Catalog 2011

Access That Lasts

Government
Carrier
Ethernet
Mobile Backhaul
Mobile Operators
First Mile
Solutions
Carriers & Service Providers
Utilities & Transportation
Multiservice
Access
Enterprises

RAD
data communications
The Access Company

Company Profile

Established nearly 30 years ago, RAD Data Communications is an award-winning manufacturer of access and backhaul solutions for mobile and fixed line carriers, service providers, enterprises, government agencies, educational institutions, transportation systems, and public utilities around the world.

Fast Facts

- Established in 1981, RAD Data Communications is the anchor of the RAD Group of companies, with revenues approaching $1 billion
- RAD maintains 26 offices on six continents, supporting 300 sales channels in 165 countries
- Approximately 30 percent of RAD's 1,000 employees are engaged in R&D
- RAD has a distinguished record of leadership in industry bodies such as the International Telecommunications Union (ITU), Metro Ethernet Forum (MEF), Broadband Forum, the Internet Engineering Task Force (IETF), and CELTIC, a EUREKA cluster that is the only European research and development program dedicated to end-to-end telecommunications solutions

Innovation Facts

- RAD was the originator of Single IP, which enables multiple users to share a common IP address for Internet access
- RAD's pioneering TDMoIP® technology, which it introduced to the market over a decade ago, is the forerunner of today's widely deployed pseudowire solutions
- RAD is the first and only vendor to miniaturize an interface converter and pseudowire gateway into an SFP
- RAD is the first vendor in the industry to win a large-scale deployment of a demarcation device with Sync-E, and to demo 1588-2005 in an incumbent carrier's live network

Green Facts

- RAD was the industry pioneer in miniaturized modems and other telecom solutions, which reduce the amount of materials that eventually has to be discarded
- RAD pioneered products powered by the current flowing through them, rather than by external sources, which significantly reduces electricity consumption
- RAD's manufacturing process is completely free of atmospheric contaminants and its packaging is eco-friendly and recyclable
- RAD has inaugurated a new generation of energy-saving devices, beginning with an optical multiplexer that consumes far less electricity than similar solutions in the market

Leading Customers

RAD is a preferred solutions provider for more than 150 carriers around the world, from Tier-1 mobile operators to fixed line incumbents, city carriers, ISPs, and rural service telcos. Customers include the industry's global leaders, from AT&T to Bell Canada, Bharti Airtel, British Telecom, China Mobile, China Telecom, Deutsche Telekom, Embratel, France Telecom, Hutchison, KDDI, KPN, Orange, SingTel, SoftBank, Sprint, Telefónica, TeliaSonera, Telstra, TELUS, T-Mobile, and Verizon.

Beyond its strong ties with telecom providers, RAD maintains extensive relationships with enterprise network professionals in the banking, commercial, educational, energy, financial, insurance, and manufacturing sectors.

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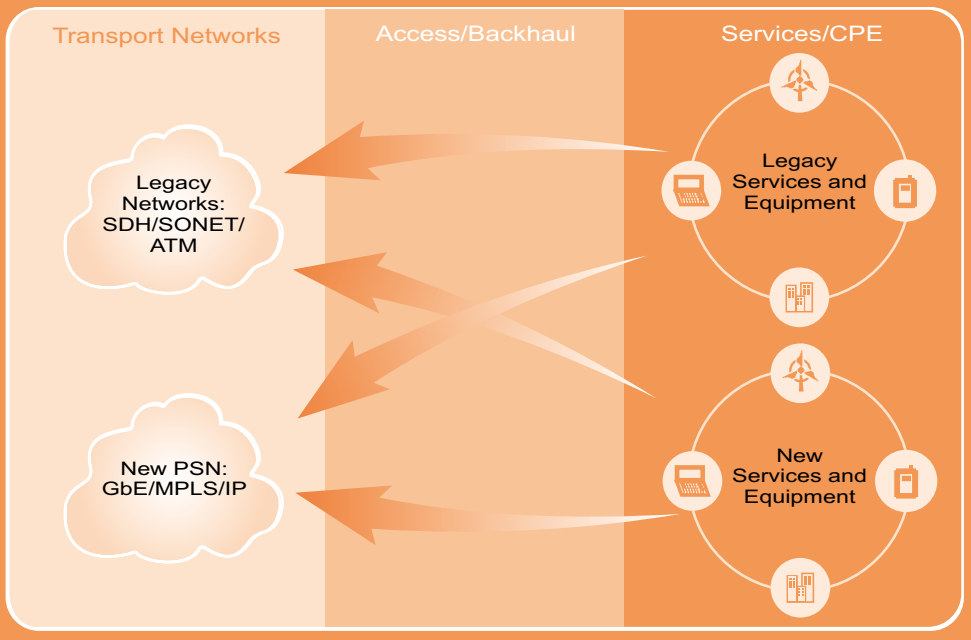
RAD's Selected Customer Applications

RAD Data Communications offers carriers, service providers, mobile operators, and enterprise users a wide range of access products and network aggregation solutions to enable the fast and easy deployment of multiple services, while controlling OpEx and CapEx and minimizing end-user outlays for new and existing communications requirements.

The company's product portfolio gives both public and private telecommunications providers a comprehensive, integrated and interoperable access solution at a competitive price, which is designed to deliver long-term value.



Access That Lasts

Carriers and Service Providers

p.4

Deploy Carrier Ethernet services and transport networks with end-to-end quality of service for SLA assurance. Roll out and extend multiple legacy and next-generation services over any infrastructure: fiber, PDH/SDH/SONET, DSL, and wireless.

Utilities and Transportation

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Support diverse applications ranging from mission-critical control data, video surveillance and voice traffic, to Internet access, LAN, and industrial Ethernet over various network topologies across their own communications grid or facilities leased from service providers. Manage the transition from existing access and transport infrastructure to new packet-based networks.

Government and Enterprise

p.24

Support disaster recovery, public safety and homeland security applications with tailored access and backhaul solutions for TETRA, video surveillance, secure fiber, and encrypted wireless networks.

Mobile Backhaul

p.30

Enable high capacity intelligent demarcation, backhaul and aggregation of 2G, 3G, HSPA, and LTE traffic over packet-based or legacy networks. Extend mobile services to underserved rural or sparsely populated areas with low cost fiber, copper and wireless modems and multiplexers.

Carriers and Service Providers

The pace of change for tele-communications service providers is relentless. Ever-escalating capacity demand from bandwidth-rich applications and the need to stake out a competitive edge by offering new services, coupled with the necessity to drive down capital equipment costs and operating expenses, provide a difficult challenge. In response, carriers and service providers of all types are increasingly relying upon lower cost packet-based access networks while cost-effectively leveraging — and transitioning from — existing traditional network infrastructure.

NGN and Legacy Migration

Motivated by the tremendous cost-savings inherent in migrating to next-generation networks and the opportunity to introduce richer services, many operators are looking to diversify their product mix by introducing Carrier Ethernet services. RAD provides an industry-leading portfolio of Carrier Ethernet access solutions, which allows operators to quickly roll out and turn up premium managed services with verifiable SLAs. In parallel, faced with the challenge of continuing to support many of their customer's traditional applications over the new packet-based infrastructure, operators are turning to RAD's full suite of multiservice access product solutions. These enable them to easily increase revenue and reduce churn by delivering legacy and new packet-based services over both traditional and next-generation network infrastructure.

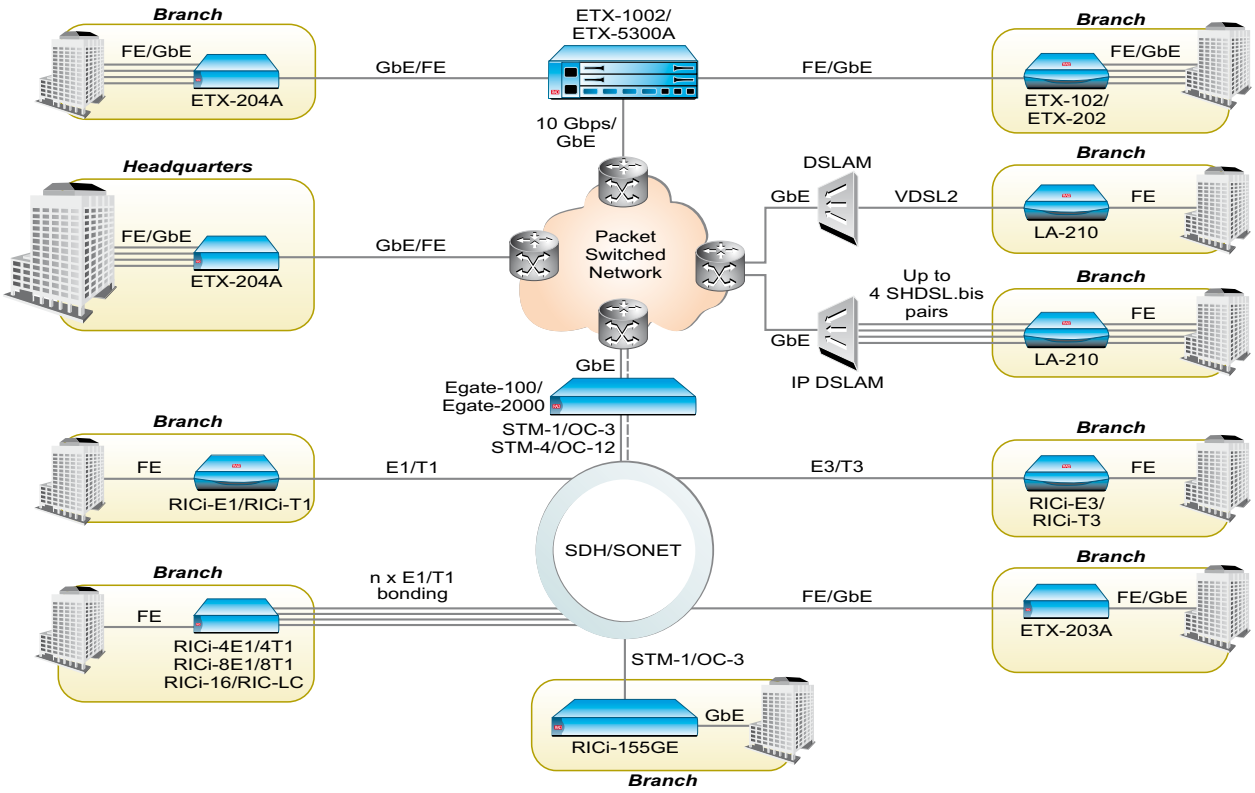
On-Net and Off-Net Ethernet Access

To maintain a competitive edge, service providers must be able to reach as many customers as they can out of their own service area and offer their users a uniform quality of experience, regardless of which access network infrastructure their traffic traverses. At the same time, service providers must have visibility to their users' end points so as to pre-empt service disruptions and avoid costly truck rolls. RAD's product solutions enable them to expand their service reach and introduce new services while effectively managing their on-net and off-network resources to improve throughput and reduce operational costs.

Mobile Backhaul

The adoption of packet-based networks for mobile backhaul is creating new business opportunities for mobile transport operators. Using RAD's mobile demarcation devices, aggregation switches and cell-site gateways, mobile transport providers can increase revenues and reduce backhaul costs of 2G and 3G traffic over any infrastructure. Furthermore, they can deploy these solutions to easily accommodate the increased capacity and network intelligence requirements from new 4G service deployments and bandwidth-rich applications.

Intelligent Ethernet Demarcation for PSN Networks



Description

Ethernet demarcation for EPL, EVPL and E-LAN services with SLA assurance over fiber, bonded circuits, SDH/SONET, and DSL access.

Benefits & Features

- Consistent service delivery over any access with MEF-9 and MEF-14 certified products
- Complete service lifecycle management and end-to-end SLA assurance with test-head functionalities: RFC-2544, 802.3ah, 802.1ag, Y.1731, L2/L3 loopbacks, and more
- Hierarchical QoS for multi-priority CIR and EIR traffic; packet delivery performance with latency, jitter, loss and availability guarantees on a per-flow basis
- Hardware-based OAM enables ultra-fast processing of hundreds of OAM sessions, highly accurate measurements and live-traffic testing
- High availability and service continuity with link redundancy, linear EVC path protection and ring topology

Product Finder

Egate-100/2000 – p.66/52

ETX-102/202 – p. 60

ETX-203A/204A – p.54/56

ETX-1002/5300A – p.65/68

LA-210 – p. 61

RIC-LC – p. 51

RICi-E1/T1/E3/T3 – p. 47

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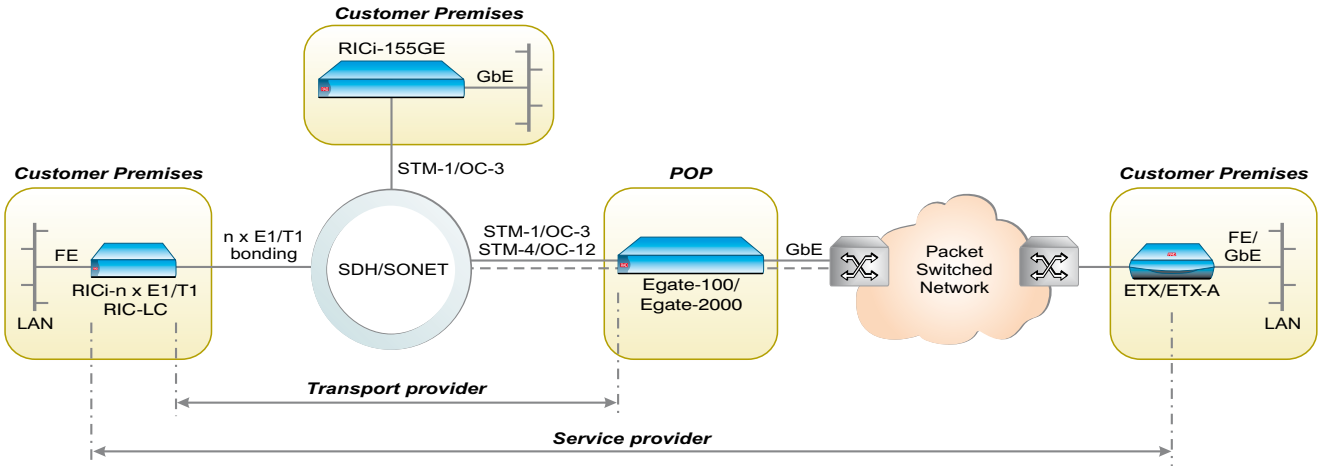
RICi-16 – p. 44

RICi-155GE – p. 48

Ethernet Demarcation over TDM Leased Lines



Product Finder

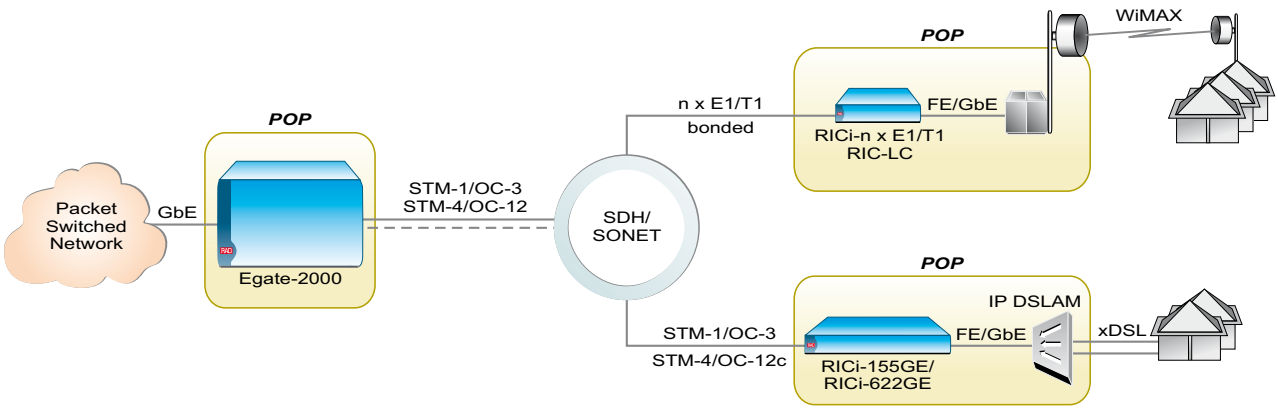
Description

Utilize leased TDM lines to reach out-of-footprint customers for Ethernet services, while ensuring consistent service attributes and end-to-end SLA control across different networks and provider domains.

Benefits & Features

- Extend Ethernet service reach over third-party networks without affecting user experience or service quality
- End-to-end service control and performance measurements using Ethernet service OAM allow SLA verification across the access provider's network
- Provide same service definition for on-net and off-net customers
- Higher bandwidth rates with Ethernet over NG-PDH/SDH encapsulation and bonding standards (GFP, VCAT, LCAS) ensures service quality with hitless restoration, flexible access rate granularity and multi-vendor interoperability

IP DSLAM and WiMAX Backhaul over SDH/SONET



Description

Provide broadband access by backhauling traffic from IP DSLAMs and WiMAX base stations over PDH and SDH/SONET transport with seamless hand-off to a packet switched network.

Benefits & Features

- A variety of access bandwidth rates up to 1 Gbps using GFP, VCAT and LCAS bonding and encapsulation protocols
- Seamless extension and aggregation of Ethernet/IP-based broadband services over TDM infrastructure
- Fast deployment of broadband services
- Reduce OpEx and CapEx by leveraging existing transport infrastructure

Product Finder

Egate-2000 – p. 66

RIC-LC – p. 51

RICi-E1/T1 – p. 47

RICi-4E1/4T1/8E1/8T1 – p. 46

RICi-16 – p. 44

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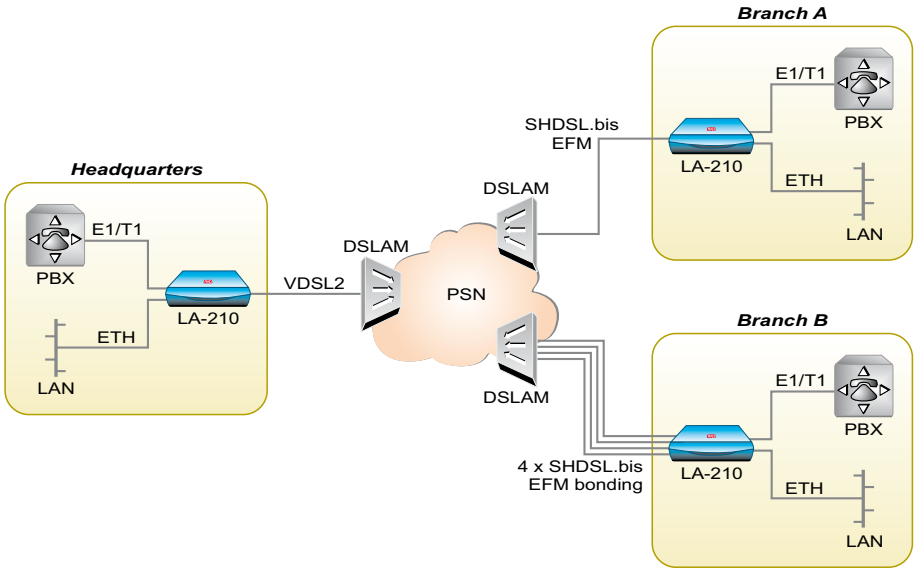
Emulated Legacy Services and Ethernet over Copper DSL



Product Finder

LA-210 – p. 61

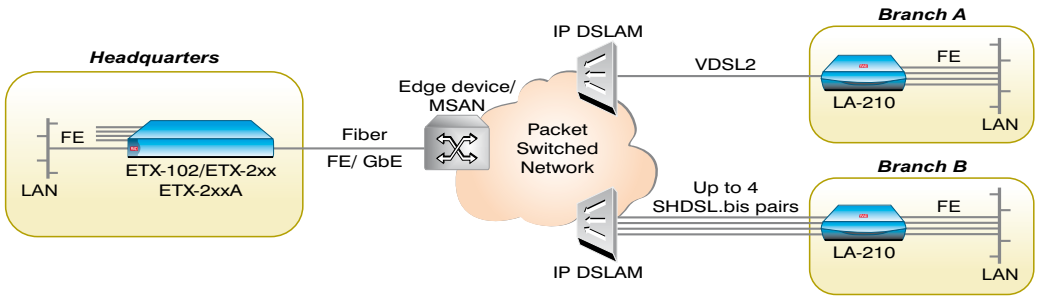
Description

Service providers can take advantage of their IP DSLAM infrastructure to deliver both Carrier Ethernet services and E1/T1 services using the same access link. Service rates can reach up to 22.8 Mbps over EFM-bonded SHDSL.bis pairs, or up to 100 Mbps downstream/50 Mbps upstream over VDSL2 connections.

Benefits & Features

- Single access link for both Ethernet and E1/T1 services
- Ensure legacy service quality and transparent delivery over packet transport with standards-based TDM pseudowire emulation, MPLS and UDP/IP encapsulation and highly accurate clock synchronization
- End-to-end SLAs and service control by employing IEEE 802.1ag and Y.1731 Ethernet OAM mechanisms

Mid-Band and High Speed Ethernet Services Using Fiber and DSL



Description

Provide Layer 2 VPN (virtual private network) services to business users with consistent service attributes over fiber, SHDSL.bis and VDSL2 access.

Benefits & Features

- Up to 22.8 Mbps over EFM-bonded SHDSL.bis pairs, 100 Mbps downstream/50 Mbps upstream over VDSL2 and 10 Gbps over Ethernet fiber
- Deliver SLA-based Ethernet Private Line (EPL), Ethernet virtual private line (EVPL) and Ethernet LAN (E-LAN) services
- Provision differentiated services across diverse access links with Ethernet OAM, performance monitoring and advanced traffic management capabilities

Product Finder

ETX-102/201/202 – p. 60

ETX-203A – p. 56

ETX-204A – p. 54

ETX-220A – p. 57

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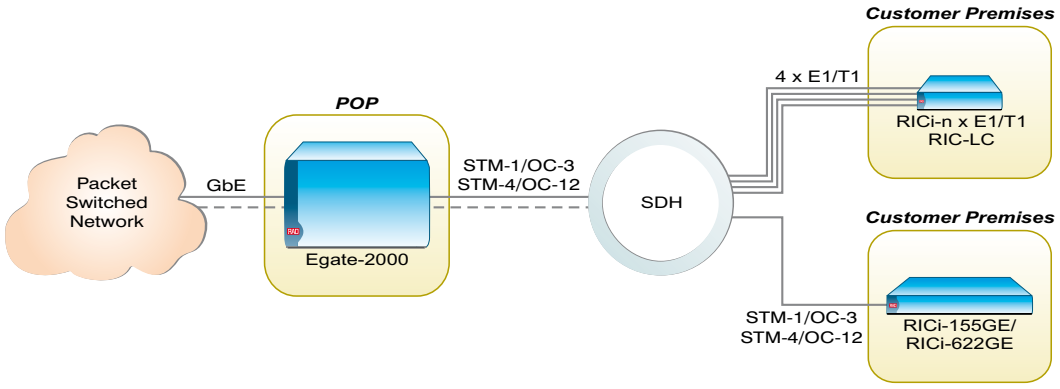
Ethernet Access over PDH and SDH/SONET



Product Finder

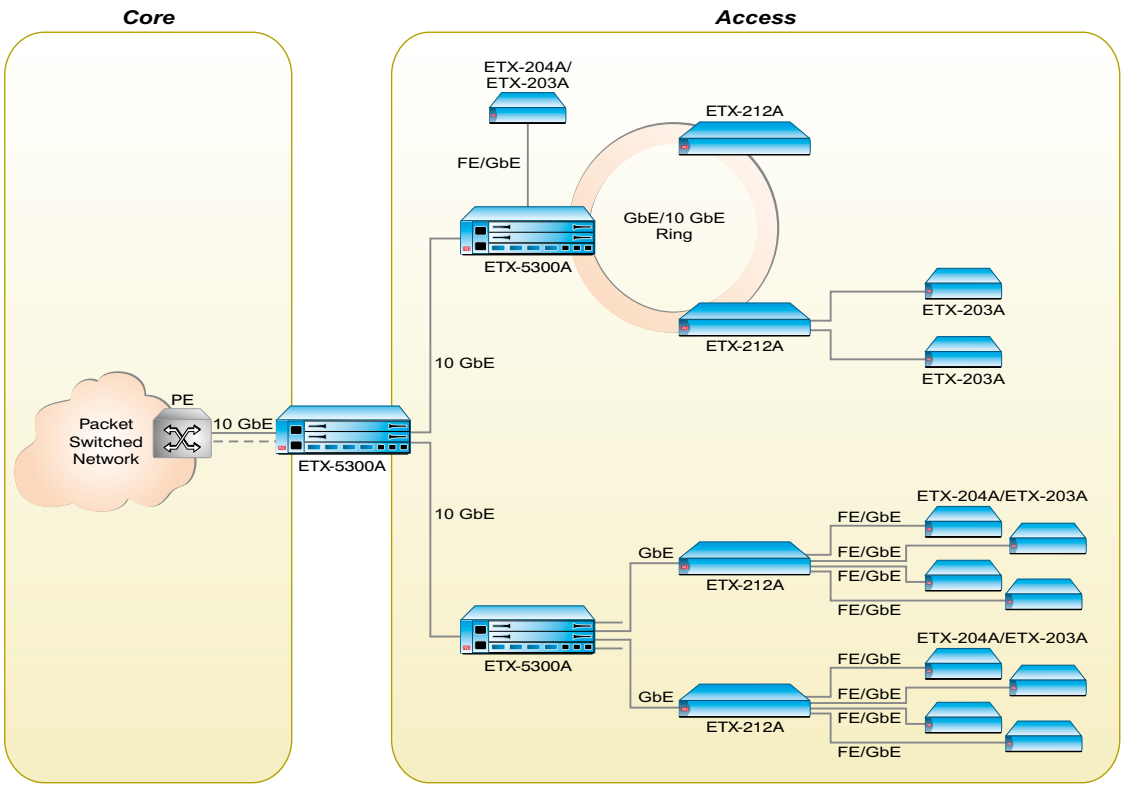
Description

Deploy Carrier Ethernet services over widely available TDM infrastructure with hand-off to PSN. Offer granular access rates and ensure end-to-end SLA management.

