the egress side.

Using VLAN tagging and stacking (802.1Q and Q-in-Q), Ethernet traffic can be delivered transparently, keeping user VLAN (CE-VLAN ID) settings intact.

SNMP management

The RICi-622GE 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, while maintaining separation between management and user traffic via the use of VLANs or the data communication channel (DCC). Advanced FCAPS (Fault, Configuration, Administration, Performance, Security) and diagnostic tools are provided by RADview-EMS, RAD's carrier-class element management system, via a Web browser.

The RICi-622GE also supports a variety of access protocols, including Telnet, SNMP, Web server, and TFTP. Incorporated security features include Secure Shell (SSH), Web-based Secure Socket Layer (SSL), SNMPv3, and RADIUS.

The device collects statistics at the Ethernet physical layer and the SONET/SDH interface frame counters.

The RICi-622GE is equipped with dual 1000BaseSX/LX optical or 1000BaseTX electrical Gigabit Ethernet interfaces, and dual STM-4/OC-12 uplinks. All fiber optics are SFP based.
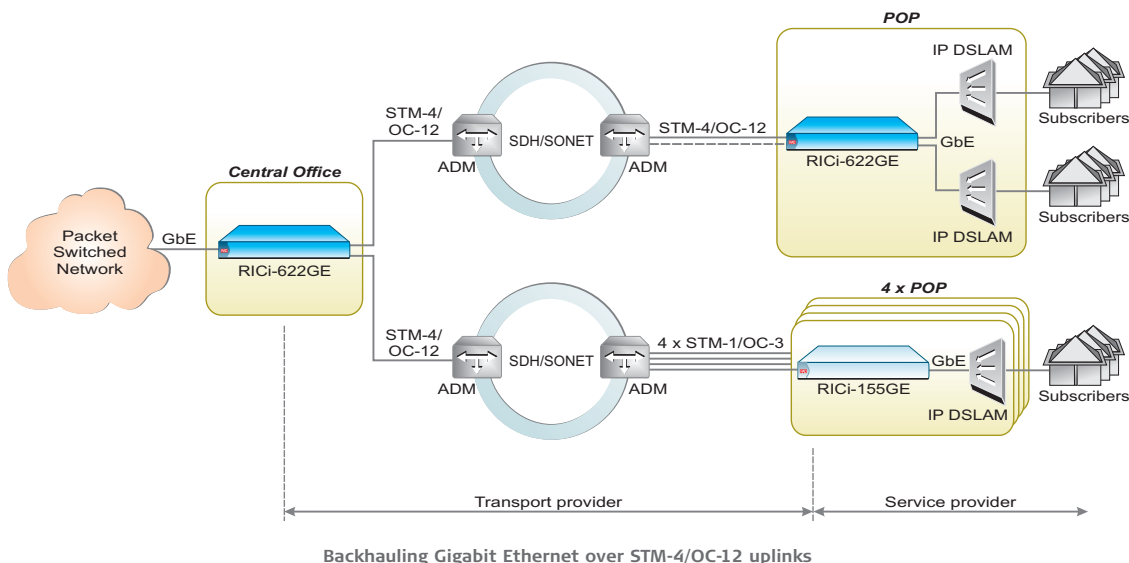
Backhauling Gigabit Ethernet over STM-4/OC-12 uplinks

RICi-155GE
Gigabit Ethernet over STM-1/OC-3 NTU

The RICi-155GE Ethernet network termination unit (NTU) provides simple, efficient and cost-effective Gigabit Ethernet (GbE) connectivity over two STM-1/OC-3 uplinks, supporting bundled access rates of 300 Mbps. It offers a migration path by connecting future-ready IP devices with 10/100/1000 Mbps interfaces to existing SONET/SDH networks, using standard GFP, VCAT and LCAS technology.

GFP or X.86 encapsulation with virtual concatenation enables Ethernet bandwidth to be configured in various increments for cost-effective adaptation of the SDH/SONET infrastructure. These increments are as follows:
- SDH: 2 Mbps (VC-12), 50 Mbps (VC-3)
- SONET: 1.5 Mbps (VT 1.5), 50 Mbps (STS-1)

This eliminates the rigid bandwidth restrictions usually imposed by SDH/SONET virtual containers and allows for scalable and efficient delivery of next-generation Ethernet services over TDM networks. In addition, the RICi-155GE supports up to 32 low-order VCAT groups (VCGs), allowing the connection of up to 32 different customers per site.

The RICi-155GE is MEF-9 and MEF-14 certified for Ethernet Private Line (EPL) and Ethernet Virtual Private Line (EVPL) services. Typical applications include IP DSLAM and WiMAX base station backhaul, inter-POP connectivity or high bandwidth private line services.

Ethernet QoS and rate limitation

The device maps Ethernet frames into a flexible priority queuing mechanism. The traffic can be mapped according to several parameters, including ingress port number, VLAN priority, IP Precedence, and DSCP. Rate limitation can be performed per Ethernet flow or per EVC.CoS at the ingress side, and per port at the egress side.

Using VLAN tagging and stacking (802.1Q and Q-in-Q), Ethernet traffic can be delivered transparently, keeping user VLAN settings (CE-VLAN ID) intact.

SNMP management

The RICi-155GE 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, while maintaining separation between management and user traffic via the use of VLANs or the data communication channel (DCC). Advanced FCAPS (Fault, Configuration, Administration, Performance, Security) and diagnostic tools are provided by RADview-EMS, RAD's carrier-class element management system, via a Web browser.

The RICi-155GE also supports a variety of access protocols, including Telnet, SNMP, Web server, and TFTP. Incorporated security features include Secure Shell (SSH), Web-based Secure Socket Layer (SSL), SNMPv3, and RADIUS.

The device collects statistics at the Ethernet physical layer and the SONET/SDH interface frame counters.

- Delivers Gigabit Ethernet over two STM-1/OC-3 links
- Supports GFP (G.7041/Y.1303), VCAT (G.707/Y.1322) and LCAS (G.7042) standards
- MEF-9 and MEF-14 EPL and EVPL
- Supports APS (1+1), 802.3ad Link Aggregation
- Ethernet OAM per 802.3-2005 (formerly 802.3ah), 802.1ag and Y.1731
- Marking and classification per EVC/EVC.CoS
- Secure Telnet and Web applications, SNMPv3 and RADIUS
- Redundant hot-swappable power supplies
- NEBS-compliant

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The RICi-155GE is equipped with dual 1000BaseSX/LX optical or 1000BaseTX electrical Gigabit Ethernet interfaces. All fiber optics are SFP-based.

The RICi-155GE is a 1U-high, 19-inch wide box with a rack-mount option. A 23-inch wide box, which is NEBS-compliant, is available as well.

Redundant hot-swappable AC or DC power supplies provide carrier-class reliability.
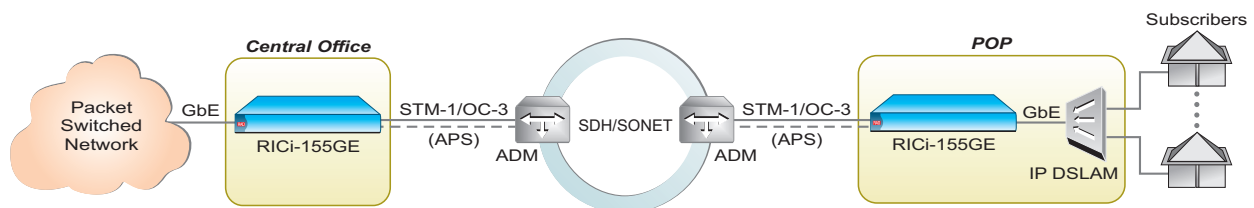
Backhauling Gigabit Ethernet over STM-1/OC-3 uplinks

RIC-155GE
Gigabit Ethernet over STM-1/OC-3 NTU

- **Connects Ethernet traffic over STM-1/OC-3 or channelized OC-3 circuits**
- **VLAN tagging and stacking**
- **Four QoS levels**
- **SNMP-based fault management, Web-based element management**
- **16,000 MAC address table**
- **Secure Telnet and Web applications, SNMPv3 and RADIUS**

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The RIC-155GE is a network termination unit (NTU), providing cost-effective bridging of Gigabit Ethernet traffic over STM-1/OC-3 access or channelized OC-3 circuits.

Typical applications include IP DSLAM and WiMAX base station backhaul, inter-POP connectivity or high bandwidth private line services. Using VLAN tagging and stacking, Ethernet traffic can be delivered transparently, while keeping user VLAN (CE-VLAN ID) settings intact.

The RIC-155GE is equipped with either a 1000BaseSX/LX optical LC connector or a 1000BaseTX electrical Ethernet interface. The optical STM-1/OC-3c network interface includes single mode and multimode options.

The RIC-155GE maps Ethernet frames into four fixed priority queues towards the network port, based on VLAN priority tagging (802.1p). This enables prioritizing and differentiation between various user applications.

Advanced management options

The RIC-155GE 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, while maintaining separation between management and user traffic via the use of VLANs. Advanced FCAPS (Fault, Configuration, Administration, Performance, Security) and diagnostic tools are provided by RADview-EMS, RAD's carrier-class element management system, via a Web browser.

The RIC-155GE also supports a variety of access protocols, including Telnet, SNMP, Web server, and TFTP. Incorporated security features include SNMPv3 and RADIUS.

The device collects statistics at the Ethernet physical layer and the STM-1/OC-3c interface frame counters.

The RIC-155GE is 1U-high, half 19-inch wide with a rack-mount option, and is available with AC or DC power supply. It is also available as a level 3 NEBS-compliant box with power supply redundancy.
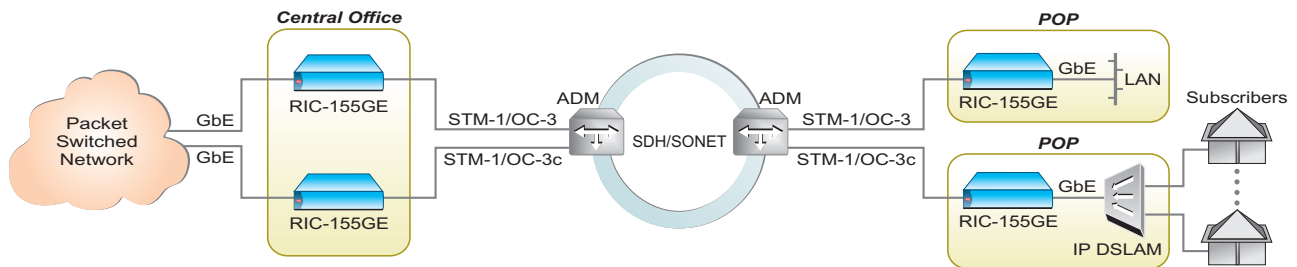
Connecting Gigabit Ethernet over STM-1/OC-3c

RIC-LC, RIC-155L

Ethernet Converters for Multiple PDH Circuits or STM-1/OC-3

NEW

The RIC-LC is a Fast Ethernet converter, delivering LAN traffic over four, eight or 16 bonded E1 circuits using Ethernet over NG-PDH encapsulation and bonding techniques. The RIC-155L provides transparent delivery of Gigabit Ethernet traffic over STM-1 or OC-3 lines. Both devices are ideal for extending Ethernet connectivity over TDM backbones in point-to-point applications, and for cost-effective backhaul of IP DSLAM traffic over PDH and SDH access networks. The RIC-LC can also work opposite Ethernet over TDM demarcation devices and aggregators, such as RAD's RICi-4/8/16E1 and Egate-100, respectively.

Ethernet over NG-PDH encapsulation and bonding

The RIC-LC supports standard Ethernet over NG-PDH protocols, including GFP (generic framing procedure), VCAT (virtual concatenation) and LCAS (link capacity adjustment scheme). These protocols allow service providers to dynamically allocate bandwidth to their customers by simply changing the number of links bonded to the virtual group, without stopping the service. The RIC-155L uses GFP to map Ethernet traffic to SDH/SONET lines.

Ethernet capabilities

Featuring four Fast Ethernet user ports, the RIC-LC supports VLAN-aware and VLAN unaware bridging, as well as VLAN stacking (Q-in-Q). It maps Ethernet frames into four priority queues based on user port, VLAN priority (802.1p) or ToS marking, to enable differentiation between various user applications. The RIC-LC supports

both Strict Priority and WFQ (weighted fair queuing), as well as per port rate limitation.

The RIC-155L features two Fast Ethernet/Gigabit Ethernet user interfaces and supports QoS per VLAN priority, with four priority queues based on Strict Priority scheduling.

Management options

The devices feature the following management alternatives:

RIC-LC:
- Local management via an ASCII terminal (RS-232)
- Out-of-band management using one of the user ports
- Remote inband management via the network ports using a dedicated management VLAN
- Remote configuration and monitoring accessible via RADview-EMS, RAD's element management system
- Access and management options include Telnet, SNMP, Web server, and TFTP

RIC-155L:
- Local configuration via an ASCII terminal (RS-232)
- Out-of-band management using a dedicated management port
- Remote inband management via the network port using a dedicated management VLAN
- Remote configuration and monitoring accessible via RADview-EMS, RAD's element management system
- Access and management options include Web server and TFTP

- **Managed converters for bridging Ethernet and n x E1 or STM-1/OC-3**
- **Ethernet over NG-PDH, SDH encapsulation and bonding: GFP (G.8040, G.7041), VCAT (G.7043), LCAS (G.7042)**
- **VLAN-aware and VLAN-unaware bridging; VLAN stacking**
- **Four QoS levels; SP and WFQ scheduling**
- **Remote and local, inband and out-of-band management**
- **Dual in-line package (DIP) switches for activating diagnostic loopback tests**
- **TDM to Ethernet fault propagation**
- **Ethernet jumbo frames supported (RIC-155L)**

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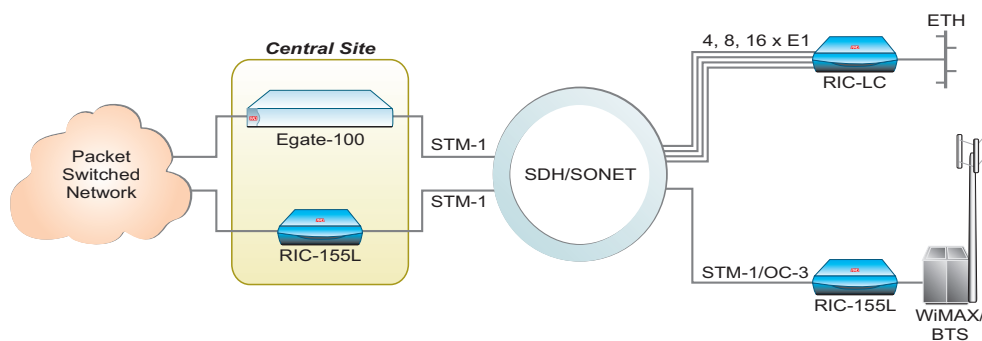
Ethernet traffic backhaul over PDH and SDH

Egate-100
Gigabit Ethernet over TDM Aggregation Gateway

- **Aggregates Ethernet traffic over channelized STM-1/OC-3 or three channelized DS3 ports for hand-off to PSN**
- **Supports MLPPP as well as GFP (G.8040, G.7041/Y.1303), VCAT (G.7043) and LCAS (G.7042) standards**
- **Enables scalable provisioning from a fractional E1/T1 to bonded n x E1/T1 channels**
- **Four SP and WFQ QoS priority queues**
- **Traffic policing per flow and per EVC.CoS**
- **Gigabit Ethernet and STM-1/OC-3 port protection**
- **Secure Telnet and Web applications, SNMPv3 and RADIUS**
- **NEBS-compliant**
- **Optimized for IP DSLAMs and WiMAX base station backhaul applications**

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Egate-100 is a gateway for interconnecting Gigabit Ethernet over channelized STM-1/OC-3 or three DS3 links. It is typically deployed in a central location to aggregate Ethernet user traffic received from remote devices, such as RAD's RICi Ethernet NTUs and FCD TDM access devices, or third-party CPEs. Together with these remote units, the Egate-100 constitutes a complete access solution from the service provider central site to the customer premises.

The Egate-100 Gigabit Ethernet over TDM gateway leverages widely available PDH/SDH/SONET networks to deliver carrier-class Ethernet services to sites where native Ethernet is not available.

Carriers can generate new revenue streams from existing infrastructure, or expand out-of-region network coverage by leasing lower cost transmission lines as an alternative to digging new infrastructure. Enterprises and utilities are also able to take advantage of available SDH/SONET transport for new Ethernet-based applications.

Multi-site Carrier Ethernet aggregation

The Egate-100 can connect up to:
- 42 remote LANs over n x E1/T1 circuits, with MLPPP or with GFP, VCAT and LCAS
- 63 or 84 remote LANs over E1 or T1 circuits, respectively
- 126 remote LANs over fractional E1/T1 circuits

This unique capability enables service providers and enterprises to deliver Ethernet Private Line (E-line point-to-point) services at granular rates from fractional E1 or T1 to n x E1/T1 channels. The Egate-100 is MEF-9 EPL certified.

Since the Egate-100 functions as a bridge operating over an SDH/SONET environment, service providers can achieve a seamless interconnection between customers connected over the TDM network and customers connected over the packet switched network, while maintaining the same service level attributes.

Ethernet OAM is one of the cornerstones in the transformation of Ethernet into a carrier-class technology. The device supports single segment OAM based on 802.3-2005 (formerly 802.3ah), allowing for remote management and fault indication, including connectivity check and remote loopback.

NG-PDH encapsulation and bonding

The GFP, VCAT and LCAS standard protocols allow service providers to dynamically allocate bandwidth to their customers by simply changing the number of E1 or T1 links bonded to the virtual group, without the need to change the device or stop the service. By incorporating these enhanced capabilities, the Egate-100 enables higher user throughput, reduces delays and minimizes service disruptions.

The Egate-100 replaces current solutions based on expensive channelized STM-1/OC-3 or DS3 routers, or multi-box solutions based on converter racks and switches. It offers the following valuable advantages over these alternatives:
- Considerably reduced equipment cost
- Single-box solution simplifies operations
- Lower operating costs due to device scalability, smaller footprint and low power consumption
- Increased service availability with port and power supply redundancy

In order to ensure higher service uptime, the Egate-100 features dual Gigabit Ethernet ports with Link Aggregation according to 802.3ad, and dual STM-1/OC-3 ports with 1+1 (MSP/APS) protection.

Service differentiation

The Egate-100 features an advanced forwarding model, including the following attributes:
- User traffic classification according to ingress port number, VLAN ID, VLAN priority, IP Precedence, or DSCP
- Class of service (CoS) mapping
- Two-rate, three-color traffic policing mechanism per CIR/CBS, EIR/EBS bandwidth profiles
- Configurable SP or WFQ queuing

These capabilities enable service differentiation and SLA guarantees.

VLAN tagging and stacking

The Egate-100 associates a bridge port and a TDM interface (e.g., a bundle of timeslots, a clear channel E1/T1 or a group of bonded E1/T1 channels), in effect creating a virtual port interconnecting the packet and the TDM networks. Using the VLAN stacking (Q-in-Q) attribute, a service provider VLAN is added to the user traffic. This allows transparent delivery of user traffic, keeping all the user VLAN (CE-VLAN ID) settings intact, and enables a seamless hand-off to the packet network.

SNMP management

The Egate-100 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, or the dedicated management port, while maintaining separation between management and user traffic via the use of VLANs. Advanced FCAPS (Fault, Configuration, Administration, Performance, Security) and diagnostic tools are provided by RADview-EMS, RAD's carrier-class element management system, via a Web browser.

The Egate-100 also supports a variety of access protocols, including Telnet, SNMP, Web server, and TFTP. Incorporated security features include Secure Shell (SSH), Web-based Secure Socket Layer (SSL), SNMPv3, and RADIUS. The Egate-100 supports Syslog (RFC 3164), to enable system logs to be forwarded to the network according to pre-defined criteria.