Benefits & Features

- Seamless GbE/FE connectivity over PDH and SDH/SONET access infrastructure
- Rate versatility from E1/T1/E3/T3 to STM-4/OC-12 with multi-GbE grooming and aggregation
- End-to-end management of EPL, EVPL and E-LAN services
- Hard QoS for multi-priority traffic from the customer premises
- Clear network visibility with Ethernet OAM and performance monitoring

Ethernet Access Aggregation



Description

Aggregate SLA-backed, QoS-differentiated Carrier Ethernet services in access and metro networks, while ensuring high level of resiliency and reliability for effective network and service control.

Benefits & Features

- Intelligent Ethernet demarcation and aggregation devices in hub-and-spoke or ring deployments
- Scalable 1-Gigabit and 10-Gigabit Carrier Ethernet fiber rings with sub-50 ms switchover protection for high availability and service continuity
- End-to-end management of EPL, EVPL, E-LAN and E-Tree services
- True SDH/SONET replacement with hard QoS, Ethernet OAM and performance monitoring

Product Finder

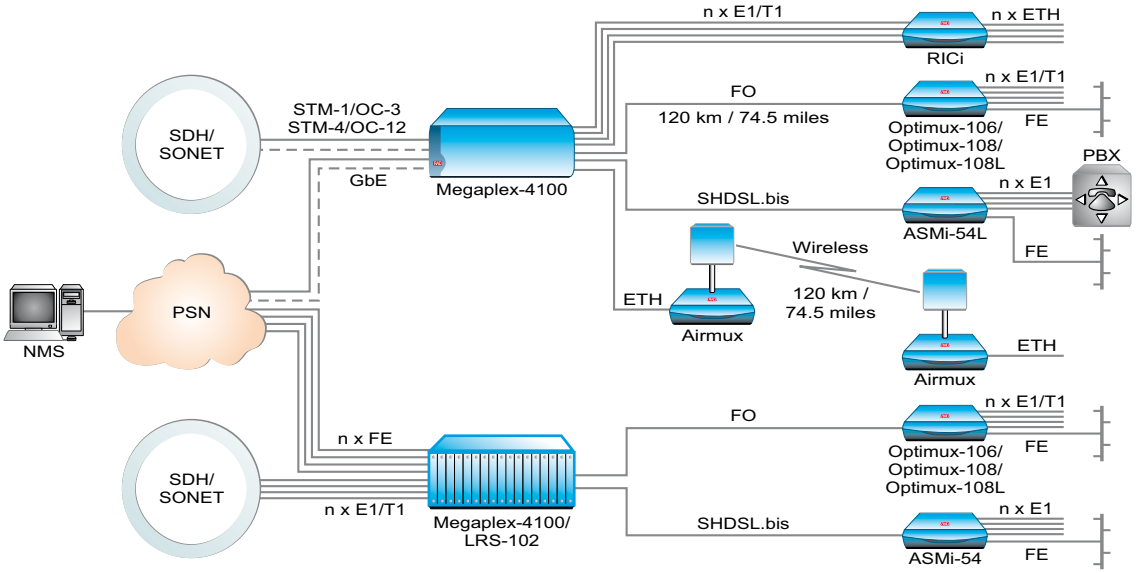
ETX-203A – p. 56

ETX-204A – p. 54

ETX-212A – p. 58

ETX-5300A – p. 68

First Mile Connectivity and Service Extension



Product Finder

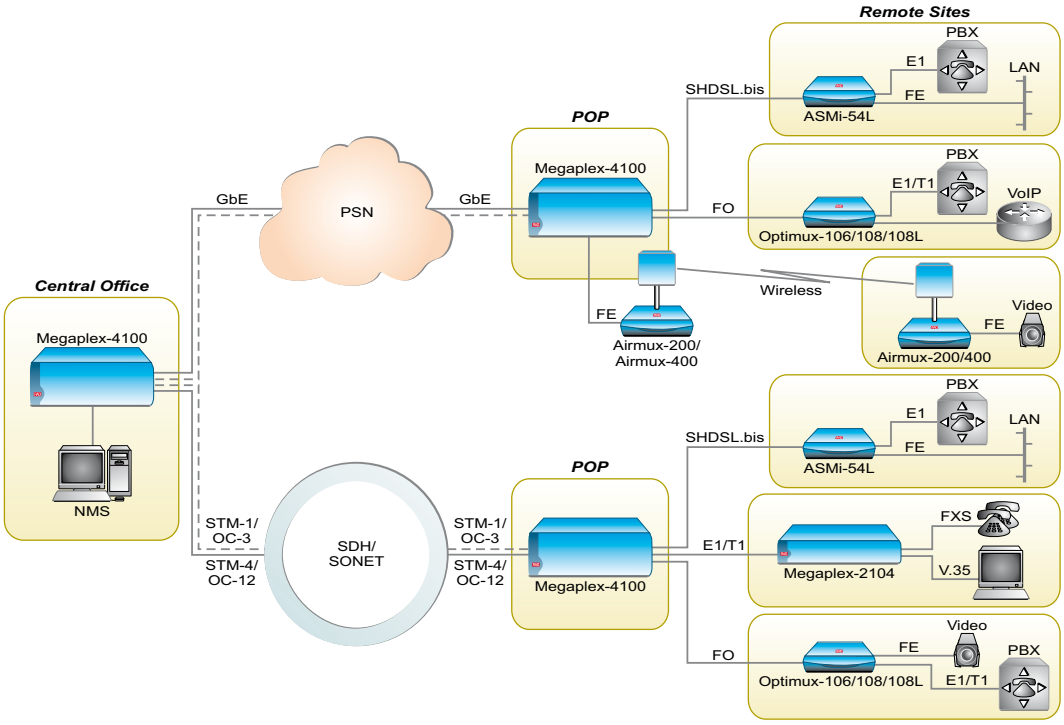
Description

Extend legacy leased lines, TDM (E1/T1) services and new Ethernet services over E1/T1, fiber optic, SHDSL.bis and wireless First Mile connections, with multiservice aggregation and simultaneous hand-off to SDH/SONET and packet cores.

Benefits & Features

- Increase service coverage and customer reach over any access; introduce new Ethernet services to remote locations
- Flexible aggregation and grooming with high granularity from DS0 to STM-4/OC-12
- Rich offering with the AXCESS+ portfolio: Multiservice multiplexers and access nodes, ADMs, cross connects, DSL/fiber modems and wireless radios
- Cost-efficient migration path from legacy TDM to next-generation PSN
- Unified RADview management system for all CPE and central-site devices

Migrating Carrier TDM Networks and Services to Packet Technology



Description

Economical migration path to next-generation networks and services with future-proof AXCESS+ solutions. Multiservice CPEs feature TDM and Ethernet support, while the same aggregation devices remain in place during and after the migration from SDH/SONET to packet transport.

Benefits & Features

- Introduce new Ethernet services for revenue growth
- Deliver TDM and Ethernet services over SDH/SONET and PSN with copper, fiber and wireless access
- Native Ethernet and TDM traffic delivery minimizes transmission delays
- Reduce costs and increase efficiency by combining legacy services with new Ethernet applications over the same link
- Ensure service continuity for legacy applications over packet with TDM circuit emulation, clock recovery functionality, differentiated quality of service, and end-to-end OAM

Product Finder

Airmux-200 – p. 135

Airmux-400 – p. 134

ASMi-54L – p. 128

Optimux-106/108 – p. 116

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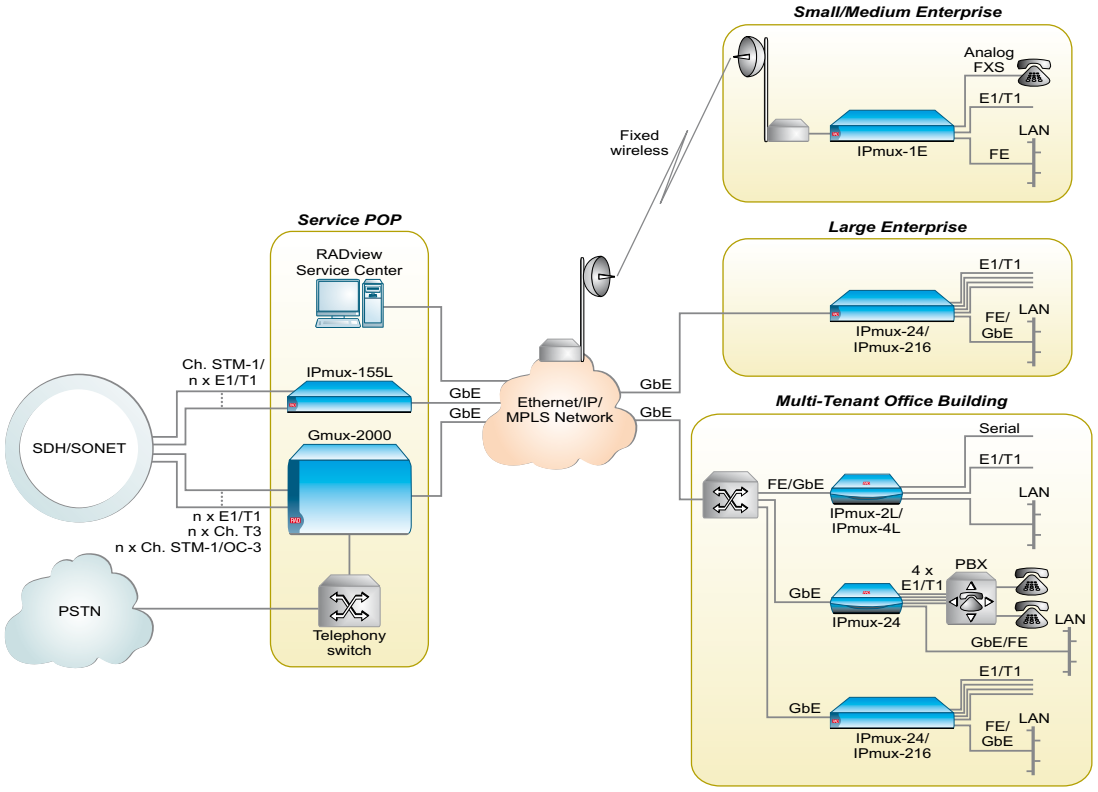
Megaplex-2104 – p. 92

Megaplex-4100 – p. 88

Circuit Emulation for Leased Line and LAN Services over Ethernet



Product Finder

Description

Use circuit emulation to seamlessly deliver leased line services (TDM and serial data) and LAN traffic over new Ethernet and packet transport. Quick, low cost and non-disruptive migration of PSTN access and PBX backhaul to economical packet switched networks with RAD's TDM pseudowire solutions.

Benefits & Features

- Reduce network operating costs by streamlining all carrier services over economical PSNs, while maintaining support of existing customer equipment
- A full range of circuit emulation CPEs support legacy services including analog voice, serial data and n x E1s/T1s, as well as new MEF-certified services
- High port density, small footprint and low power consumption reduce POP/CO costs
- TDM service quality with standards-compliant pseudowire emulation per TDMoIP, CESoPSN and SAToP; high precision clock recovery for minimal latency and ring protection for service resiliency
- Ethernet QoS, traffic management and end-to-end OAM

Utilities and Transportation

Utilities and transportation environments present several unique challenges to any network designer. They typically must support a wide variety of communications applications. These range from analog control circuits, low speed data, TDM circuits, digital and analog voice (including Omnibus), and mobile, to video surveillance, LAN traffic, broadband Internet access, and Wi-Fi. Network topologies can vary from daisy-chain to star or ring designs. Additionally, utility and transportation networks must be highly reliable and resilient due to the critical nature of the traffic they carry and the enhanced security environment in which they operate.

Utilities

Power
Provide reliable transmission of mission-critical Teleprotection data and real-time video between power plant control centers and remote sites.

Gas and Oil
Enable connectivity to remote gas and oil platforms and distribution facilities. Support a wide variety of voice, data and video surveillance applications across links with limited and/or expensive bandwidth such as satellite.

Water
Provide reliable communications to distributed locations, such as pumping stations, treatment plants and control rooms.

Pipelines
Enable add/drop communications in a daisy-chain configuration across long distances. Support voice, data and video surveillance applications with high reliability over limited bandwidth and resiliency.

Transportation

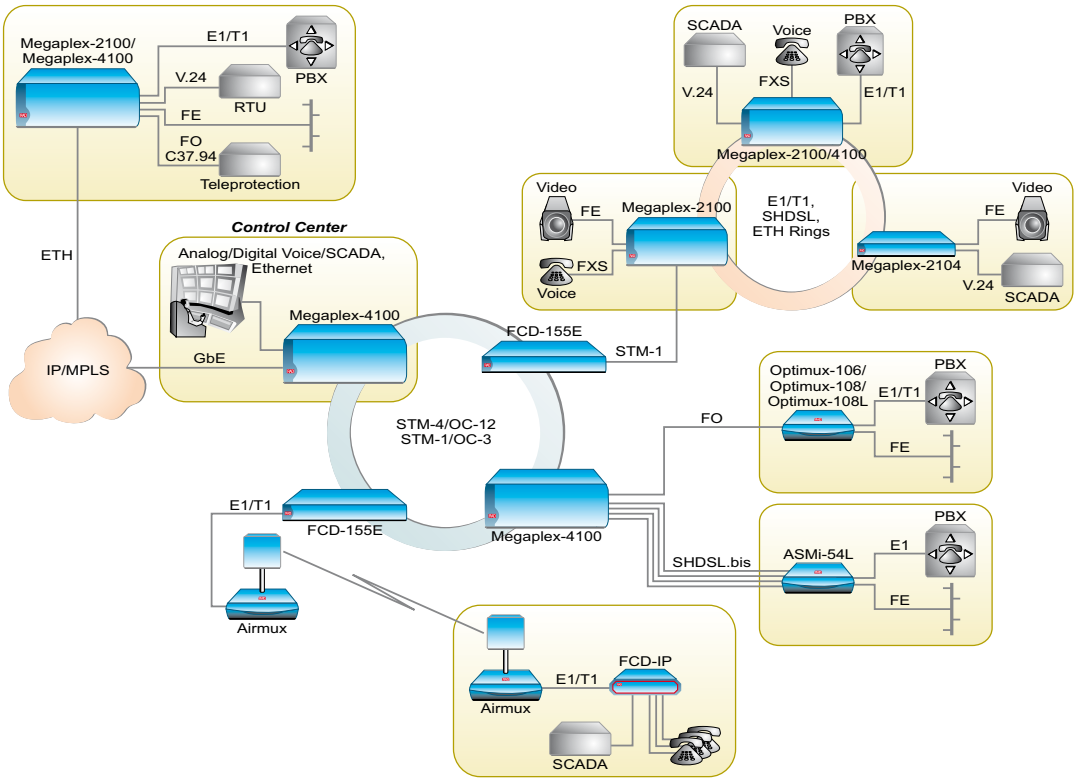
Rail
Provide reliable and efficient communications for a wide variety of applications, ranging from Omnibus voice, track signaling and control, to train schedule display panels and ticketing terminals in stations.

Motorways
Enable efficient communications between digital message boards along the highway and centralized control facilities.

Air
Ensure highly reliable and resilient communications for all aspects of airline, airport and air traffic control operations.

Maritime
Provide reliable and efficient ship-to-shore communications for applications, including navigation data, voice, Ethernet, and GSM connectivity, as well as maritime traffic control operations.

Service Multiplexing for Substations and Remote Locations



Product Finder

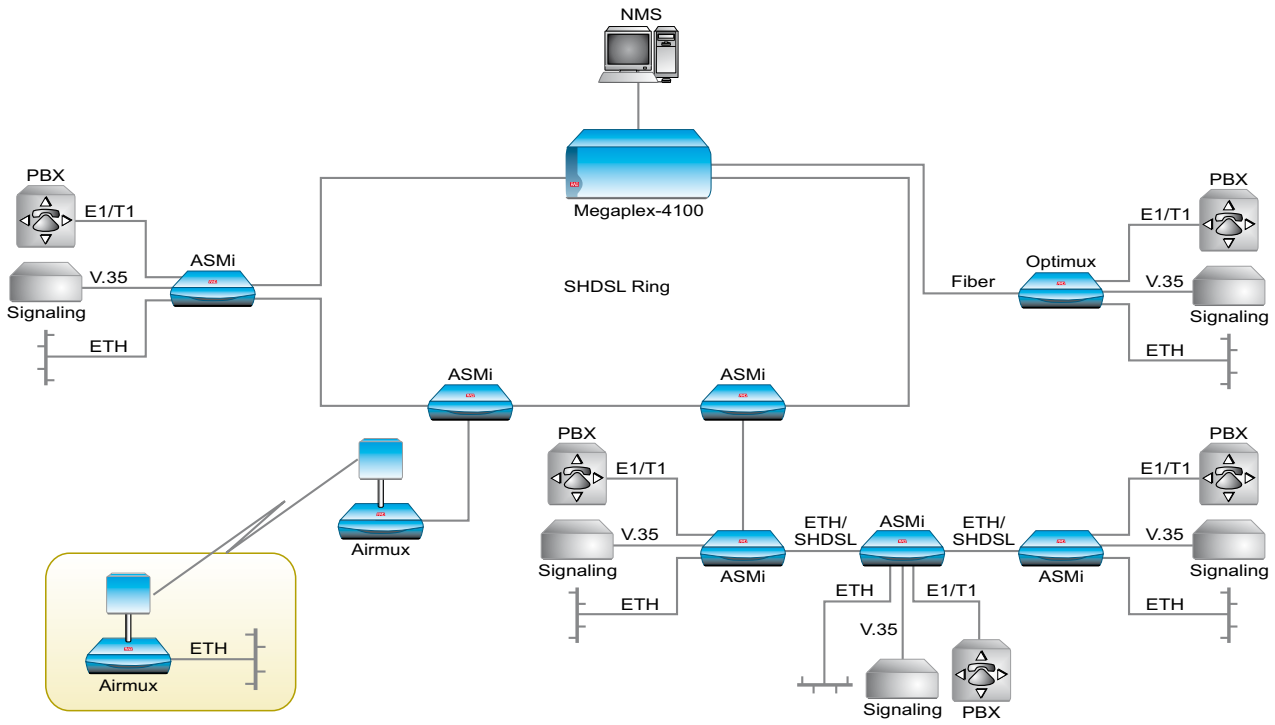
Description

Reliable, accurate and immediate delivery of critical TDM and Ethernet traffic between central control and multiple remote locations over fiber optic, copper, or wireless connections. Ensure high availability and service resiliency with comprehensive redundancy and link protection options.

Benefits & Features

- Deliver SCADA, voice, video, LAN, and data traffic with multiservice single-box solutions
- DS0 cross connect for grooming of fractional E1/T1 links to full TDM fiber trunks
- Self-healing E1/T1, SDH/SONET and Ethernet ring topologies with sub-50 ms restoration
- Carrier-class central management system offers easy integration with OSS and umbrella systems
- Small footprint saves rack space and power consumption, as well as cabling and cooling resources

Service Extension over DSL and Fiber



Description

Enable service extension across long distances while reducing the costs associated with connecting geographically dispersed locations with multidrop (daisy-chain) installations. Easy implementation of ring topology when additional link/service protection is required.

Benefits & Features

- Connect remote devices and services, such as video surveillance cameras, signaling equipment and analog phones over E1/T1, DSL, fiber optic, or wireless connections
- Ensure reliable communications across long distances (10 km/6.2 miles over SHDSL or 120 km/74.5 miles over fiber) with data transmission rates of up to 22.8 Mbps (SHDSL) or 100 Mbps (FO/wireless)
- Ruggedized enclosures for outdoor deployments; dedicated devices for trackside deployments
- Multi-rate TDM and Ethernet ring support for sub-50 ms restoration and a cost-effective alternative to multilink connectivity

Product Finder

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Airmux-400	– p. 134
ASMi-52	– p. 131
ASMi-54/54L	– p. 128
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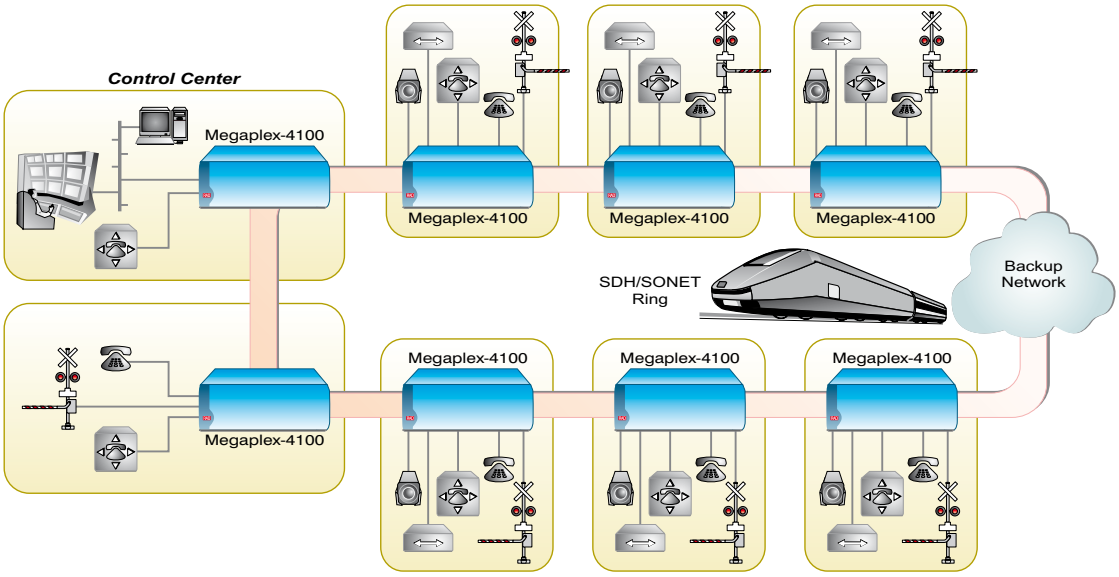
Protected Multi-Station Connectivity



Product Finder

Megaplex-4100 – p. 88

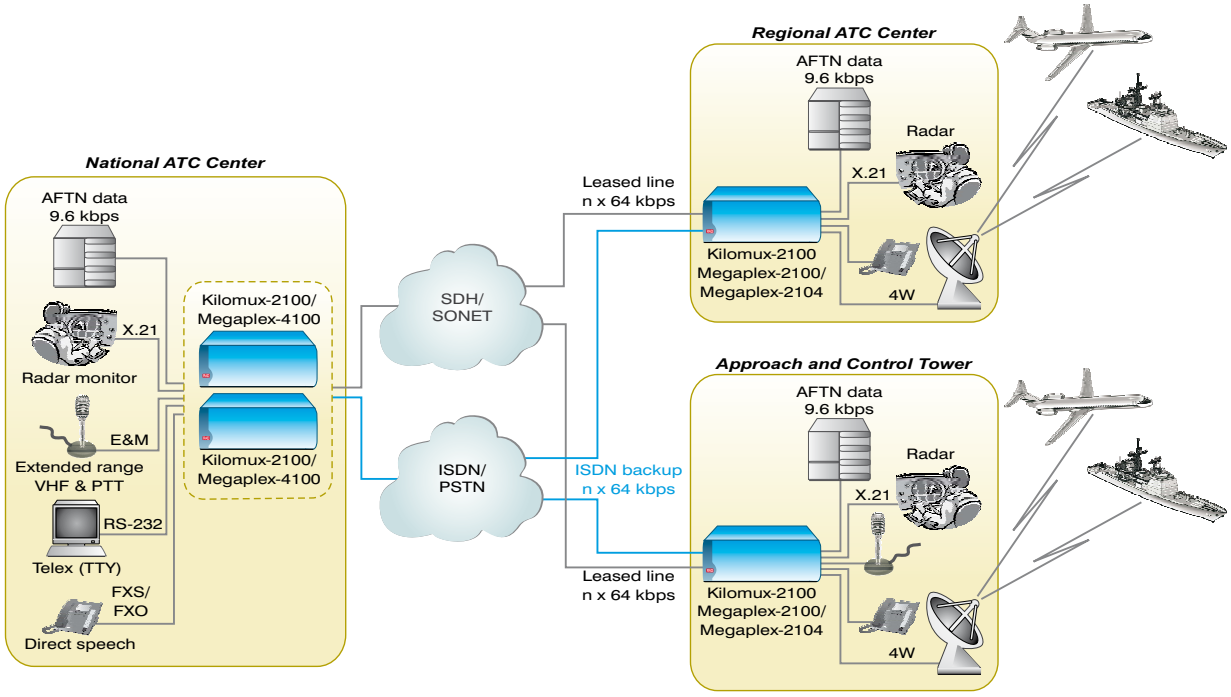
Description

Ensure protected connectivity for mission-critical railway applications, including automatic train supervision (ATS), centralized traffic control (CTC), SCADA, multi-party hotlines, and passenger information systems (PIS) between stations and control room using multidrop and ring topologies.