Egate-100 is a compact, 1U-high, 19-inch wide, standalone device in a metal enclosure. Its channelized STM-1/OC-3 uplinks are available with SFP optical and electrical modules. DS3 ports are available with coax interfaces. The Gigabit Ethernet ports can be ordered with 10/100/1000BaseT or 1000BaseSX/LX interfaces. The Egate-100 has one or two AC or DC power supplies.
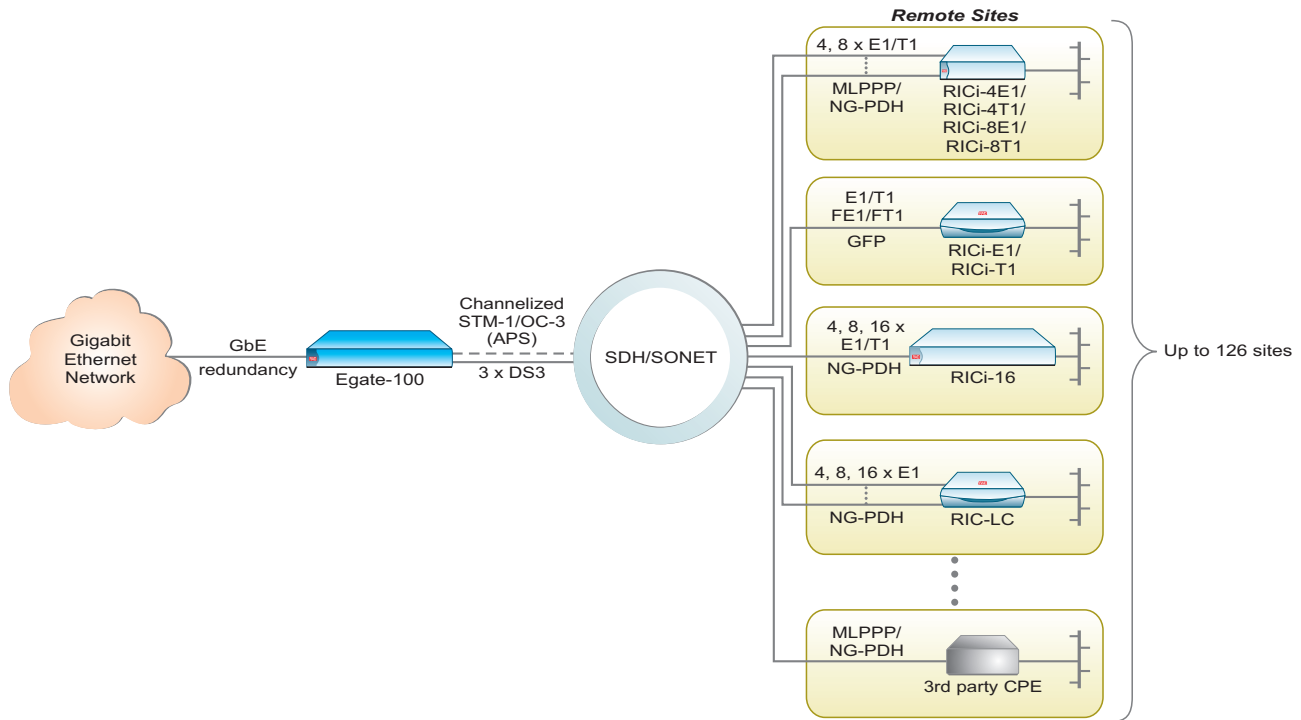
Aggregation of Ethernet services over channelized STM-1/OC-3 or 3 x DS3

Egate-20
Ethernet over TDM Aggregation Gateway

- **Aggregates and switches Fast Ethernet traffic over eight E1 or T1 ports**
- **Connects up to 248 or 192 remote sites via channelized E1 or T1 lines**
- **Loop detection of TDM ports to avoid Ethernet storms**
- **Provides QoS utilizing four priority queues according to VLAN priority field (802.1p), DSCP, IP Precedence, or per port**
- **Enables transparent Ethernet services utilizing VLAN tagging and stacking**
- **Competitive equipment and maintenance costs**

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The Egate-20 is an Ethernet to TDM gateway for interconnecting channelized E1s or T1s and packet networks. The Egate-20 is typically deployed in a central location, aggregating user LAN traffic received from remote devices, such as RAD's RICi and FCD. Together with these remote units, the Egate-20 constitutes a full access solution from the service provider central site to the customer premises.

Carrier Ethernet services

The Egate-20 can connect up to eight remote LANs over framed or unframed E1 or T1 circuits, or 248 or 192 remote LANs over fractional E1 or T1 circuits, respectively. This unique capability

enables service providers and enterprises to provide transparent Ethernet Private Line (point-to-point) services at granular rates from fractional to full E1 or T1. The Egate-20 supports differentiated services by classifying user traffic according to VLAN priority (802.1p), DSCP, IP Precedence, and per port.

Egate-20 immediately detects E1/T1 loops when they occur and closes the bridge port to avoid Ethernet storms. Once the E1/T1 loops are released, Egate-20 reverts to normal operation.

Since the Egate-20 functions as a bridge operating over a PDH environment, a seamless interconnection between customers connected over the TDM network and customers connected over the packet network can be achieved while maintaining the same service level attributes.

It replaces current solutions based on expensive multiple channelized E1/T1 routers or multi-box solutions based on cross connects and switches. For the service provider, this means simplified operations and considerably reduced costs for channelized bridge applications.

The Egate-20 maps Ethernet user traffic over complete E1/T1 clear channels or bundles of timeslots assigned to a specific bridge port (VLAN), in effect creating a virtual port interconnecting the packet and the TDM networks.

Using the VLAN stacking (Q-in-Q) capabilities, a special provider VLAN is added to the user traffic. This allows transparent delivery of the

user traffic, keeping all the user VLAN settings intact, and enables a seamless hand-off to the packet network. VLAN switching permits specific VLANs to be forwarded to virtual ports, while blocking others. With this feature, it is possible to define different traffic profiles for members of different VLAN domains. Management traffic is given a common profile, creating one broadcast domain in which all users are managed over a single VLAN.

SNMP management

The Egate-20 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, while maintaining separation between management and user traffic via the use of VLANs. Advanced FCAPS (Fault, Configuration, Administration, Performance, Security) and diagnostic tools are provided by RADview-EMS, RAD's carrier-class element management system, via a Web browser.

The Egate-20 also supports a variety of access protocols, including Telnet, SNMP, Web server, and TFTP. A DHCP server is employed to provide IP address, IP mask and default gateway, automatically saving set-up time.

The Egate-20 provides eight E1 or T1 ports and four 10/100BaseT user LAN ports. For management, it is equipped with a dedicated 10/100BaseT management port. It is available as a compact, 1U-high, half 19-inch wide, standalone device in a metal enclosure.
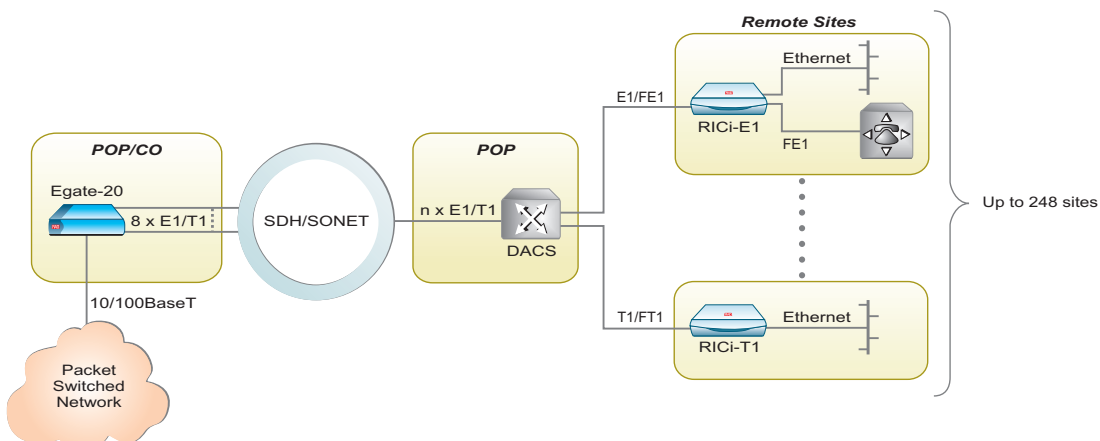
Aggregation of Ethernet services over channelized E1 or T1 lines

ETX-1002
10-Gigabit Carrier Ethernet Aggregation Switch

NEW

EtherAccess

High-capacity transport and service aggregation

The ETX-1002 10-Gigabit non-blocking Carrier Ethernet aggregation switch grooms traffic from up to 24 Fast Ethernet/Gigabit Ethernet links over a 10-Gigabit connection at wire-speed. The device features two redundant 10-GbE XFP network ports, with two additional ports available via an expansion module. Deployed in a hub and spoke topology, the high-capacity edge switch provides a central aggregation solution for Carrier Ethernet demarcation devices deployed at the customer premises, such as RAD's ETX-102, ETX-201 or ETX-202, as well as the ETX-A series. In addition, it supports resilient GbE/10GbE Carrier Ethernet access rings.

The ETX-1002 is ideal for transport aggregation of Layer 3 business services, such as IP VPN, VoIP and dedicated Internet access, converging voice and data services over a unified Ethernet, IP or MPLS network. Alternatively, the ETX-1002 provides service aggregation with quality of service control for Layer 2 business applications, such as LAN-to-LAN services.

Enhanced QoS capabilities

The ETX-1002 is equipped with advanced capabilities for handling multi-priority traffic, ensuring latency, jitter and packet delivery performance on a per-port or per-flow basis. The device supports traffic classification according to user-defined criteria, including VLAN priority (P-bit), DiffServ, ToS, and DSCP. In addition, metering, policing, and shaping functionalities help carriers to rate-limit user traffic according to pre-defined CIR (committed information rate) and EIR (excess information rate) profiles, thereby supporting customized service packages and enabling carriers to introduce new revenue generators.

Enhanced quality of service is further supported by an 8-queue scheduling mechanism that combines Strict Priority (SP) and weighted round robin (WRR) queuing, to efficiently handle real-time, premium and best-effort traffic.

Ethernet OAM for SLA assurance

The ETX-1002 features Ethernet OAM capabilities to enable remote and automatic fault localization without service interruptions or costly on-site inspections. The device's Ethernet OAM suite includes Ethernet Link OAM (IEEE standard 802.3-2005, formerly 802.3ah), and Ethernet Connectivity Fault Management (IEEE 802.1ag)

Uplink redundancy and Ethernet ring protection

Some customers require high level service resiliency. In such cases, the aggregation device should also be able to provide uplink redundancy to protect the access link and allow five nines (99.999%) reliability.

The ETX-1002 offers Link Aggregation redundancy to ensure service continuity in the event of link failure. Furthermore, it supports GbE ring protection with sub-50 ms restoration.
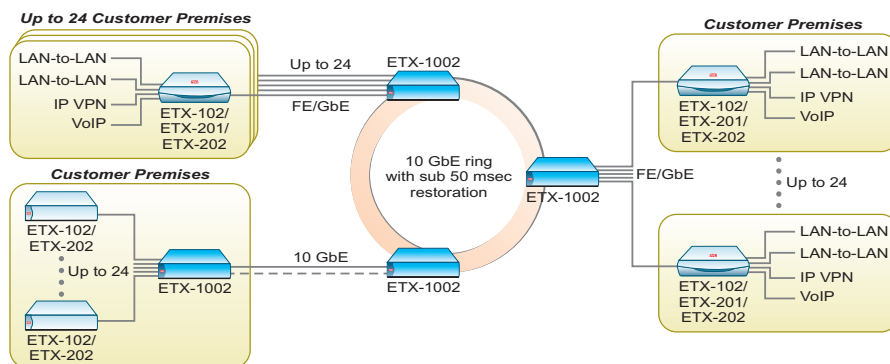
Management and security

The ETX-1002 features flexible management capabilities, including local management via an ASCII terminal (RS-232). In addition, remote management can be performed either out-of-

- **10-Gigabit aggregation point for L2/L3 transport and SLA-based business services**
- **Four 10-GbE XFP network ports; 24 Fast Ethernet or GbE SFP user ports**
- **MEF-9 and MEF-14 certified for EPL, EVPL services**
- **QoS with CIR/EIR rate limitation per user port or per flow**
- **Ethernet OAM per IEEE 802.3-2005 (formerly 802.3ah) and IEEE 802.1ag**
- **GbE ring support; uplink redundancy per IEEE 802.3ad with LACP**
- **Compact size for limited space installations**
- **Temperature hardened enclosure for outdoor deployments**
- **Remote management; CLI configuration**

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band or inband, using a dedicated management port while maintaining separation between management and user traffic via the use of VLANs. Advanced fault management and diagnostics is provided by RADview-EMS, RAD's carrier-class element management system, via an SNMP-based GUI.

The ETX-1002 also supports a variety of access protocols, including CLI over Telnet, SNMP and TFTP. Incorporated security features include Secure Shell (SSH), SNMPv3 and RADIUS.

Up to 24 Customer Premises

LAN-to-LAN
LAN-to-LAN
IP VPN
VoIP
ETX-102/ETX-201/ETX-202

Up to 24
FE/GbE
ETX-1002

Customer Premises

ETX-102/ETX-202
Up to 24
ETX-1002

10 GbE ring with sub 50 msec restoration

10 GbE
ETX-1002

ETX-1002
FE/GbE

Customer Premises

LAN-to-LAN
LAN-to-LAN
IP VPN
VoIP
ETX-102/ETX-201/ETX-202

Up to 24

LAN-to-LAN
LAN-to-LAN
IP VPN
VoIP
ETX-102/ETX-201/ETX-202

High capacity transport and service aggregation over 10 GbE ring

ETX-201A, ETX-202A, ETX-204A

Carrier Ethernet Demarcation Devices

EtherAccess

ETHERNET OVER FIBER

- **User/network demarcation point for L2/L3 transport and SLA-based business services or cellular backhaul**
- **Up to two Fast Ethernet or GbE UTP/SFP combo network ports; up to four user ports**
- **Extensive synchronization schemes for cellular backhaul applications (ETX-204A)**
- **MEF-9 and MEF-14 certified for EPL, EVPL services**
- **Flow-based or bridge-based forwarding**
- **QoS: rate limitation and shaping per Ethernet flow (EVC.CoS)**
- **Ethernet OAM, performance monitoring and in-service/out-of-service loopback testing**
- **ITU-T G.8032 Ethernet Rings Protection Switching (ERPS)**
- **Standard pseudowire support for TDM traffic over packet (ETX-204A)**
- **RADview-EMS management; CLI configuration**

End-to-end service and transport demarcation

The ETX-201A, ETX-202A and ETX-204A Carrier Ethernet demarcation devices deliver SLA-based Layer 2 and Layer 3 business services to the customer premises over native Ethernet access. They transport up to 1 Gigabit of user throughput while ensuring SDH/SONET-like performance and five nines reliability. Converging voice and data services over a unified Ethernet, IP or MPLS network, a single ETX-A device delivers IP VPN, VoIP and dedicated Internet access over the same physical link as a Layer 2 LAN-to-LAN service, all with differentiated quality of service and end-to-end monitoring.

Cell-site transport gateways for cellular backhaul

Synchronization in cellular networks is critical to ensure proper quality for mobile services. As radio access networks (RANs) are rapidly transitioning to asynchronous packet switched technologies, which introduce packet delay variation and packet loss, timing distribution and recovery have become a major challenge in the migration to IP backhaul.

With powerful synchronization capabilities, as well as extensive pseudowire support for TDMoIP, CESoPSN and SAToP standards, the ETX-204A

ensures highly accurate, seamless delivery of 2G, 3G and 4G traffic over packet backhaul. It enables mobile operators and transport providers to eliminate the risk of service disruptions, impaired cell hand-offs and excessive dropped calls, thereby supporting reliable transmission of real-time traffic over PSNs. It also ensures QoS priorities for clock traffic and supports "SDH/SONET or better" performance requirements for voice and video traffic, such as up to 16 ppb (parts per billion) frequency accuracy.

The ETX-204A's SyncToP™ suite includes clock recovery and distribution using IEEE 1588v2 Precision Time Protocol, Synchronous Ethernet (Sync-E) and a built-in input/output clock interface. Furthermore, it provides unique flexibility in supporting the simultaneous use of different clock transfer methodologies, for example, employing 1588v2 to receive the clock from the network then distributing it to the cell-site with Sync-E.

In addition, the ETX-A devices deliver managed quality of service in next-generation radio access networks (RANs), allowing mobile operators to enhance their 3.5G/4G service performance by combining Ethernet aggregation with OAM and SLA enforcement capabilities – starting at the LTE eNode B, HSDPA base station or WiMAX cell site.

SLA assurance, Ethernet OAM and performance monitoring

The ETX-201A, ETX-202A and ETX-204A feature enhanced Ethernet OAM capabilities, to enable remote and automatic fault localization without service interruptions or costly on-site inspections. The devices' comprehensive Ethernet OAM suite includes Ethernet Link OAM (IEEE standard 802.3-2005, formerly 802.3ah), Ethernet Service OAM (IEEE 802.1ag) and Performance Measurement (ITU-T Y.1731).

In addition to the non-intrusive OAM-based loopback testing, the ETX-A demarcation devices support Layer 1, Layer 2 and Layer 3 loopbacks for link integrity diagnostics, performed per VLAN, per EVC or per EVC.CoS, whereby the source and destination MAC and IP addresses are swapped without disrupting the traffic flows that are not being tested.

Remote provisioning and traffic management

The ETX-201A, ETX-202A and ETX-204A are equipped with advanced, software-based capabilities for handling multi-priority traffic, ensuring latency, jitter and packet delivery performance on a per-flow basis. The devices

support traffic classification according to any user-defined criteria, including VLAN ID, VLAN priority (P-bit), DSCP/ToS, subscriber port, and others, as well as their combinations. In addition, metering, policing and shaping functionalities help carriers rate-limit user traffic according to pre-defined CIR (committed information rate) and EIR (excess information rate) profiles, thereby supporting customized service packages and enabling carriers to introduce new revenue generators.

Enhanced quality of service is further supported by a hierarchical scheduling mechanism that combines Strict Priority (SP) and weighted fair queue (WFQ) scheduling, to efficiently handle real-time, premium and best-effort traffic. The ETX-A devices also use weighted random early detection (WRED) policy for intelligent queue management and congestion avoidance.

VLAN stacking and color-sensitive P-bit re-marking

By supporting VLAN stacking (Q-in-Q), the ETX-A devices enable service providers to ensure transparent delivery of user traffic, while minimizing the number of required VLAN IDs in the network.

In addition, the ETX-A demarcation devices feature unique P-bit re-marking capabilities, which assign color-specific P-bit values to Ethernet frames at the network ingress to ensure metering continuity across the Metro Ethernet network. User traffic that was marked "yellow" according to the CIR/EIR parameters by the device's QoS engine is assigned a new P-bit value to signal its status and priority, so that it is dropped first by 802.1Q and 802.1ad network elements in the event of congestion. This is especially useful in color-blind as well as in color-aware networks with no "discard eligible" ("yellow") marking.

Uplink redundancy and Ethernet ring protection

The ETX-A devices voffer both dual homing and single homing redundancy to protect the access link and ensure service continuity in events of link failure. Furthermore, the devices support Ethernet Rings Protection Switching (ERPS), using ring topology to ensure service restoration without the risk of Ethernet loops.