Benefits & Features

- Wide range of protected ring capacities: 622 Mbps, 155 Mbps, 100 Mbps, 45 Mbps, 20 Mbps, 2 Mbps, 1.5 Mbps
- Provide no single point of failure (NSPF) resiliency for critical applications
- High ring granularity at E1/T1 or VC-12/VT 1.5 level allows bandwidth optimization over copper, dark fiber and SDH/SONET

Air Traffic Control and Maritime Communications



Description

Ensure uninterrupted air-ground communications between aircrafts or vessels, control towers, and traffic control centers with RAD's multiservice connectivity solutions for air traffic control and maritime communications.

Benefits & Features

- Deliver direct speech (DS), Telex (TTY), radar data (RD), extended range VHF (ER), and VHF data link (VDL) traffic, together with other voice, fax and LAN services using industry standard interfaces
- Transport traffic over copper, fiber, microwave, or satellite links
- Optimized for sub-rate leased line transmission and dialed backup to reduce OpEx
- Ruggedized platforms withstand the rigors of field operations
- Support fail-safe operations with ISDN or VSAT backup

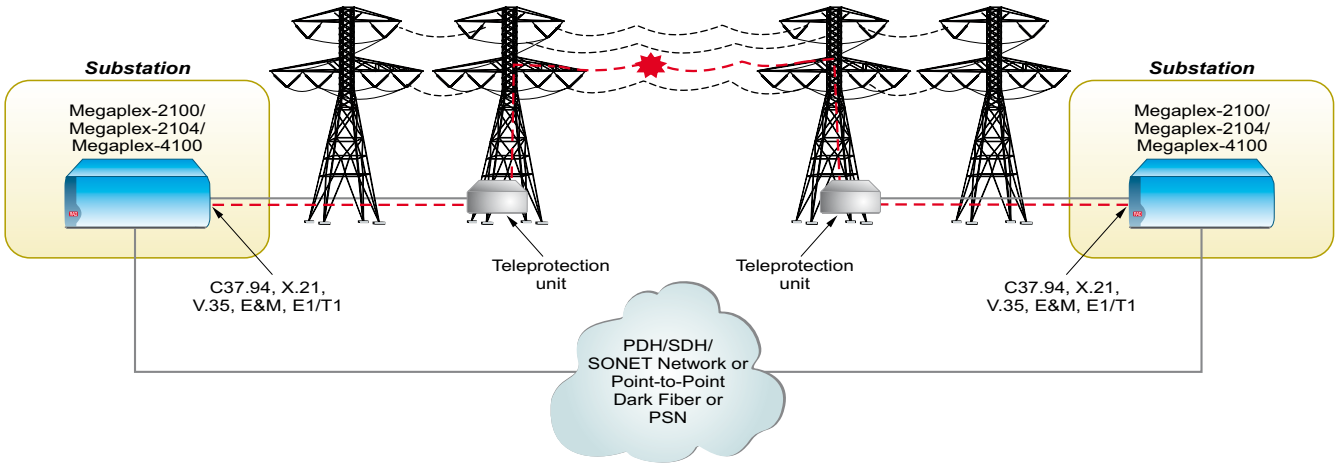
Product Finder

Kilomux-2100 – p. 113

Megaplex-2100/2104 – p. 92

Megaplex-4100 – p. 88

Teleprotection Connectivity



Product Finder

Megaplex-2100/2104 – p. 92

Megaplex-4100 – p. 88

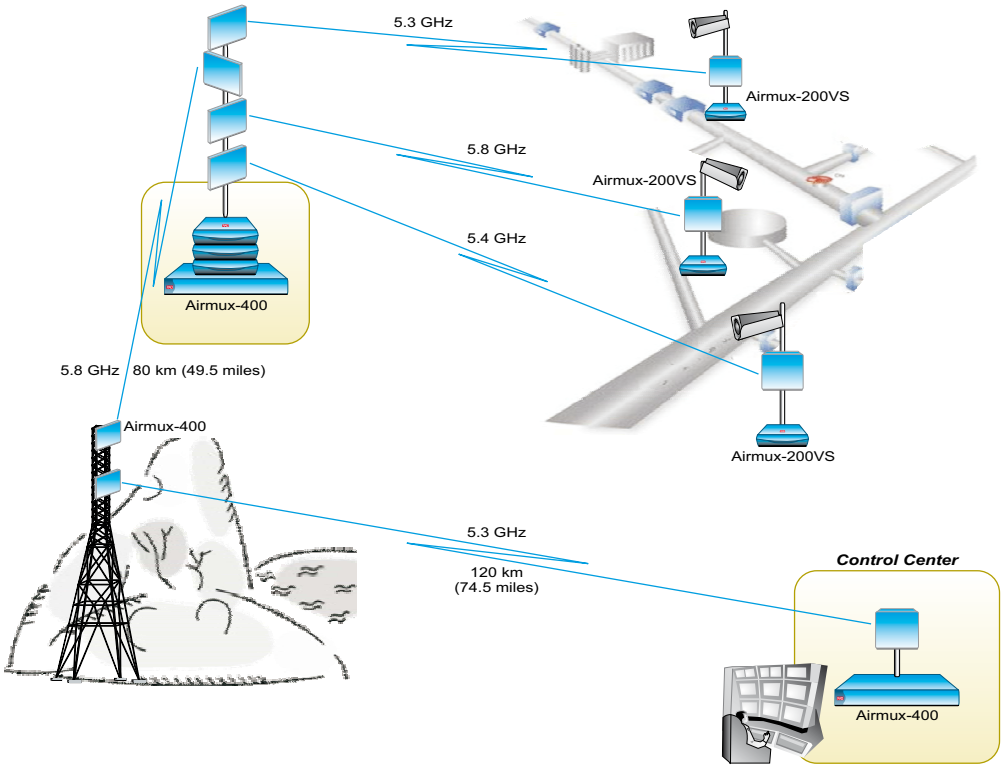
Description

Enable mission-critical accuracy for Teleprotection signal delivery over TDM or IP without requiring dedicated fiber.

Benefits & Features

- A wide variety of Teleprotection communication channel interfaces including C37.94, X.21, E1/T1, E&M, and V.35
- Reduce CapEx and OpEx with a single-box solution for all substation communications services, including Teleprotection signals
- Ultra-low end-to-end propagation delay supports immediate delivery of Transfer Trip commands from protective relay/contact transfer to remote-end substations
- Maintain performance levels for mission-critical applications when migrating to packet networks with definitive QoS, high priority delivery and robust latency and jitter protection

Video Surveillance over Wireless for Public Utilities



Description

Backhaul high definition video feeds from remote facilities and substations over high speed sub-6 GHz microwave links. Quick deployments at minimal cost by operating at unlicensed radio bands.

Benefits & Features

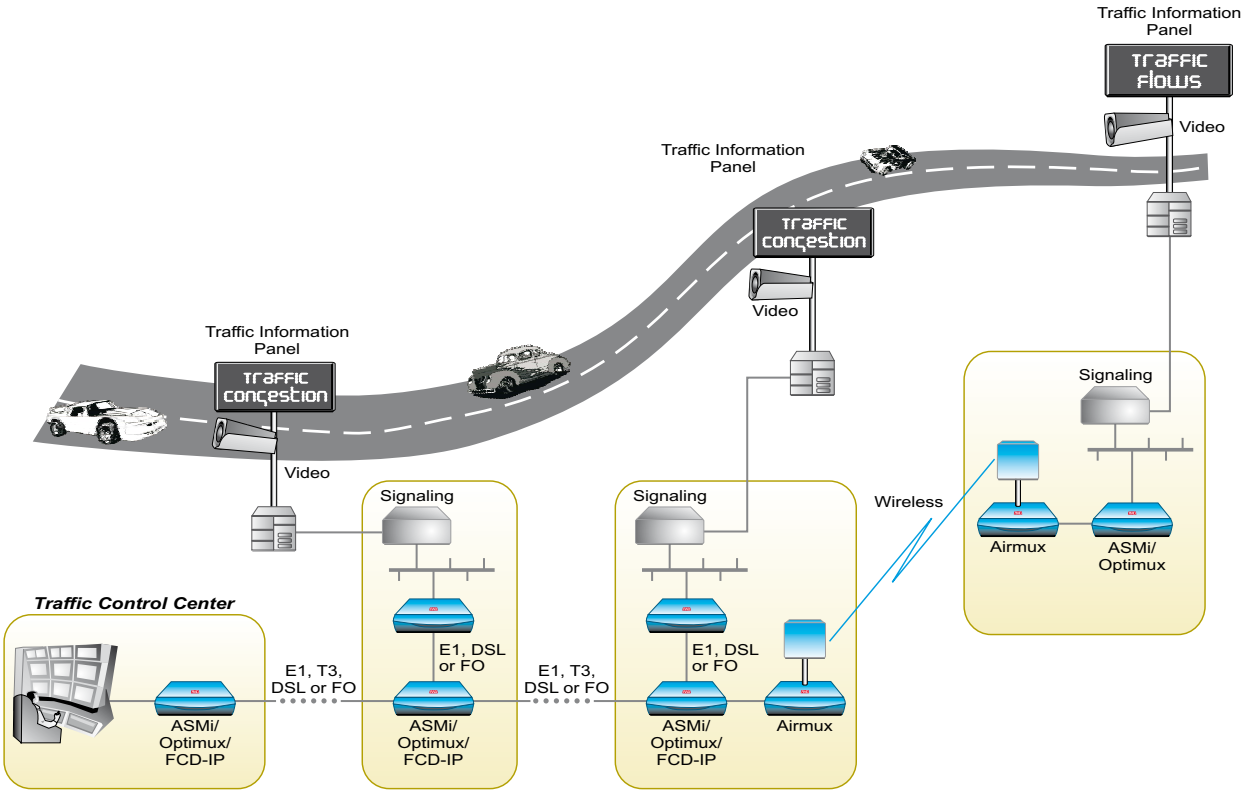
- Monitor remote and unmanned facilities with point-to-point and multipoint-to-point broadband wireless multiplexers
- Net payload throughput of up to 100 Mbps and a maximum transmission distance of up to 120 kilometers (74.5 miles)
- Cost-optimized for megapixel camera transmissions with asymmetric 2 Mbps uplink/5 Mbps downlink capacity, for economical use of available bandwidth
- Hub-site synchronization (HSS) and monitored hot standby (MHS) enable simultaneous transmission to multiple locations with high availability and service reliability

Product Finder

Airmux-200 – p. 135

Airmux-400 – p. 134

Highway Communications



Product Finder

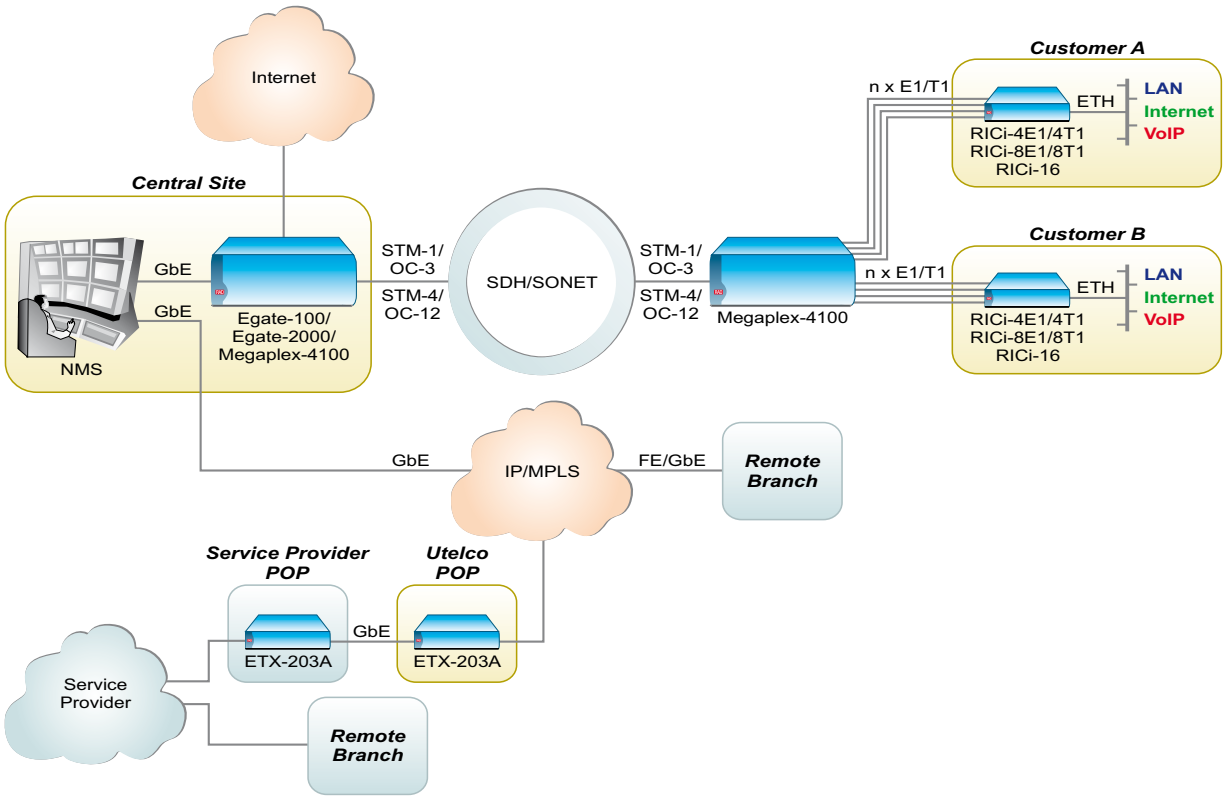
Description

Connect communications from electronic highway message boards, IP video cameras, telephony equipment, and roadside signaling devices to traffic control centers over TDM, copper DSL, fiber optic, or wireless infrastructure.

Benefits & Features

- Multidrop connectivity solutions for cost-effective service extension over long distances
- Unified remote management for all devices
- Support license plate recognition and other applications requiring bandwidth-intensive transmissions with minimal latency
- Ideal for traffic regulation, accident detection and emergency response applications

Utelco Business Connectivity and Carrier-of-Carrier Services



Description

Enable utility companies to easily and cost-effectively increase revenues by leveraging their footprint to provide competitive retail and wholesale communications services.

Benefits & Features

- Take advantage of increasing deregulation to deliver Internet access, VoIP, LAN extension, and SAN services to enterprises with centralized management
- Offer service providers leased bandwidth, shared access and other carrier-of-carrier services, to allow them to reach out-of-footprint customers
- Wide range of TDM and Ethernet CPEs, demarcation devices and aggregation switches for business and wholesale customers support differentiated QoS, Ethernet OAM and end-to-end performance monitoring

Product Finder

Egate-100 – p. 52

Egate-2000 – p. 66

ETX-203A – p. 56

Megaplex-4100 – p. 88

RICi-4E1/4T1/8E1/8T1 – p. 46

RICi-16 – p. 44

Enterprise and Government

Government and Public Safety
Governments are upgrading their networks and systems to enable, among other things, Web-based access to resources, real-time collaboration, video conferencing, video surveillance, and improved inter-agency communications. With a wide assortment of devices and systems in place – some dozens of years old – the communications network needs to be able to support both legacy interfaces as well as leading-edge communications technologies, for example, migrating TETRA networks to packet-based infrastructures.

Education
Educational institutions are very focused on cost-effective solutions with rapid ROI. RAD Data Communications offers versatile solutions via fiber, copper or wireless to support virtually any type of communications protocol or network topology, enabling the creation of an integrated communications network.

Financial Services
RAD offers various solutions tailored to the demanding requirements of today's trading and financial services environment. These include support for TDM-based trader turret connectivity over IP networks as well as Carrier Ethernet demarcation and aggregation devices with powerful SLA enforcement tools for ensuring low latency and high availability.

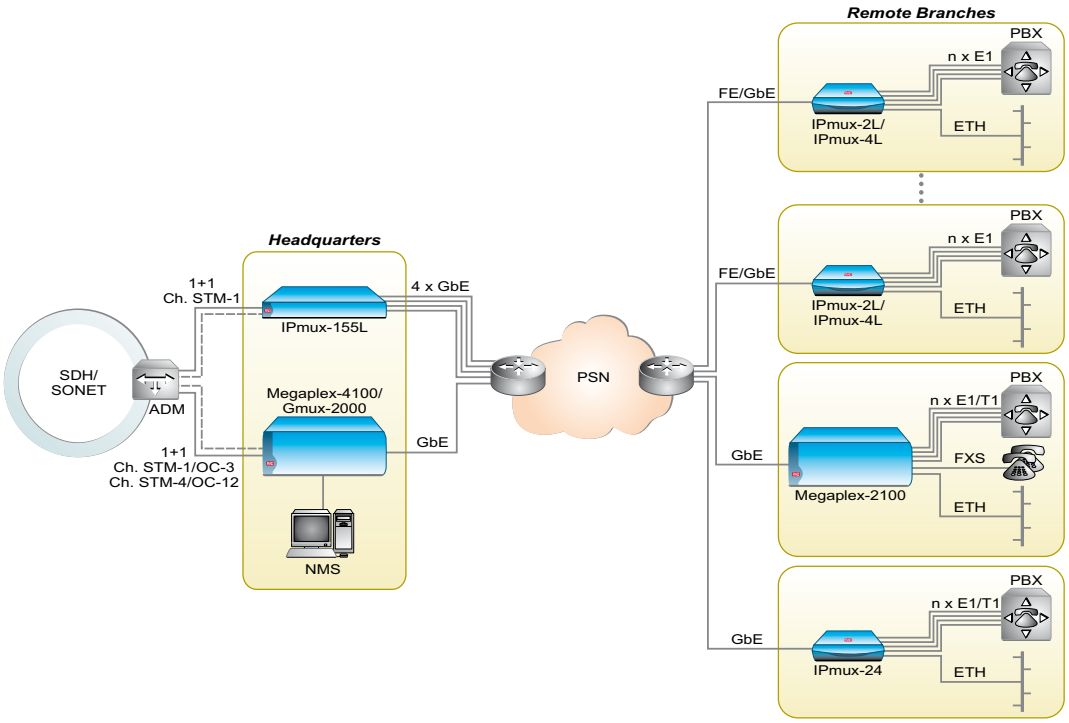
Broadcasting
RAD has a broad portfolio of solutions well suited to the needs of broadcasters. These range from voice compression gateways, which are ideal for economically transmitting voice across limited and/or expensive satellite bandwidth, to multiservice access multiplexers, which are frequently employed to terminate the disparate types of communications used by broadcasters.

Healthcare
Medical imaging, telemedicine, regulatory compliance, pharmaceuticals management, and administrative requirements are placing a huge burden on existing communications and data networking systems. These activities necessitate high performance, real-time connectivity across multiple locations.

Manufacturing
Real-time collaboration with suppliers, videoconferencing, migration of shop floor control networks to Ethernet, and online linkages with parts manufacturers, are just a few examples forcing manufacturers to deploy the latest communication technologies.

Mining
Frequently situated in remote locations ill-served by existing communications infrastructure, natural resource extractors need to build highly efficient communications network uplinks via satellite and/or wireless connections.

PBX, Analog Voice and Data over Ethernet



Description

Reduce the costs of traditional voice and Ethernet services for enterprises over packet switched access networks. Allow multi-site organizations to reduce their OpEx and simplify operations by seamlessly converging next-generation data applications and legacy PSTN services over packet.

Benefits & Features

- Support legacy TDM user equipment and services while reducing transport costs; transparent voice connectivity maintains all PBX features seamlessly
- Economical aggregation in small POPs with high port density, small footprint and low power consumption
- Same Ethernet service hand-off is used for both voice and data services
- Ensure TDM service quality over packet with a full range of standard TDM circuit emulation modes: TDMoIP, CESoPSN, SAToP, HDLCoPSN, and CESoEth (MEF-8)

Product Finder

Gmux-2000 – p. 156

IPmux-2L/4L – p. 152

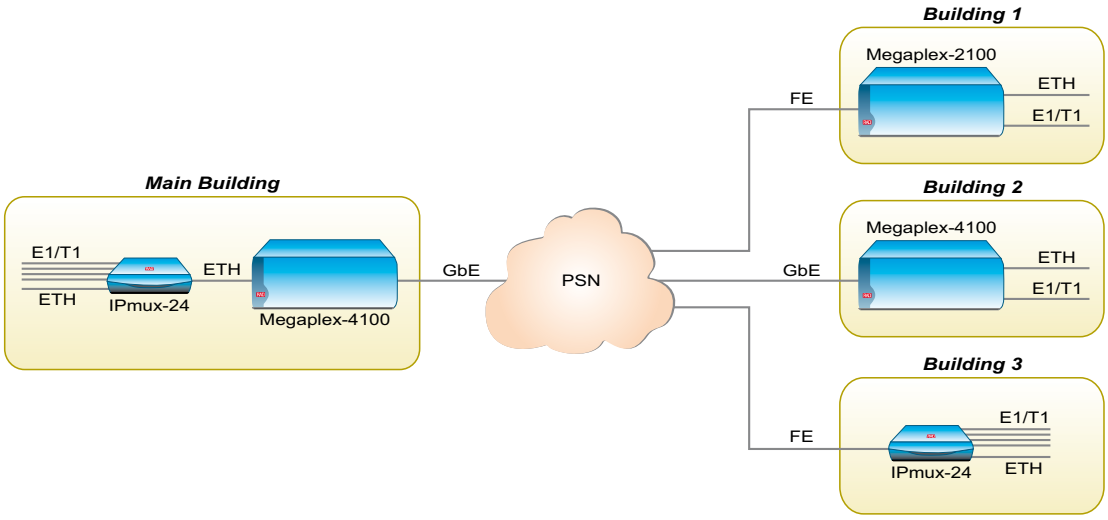
IPmux-24 – p. 150

IPmux-155L – p. 154

Megaplex-2100 – p. 92

Megaplex-4100 – p. 88

Multiservice Campus Connectivity over Ethernet



Product Finder

IPmux-24 – p. 150

Megaplex-2100 – p. 92

Megaplex-4100 – p. 88

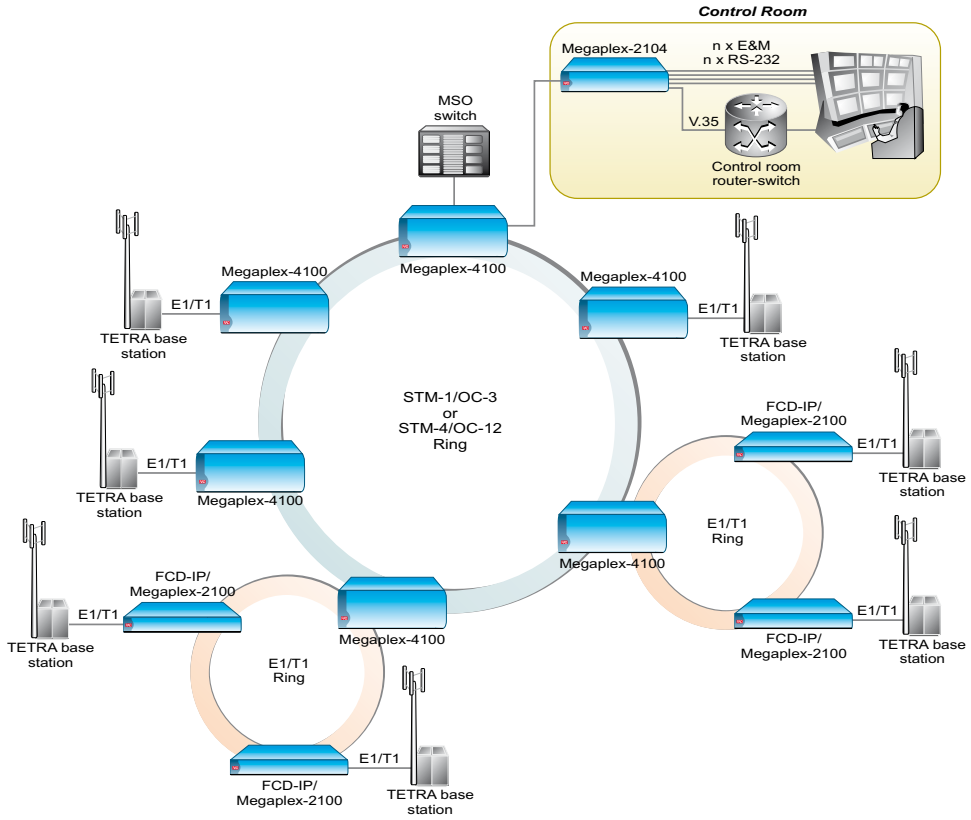
Description

Converge legacy services (voice, E1/T1) and Ethernet traffic over private packet networks for high speed, low cost intra-campus connectivity.