Management and security

The ETX-201A, ETX-202A and ETX-204A feature flexible management capabilities, including local management via an ASCII terminal (RS-232). In addition, remote management can be performed
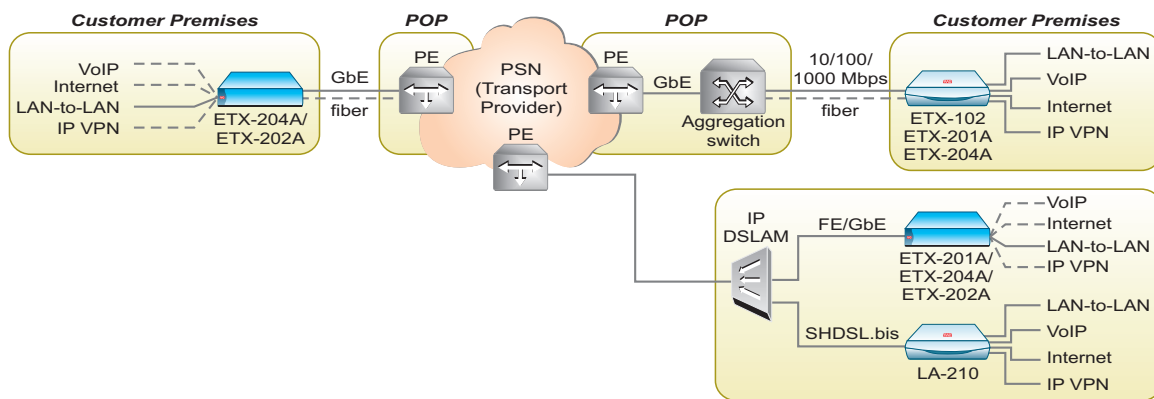
ETX-202A

ETHERNET OVER FIBER

either inband using the network or user ports, or out-of-band using a dedicated management port, while maintaining separation between management and user traffic via the use of VLANs. Advanced FCAPS (Fault, Configuration, Administration, Performance, Security) and

diagnostic tools are provided by RADview-EMS, RAD's carrier-class element management system, via an SNMP-based GUI.

The ETX-A devices also support a variety of access protocols, including CLI over Telnet, SNMP, Web server, and TFTP. Incorporated

security features include Secure Shell (SSH), Web-based Secure Socket Layer (SSL), SNMPv3, and RADIUS, as well as management access control list (ACL).

Ethernet service demarcation over packet with traffic management starting at customer premises
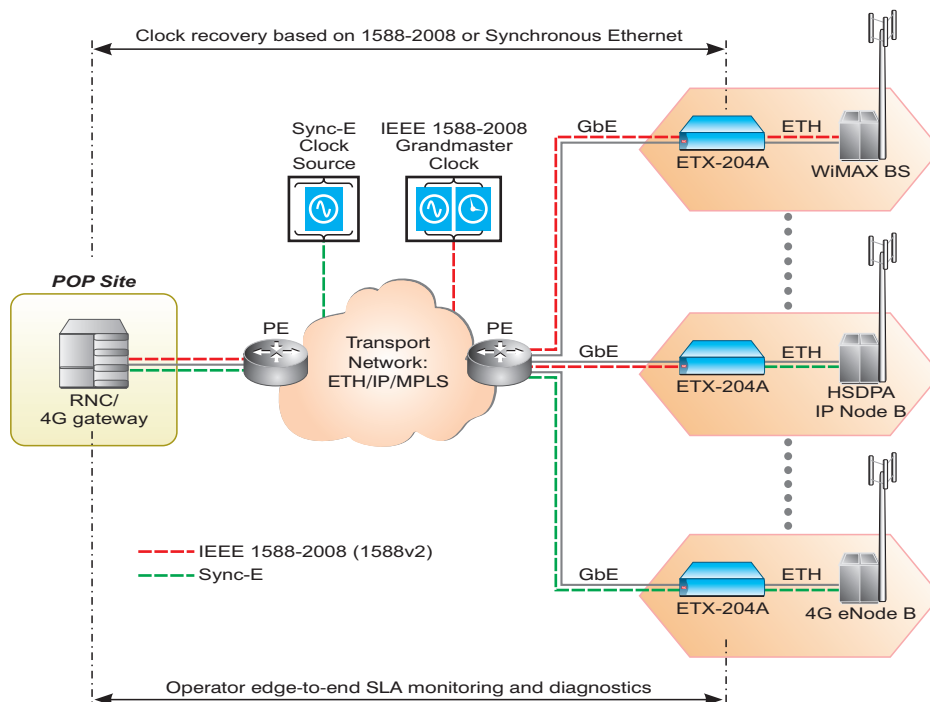
Transport demarcation for LTE and IP RAN backhaul with Timing over Packet synchronization

ETX-102, ETX-201, ETX-202

Carrier Ethernet Demarcation Devices

- • User/network demarcation point for L2/L3 transport and SLA-based business services
- • Up to two Fast Ethernet or GbE network ports; up to four user ports
- • MEF-9 and MEF-14 certified for EPL services
- • VLAN-unaware and VLAN-aware bridging
- • QoS with rate limitation per user port
- • Ethernet OAM, performance monitoring and in-service/out-of-service loopback testing
- • Uplink redundancy
- • Fault propagation
- • RADview-EMS management

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End-to-end service and transport demarcation

The ETX-102, ETX-201 and ETX-202 Carrier Ethernet demarcation devices deliver up to 1 Gigabit of user throughput over native Ethernet access.

They provide transport demarcation to SLA-based Layer 3 business services, such as IP VPN, VoIP and dedicated Internet access, converging voice and data services over a unified Ethernet, IP or MPLS network. Alternatively, the ETX devices perform service demarcation for Layer 2 applications, such as LAN-to-LAN services, with end-to-end quality of service control.

SLA assurance, Ethernet OAM and performance monitoring

The ETX-102, ETX-201 and ETX-202 feature enhanced Ethernet OAM capabilities, to enable remote and automatic fault localization without service interruptions or costly on-site inspections. The devices' comprehensive Ethernet OAM suite includes Ethernet Link OAM (IEEE standard 802.3-2005, formerly 802.3ah), Ethernet Service OAM (IEEE 802.1ag) and Performance Measurement (ITU-T Y.1731).

In addition to the non-intrusive OAM-based loopback testing, the ETX demarcation devices support Layer 1 and Layer 2 loopbacks for link integrity diagnostics, performed per port, whereby the source and destination MAC addresses are swapped without disrupting the traffic flows that are not being tested.

Remote provisioning and traffic management

The ETX devices are equipped with advanced, software-based capabilities for handling multi-priority traffic, ensuring latency, jitter and packet delivery performance on a per-port basis. The devices support traffic classification according to user-defined criteria, including VLAN priority (P-bit), DSCP/ToS and subscriber port. In addition, metering and policing functionalities help carriers to rate-limit user traffic according to pre-defined CIR (committed information rate) profiles, while traffic prioritization per class of service guarantees level of service during periods of congestion.

By supporting VLAN stacking (Q-in-Q), the ETX devices enable service providers to ensure transparent delivery of user traffic, while minimizing the number of required VLAN IDs in the network.

Uplink redundancy

Some customers require high level service resiliency. In such cases, the demarcation device should also be able to provide uplink redundancy to protect the access link and allow five nines (99.999%) reliability.

The ETX-102, ETX-201 and ETX-202 offer both dual homing and single homing redundancy.

Management and security

The ETX-102, ETX-201 and ETX-202 feature 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, while maintaining separation between management and user traffic via the use of VLANs. Advanced FCAPS (Fault, Configuration, Administration, Performance, Security) and diagnostic tools are provided by RADview-EMS, RAD's carrier-class element management system, via an SNMP-based GUI.

The ETX-102, ETX-201 and ETX-202 also support a variety of access protocols, including Telnet, SNMP, Web server, and TFTP. Incorporated security features include Secure Shell (SSH), Web-based Secure Socket Layer (SSL), SNMPv3, and RADIUS.

Available ETX configurations

All ETX units are equipped with two network ports for link redundancy and are available with SFP or UTP port configurations. The ETX-102 is a Fast Ethernet NTU with two network ports and up to four subscriber ports. The ETX-201 is a Gigabit Ethernet NTU with two GbE network ports (SFP only) and up to four Fast Ethernet subscriber ports. The ETX-202 is an all Gigabit Ethernet NTU with two GbE network ports and up to four GbE subscriber ports.

Port-based Ethernet services over fiber
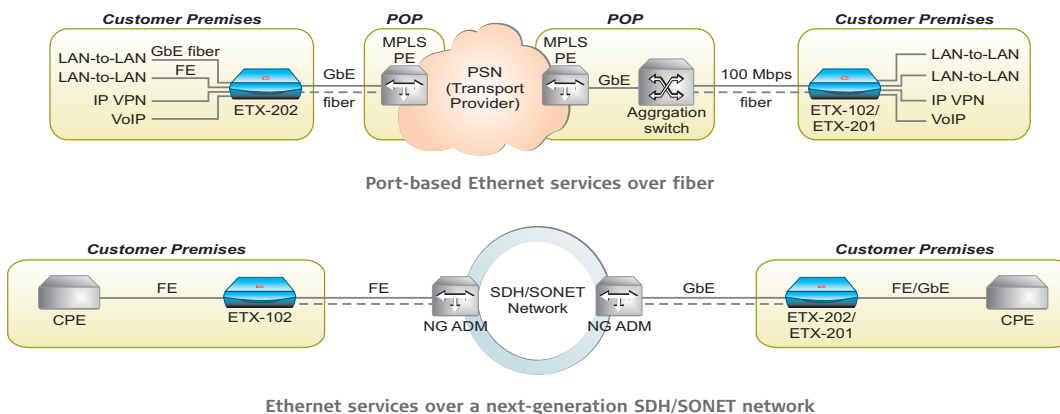
Ethernet services over a next-generation SDH/SONET network

ETX-208
Carrier Ethernet Demarcation Device

End-to-end service and transport demarcation

The ETX-208 Carrier Ethernet demarcation device delivers up to 1 Gigabit of user throughput over native Ethernet access. It provides transport demarcation to SLA-based Layer 3 business services, such as IP VPN, VoIP and dedicated Internet access, converging voice and data services over a unified Ethernet, IP or MPLS network. Alternatively, the ETX-208 performs service demarcation for Layer 2 applications, such as LAN-to-LAN services, with end-to-end quality of service control.