Benefits & Features

- Seamlessly transport TDM traffic over PSN with a full range of standard TDM circuit emulation modes: TDMoIP, CESoPSN, SAToP, HDLCoPSN, and CESoEth (MEF-8)
- Reduce costs of multi-building campus communications with efficient use of fiber infrastructure
- Enhance user experience by supporting next-generation broadband applications

TETRA and Two-Way Radio Backhaul



Description

Connect remote dispatcher and TETRA (terrestrial trunked radio) control rooms with MSO (main switching office) sites and TETRA switches over TDM links, while ensuring service resiliency and high availability. Scalable capacity supports bandwidth range from E1/T1 to STM-4/OC-12.

Benefits & Features

- Resilient ring topologies to ensure fail-safe communications of TETRA V+D (voice and data), high speed TEDS (TETRA enhanced data services) and PMR (professional mobile radio) traffic
- Future-proof systems eliminate the need for deploying new equipment as the network is upgraded from TDM to IP
- Extensive experience with TETRA radio equipment from major vendors to provide standards-based interoperability
- Simplify network monitoring and control with remote management

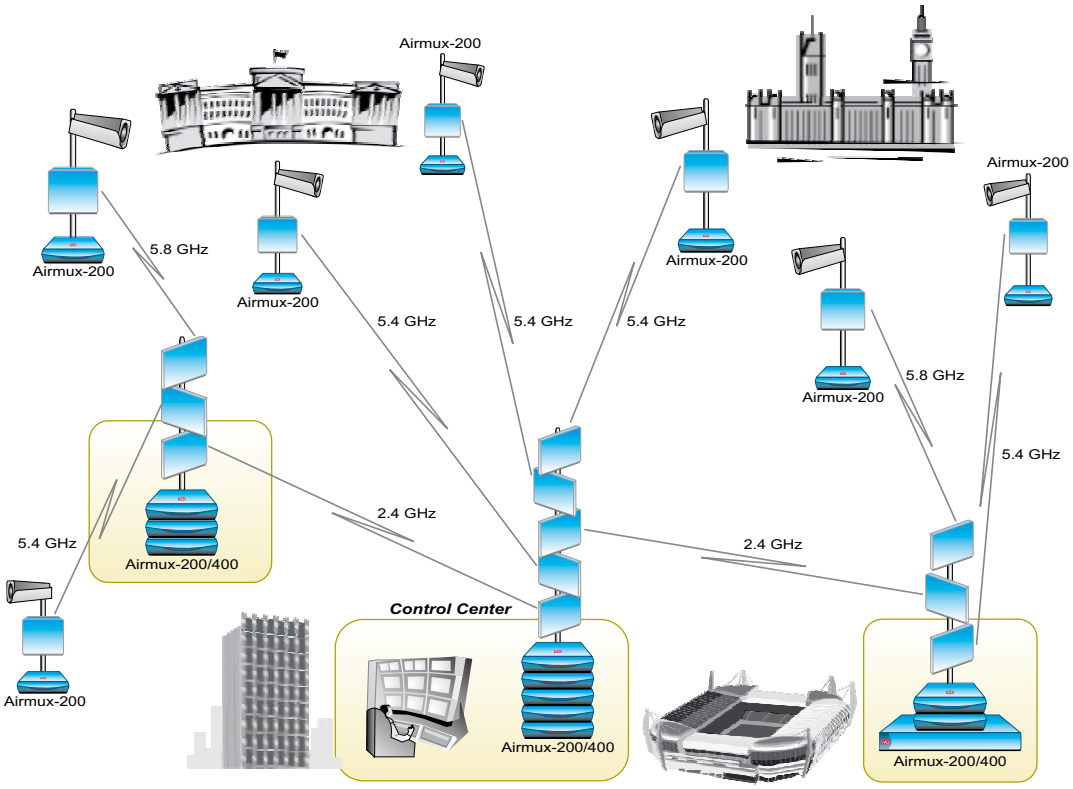
Product Finder

FCD-IP – p. 110

Megaplex-2100/2104 – p. 92

Megaplex-4100 – p. 88

Backhauling Urban Surveillance Video over Wireless Infrastructure



Product Finder

Airmux-200 – p. 135

Airmux-400 – p. 134

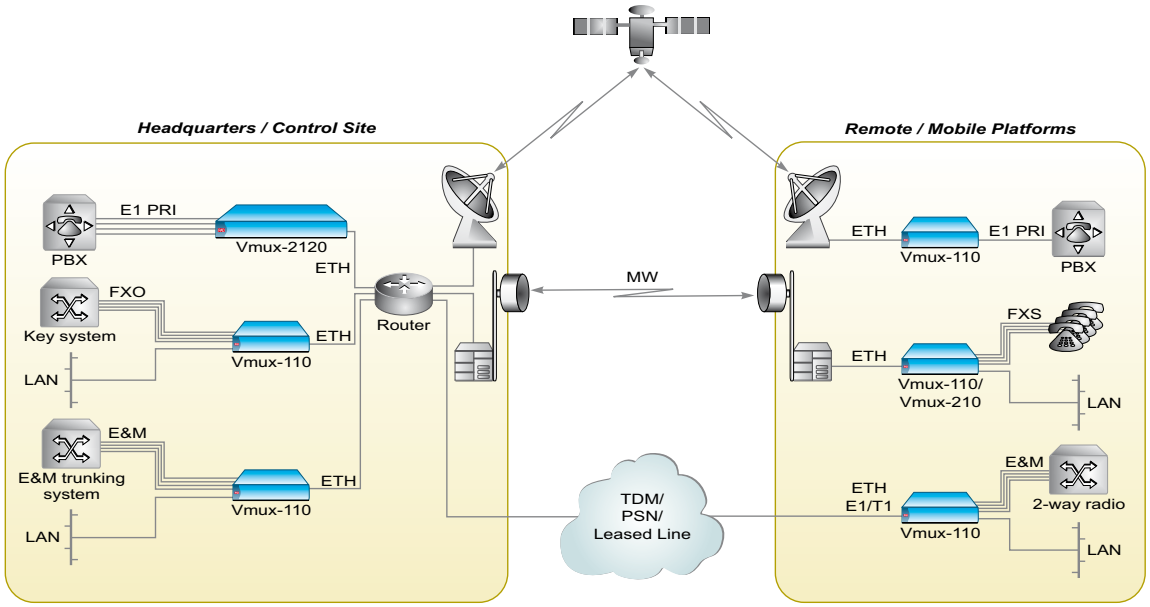
Description

Carrier-class point-to-point and multipoint-to-point sub-6 GHz transmission system connects security cameras in metropolitan areas for public safety and crime prevention, as well as for ad-hoc event installations.

Benefits & Features

- Backhaul bandwidth-intensive traffic from high definition IP cameras, while supporting real-time alerts, image analysis and face recognition applications
- Net payload throughput of up to 100 Mbps and a maximum transmission distance of up to 120 kilometers (74.5 miles)
- Enable fast and affordable deployments with license-exempt transmission

Voice Compression for Satellite Applications



Description

RAD's Vmux voice trunking gateways reduce the costs and increase the capacities involved in extending voice services over satellite, as well as over microwave radio links or over TDM and PSN leased lines.

Benefits & Features

- Significant bandwidth reduction (up to 16:1) translates to large cost savings and rapid ROI
- Transparent to all telephony features
- Compact, scalable and simple to deploy
- Ideal for oil/gas, maritime, broadcasting, emergency response, and government/military communications

Product Finder

Vmux-110 – p. 146

Vmux-210 – p. 145

Vmux-2120 – p. 144

Mobile Backhaul

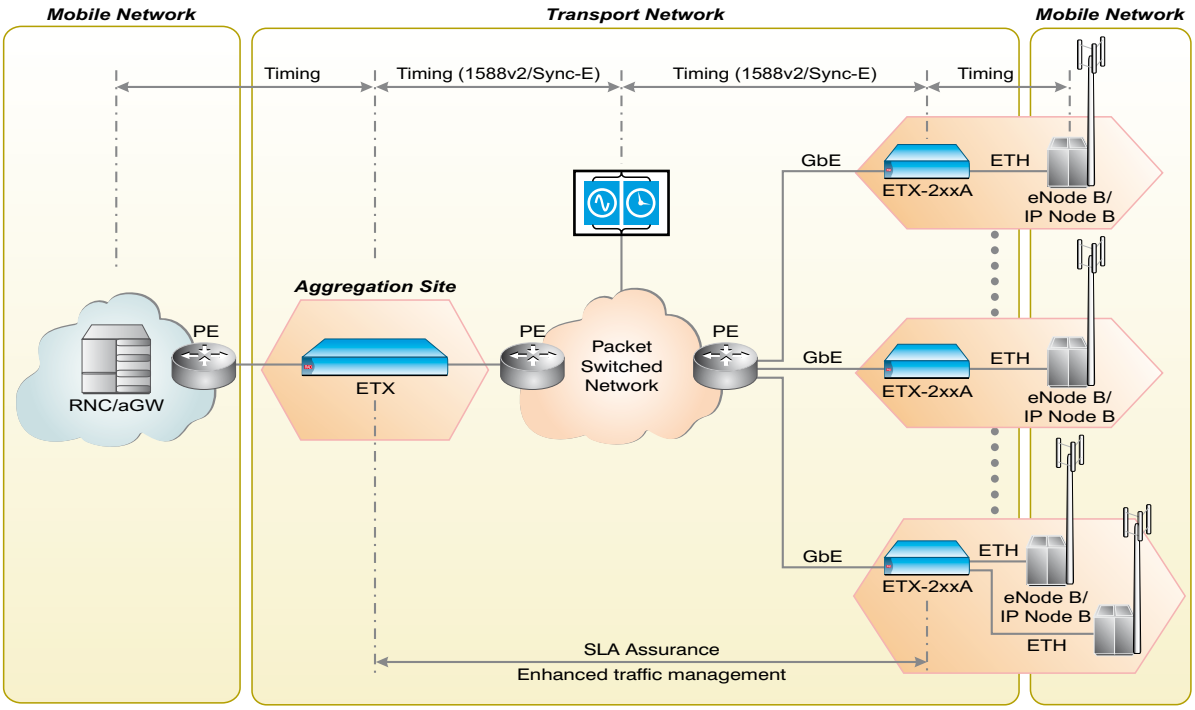
Mobile backhaul – the part of the radio network connecting base stations to their controllers – has always been a major contributor to the high costs of building out and running a mobile network. Now it is recognized as the crucial segment that can make or break mobile service delivery and significantly impact operators' profitability.

Unlimited iPhone data packages, mobile TV offerings and other bandwidth-guzzling mobile broadband services, shift the transport burden to the RAN (radio access network), which was originally designed to handle mainly voice traffic with a small number of E1/T1 links. The need to accommodate mobile broadband bandwidth requirements is further complicated by continuously declining average revenues per user (ARPU), the effect of which can only be mitigated by dropping the cost per Mbps.

HSPA+ upgrades, Ethernet backhaul rollouts and the migration to 4G LTE's all-IP networks, are some of the strategies implemented by operators and transport providers to improve the efficiency of their networks and to make room for data-intensive, rich-media traffic. These strategies, however, introduce a new set of hurdles. Ensuring accurate timing and synchronization over clocking-challenged networks; supporting multi-operator colocation with customized Ethernet backhaul SLAs; smartly managing RAN traffic in LTE's flat architecture; and enabling backward compatibility to ensure service continuity for legacy 2G and 3G traffic are a few of the issues that need addressing.

RAD's mobile backhaul solutions ensure cost reduction and high quality delivery for GSM, CDMA and UMTS voice and video traffic, as well as for HSPA+ and LTE mobile broadband applications. Featuring best-of-breed cell-site gateways, mobile demarcation devices and aggregation hubs, RAD's mobile backhaul products enable operators and transport providers to optimize bandwidth utilization and converge all services over a unified network, using any available access link – whether TDM, copper DSL, fiber, or microwave. In addition, multi-standard pseudowire support, resilient ring functionality and extensive Timing over Packet capabilities – including 1588v2 and Sync-E – enable a smooth and cost-effective transition to all-IP RANs.

End-to-End SLA Assurance with Mobile Demarcation Devices



Description

Backhaul IP Node B and eNode B traffic over Ethernet/IP/MPLS networks with end-to-end SLA assurance, performance monitoring and easy fault localization – right off the base station. Combine Ethernet demarcation functionalities with powerful clock transfer support to ensure service quality over packet transport.

Benefits & Features

- MEF-defined Ethernet service features with hierarchical QoS per flow/service
- Five nines (99.999%) availability and resiliency with Ethernet linear and ring protection switching
- Fast and reliable diagnostics with hardware-based OAM
- Extensive 1588v2, Synchronous Ethernet support for frequency, phase and ToD synchronization
- Terminate thousands of EVC flows using powerful high capacity aggregation device

Product Finder

ETX-203A – p. 56

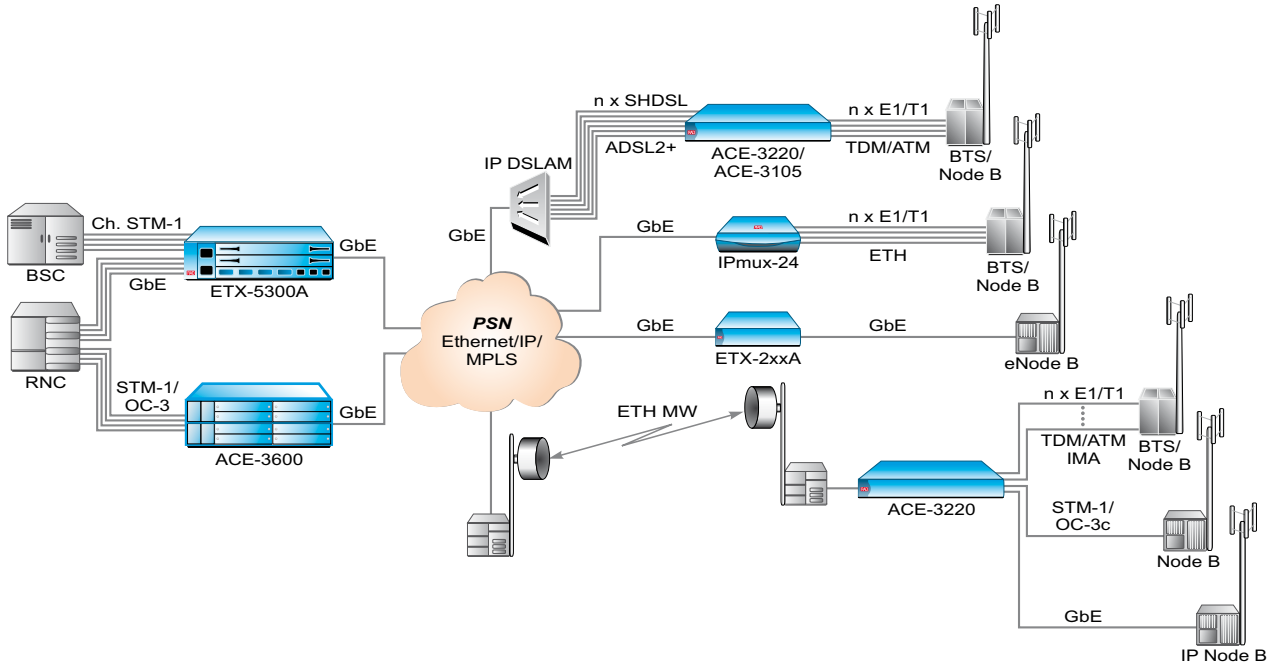
ETX-204A – p. 72

ETX-212A – p. 74

ETX-220A – p. 76

ETX-5300A – p. 68

Leverage Low Cost-Per-Bit Packet Transport for Mobile Backhaul



Product Finder

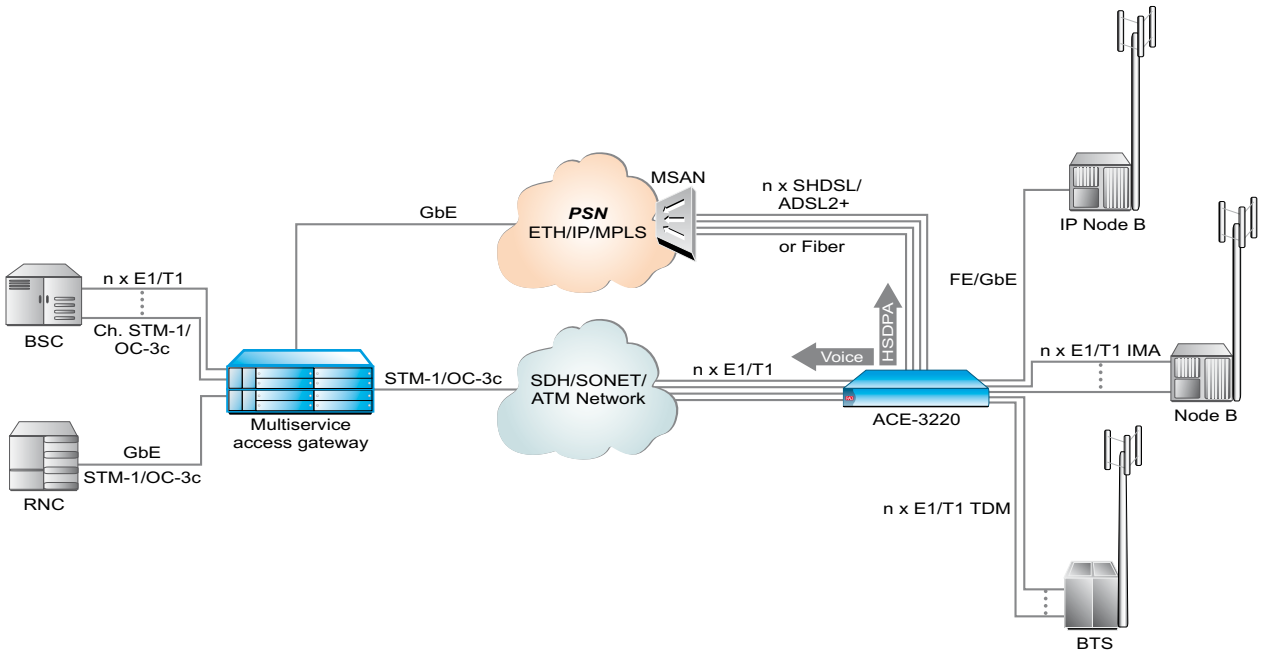
Description

Leverages low cost-per-bit next-generation packet transport (DSL, fiber) for 2G/2.5G/3G/4G backhaul to support higher bandwidth availability while reducing OpEx.

Benefits & Features

- Single platform for multi-generation traffic (TDM, ATM, IP), to allow a gradual migration to all-IP backhaul networks
- Provide robust timing and synchronization over the packet transport network with ACR, Synchronous Ethernet and IEEE 1588v2 support
- Support Ethernet SLA-based quality-of-service (QoS) and traffic prioritization per service
- Extensive TDM and ATM pseudowire capabilities for seamless 2G and 3G circuit emulation over packet

HSDPA Hybrid Broadband Transport



Description

Backhaul operators can use multiservice cell-site gateways to optimize bandwidth utilization by separating voice and data transport. Bandwidth-intensive HSDPA data streams are delivered over economical PSNs using DSL or fiber access, while lower volume traffic of 2G and 3G voice is transported over SDH/SONET.

Benefits & Features

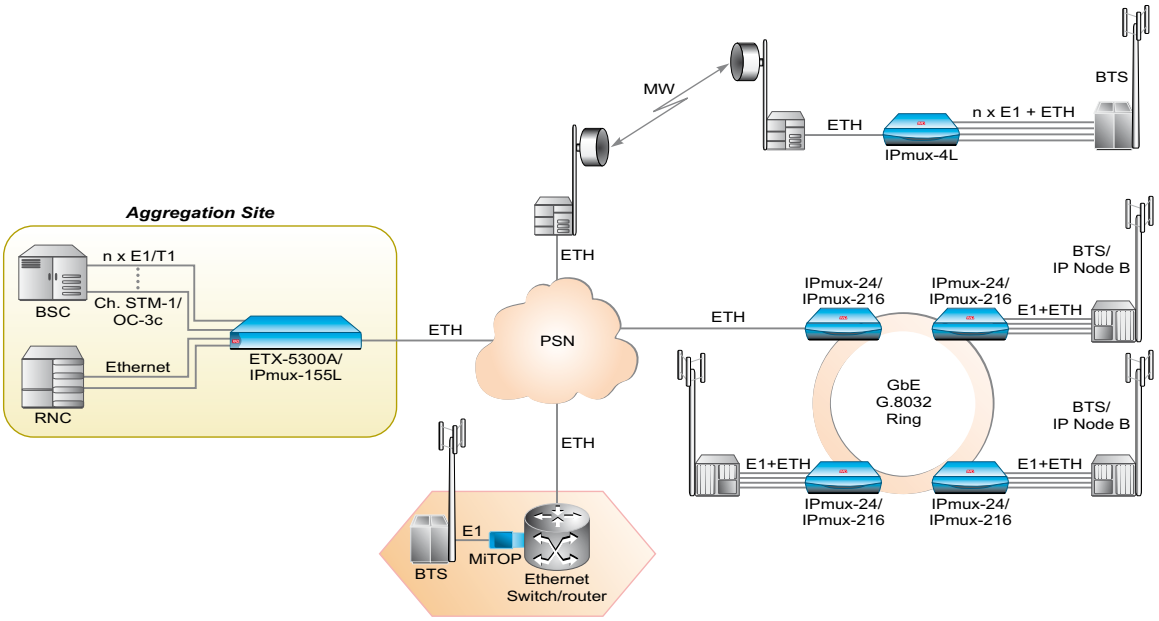
- Reduce HSDPA transport costs by using packet switched transport
- Scalable cost-effective broadband access service (DSL) and point-to-point active Ethernet
- Ensure QoS for voice and real-time traffic

Product Finder

ACE-3220 – p. 80

ACE-3400/3402 – p. 78

Low Cost Mobile Backhaul over Any Infrastructure



Product Finder

ETX-5300A	– p. 68
IPmux-4L	– p. 152
IPmux-24	– p. 150
IPmux-155L	– p. 154
IPmux-216	– p. 150
MiTOP-E1/T1, E3/T3	– p. 158

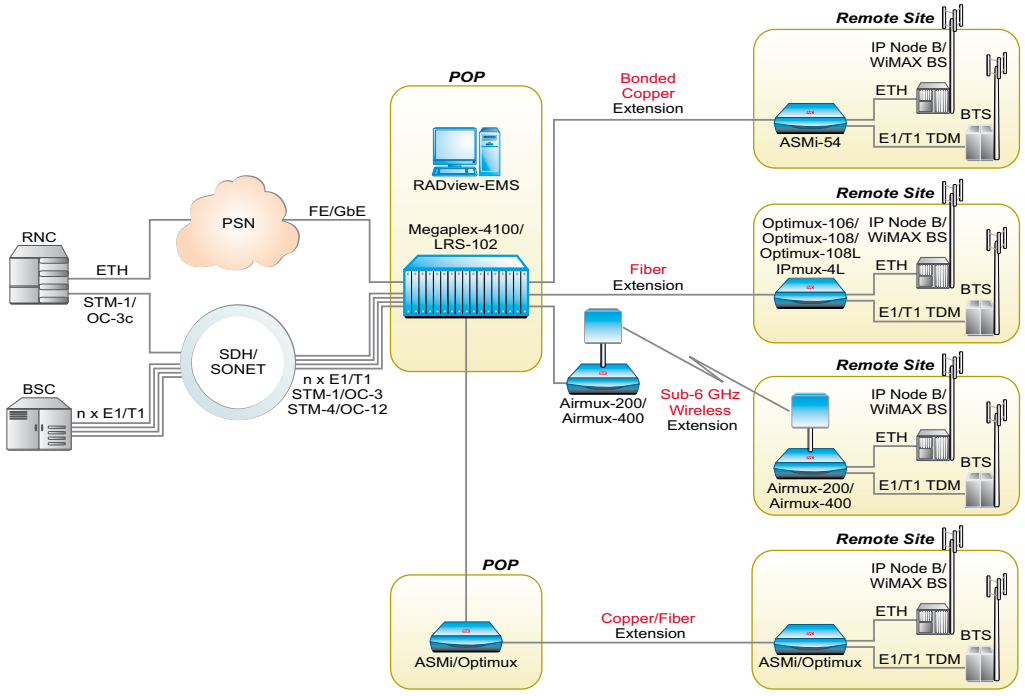
Description

Enable economical service extension and low cost aggregation between 2G BTSs and 3G IP Node Bs and their controllers over fiber and wireless.

Benefits & Features

- G.8032 ring protection for service resiliency
- Deploy RAD's pseudowire gateways to easily transport mobile traffic over GPON
- SFP pseudowire gateways allow TDM-served base stations to quickly and cost-effectively connect over packet networks

Mobile Backhaul in Rural Areas



Description

Extend coverage to underserved areas with affordable 2G, 3G and WiMAX backhaul solutions over copper, fiber or wireless infrastructure. RAD's RuralSuite portfolio ensures fast and simple service set-up, while driving down the rollout and maintenance costs associated with long-distance backhaul over varied terrains.

Benefits & Features

- Connect multi-generation base stations over a single access link to reduce OpEx and CapEx
- Point-to-point or point-to-multipoint service extension over fiber, SHDSL.bis and sub-6 GHz wireless links provides high flexibility in choosing the most cost-efficient transport alternative
- 100 Mbps over wireless and fiber, or 22.8 Mbps over EFM bonded copper
- Wireless solutions ensure service coverage in difficult terrains and across geographic barriers

Product Finder

Airmux-200 – p. 135

Airmux-400 – p. 134

ASMi-54/54L – p. 128

IPmux-4L – p. 152

LRS-102 – p. 126

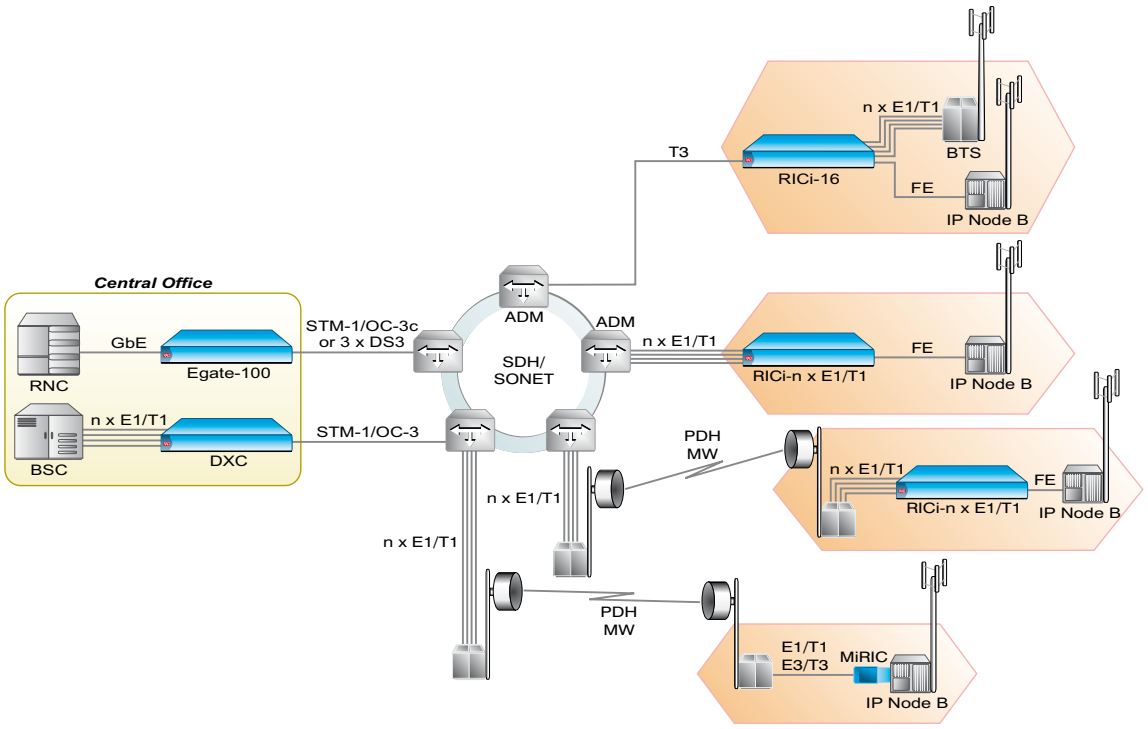
Megaplex-4100 – p. 88

Optimux-106/108 – p. 116

Optimux-108L – p. 117

RADview-EMS – p. 176

Mobile Backhaul over PDH/SDH/SONET



Product Finder

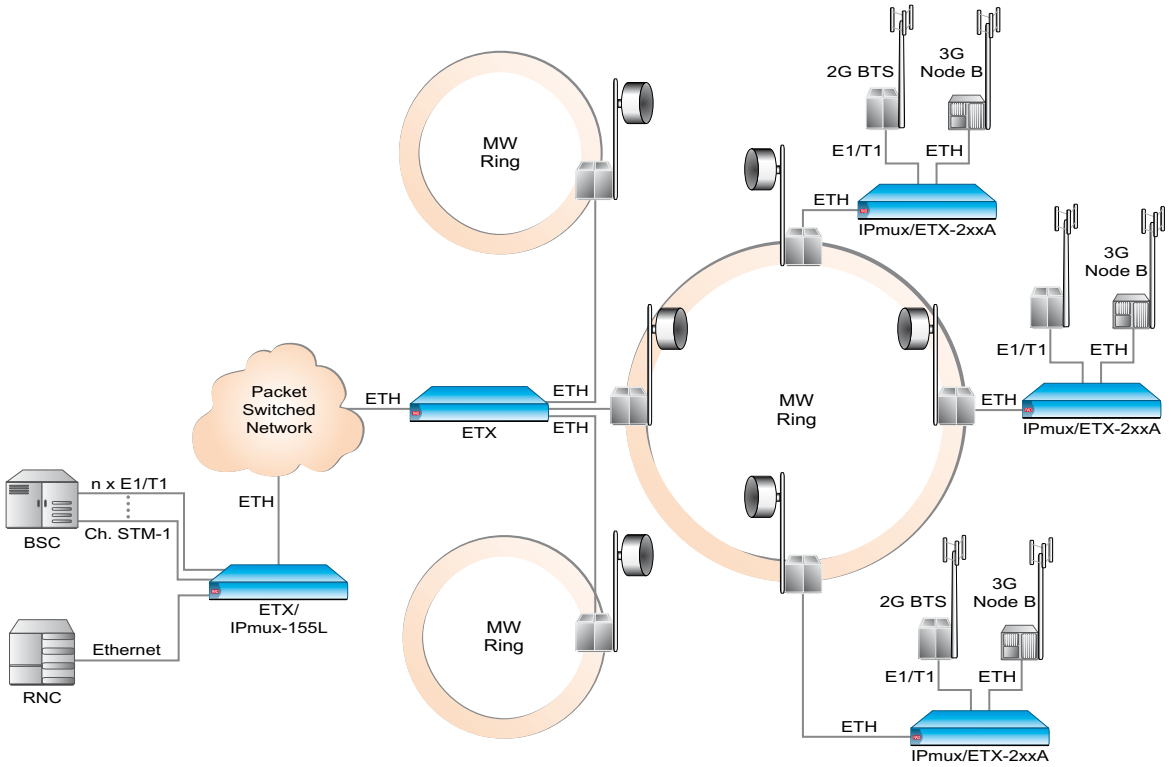
Description

Transport IP Node B Ethernet traffic over PDH and SDH/SONET infrastructure, together with TDM aggregation and a seamless hand-off to the packet network. RAD's RICi demarcation devices enable operators to cost-effectively reduce their time-to-market and set-up costs for new service offerings by leveraging widely available TDM networks.

Benefits & Features

- Flexible bandwidth allocation up to 32 Mbps with circuit bonding
- CapEx reduction through leverage of existing SDH/SONET/PDH links where fiber is not available
- Standard Ethernet over NG-PDH (RICi-16) and NG-SDH/SONET (Egate-100), GFP, VCAT and LCAS protocols
- Reduce OpEx by using a single management system with flexible service provisioning
- Ethernet OAM and traffic management capabilities support MEF-defined Carrier Ethernet services

Mobile Backhaul over Ethernet Microwave



Description

Backhaul multi-generation 2G and 3G traffic over native Ethernet radio links with SLA assurance, OAM diagnostics and highly accurate clock synchronization over packet.

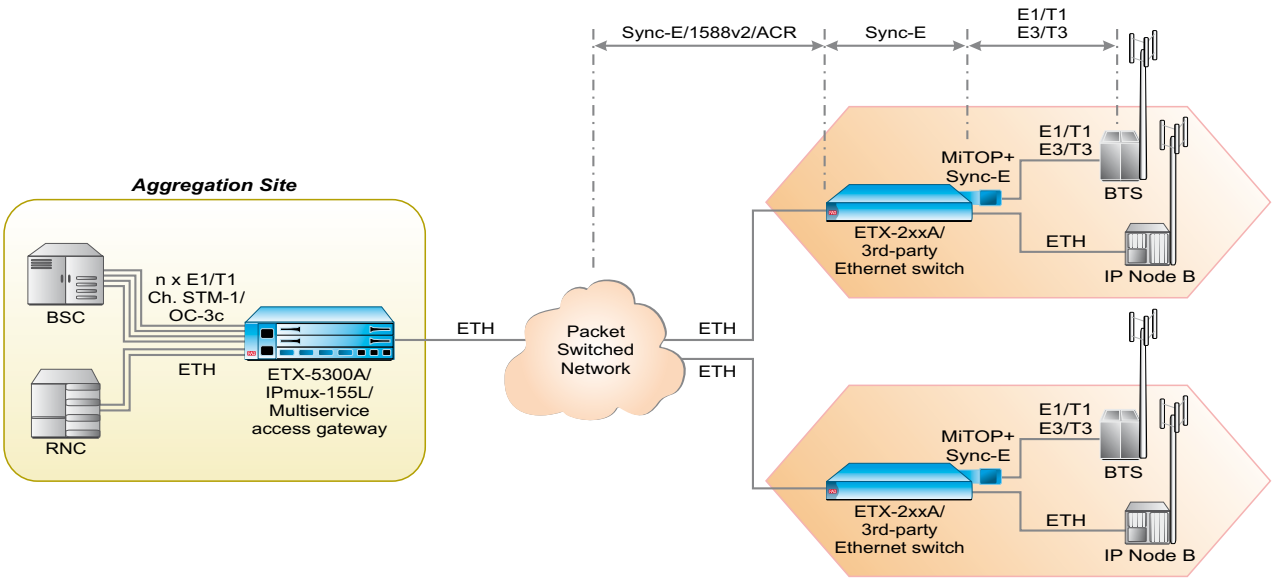
Benefits & Features

- Wide range of mobile demarcation devices, access gateways and high capacity aggregation platforms support rapid deployment of Ethernet radios
- Transparent delivery of TDM traffic over Ethernet microwave with extensive TDM pseudowire support
- End-to-end Ethernet OAM and performance monitoring
- 1588v2, Synchronous Ethernet and adaptive clock recovery for timing and synchronization over packet microwave
- MEF-defined Ethernet service features with QoS per flow/service

Product Finder

ETX-204A	– p. 72
ETX-212A	– p. 74
ETX-220A	– p. 76
ETX-5300A	– p. 68
IPmux-2L/4L	– p. 152
IPmux-24/216	– p. 150
IPmux-155L	– p. 154

Mobile Backhaul Using Smart SFP with Timing Capabilities



Product Finder

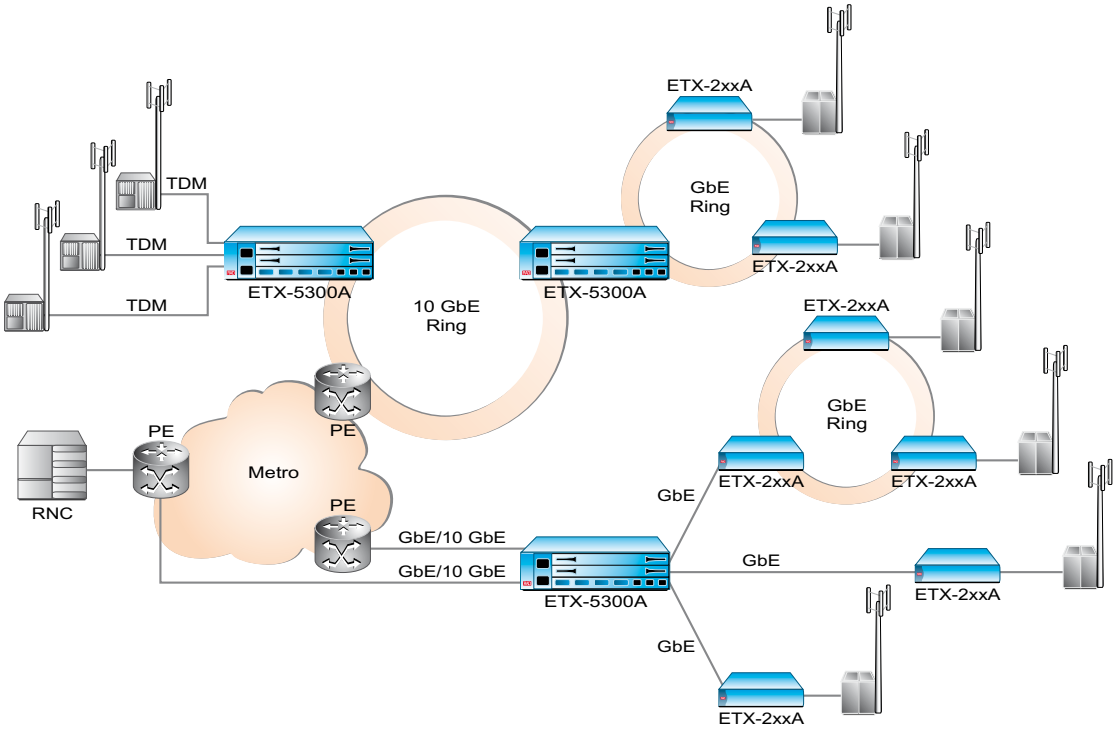
Description

RAD's MiTOP can connect E1/T1 and E3/T3 traffic from base stations to RAD's ETX-A Carrier Ethernet mobile demarcation devices or to MSA-compliant third-party Ethernet switch-routers. This allows operators and transport providers to use a single device to backhaul multiple-generation traffic over packet-based transport.

Benefits & Features

- Multi-standard TDM pseudowire support with CESoPSN, SAToP, using MEF-8 or UDP/IP encapsulation
- Synchronous Ethernet capabilities ensure accurate clock distribution to the base station
- No need for dedicated power supply
- Central aggregation and termination of pseudowire with ETX-5300A or IPmux-155L

10-GbE Ring Connectivity for Mobile Backhaul



Description

Ensure five nines (99.999%) availability and sub-50 ms restoration with G.8032 Ethernet Rings Protection Switching (ERPS) for GbE and 10-GbE ring in Ethernet-based mobile backhaul.

Benefits & Features

- Ultra-high capacity enables simultaneous processing of thousands of service flows
- Carrier-class Layer 2 aggregation switches with high port density for space-restricted facilities
- Full system redundancy for service resiliency and high availability
- Hierarchical QoS, intelligent traffic management and end-to-end SLA assurance
- Extensive SyncToP functionalities include high performance 1588v2 and Synchronous Ethernet

Product Finder

ETX-203A – p. 56

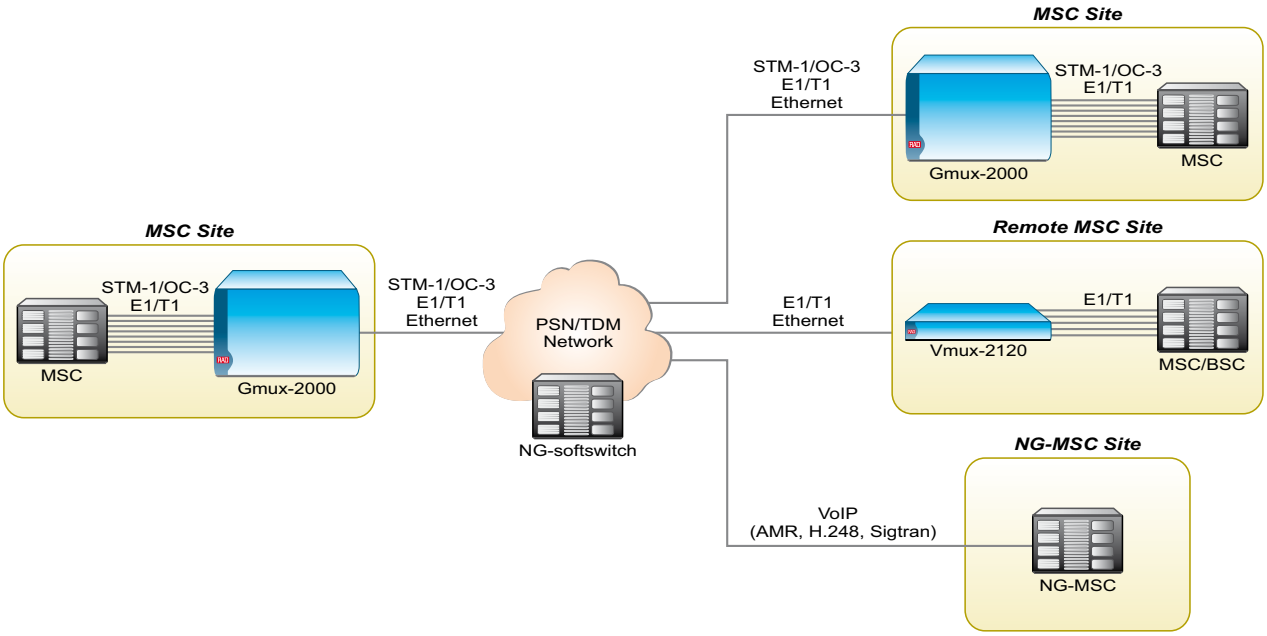
ETX-204A – p. 72

ETX-212A – p. 74

ETX-220A – p. 76

ETX-5300A – p. 68

Inter-MSC and 3G Media Gateway Solutions



Product Finder

Gmux-2000 – p. 147

Vmux-2120 – p. 144

Description

RAD's Vmux/Gmux voice trunking gateways use advanced voice compression technologies to significantly reduce the number of required leased lines for inter-MSC E-channel connections. In addition, the Vmux family also supports 3G media gateway services on the legacy MSC network.

Benefits & Features

- Quick ROI
- Up to 16:1 voice compression for higher bandwidth utilization and OpEx savings
- Support and optimize all types of signaling channels
- Seamless migration from TDM to IP networks
- Small, scalable and easy to install
- Future-ready for interoperability with next-generation mobile core (softswitch-based)

Best of Breed!

Hybrid Solution for SDH/SONET and PSN Access

Megaplex-4100

Next-Generation Multiservice Access Node

- Voice & Data Services over TDM and Packet Networks
- STM-4/OC-12, GbE Capacity
- Extensive Support for Legacy Services and Interfaces
- Future Proof Carrier Ethernet Capabilities
- Enhanced Connectivity for Any Topology
- Grooming, Aggregation, DS0 Cross Connect, or Transparent Traffic Delivery
- Part of the AXCESS+ Portfolio

Email: market@rad.com | www.rad.com

RAD
data communications
The Access Company

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. 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 advanced traffic management, end-to-end network visibility with hardware-based Ethernet OAM (operations, administration and maintenance) functionality, proactive performance measurement, granular QoS (quality of service), and advanced Timing over Packet capabilities.

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 fiber

RAD enables carrier-grade Ethernet service delivery over fiber access with a variety of Ethernet network termination units (E-NTUs), 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. Clocking mechanisms include Precision Time Protocol (IEEE 1588-2008), Synchronous Ethernet and adaptive clock recovery. 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 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 DSL

RAD's Ethernet over xDSL copper access solutions leverage widely deployed IP DSLAMs to deliver mid-band Ethernet services, with access rates 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.

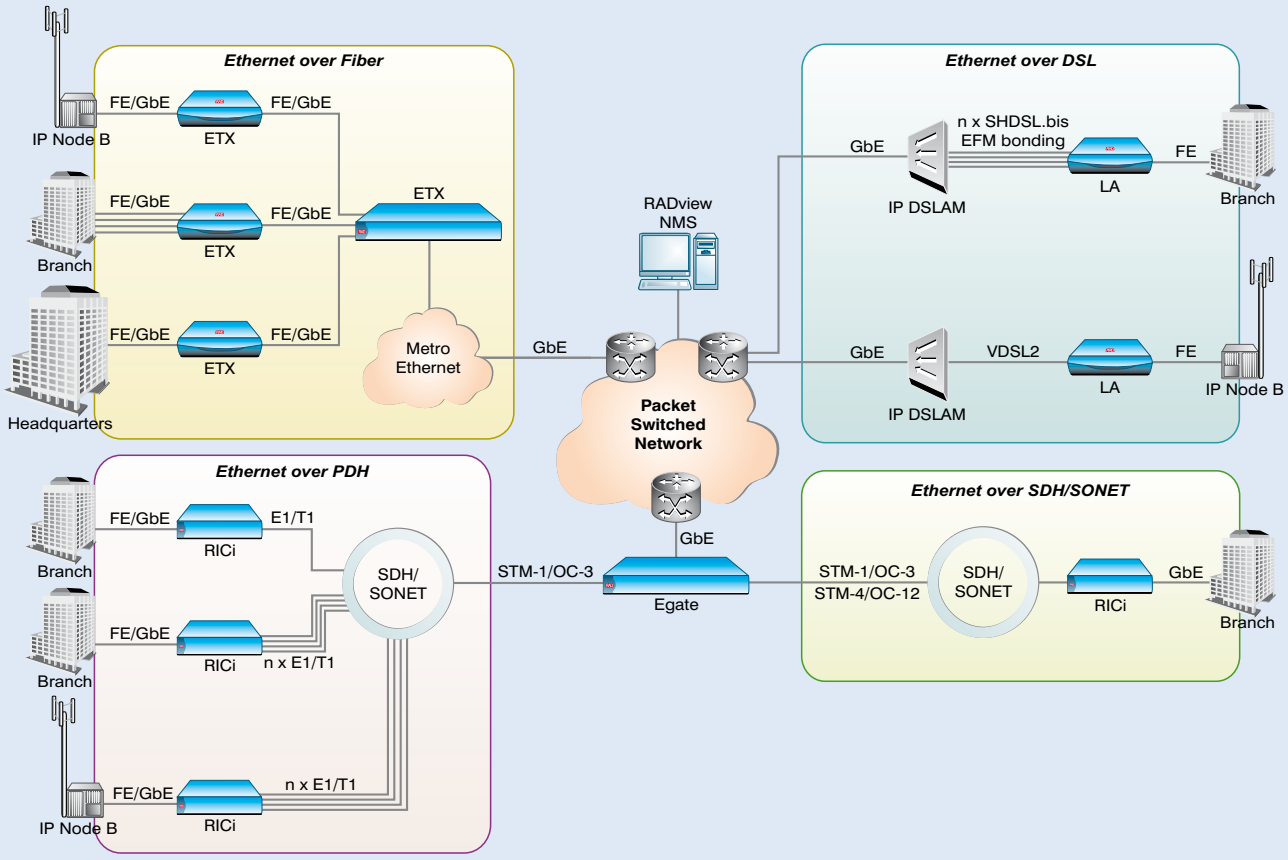
Ethernet over wireless

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 devices, they support point-to-point and point-to-multipoint topologies, over a wide range of licensed and license-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.

Ethernet aggregation

RAD has also introduced a series of Ethernet aggregation solutions, which provide up to 10 Gbps connectivity to packet switched networks and up to STM-16/OC-48 for SDH/SONET transport. Working opposite RAD's Carrier Ethernet demarcation and mobile demarcation devices, they offer an integrated end-to-edge system for highly reliable and resilient access, backhaul and transport with comprehensive SLA assurance mechanisms.

For further information, see the Next Generation Aggregation chapter, pages 64-69.



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**

For latest updates visit www.rad.com

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.

RICi-16 features a "pay-as-you-grow" license model, allowing the addition of E1/T1 links according to the customer's bandwidth requirements.

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.