SLA assurance, Ethernet OAM and performance monitoring

The ETX-208 features enhanced Ethernet OAM capabilities, to enable remote and automatic fault localization without service interruptions or costly on-site inspections. The device's comprehensive Ethernet OAM suite includes Ethernet Link OAM (IEEE standard 802.3-2005, formerly 802.3ah), Ethernet Service OAM (IEEE 802.1ag) and Performance Measurement (ITU-T Y.1731).

In addition to the non-intrusive OAM-based loopback testing, the ETX-208 supports Layer 1 and Layer 2 loopbacks for link integrity diagnostics, performed per port, whereby the source and destination MAC addresses are swapped without disrupting the traffic flows that are not being tested.

Remote provisioning and traffic management

The ETX-208 is equipped with advanced, software-based capabilities for handling multi-priority traffic, ensuring latency, jitter and packet delivery performance on a per-port basis. The device supports traffic classification according to user-defined criteria, including VLAN priority (P-bit), DSCP/ToS and subscriber port. In addition, metering and policing functionalities help carriers to rate-limit user traffic according to pre-defined CIR (committed information rate) profiles, while traffic prioritization per class of service guarantees level of service during periods of congestion.

By supporting VLAN stacking (Q-in-Q), the ETX-208 enables service providers to ensure transparent delivery of user traffic, while minimizing the number of required VLAN IDs in the network.

Uplink redundancy

Some customers require high level service resiliency. In such cases, the demarcation device can also provide uplink redundancy to protect the access link and allow five nines (99.999%) reliability.

The ETX-208 offers both dual homing and single homing redundancy.

Management and security

The ETX-208 features flexible management capabilities, including local management via an ASCII terminal (RS-232). In addition, remote

- **User/network demarcation point for L2/L3 transport and SLA-based business services**
- **High port density with a small form factor: Up to two Fast Ethernet or GbE SFP/UTP combo network ports; up to eight Fast Ethernet user ports**
- **Complies with MEF-6 and MEF-10 specifications for EPL services**
- **VLAN-unaware and VLAN-aware bridging**
- **QoS with rate limitation per user port**
- **Ethernet OAM, performance monitoring and in-service/out-of-service loopback testing**
- **Uplink redundancy: Link Aggregation per IEEE802.3ad or Dual Homing**
- **Temperature-hardened enclosure for outdoor installations (-30°C to 65°C, -22°F to 149°F)**

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management can be performed either inband or out-of-band, using the network or user ports, while maintaining separation between management and user traffic via the use of VLANs.

The ETX-208 also supports a variety of access protocols, including Telnet, SNMP, Web server, and TFTP. Incorporated security features include Secure Shell (SSH), Web-based Secure Socket Layer (SSL), SNMPv3, and RADIUS.
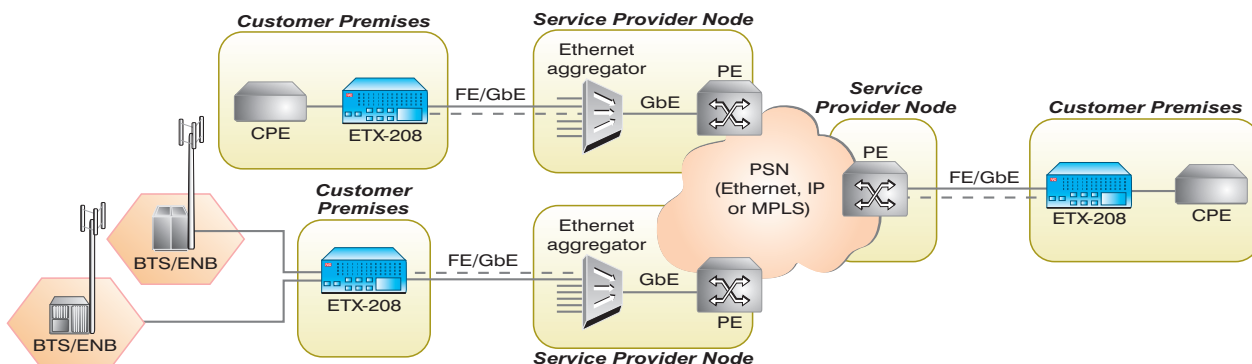
Access topologies for providing managed Ethernet services over a PSN

LA-210
EFM DSL Network Termination Unit

- **Mid-band Ethernet access up to 22 Mbps using EFM bonding or up to 100 Mbps downstream/50 Mbps upstream**
- **Up to four SHDSL.bis EFM uplink pairs or a single VDSL2 network interface**
- **Up to four Fast Ethernet user ports**
- **MEF-9 and MEF-14 EPL and EVPL certified**
- **Advanced QoS mechanism per EVC/EVC.CoS**
- **Ethernet link and service OAM with performance monitoring for end-to-end SLA control**
- **Multi-standard pseudowire support for legacy services over PSN**

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The LA-210 EFM (Ethernet in the First Mile) access device transports Ethernet traffic over low cost xDSL infrastructure, delivering Ethernet services, such as inter-office LAN connectivity, Internet access and virtual private networks (VPNs).

The LA-210 network termination unit (NTU) is customer-located equipment (CLE), owned and operated by the service provider and installed at the customer premises to mark a clear demarcation between the user and operator networks. It supports either multiple SHDSL.bis (ITU 991.2) access links with EFM bonding, or a single VDSL2 (ITU 993.2) connection with a wide-range of profiles for different deployment architectures. This enables service providers to deliver mid-band Ethernet and high-speed Ethernet where fiber is not present.

Service differentiation

The LA-210 features an advanced forwarding model to facilitate management of differentiated services. It includes the following attributes:

- User traffic classification according to ingress port number, VLAN ID, VLAN priority, IP Precedence, or DSCP, as well as combinations
- Class of service (CoS) mapping
- Two-rate, three-color traffic policing mechanism per CIR/CBS, EIR/EBS bandwidth profiles
- Hierarchical QoS with configurable Strict Priority and WFQ (weighted fair queuing) scheduling
- Traffic marking and EVC shaping

These capabilities enable service differentiation and SLA guarantees

Ethernet OAM

Ethernet OAM is a cornerstone in the transformation of Ethernet into a carrier-class technology. The LA-210 EFM DSL NTU provides two types of Ethernet OAM:

Ethernet Link OAM based on 802.3-2005 (formerly 802.3ah) allows for remote management, including remote loopback, remote fault indication, dying gasp, and retrieval of MIB parameters.

Ethernet Service OAM based on 802.1ag and Y.1731 provides end-to-end fault monitoring and performance measurements. Ethernet OAM enables Ethernet service providers to proactively monitor their service end-to-end, thus minimizing their operational expenses.

VLAN stacking and color-sensitive P-bit re-marking

By supporting VLAN stacking (Q-in-Q), the LA-210 enables service providers to ensure transparent delivery of user traffic, while minimizing the number of required VLAN IDs in the network. In addition, the LA-210 features unique P-bit re-marking capabilities, which assign color-specific P-bit values to Ethernet frames at the network ingress to ensure metering continuity across the Metro Ethernet

network. User traffic that was marked "yellow" according to the CIR/EIR parameters by the device's QoS engine is assigned a new P-bit value to signal its status and priority, so that it is dropped first by 802.1Q and 802.1ad network elements in the event of congestion. This is especially useful in color-blind as well as in color-aware networks with no "discard eligible" ("yellow") marking.

SNMP management and security

The LA-210 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, while maintaining separation between management and user traffic via the use of VLANs. Advanced FCAPS (Fault, Configuration, Administration, Performance, Security) and diagnostic tools are provided by RADview-EMS, RAD's carrier-class element management system, via an SNMP-based GUI.

The LA-210 also supports a variety of access protocols, including CLI over Telnet, SNMP, Web server, and TFTP. Incorporated security features include Secure Shell (SSH), Web-based Secure Socket Layer (SSL), SNMPv3, and RADIUS, as well as management access control list (ACL).
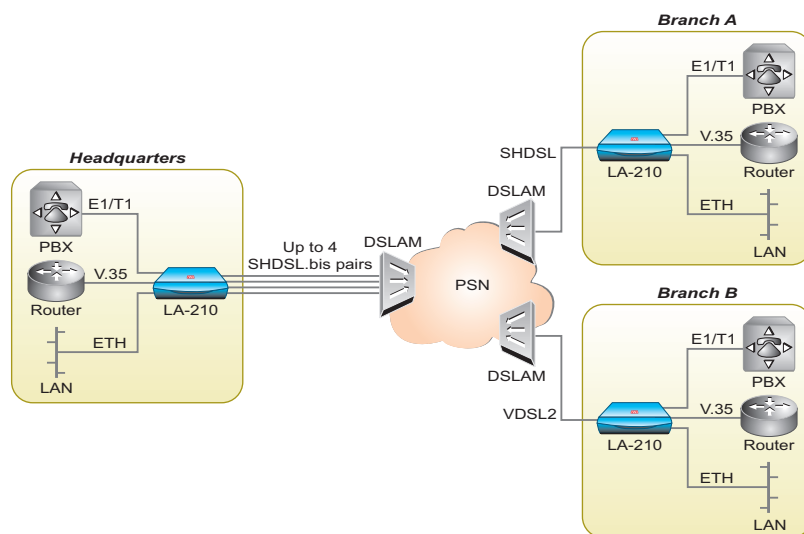
Ethernet and legacy services over SHDSL.bis and VDSL2

MiRICi-E1T1, MiRICi-E3T3

Miniature Ethernet to E1/T1 or E3/T3 Remote Bridges

System on an SFP

The innovative SFP-format MiRICi-E1T1 and MiRICi-E3T3 remote bridges connect Fast Ethernet or GbE LANs over framed or unframed E1/T1 and E3/T3 circuits. Housed in a small form factor pluggable (SFP) enclosure, they are designed for quick and simple insertion into any Ethernet device port with a compatible SFP socket. These unique devices are perfect for providing transparent LAN services over leased lines and remote branch connectivity over E1/T1 and E3/T3 circuits as well as over radio links. Deriving power from the host device, they require no additional power supply. The MiRICi devices are simple and cost-effective alternatives to external, standalone bridge units or conversion cards for user devices, saving on space, cabling and power consumption, and simplifying management.