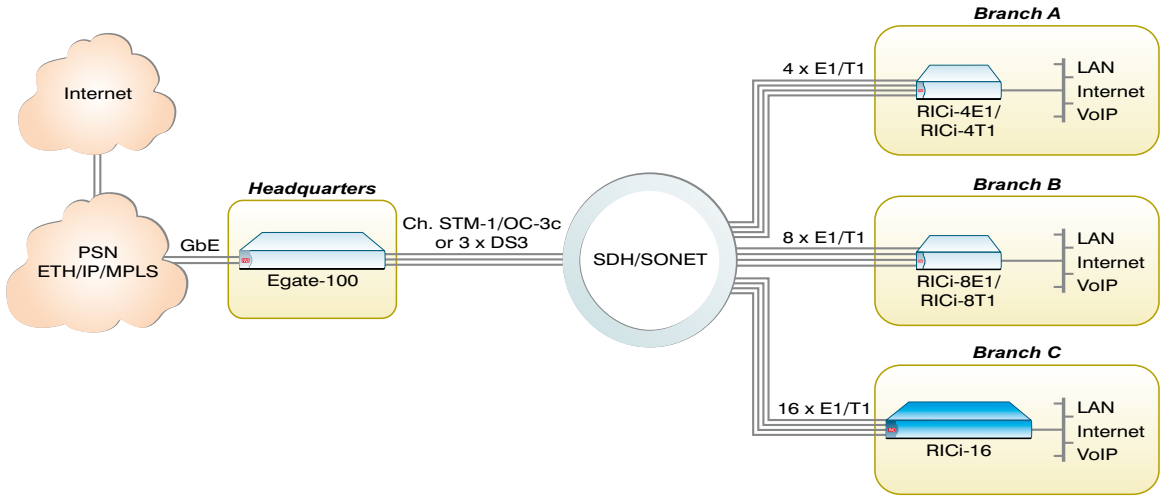
VLAN stacking and color-sensitive P-bit re-marking

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.

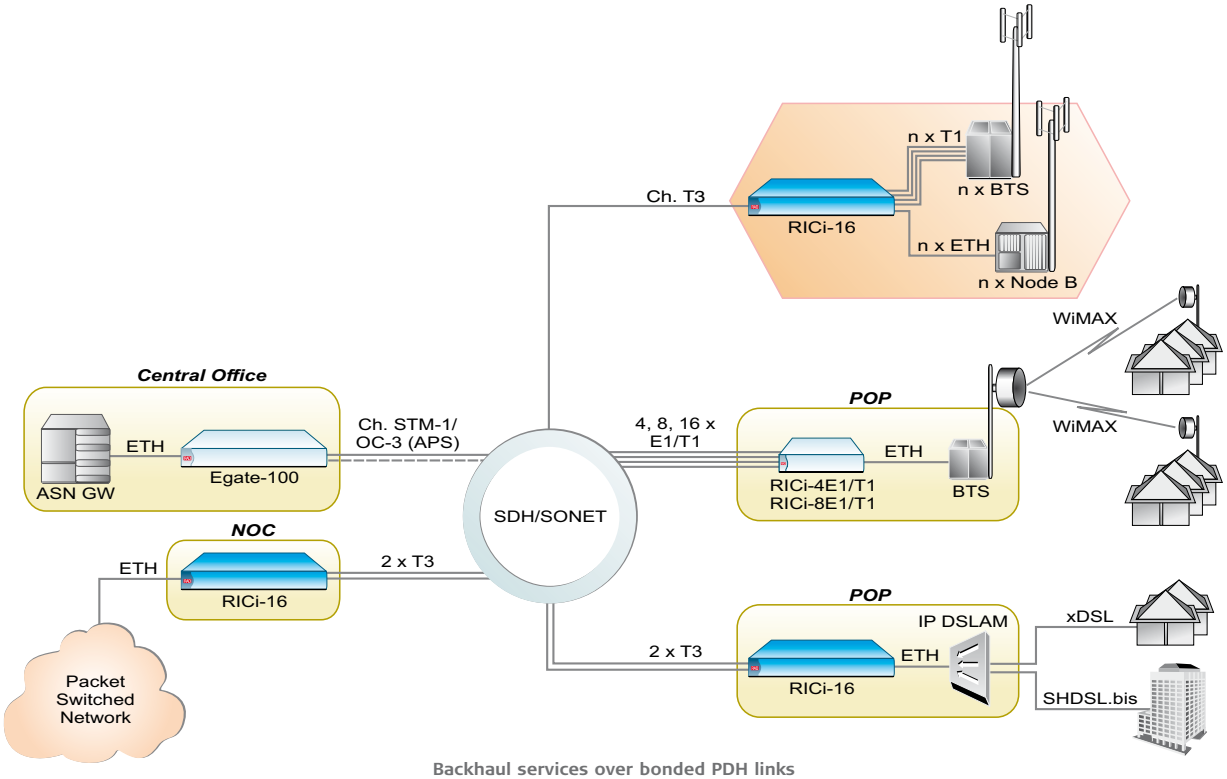
SNMP management

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).



Differentiated Ethernet business services over bonded PDH



Backhaul services over bonded PDH links

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

Ethernet over Four or Eight E1 or T1 NTUs

EtherAccess

- **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.

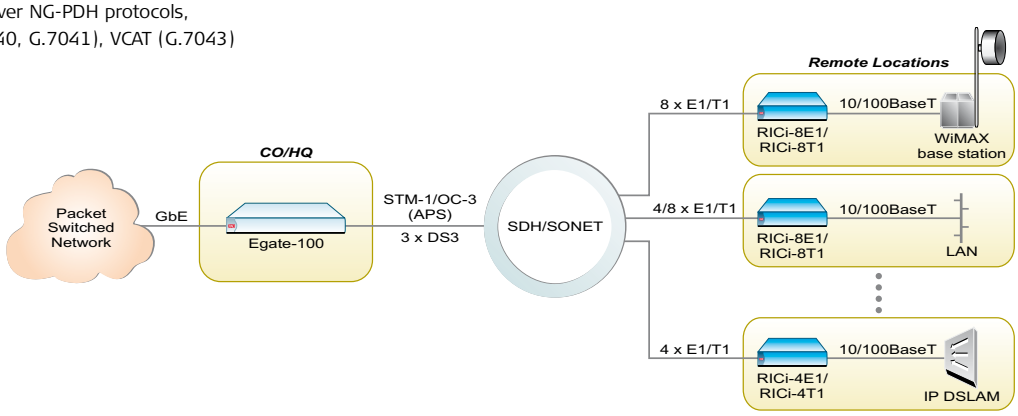
VLAN stacking and color-sensitive P-bit re-marking

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 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.

- **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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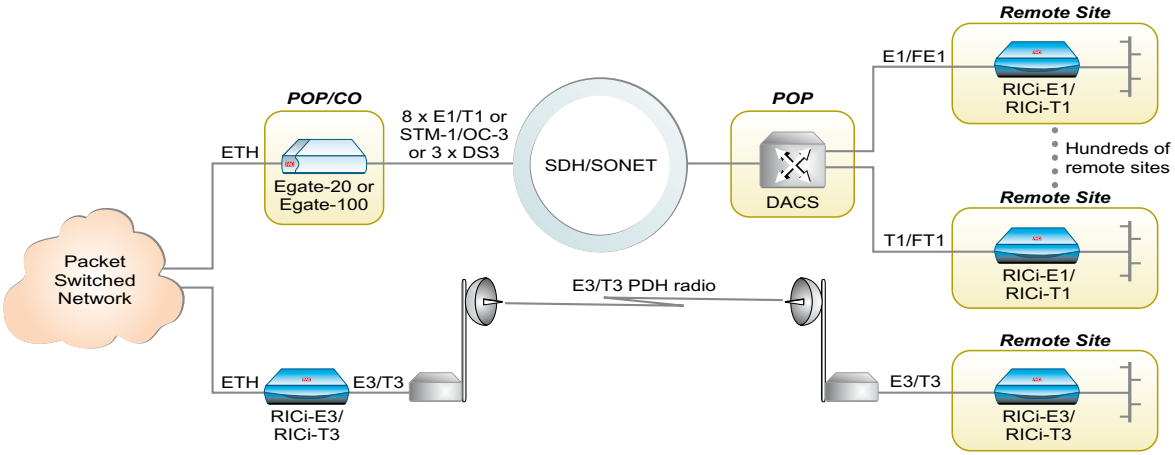

Transparent LAN services over E1/E3 or T1/T3 lines

RICi-155GE, RICi-622GE

Gigabit Ethernet over STM-1/OC-3 or STM-4/OC-12 NTUs

EtherAccess

- **Delivers Gigabit Ethernet over two STM-1/OC-3 links (RICi-155GE) or two STM-4/OC-12 (RICi-622GE)**
- **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 and RICi-622GE Ethernet network termination units (NTU) provide simple, efficient and cost-effective Gigabit Ethernet (GbE) connectivity over two STM-1/OC-3 or over two STM-4/OC-12 uplinks, supporting bundled access rates of 300 Mbps and 1/2 Gbps, respectively. It offers a migration path by connecting future-ready IP devices with 10/100/1000 Mbps interfaces to existing SDH/SONET 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), 155 Mbps (VC-4, RICi-622GE only)
- SONET: 1.5 Mbps (VT 1.5), 50 Mbps (STS-1), 155 Mbps (STS-3, RICi-622GE only)

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 devices support up to 32 low-order VCAT groups (VCGs), allowing the connection of up to 32 different customers per site.

The RICi-155GE and RICi-622GE are 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 devices map 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 and RICi-622GE 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 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.

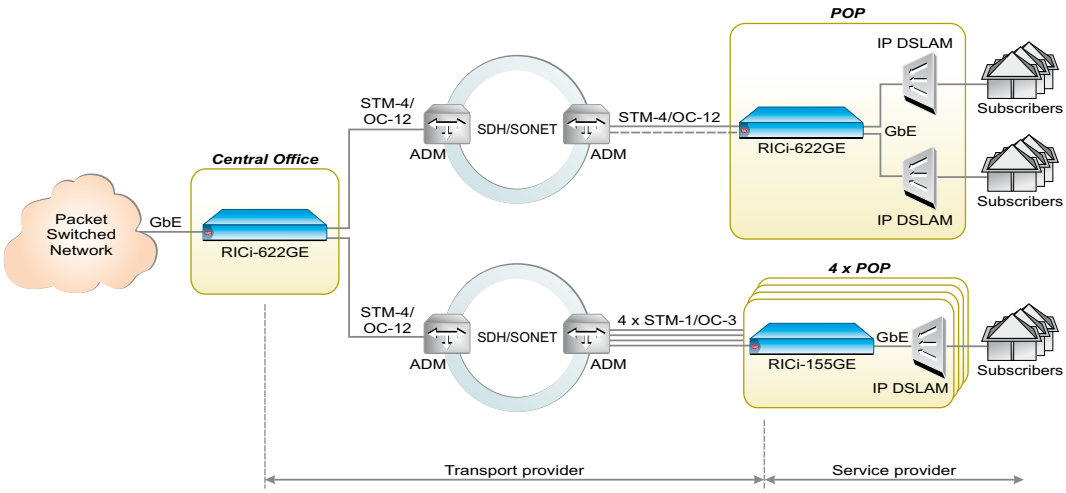
The devices also support a variety of access protocols, including Telnet, SNMP, Web server, and TFTP. Incorporated security features include Secure Shell (SSH), Web-based Secure Socket Layer (SSL), SNMPv3, and RADIUS.

The devices collect statistics at the Ethernet physical layer and the SDH/SONET interface frame counters.

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 and RICi-622GE are 1U-high, 19-inch wide boxes with a rack-mount option. 23-inch wide enclosures, which are NEBS-compliant, are available as well.

Redundant hot-swappable AC or DC power supplies provide carrier-class reliability.



Backhauling IP DSLAMs over STM-4/OC-12 uplinks

RIC-155GE

Gigabit Ethernet over STM-1/OC-3 NTU

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.

- **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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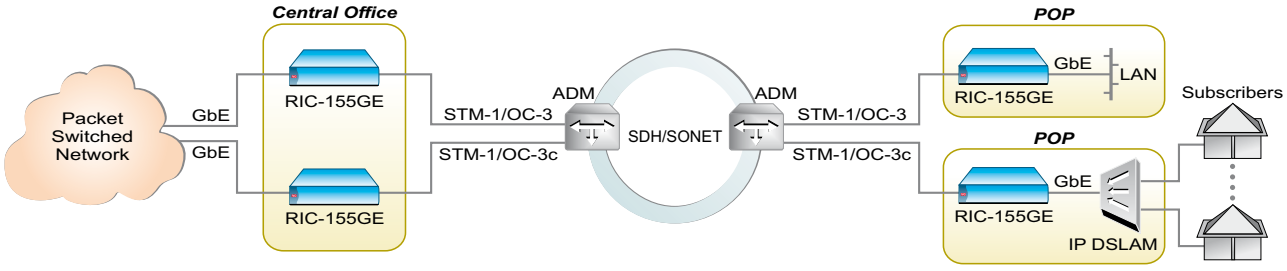

Connecting Gigabit Ethernet over STM-1/OC-3c

Price Buster!

Best Price.
Top Performance.

ETX-203A

Richly Featured Carrier Ethernet NTU

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- License-activated Upgrades
- Hardware-based E-OAM
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RIC-LC, RIC-155L

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

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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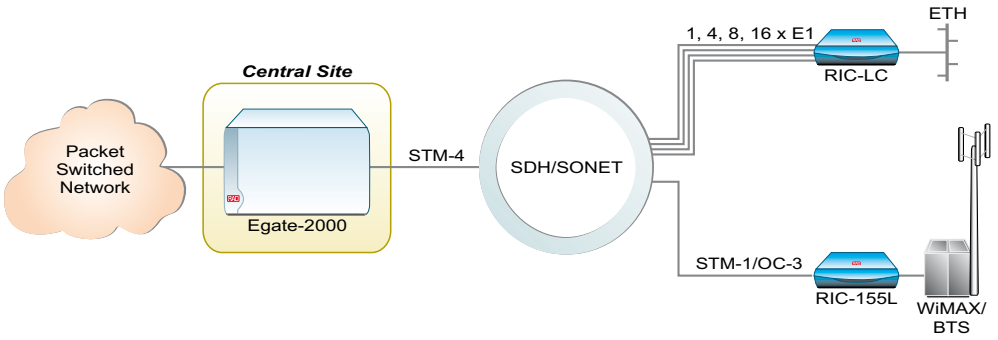

Ethernet traffic backhaul over PDH and SDH

Egate-100

Gigabit Ethernet over TDM Aggregation Gateway

EtherAccess

- **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

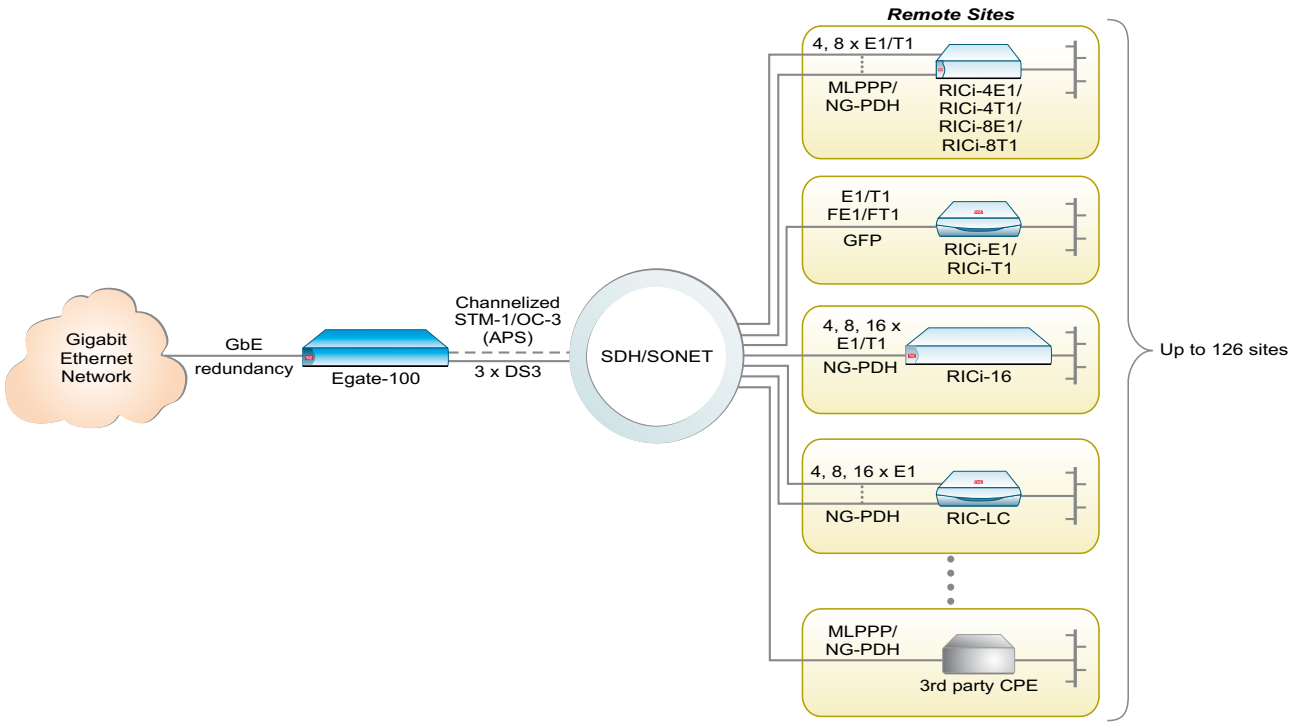
The Egate-100 associates a bridge port and a TDM interface (e.g., a bundle of timeslots, a clear channel E1/T1 or a group of bonded E1/T1 channels), in effect creating a virtual port interconnecting the packet and the TDM networks. Using the VLAN stacking (Q-in-Q) attribute, a service provider VLAN is 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 three x DS3

ETX-204A

Carrier Ethernet Demarcation Device – Flexible Core

- **Demarcation device for SLA-based Ethernet business services and mobile backhaul**
- **MEF-9 and MEF-14 certified for EPL, EVPL services**
- **Multi-rate FE/GbE UTP/SFP combo ports with auto detection**
- **Enhanced traffic management with multiple shapers and H-QoS per EVC**
- **Ethernet OAM, performance monitoring and built-in RFC-2544 tester capabilities; L2/L3 diagnostic loopbacks**
- **ITU-T G.8031 Ethernet Linear Protection Switching**
- **Temperature-hardened enclosure; AC/DC redundancy**
- **Sync-E, 1588v2 support**
- **RADview-EMS management; CLI configuration**

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End-to-end service and transport demarcation

The ETX-204A Carrier Ethernet demarcation device delivers SLA-based business services to the customer premises over native Ethernet access. It transports up to 1 Gbps of user throughput while ensuring SDH/SONET-like performance and five nines (99.999%) reliability. Converging voice and data services over a unified Ethernet, IP or MPLS network, a single ETX-204A 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.

The ETX-204A features two Gigabit Ethernet network ports and two or four GbE user ports. All ports are SFP and UTP compatible with auto-detection of fiber and copper connections.

Incorporating RAD's SyncToP platform of synchronization and Timing over Packet feature set, the ETX-204A utilizes standard technologies such as 1588v2 Precision Time Protocol and Synchronous Ethernet, to ensure highly accurate traffic delivery in packet-based mobile backhaul networks. For further details on the ETX-204A's SyncToP capabilities, please refer to page 72.

Hardware-based Ethernet OAM and performance monitoring for SLA assurance

The ETX-204A combines Ethernet demarcation with test-head functionalities, featuring a complete Ethernet OAM suite that includes Ethernet Link OAM (IEEE standard 802.3-2005, formerly 802.3ah), Ethernet Service OAM (IEEE 802.1ag) and Performance Monitoring (ITU-T Y.1731). These are enhanced with a built-in RFC-2544 test generation engine for uni-directional and bi-directional testing of throughput, latency and frame loss. In addition, the device incorporates Layer 1, 2 and 3 diagnostic loopback capabilities with MAC and IP address swap.

Featuring ultra-fast, hardware-based processing capabilities, the ETX-204A performs OAM and PM measurements in under 1 microsecond with maximum precision, offering the following powerful benefits:

- Immediate detection of loss of continuity (LOC) to ensure under 50 ms protection switching
- Highly accurate frame loss measurements with live-traffic testing
- Flow-level monitoring enables simultaneous processing of hundreds of OAM sessions
- Loopback testing at line rate

The ETX-204A offers advanced SLA assurance tools, including user-defined KPI (key performance indicators) threshold configuration, real-time SLA violation alerts and per-flow daily statistics reporting.

Fault propagation mechanisms include subscriber port shutdown, as well as alarm indication signal (AIS) and remote defect indication (RDI) per Y.1731, to allow immediate notification and containment of service-affecting problems.

The ETX-204A also supports AC and DC power failure indication, using IEEE 802.3ah dying gasp or SNMP traps.

Remote provisioning and traffic management

The ETX-204A features advanced softcore architecture for efficient handling of multi-priority traffic on a per-flow basis. The device enables multi-criteria traffic classification as well as metering, policing and shaping to help carriers rate-limit user traffic according to pre-defined CIR (committed information rate) and EIR (excess information rate) profiles.

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-204A also uses weighted random early detection (WRED) policy for intelligent queue management and congestion avoidance. Packet editing functionalities, such as color-sensitive P-bit re-marking, ensure metering continuity across color-aware and color-blind metro networks and WANs.

Uplink resiliency and protection

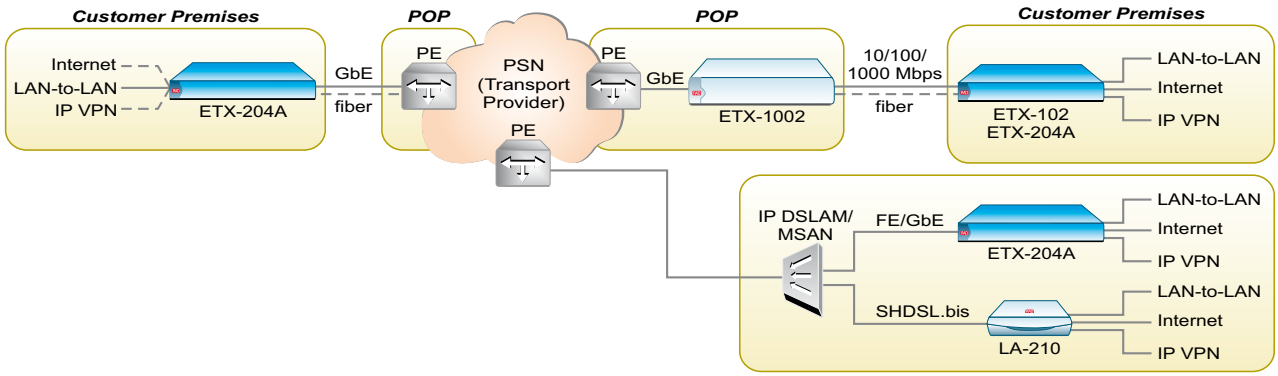
The ETX-204A offers various tools to ensure five nines (99.999%) availability and speedy restoration in the event of network outages. These include dual homing link redundancy and Link Aggregation (LAG) using 802.3ad LACP. In addition, path protection is supported with Ethernet Linear Protection Switching per ITU-T G.8031 to ensure end-to-end service is maintained when a fault is detected in one of the logical EVCs.

Management and security

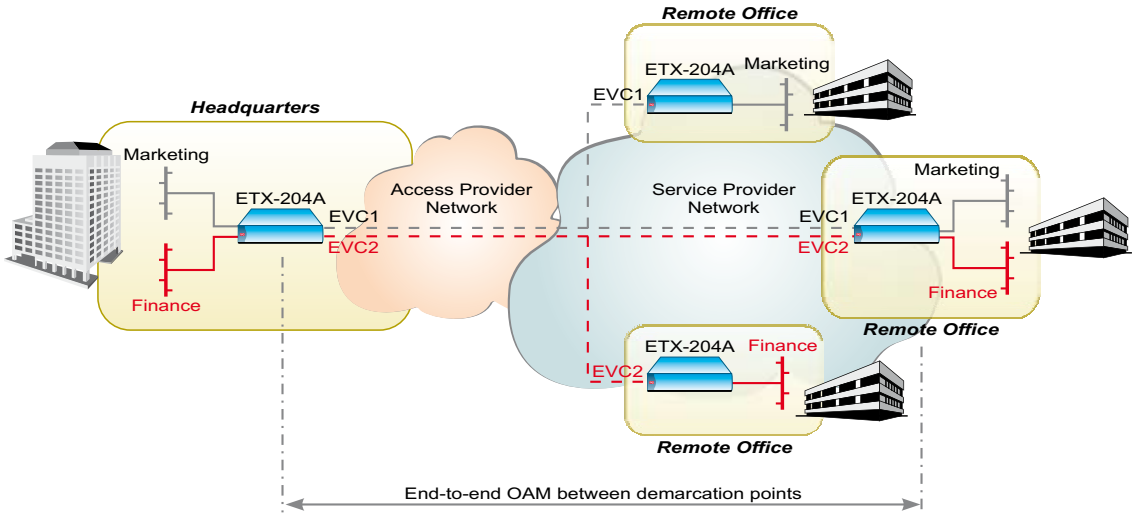
The ETX-204A features flexible management capabilities, including local management via an ASCII terminal (RS-232). In addition, remote management can be performed either inband using the network or user ports, or out-of-band using a dedicated management port, while maintaining separation between management 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-204A also supports a variety of access protocols, including CLI over Telnet, SNMP, and TFTP. Incorporated security features include Secure Shell (SSH), Web-based Secure Socket Layer (SSL), SNMPv3, RADIUS and Terminal Access Controller Access-Control System (TACACS+), as well as management access control list (ACL).