The low cost SFP plug format is an ideal and affordable solution for carriers and service providers bridging Fast Ethernet LANs over TDM-based WANs, as well as for similar applications in private enterprise and campus networks. The MiRICi units permit easy adaptation of equipment with fiber optic Fast Ethernet interfaces for transmission over TDM-based infrastructures. If the transport network changes to Ethernet, the MiRICi can be quickly removed and reused elsewhere.

Inband and out-of-band management

Enhanced management for control status is supported via inband Ethernet packets and out-of-band I^2C.

The MiRICi bridges forward LAN Ethernet packets to the TDM-based WAN at wire-speed, fully utilizing the expensive E1/T1 and E3/T3 TDM circuit bandwidth.

LAN traffic is transported transparently, thus keeping user LAN settings intact. The bridges handle 64 to 2016-byte frames, including VLAN-tagged frames. The MiRICi devices support jumbo frames when working with GbE.

The MiRICi products support standard GFP encapsulation (G.8040, G.7041/Y.1303) for book-end connections as well as third-party GFP interoperability.

On the WAN side, each bridge has a single E1/T1 or E3/T3 interface, terminated in an RJ-45 or unbalanced 75Ω SMB connector, respectively. For controlled bandwidth adjustment between LAN and WAN, a flow control mechanism is activated.

Pause frames are generated whenever the internal buffer reaches its high water mark.

The bridges support Multisource Agreement (MSA) product identification codes. Once plugged in, they begin to operate autonomously

- Support framed and unframed E1/T1, E3/T3 link
- Support standard GFP and HDLC-like encapsulation
- Hot-insertion SFP-format plug, MSA-compliant
- User-configurable
- Enhanced management of control, status and monitoring
- Out-of-band management through I^2C
- Supports full duplex flow control
- Fault propagation from WAN to LAN link

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without any need for software configuration. The bridges are hot-swappable and feature a special release mechanism for easy extraction from the SFP socket.

MiRICi-E1T1 and MiRICi-E3T3 can operate opposite their respective MiRICi units installed on remote equipment. Alternatively, they can work opposite any Ethernet switch or device that supports standard GFP such as RAD's RICi-E1, RICi-T1 and RICi-16 Fast Ethernet over E1/T1 NTUs, or RAD's Egate-100 channelized Ethernet gateway.
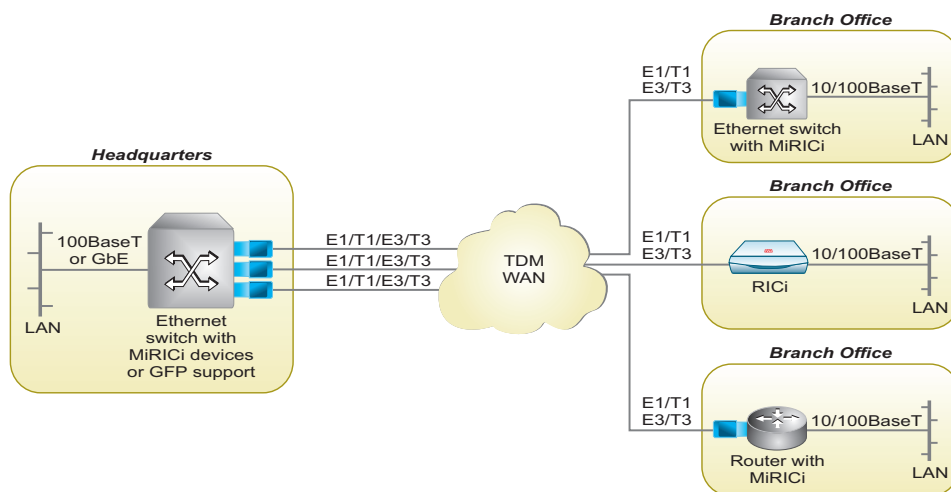
Providing transparent LAN services over E1/T1 and E3/T3 leased lines

MiRICi-155
Miniature Gigabit Ethernet over STM-1/OC-3 Converter

System on an SFP

- **Delivers Gigabit Ethernet traffic over a single STM-1/OC-3 link**
- **Supports standard GFP encapsulation**
- **Hot-insertion SFP-format plug, MSA-compliant**
- **User-configurable**
- **Enhanced management of control, status and monitoring**
- **Out-of-band management through I^{2}C**
- **Supports full duplex flow control**
- **Fault propagation from WAN to LAN link**

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The innovative SFP-format MiRICi-155 is a miniature converter, delivering Gigabit Ethernet (GbE) services over existing SDH/SONET networks, simply and cost effectively.

The MiRICi-155 maps GbE frames into VC-4 or STSc-3, using standard GFP encapsulation according to G.7041/Y.1303. This allows book-end connections as well as third-party interoperability.

Housed in a small form factor (SFP) enclosure, it is designed for quick and simple insertion into any Ethernet device port with a compatible SFP socket.

The MiRICi-155 is a simple and cost-effective alternative to external, standalone converter units or conversion cards for user devices. Deriving power from the host device, it requires no additional power supply and offers significant savings in space, cabling and power consumption, as well as simplifying management.

The MiRICi-155 features a standard Multisource Agreement (MSA) edge connector as the GbE interface, supporting 1000BaseX in full duplex mode. Connection to the STM-1/OC-3 link is performed via a standard FO LC connector.

Inband and out-of-band management

The MiRICi-155 can be managed out-of-band through the I^{2}C serial bus on the MSA connector. Inband management is performed via any Web browser, as the Web agent is implemented inside the MiRICi-155.

The MiRICi-155 supports flow control by generating standard Pause frames whenever the internal buffer reaches its high water mark, thereby adjusting the bandwidth between the LAN and WAN as necessary. In addition, it supports fault propagation from the WAN to the LAN.

End-to-end quality of service (QoS) is enabled using four priority queues per VLAN priority (802.1p) and ToS.

In addition to supporting MSA product identification codes, the MiRICi-155 is hot-swappable and features a special release mechanism for easy extraction from the SFP socket.

The economical SFP plug format is an ideal and affordable solution for carriers and service providers bridging GbE LANs over SDH/SONET WANs, as well as for similar applications in private enterprise and campus networks.

MiRICi-155 can operate opposite MiRICi units installed on remote equipment or opposite RAD's RICi-155GE Gigabit Ethernet over STM-1/OC-3 NTU. Alternatively, the MiRICi devices can operate opposite any Ethernet switch that supports standard GFP encapsulation.
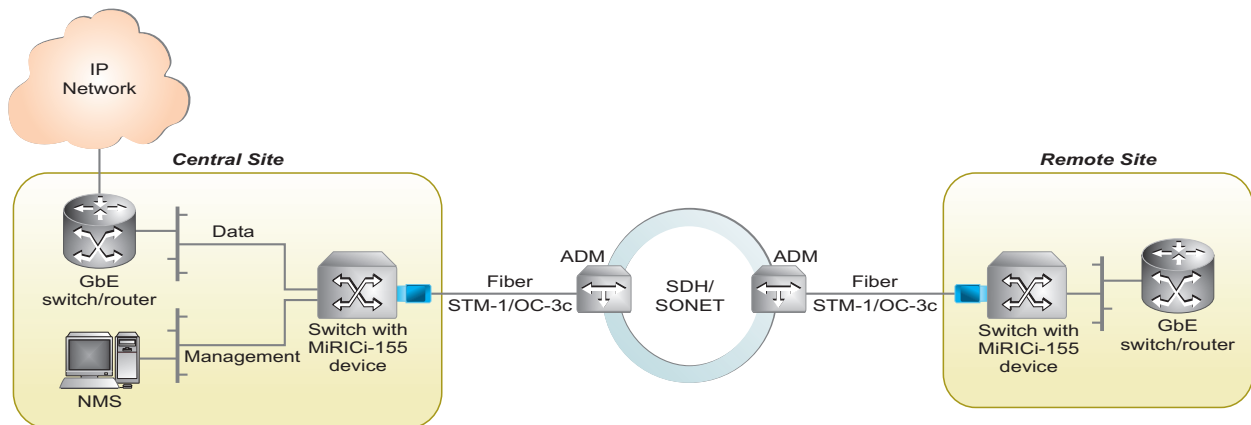
Providing transparent LAN services over SDH/SONET networks

SPH-4, SPH-16
SFP Patch Hubs

The SPH-4 and SPH-16 are managed SFP patch hubs that connect four or 16 Fast Ethernet (100 Mbps) and Gigabit Ethernet (1000 Mbps) copper sockets (RJ-45) to any standard SFP device.

The SFP patch hubs work with standard SFPs from any vendor, including RAD's special "System on an SFP" devices (MiRICi, MiTOP) as well as with Ethernet switches featuring RJ-45 connectors.

The SFP patch hubs provide users a high degree of flexibility by enabling them to use any SFP device instead of expensive dedicated SFPs.

The SPH-4 and SPH-16 can also be used as Ethernet copper-to-fiber converters, extending the reach of Fast Ethernet and Gigabit Ethernet networks.

SNMP management

The SPH-4 and SPH-16 can be managed via an ASCII terminal, a PC running a Web browser, a Telnet host, or an SNMP-based network management station. They provide SNMP management for I^2C parameters of standard SFP devices and enable software downloads to the SFPs. In addition to enabling flow control via a back pressure mechanism, the SFP patch hubs support major and minor alarm reports, and feature LED status indicators to facilitate system diagnostics.