The ETX-204A can also be easily integrated in third-party OSS.



Ethernet service demarcation over packet with traffic management starting at the customer premises



End-to-end Carrier Ethernet services over multiple networks

ETX-203A

Carrier Ethernet Demarcation Device

EtherAccess

- **Demarcation device for SLA-based Ethernet business services**
- **MEF-9 and MEF-14 certified for EPL, EVPL services**
- **Two FE/Gigabit Ethernet network ports; two FE/Gigabit Ethernet user ports**
- **Enhanced traffic management with multiple shapers and H-QoS per EVC/ EVC.CoS**
- **Ethernet OAM, performance monitoring and built-in RFC-2544 tester capabilities; L2/L3 diagnostic loopbacks**
- **ITU-T G.8031 Ethernet Linear Protection Switching**
- **RADview-EMS management; CLI configuration**
- **Ultra-low cost for end-to-end service and transport demarcation**

For latest updates visit www.rad.com

The ETX-203A Carrier Ethernet demarcation device delivers SLA-based business services to the customer premises over native Ethernet access.

The ASIC-based ETX-203A is extremely price-competitive, ensuring SDH/SONET-like performance and five nines (99.999%) reliability for IP VPN and VoIP transport, as well as for dedicated Internet access and Layer 2 LAN-to-LAN services, all with differentiated quality of service and end-to-end monitoring.

Hardware-based Ethernet OAM and performance monitoring for SLA assurance

The device includes a complete Ethernet OAM suite that supports Ethernet Link OAM (IEEE standard 802.3-2005, formerly 802.3ah), Ethernet Service OAM (IEEE 802.1ag) and Performance Monitoring (ITU-T Y.1731). These are enhanced with a built-in RFC-2544 test generation engine, as well as Layer 1, 2 and 3 diagnostic loopback capabilities with MAC and IP address swap.

Featuring ultra-fast, hardware-based processing capabilities, the ETX-203A performs OAM and PM measurements in under 1 microsecond with maximum precision.

The device offers advanced SLA assurance tools, including user-defined KPI (key performance indicators) threshold configuration, real-time SLA violation alerts and per-flow daily statistics reporting.

Remote provisioning and traffic management

The ETX-203A allows efficient handling of multi-priority traffic on a per-flow basis. It enables multi-criteria traffic classification as well as metering, policing and shaping to help carriers rate-limit user traffic according to pre-defined CIR (committed information rate) and EIR (excess information rate) profiles.

Enhanced quality of service is further supported by a hierarchical scheduling mechanism that combines Strict Priority (SP) and weighted fair queue (WFQ) scheduling, as well as weighted random early detection (WRED) policy and color-sensitive P-bit re-marking packet editing functionalities.

Uplink resiliency and protection

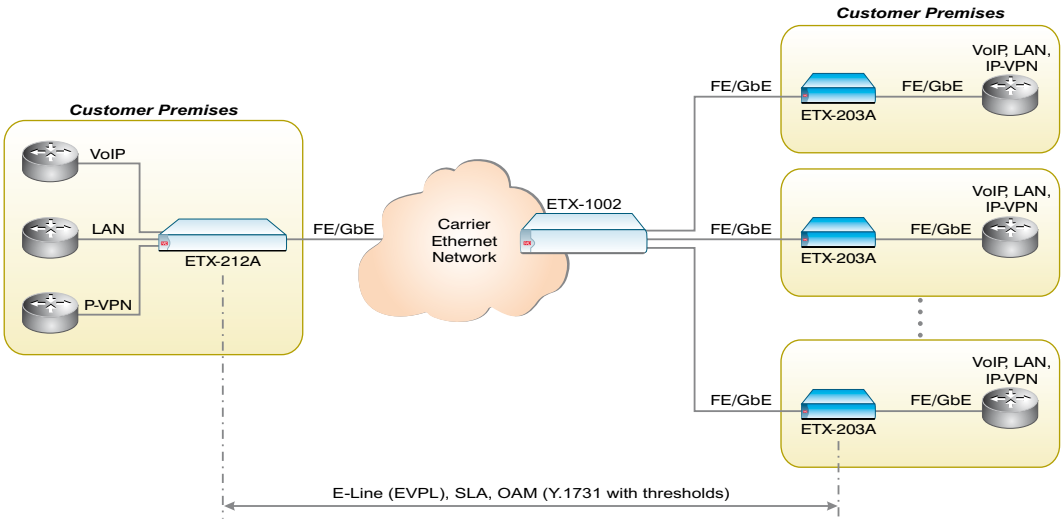
The ETX-203A supports dual homing link redundancy and Link Aggregation (LAG) using 802.3ad LACP. In addition, EVC path protection is supported with Ethernet Linear Protection Switching per ITU-T G.8031.

Management and security

The ETX-203A features flexible management capabilities, including local management via an ASCII terminal (RS-232). In addition, remote management can be performed 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-203A also supports a variety of access protocols, including CLI over Telnet, SNMP, and TFTP. Incorporated security features include Secure Shell (SSH), Web-based Secure Socket Layer (SSL), SNMPv3, RADIUS and Terminal Access Controller Access-Control System (TACACS+), as well as management access control list (ACL).

The ETX-203A features a compact design and is ideal for limited space installations.



ETX-220A

10G Carrier Ethernet Demarcation Device – Flexible Core

The ETX-220A Carrier Ethernet demarcation device delivers SLA-based business services to the customer premises over native Ethernet access.

Transporting up to 10 Gbps of user throughput, it converges voice and data services over a unified Ethernet, IP or MPLS network.

The ETX-220A features two 10-Gigabit Ethernet network ports and a 10-GbE user port (hardware-ready for 1+1 redundancy). All ports are SFP+ or XFP compatible.

Hardware-ready for RAD's SyncToP platform of synchronization and timing over packet feature set, the ETX-220A is designed to support standard technologies, such as 1588v2 Precision Time Protocol and Synchronous Ethernet. For further details on the ETX-220A's SyncToP capabilities, please refer to page 76.

Hardware-based Ethernet OAM and performance monitoring for SLA assurance

The ETX-220A combines Ethernet demarcation with test-head functionalities, featuring a complete Ethernet OAM suite that includes Ethernet Link OAM (IEEE standard 802.3-2005, formerly 802.3ah), Ethernet Service OAM (IEEE 802.1ag) and Performance Monitoring (ITU-T Y.1731). These are enhanced with a built-in RFC-2544 test generation engine, as well as Layer 1, 2 and 3 diagnostic loopback capabilities with MAC and IP address swap.

Featuring ultra-fast, hardware-based processing capabilities, the ETX-220A performs OAM and PM measurements in under 1 microsecond with maximum precision.

The ETX-220A offers advanced SLA assurance tools, including user-defined KPI (key performance indicators) threshold configuration, real-time SLA violation alerts and per-flow daily statistics reporting.

Remote provisioning and traffic management

The ETX-220A features advanced softcore architecture for efficient handling of multi-priority traffic on a per-flow basis, with ultra-high capacity that enables simultaneous processing of hundreds of service flows. The device enables multi-criteria traffic classification as well as metering, policing and shaping to help carriers rate-limit user traffic according to pre-defined CIR (committed information rate) and EIR (excess information rate) profiles.

Enhanced quality of service is further supported by a hierarchical scheduling mechanism that combines Strict Priority (SP) and weighted fair queue (WFQ) scheduling, as well as weighted random early detection (WRED) policy and color-sensitive P-bit re-marking packet editing.

Uplink resiliency and protection

The ETX-220A supports dual homing link redundancy and Link Aggregation (LAG) using 802.3ad LACP. In addition, path protection is supported with Ethernet Linear Protection Switching per ITU-T G.8031.

Management and security

The ETX-220A features flexible management capabilities, including local management via an ASCII terminal (RS-232). In addition, remote management can be performed 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.

- **10G demarcation device for SLA-based Ethernet business services and mobile backhaul**
- **MEF-9 and MEF-14 certified for EPL, EVPL services**
- **Two redundant 10-GbE network ports and a 10-GbE user port**
- **Enhanced traffic management with multiple shapers and H-QoS per EVC/ EVC.CoS**
- **Ethernet OAM, performance monitoring and built-in RFC-2544 tester capabilities; L2/L3 diagnostic loopbacks**
- **ITU-T G.8031 Ethernet Linear Protection Switching**
- **Temperature-hardened enclosure; AC/DC redundancy**
- **RADview-EMS management; CLI configuration**
- **End-to-end service and transport demarcation**

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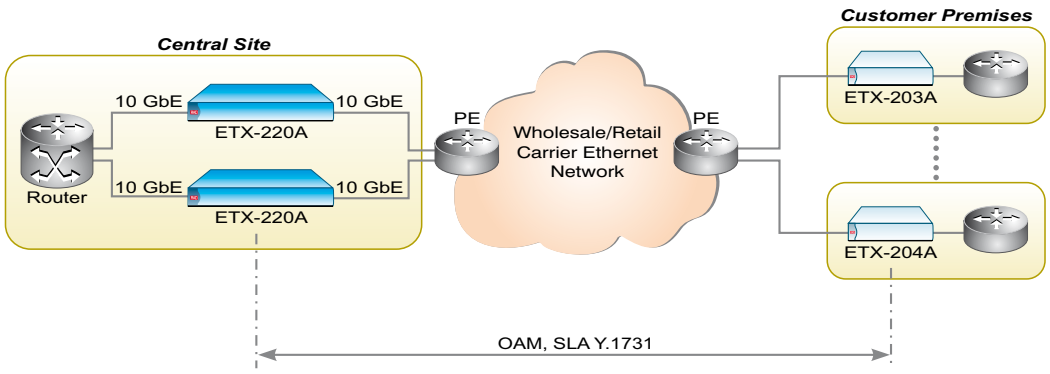
The ETX-220A also supports a variety of access protocols, including CLI over Telnet, SNMP, and TFTP. Incorporated security features include Secure Shell (SSH), Web-based Secure Socket Layer (SSL), SNMPv3, RADIUS and Terminal Access Controller Access-Control System (TACACS+), as well as management access control list (ACL).



10 Gigabit Ethernet Access

ETX-212A

Modular Carrier Ethernet Demarcation Device – Flexible Core

EtherAccess

- **High capacity demarcation device for SLA-based Ethernet business services and mobile backhaul**
- **MEF-9 and MEF-14 certified for EPL, EVPL services**
- **Dual GbE network port; up to eight multi-rate FE/GbE user ports**
- **Expandable capacity with two pluggable modules, each supporting TDM or Ethernet interfaces:**
  - **Eight or 16 E1/T1 pseudowire connections; or**
  - **Two 10 Gigabit Ethernet XFP/SFP+ ports for G.8032 ERPS**
- **Enhanced traffic management with multiple shapers and H-QoS per EVC/ EVC.CoS**
- **Ethernet OAM, performance monitoring and built-in RFC-2544 tester capabilities; L2/L3 diagnostic loopbacks**
- **ITU-T G.8031 Ethernet Linear Protection Switching; ITU-T G.8032 Ethernet Rings Protection Switching**
- **Sync-E, 1588v2 support**
- **Temperature-hardened enclosure; AC/DC redundancy**

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The ETX-212A modular Carrier Ethernet demarcation device delivers SLA-based services to the customer premises over native Ethernet access. Located in enterprise headquarters and mobile backhaul network hub sites, it is designed to transport up to 10 Gbps of user throughput while ensuring SDH/SONET-like performance and five nines (99.999%) reliability.

Converging voice and data services over a unified Ethernet, IP or MPLS network, a single ETX-212A 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.

The ETX-212A features two Gigabit Ethernet network ports and up to eight GbE user ports. All ports are SFP compatible. In addition, two pluggable modules support up to 16 E1/T1 ports for TDM pseudowire emulation over packet. Alternatively, one of the modules can be equipped with two 10-GbE ports for G.8032 ERPS.

Incorporating RAD's SyncToP synchronization and Timing over Packet feature set, the ETX-212A utilizes standard technologies, such as 1588v2 Precision Time Protocol and Synchronous Ethernet, to ensure highly accurate traffic delivery in packet-based mobile backhaul networks. For further details on ETX-212A's SyncToP capabilities, please refer to page 74.

Hardware-based Ethernet OAM and performance monitoring for SLA assurance

The ETX-212A combines Ethernet demarcation with test-head functionalities, featuring a complete Ethernet OAM suite that includes Ethernet Link OAM (IEEE standard 802.3-2005, formerly 802.3ah), Ethernet Service OAM (IEEE 802.1ag) and Performance Monitoring (ITU-T Y.1731). These are enhanced with a built-in RFC-2544 test generation engine for unidirectional and bi-directional testing of throughput, latency and frame loss. In addition, the device features Layer 1, 2 and 3 diagnostic loopback capabilities with MAC and IP address swap.

Featuring ultra-fast, hardware-based processing capabilities, the ETX-212A performs OAM and PM measurements in under 1 microsecond with maximum precision, offering the following powerful benefits:

- Immediate detection of loss of continuity (LOC) to ensure under 50 ms protection switching
- Highly accurate frame loss measurements with live-traffic testing
- Flow-level monitoring enables simultaneous processing of hundreds of OAM sessions
- Loopback testing at line rate

The ETX-212A offers advanced SLA assurance tools, including user-defined KPI (key performance indicators) threshold configuration, real-time SLA violation alerts and per-flow daily statistics reporting.

Fault propagation mechanisms include subscriber port shutdown, as well as alarm indication signal (AIS) and remote defect indication (RDI) per Y.1731, to allow immediate notification and containment of service-affecting problems.

Remote provisioning and traffic management

The ETX-212A features advanced softcore architecture for efficient handling of multi-priority traffic on a per-flow basis, with ultra-high capacity that enables simultaneous processing of hundreds of service flows. The device enables multi-criteria traffic classification as well as metering, policing and shaping to help carriers rate-limit user traffic according to pre-defined CIR (committed information rate) and EIR (excess information rate) profiles.

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-212A also uses weighted random early detection (WRED) policy for intelligent queue management and congestion avoidance. Packet editing functionalities, such as color-sensitive P-bit re-marking, ensure metering continuity across color-aware and color-blind metro networks and WANs.

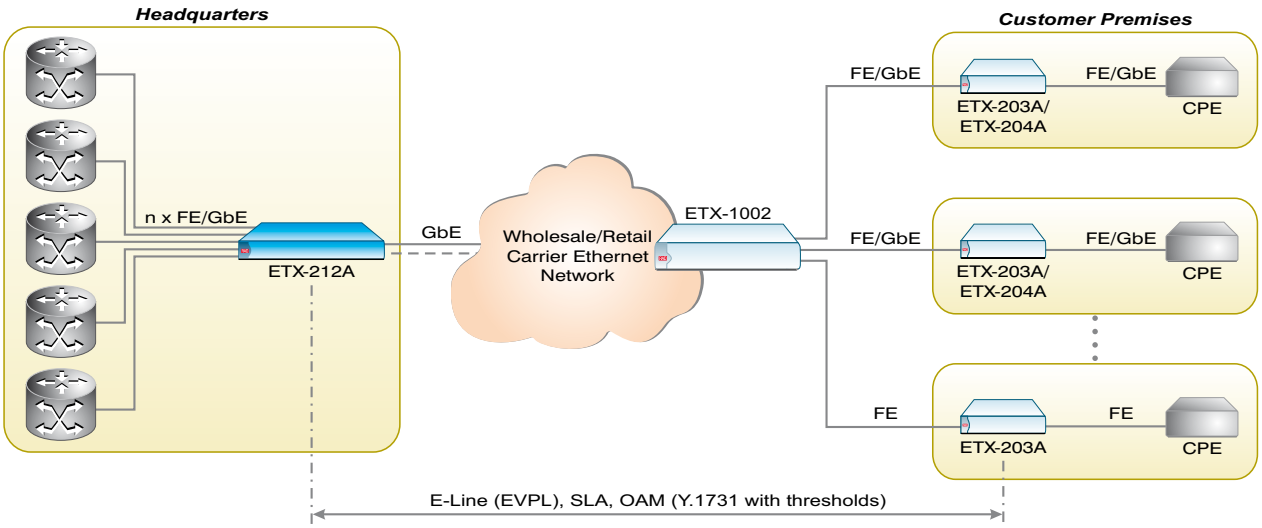
Uplink resiliency and protection

The ETX-212A offers various tools to ensure five nines (99.999%) availability and speedy restoration in the event of network outages. These include dual homing link redundancy and Link Aggregation (LAG) using 802.3ad LACP. Path protection is supported with Ethernet Linear Protection Switching per ITU-T G.8031, to ensure end-to-end service is maintained when a fault is detected in one of the logical EVCs. In addition, the ETX-212A supports Ethernet 1-GbE or 10-GbE Rings Protection Switching (ERPS) per G.8032.

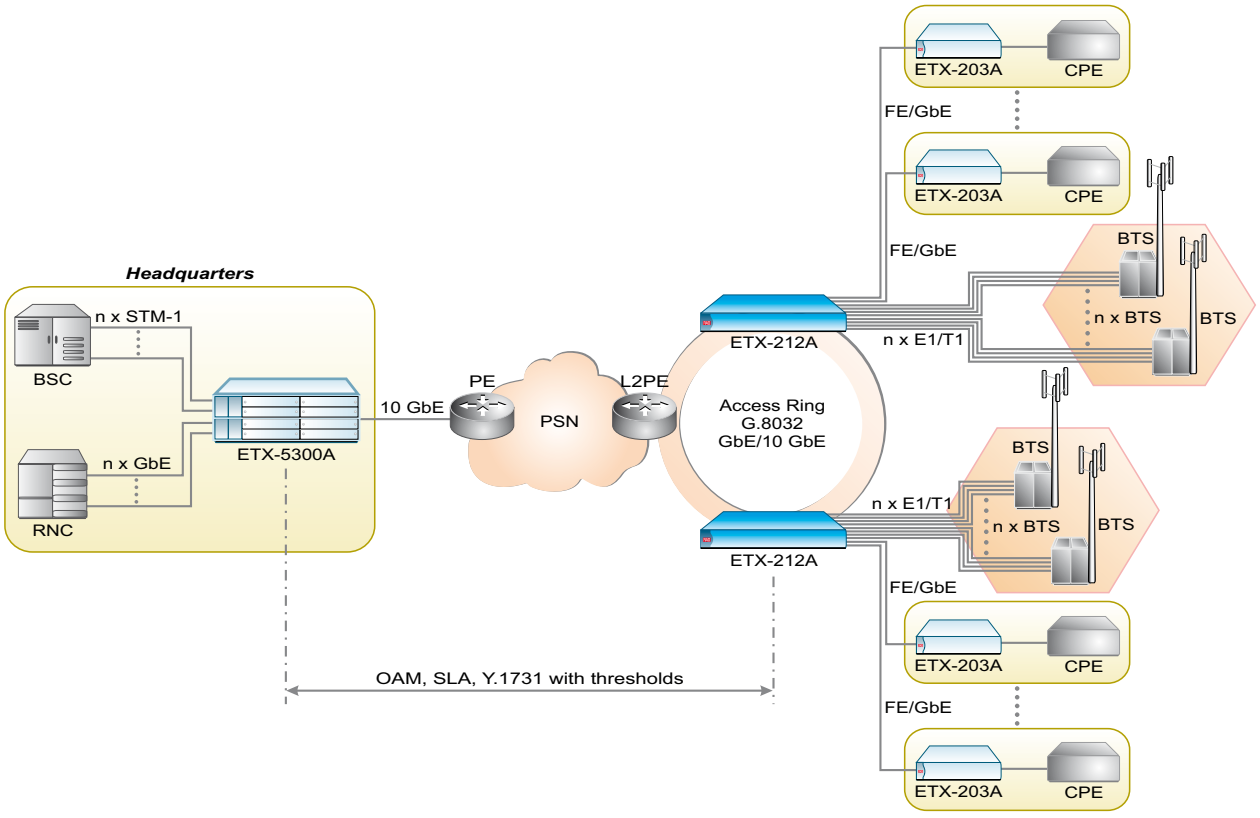
Management and security

The ETX-212A features flexible management capabilities, including local management via an ASCII terminal (RS-232). In addition, remote management can be performed 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-212A also supports a variety of access protocols, including CLI over Telnet, SNMP, and TFTP. Incorporated security features include Secure Shell (SSH), Web-based Secure Socket Layer (SSL), SNMPv3, RADIUS and Terminal Access Controller Access-Control System (TACACS+), as well as management access control list (ACL).



Ethernet service demarcation over packet network ensures end-to-end SLA



Ethernet service demarcation over packet network and ring resiliency at the access

ETX-102, ETX-201, ETX-202

Basic 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 basic 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.

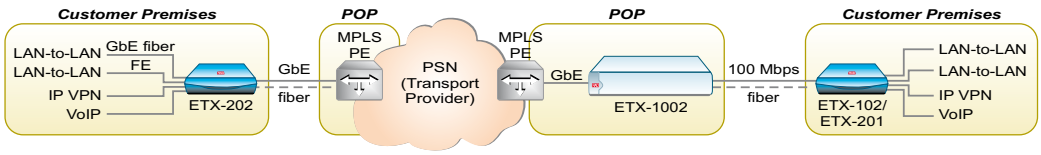
Management and security

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.

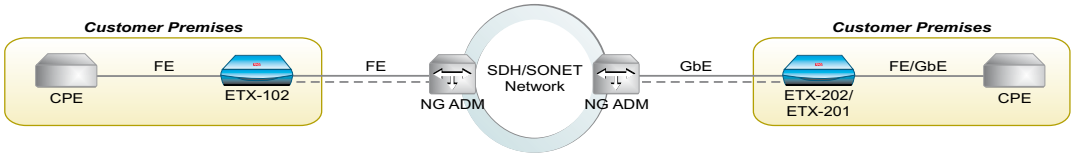
The ETX-102, ETX-201 and ETX-202 also support a variety of access protocols, including Telnet, SNMP, Web server, and TFTP. Incorporated security features include Secure Shell (SSH), Web-based Secure Socket Layer (SSL), SNMPv3, and RADIUS.

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

LA-210

EFM DSL Network Termination Unit

EtherAccess

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

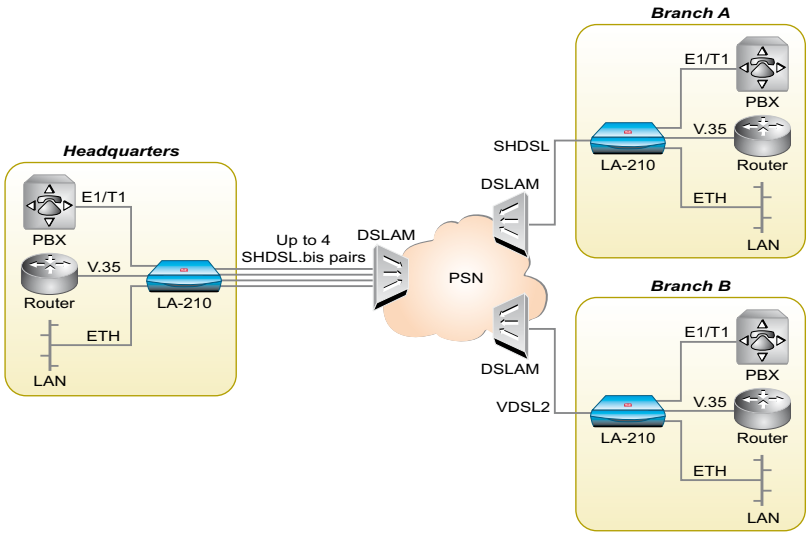
Ethernet OAM is a cornerstone in the transformation of Ethernet into a carrier-class technology. The LA-210 EFM DSL NTU provides two types of Ethernet OAM:

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.



Ethernet and legacy services over SHDSL.bis and VDSL2

- **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**

For latest updates visit www.rad.com

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).

MiRICi-E1/T1, MiRICi-E3/T3

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

System on an SFP

- **Supports framed and unframed E1/T1, E3/T3 link**
- **Supports 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**
- **Software download via TFTP**
- **Supports Ethernet OAM per 802.3-2005 (formerly 802.3ah)**

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The innovative SFP-format MiRICi-E1/T1 and MiRICi-E3/T3 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.