- Convert standard Ethernet copper (RJ-45) ports to SFP sockets
- Fully transparent Layer 1 conversion at wire-speed
- Supports any standard SFP device, bypassing the vendor's specific SFP port protection
- Auto-discovery of Fast Ethernet and Gigabit Ethernet
- Optional dual power supplies with full redundancy in SPH-16
- Fault propagation from WAN to LAN

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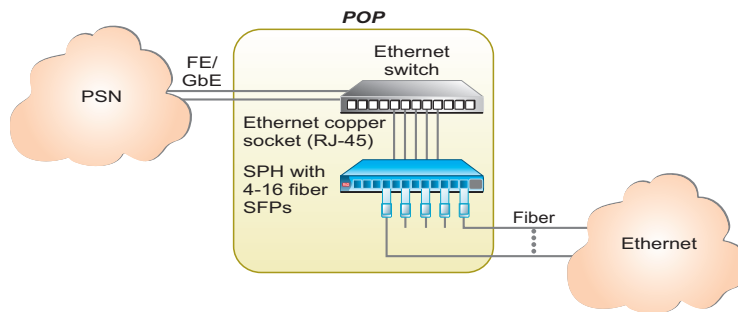
Fiber SFP application
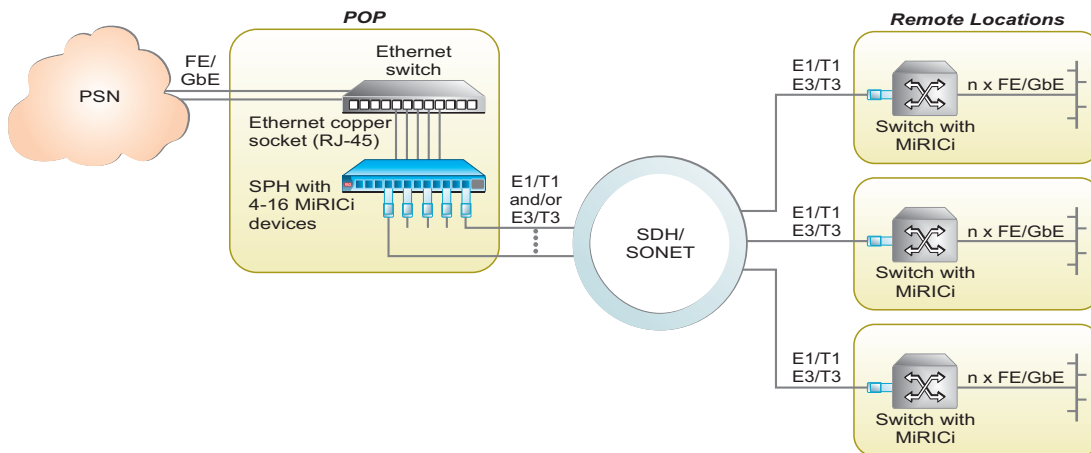
LAN over PDH application: RAD's "System on an SFP" connected to an Ethernet switch via SPH

WEB RANger-II
Internet Access Router

- **Connects small or medium-sized offices to Internet/intranet**
- **Supports data services over E1/T1, fractional E1/T1, Frame Relay and leased line**
- **IP and IPX routing and standard bridging**
- **One or two Ethernet LAN interfaces (10BaseT)**
- **Sub-E1/T1**
- **Data interfaces: V.35, RS-530, V.36/RS-449, V.24, X.21, and integrated 4-wire modem**
- **Optional backup link**
- **Supports PPP and MLPPP**
- **NAT and single IP address translation**

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WEB RANger-II is a compact access router that connects a small to medium-sized network to the Internet or intranet services, utilizing Frame Relay, E1/T1 or synchronous services.

IP and IPX routing and standard bridging work with any third-party router.

One or two Ethernet interfaces are supported (10BaseT) in WEB RANger-II.

Multi-office voice and data integration

WEB RANger-II allows branch offices to integrate routed LAN traffic and voice from a PBX over a single E1/T1 connection to company headquarters. The single IP address translation feature allows a small or medium-sized office LAN to connect to the Internet using a single, dynamically or statically allocated IP address from the central access router.

NAT allows an organization with addresses that are not globally unique to connect to the Internet by translating those addresses into globally routable address space.

SNMP and Telnet support

The SNMP agent provides management by RADview or any other standard SNMP management station.

In the WEB RANger-II, the automatic bypass feature for sub-E1/T1 provides automatic join-up of timeslots on E1/T1 and sub-E1/T1 links in the event of power failure.

Quick setup is performed via a terminal attached to the control port, or by using Telnet access to the device over the LAN or WAN.

Solid Firewall™ (session-based) protection

Security features include Solid Firewall™ to protect an office LAN from undesired entry from the Internet. IP service access authentication is provided by PAP/CHAP. Undesired access to the WEB RANger-II via Telnet or SNMP can be blocked or password-protected.

Software downloading is available via the control port using XMODEM, and via LAN or WAN using TFTP.

Parameter file downloading is available via LAN or WAN using TFTP.

LAN connectivity
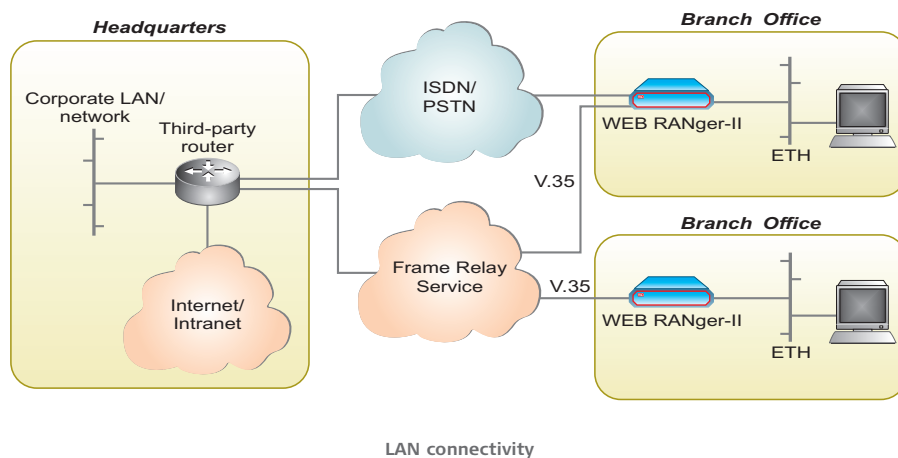
TinyBridge-100
Miniature Remote Ethernet Bridge/Extender

TinyBridge-100 is a high performance, remote, self-learning Ethernet bridge. Its small size and low cost make it ideal for cost-sensitive bridging applications or as a LAN extender over bitstream-type infrastructures. TinyBridge-100 is available with a variety of WAN interfaces, including V.24, V.35, V.36, RS-530, and X.21.

The device automatically learns MAC addresses on the LAN to which it is connected and forwards only those frames destined for another LAN. Filtering and forwarding are performed at wire-speed.

Extension up to 1.3 km

The TinyBridge-100 4-wire option extends the LAN over 4-wire to 1.3 km (4,265 ft) when operating at 5 Mbps, and up to 500 meters (1,640 ft) when operating at 10 Mbps. The device can support rates up to 10 Mbps over synchronous links.

The TinyBridge-100 is available with a 10/100BaseT interface and with support of frames up to 1,536 bytes, enabling transparent forwarding of VLAN frames.

### Optimize bandwidth utilization on the WAN link

The TinyBridge-100 device uses HDLC framing for high utilization of the WAN link. The device does not perform any negotiation over the link.

This feature eliminates waste of valuable bandwidth. It also makes the device especially useful for satellite and other wireless broadcast applications. Any variable speed up to 10 Mbps on the link is supported transparently. The link speed may be adjusted "on-the-fly."

In cases of error conditions on the TinyBridge-100 WAN port, a fault propagation feature will tear down the link integrity on the Fast Ethernet port. This will indicate the error conditions to the Ethernet device connected to the TinyBridge-100 and will enable automatic rerouting of the traffic if required.

- **High performance remote Ethernet bridge/extender**
- **WAN interfaces: V.24, V.35, V.36, RS-530, X.21**
- **WAN link rate of up to 10 Mbps sync**
- **10/100BaseT port**
- **Ideal for satellite and wireless applications**
- **Transparent forwarding of VLAN frames**
- **Priority according to IP ToS or 802.1p**
- **Fault propagation of WAN error conditions to the Ethernet port**
- **4-wire option for extending traffic over copper lines**

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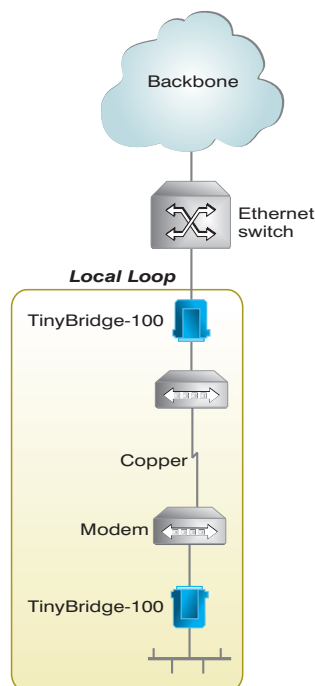
Connecting LANs over Local Loop
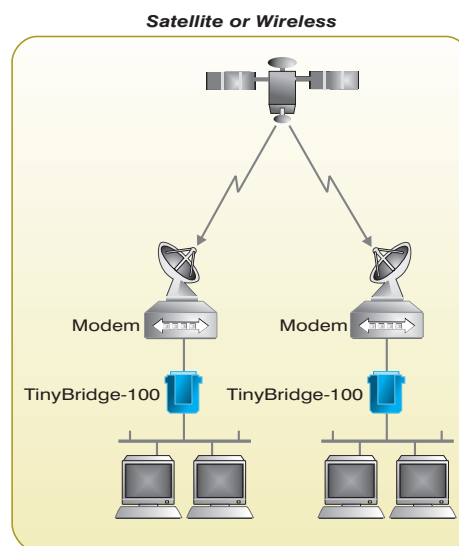
Connecting LANs over a satellite connection