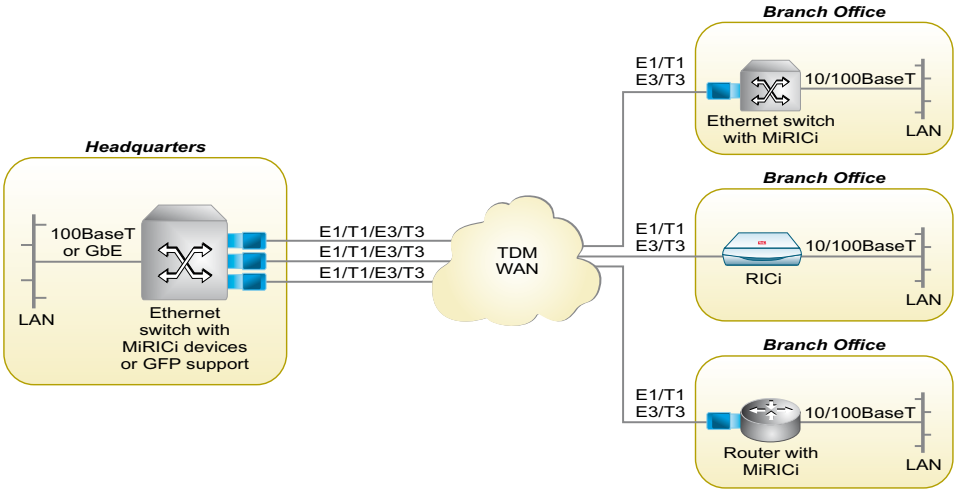
The MiRICi products support standard GFP encapsulation (G.8040, G.7041/Y.1303) for book-end connections as well as third-party GFP interoperability.

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 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-E1/T1 and MiRICi-E3/T3 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

Gigabit Ethernet over STM-1/OC-3 SFP Converter

System on an SFP

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 pluggable (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^2C 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.

- **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^2C**
- **Supports full duplex flow control**
- **Fault propagation from WAN to LAN link**

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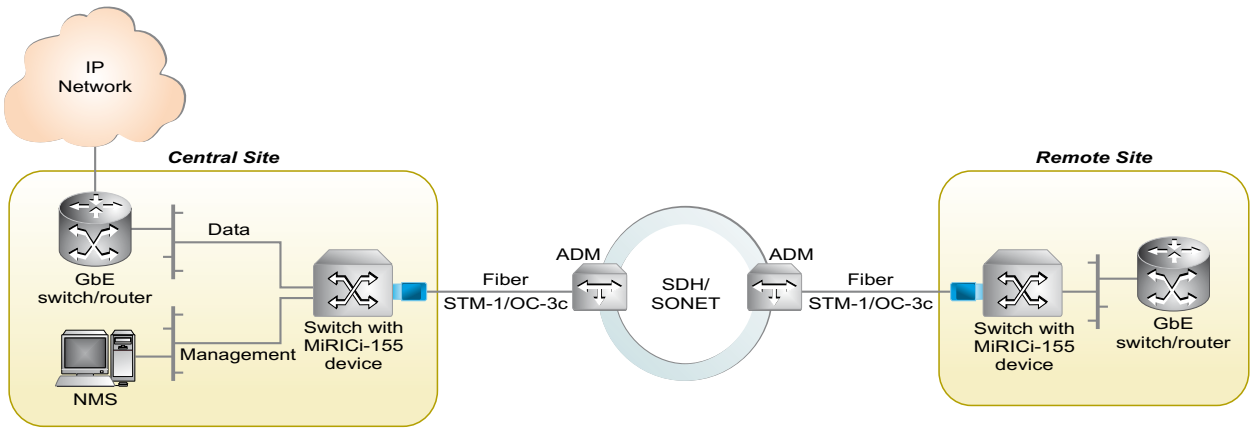
MiRICi-155 can operate opposite MiRICi units installed on remote equipment or opposite RAD's RICi-155GE Gigabit Ethernet over STM-1/OC-3 NTU. Alternatively, the MiRICi devices can operate opposite any Ethernet switch that supports standard GFP encapsulation.



Providing transparent LAN services over SDH/SONET networks

2

Next Generation Aggregation

Industry standardization efforts coupled with advancements in Carrier Ethernet technology have resulted in a new generation of up to 10 Gbps connection-oriented Layer 2 aggregation devices capable of replacing SDH/SONET in the transport and Middle Mile.

RAD Data Communications has added three next generation aggregation devices to its portfolio of business Ethernet and mobile backhaul solutions. The first solution is the ETX-5300A that enables high speed fiber-based access with the ability to deliver TDM services in the form of TDM pseudowires. The second solution, the ETX-1002, is a pure fiber aggregation solution that provides high speed 1 Gbps to 10 Gbps aggregation. The third solution, the Egate-2000 allows operators to deploy profitable and growing Layer 2 services on existing PDH First Mile lines.

ETX-5300A 10G Carrier Ethernet access aggregation platform

The ETX-5300A is a powerful aggregation platform for SLA-based wholesale services, Ethernet business services, legacy TDM service emulation, and mobile backhaul over native 1 Gbps/10 Gbps Ethernet access. It is also ideal for inter-carrier external network-network interface (E-NNI) applications, as well as for high capacity grooming of E-OAM and performance monitoring sessions. The ETX-5300A reduces carrier TCO (total cost of ownership) by combining diverse functionalities in a single device. It works opposite the ETX Carrier Ethernet demarcation devices and the IPmux TDM pseudowire gateways. Together, they provide a complete end-to-edge solution that allows carriers and service providers to easily migrate from SDH/SONET to packet technology and to converge voice and data services – both TDM- and packet-based – over Ethernet, IP or MPLS networks. The ETX-5300A is a fully redundant, no-single-point-of-failure device and is MEF-9 and MEF-14 compliant.

ETX-1002 10-Gigabit Carrier Ethernet aggregation switch

The ETX-1002 10-Gigabit Carrier Ethernet aggregation switch grooms traffic from up to 24 Fast Ethernet or Gigabit Ethernet links over 10 Gigabit Ethernet links at wire-speed. Featuring two redundant 10 Gigabit Ethernet network ports (total of four), the high capacity non-blocking edge switch provides a central aggregation solution for ETX Carrier Ethernet demarcation devices or third-party NTUs installed at the customer premises.

Deployed in hub and spoke or resilient ring topologies, the ETX-1002 10-Gigabit Carrier Ethernet aggregation switch is equipped with multi-priority traffic management capabilities. These, together with Ethernet OAM diagnostics, allow carrier-grade service assurance, making it ideal for aggregation of business services and VPNs, triple-play and broadband aggregation, as well as data center consolidation. The ETX-1002 is a fully redundant, no-single-point-of-failure device and is MEF-9 and MEF-14 compliant.

Egate-2000 Gigabit Ethernet aggregator over PDH, SDH/SONET access

PDH and SDH/SONET continue to dominate at many locations as the most prevalent means of access and transport for customer premises connectivity and mobile backhaul despite the rapid growth of fiber access. Egate-2000 is a high capacity aggregator that is typically deployed in a central location to groom multiple Ethernet over TDM traffic streams received from remote users. Using next generation Ethernet over PDH/SDH/SONET encapsulation and bonding methods, the Egate-2000 can support Ethernet over PDH and SDH/SONET over a variety of containers over the STM-4/OC-12 and STM-16/OC-48 links. The Egate-2000 is a fully redundant, no-single-point-of-failure device and is MEF-9 and MEF-14 compliant.

ETX-1002

10-Gigabit Carrier Ethernet Aggregation Switch

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-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.

- **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 802.1ag and IEEE 802.3-2005 (formerly 802.3ah)**
- **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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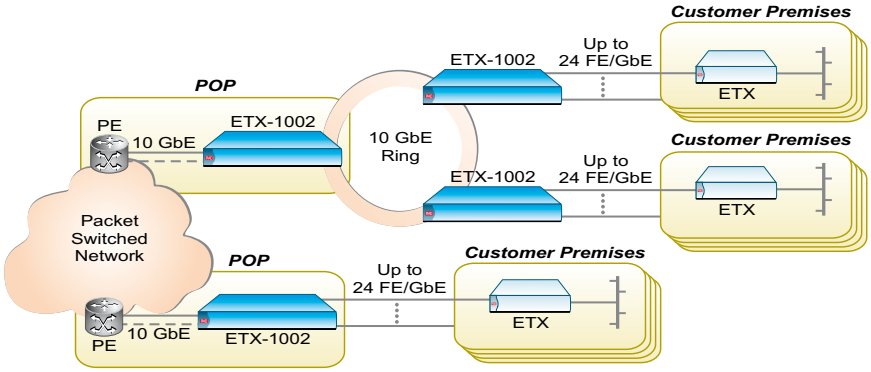

High capacity transport and service aggregation over 10-GbE ring

NEXT GENERATION AGGREGATION

Egate-2000

Gigabit Ethernet Aggregator over PDH, SDH/SONET Access

- **Five channelized SDH/SONET ports supporting a combination of STM-16/OC-48, STM-4/OC-12 and STM-1/OC-3**
- **Eight Gigabit Ethernet interfaces (UTP and SFP)**
- **GFP (G.8040, G.7041/Y.1303), VCAT (G.7043) and LCAS (G.7042) encapsulation**
- **Non-blocking switching with VC-12/VT 1.5 granularity**
- **MEF-9 and MEF-14 compliant for EPL, EVPL, E-LAN**
- **Enhanced Ethernet traffic management with multiple shapers and hierarchical QoS**
- **ITU-T G.8032 Ethernet Rings Protection Switching**
- **Full system redundancy; CE and NEBS compliant**

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The high capacity Egate-2000 aggregator is typically deployed in a central location to groom Ethernet user traffic received from remote devices, such as RAD's RICi Ethernet over PDH and Ethernet over SDH/SONET NTUs, over channelized STM-16/OC-48 connections. The Egate-2000 then transmits the aggregated traffic to the PSN over eight GbE links. Together with the RICi remote units, the Egate-2000 constitutes a complete access solution from the service provider central site to the customer premises.

Ideal for IP DSLAM and WiMAX base station backhaul applications, the Egate-2000 leverages widely available PDH/SDH/SONET infrastructure to deliver carrier-class Ethernet services to sites where native Ethernet is not available.

Egate-2000 features five SDH/SONET ports supporting various configurations of STM-16/OC-48, STM-4/OC-12 and STM-1/OC-3 interfaces. Ethernet tributary interfaces include four multi-rate FE/GbE UTP ports and four GbE SFP ports. The device is fully redundant, including redundant AC/DC power supply modules.

Multi-site Carrier Ethernet aggregation

The Egate-2000 can connect up to:

- 256 remote LANs over E1 or T1 circuits, working opposite RIC, RICi and MiRICi Ethernet over PDH access devices
- Four or 12 VC-4/STS-3c or VC-3/STS-1 circuits, respectively, working opposite the RICi-155GE and RIC-155L Ethernet over SDH/SONET access devices

In addition, it supports any combination of the above with VC-12/VT 1.5 rate granularity and aggregation capacity of up to 2 x STM-4/OC-12.

NG-PDH, SDH encapsulation and bonding

The Egate-2000 supports next-generation Ethernet over TDM encapsulation, using standard protocols for generic framing procedure (GFP), virtual concatenation (VCAT) and link capacity adjustment scheme (LCAS). 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 to supporting easy interoperability with third-party equipment, these protocols eliminate SDH/SONET bandwidth restrictions and provide bandwidth-on-demand flexibility for delay-sensitive applications.

The Egate-2000 supports up to 256 GFP VCAT groups (VCG), with 16 E1/T1 per VCG.

Service resiliency

To ensure higher service uptime and carrier-grade resiliency, the Egate-2000 supports standard Ethernet Rings Protection Switching per G.8032 as well as Ethernet Link Aggregation per IEEE 802.3ad and SDH/SONET 1+1 APS redundancy protection.

The Egate-2000 supports STM-1/OC-3, STM-4/OC-12 and STM-16/OC-48 add/drop multiplexing (ADM) for grooming LAN and TDM traffic over SDH/SONET networks.

Ethernet traffic management

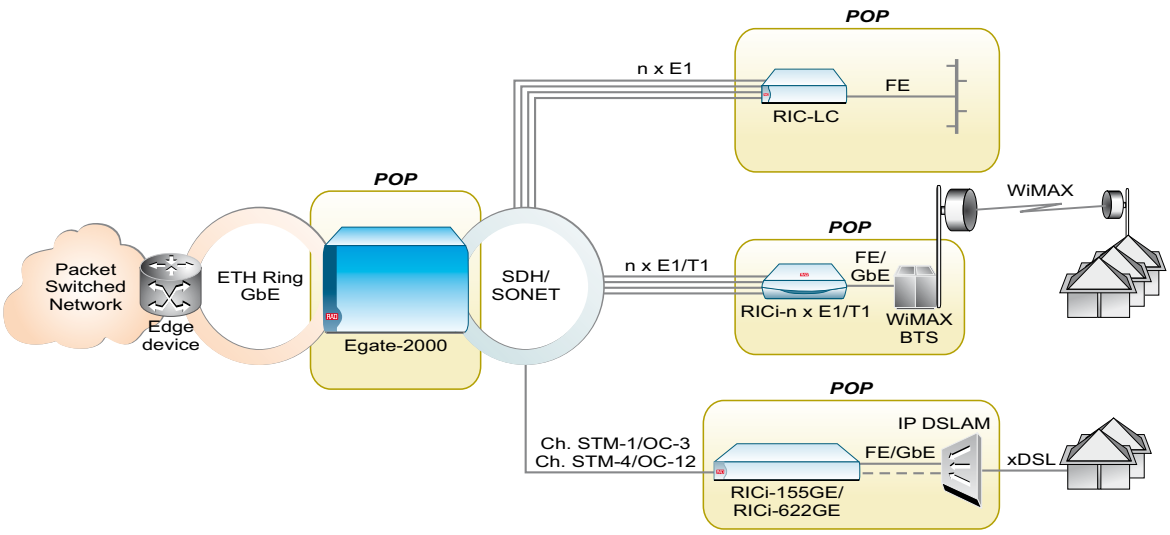
The Egate-2000 features advanced traffic management capabilities:

- User traffic classification according to VLAN ID, VLAN priority, DSCP, ToS, or MAC address, supporting thousands of CoS flows (EVC.CoS) per EVC
- Two-rate, three-color traffic policing per CIR/CBS, EIR/EBS bandwidth profiles
- Hierarchical QoS supporting multiple priority queues per EVC with Strict Priority, weighted round robin (WRR) and weighted fair queuing (WFQ) scheduling

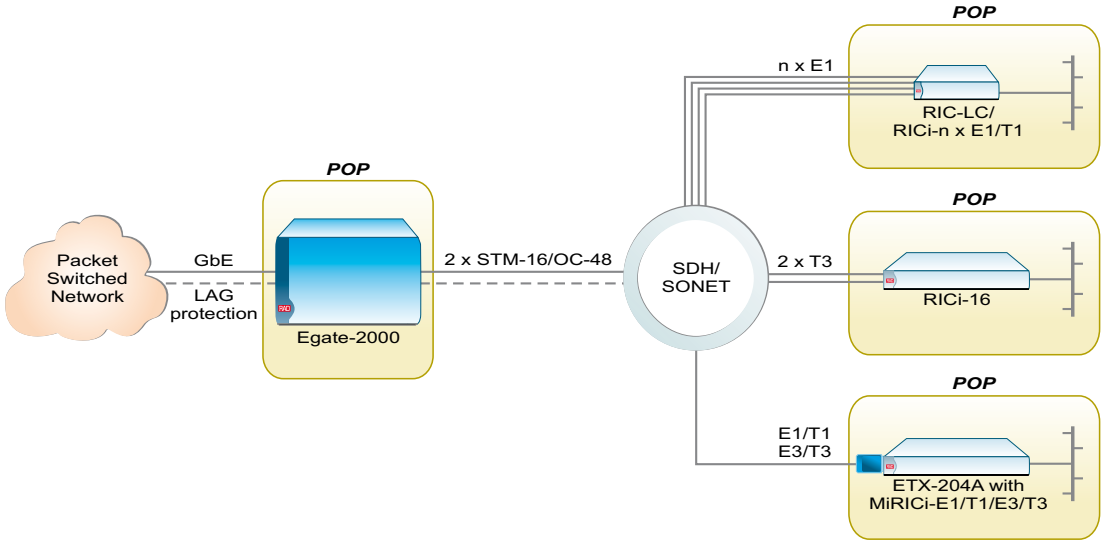
These capabilities enable service differentiation and SLA guarantees for point-to-point Ethernet Private Line (EPL) and Ethernet Virtual Private Line (EVPL) services, as well as for Ethernet Private LAN and Ethernet Virtual Private LAN services.

The device supports VLAN-aware bridging, IEEE 802.1Q VLAN tagging, Q-in-Q, Rapid Spanning Tree Protocol, and Ethernet jumbo frames.

The Egate-2000 is managed by the RADview-EMS, RAD's carrier-class management system.



Ethernet and backhaul services over PDH/SDH/SONET



Ethernet services over PDH/SDH/SONET

ETX-5300A

10G Carrier Ethernet Access Aggregation Platform

- **Aggregates SLA-based business Ethernet, legacy TDM and mobile backhaul services**
- **Ethernet OAM termination and grooming**
- **3U device with high port density, delivering a 120 Gbps throughput**
- **Fully redundant system with modular design:**
  - **Network ports: eight 10 GbE**
  - **Tributary ports: up to 80 x 1 GbE or 16 channelized STM-1/OC3**
- **Carrier Ethernet MEF compliant for:**
  - **MEF-9, MEF-14: E-Line, E-LAN, E-Tree services; MEF-8**
  - **MEF-22: mobile backhaul**
  - **MEF-26: E-NNI**
- **Ethernet Linear and Rings Protection Switching: ITU-T G.8031, G.8032**
- **Extensive Sync-E, 1588v2 support**
- **Extensive TDM pseudowire support: CESoPSN, SAToP, CESoETH (MEF-8), UDP/IP encapsulation**
- **Extremely low power consumption; temperature-hardened enclosure; NEBS compliant**

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Carrier-class Layer 2 aggregation switch

The ETX-5300A reduces carrier TCO (total cost of ownership) in delivering aggregated traffic from the access network to the PE (provider edge) over native 10-Gigabit Ethernet links. It combines high capacity aggregation, carrier-grade performance, small form-factor, and low cost per Mbps, thereby enabling cost optimization and freeing up expensive capacity at the PE.

The ETX-5300A aggregates SLA-based wholesale services, Ethernet business services, legacy TDM service emulation, and mobile backhaul. It is also ideal for high capacity grooming of E-OAM and performance monitoring sessions.

The ETX-5300A powerful aggregation platform works opposite the ETX Carrier Ethernet demarcation devices and the IPmux TDM pseudowire gateways. Together, they provide a complete end-to-edge solution that allows carriers and service providers to easily migrate from SDH/SONET to packet technology and to converge voice and data services – both TDM- and packet-based – over Ethernet, IP or MPLS networks. A true service delivery platform, the ETX-5300A supports "point-and-click" provisioning and delivers predictable performance with end-to-end SLA assurance.

Supported services include:

- E-Line (EPL and EVPL) for LAN-to-LAN, VoIP and IP-VPN connectivity, as well as for storage and dedicated Internet access
- E-LAN (EP-LAN and EVP-LAN) for multipoint Layer 2 VPN, transparent LAN services and multicast networks
- E-Tree (EP-Tree, EVP-Tree) for rooted multipoint Layer 2 VPNs, broadcast and telemetry networks
- 2G, 3G, HSPA, and LTE transport

The 3U modular system features high port density for space-restricted facilities, delivering up to 120 Gbps of user throughput via the following interfaces:

- Two redundant main cards, each housing four 10-GbE network ports
- Up to four service cards, each housing 20 UTP or SFP 1-GbE tributary ports, four channelized STM1/OC-3 ports, or combinations

The ETX-5300A features non-blocking architecture, allowing wire-speed forwarding for all packet sizes. Designed for high availability and "always-on" service reliability, it includes port and power supply redundancy, with hot-swappable cards and modules, as well as in-service software upgrade capabilities. In addition, it supports carrier-grade service resiliency, as detailed below.

Remote provisioning and traffic management

The ETX-5300A enables efficient handling of multi-priority traffic on a per-flow basis, with ultra-high capacity that enables simultaneous processing of thousands of service flows. The device enables multi-criteria traffic classification as well as metering, policing and shaping to help carriers rate-limit user traffic according to pre-defined CIR (committed information rate) and EIR (excess information rate) profiles.

Enhanced quality of service is further supported by a 3-level 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-5300A also uses weighted random early detection (WRED) policy for intelligent queue management and congestion avoidance. Packet editing capabilities include 802.1ad Q-in-Q tagging and color-sensitive P-bit re-marking, which ensures metering continuity across color-aware and color-blind Metro networks and WANs.

Hardware-based Ethernet OAM and performance monitoring for SLA assurance

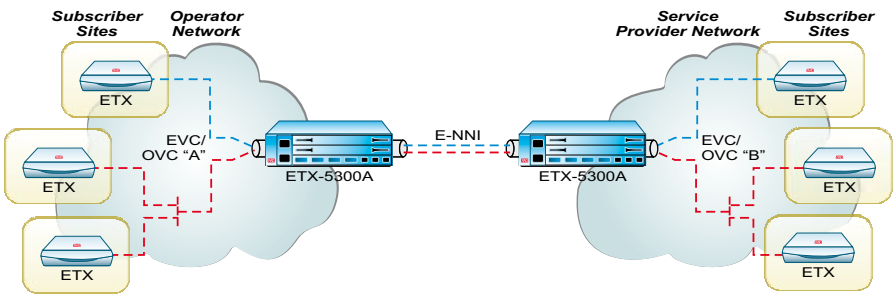
The ETX-5300A features a comprehensive Ethernet OAM suite that includes Ethernet Service OAM (IEEE 802.1ag) and Performance Monitoring (ITU-T Y.1731).

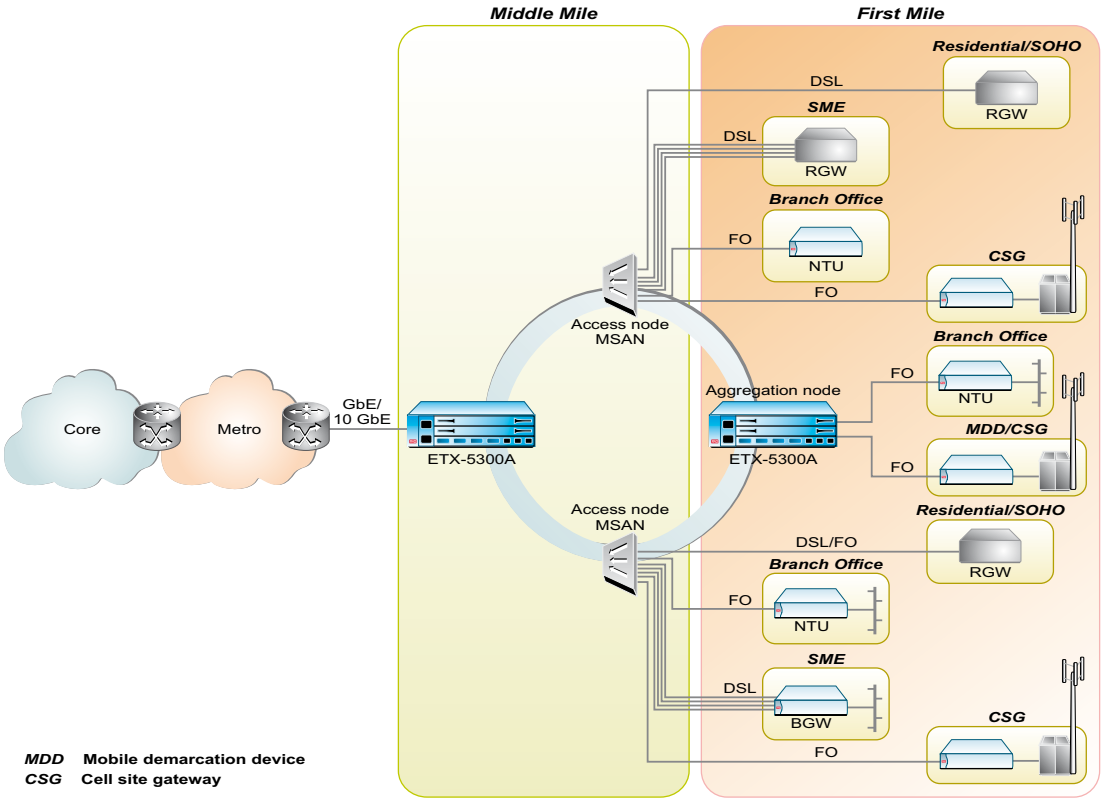
Featuring ultra-fast, hardware-based processing capabilities, the ETX-5300A performs OAM and PM measurements in nanoseconds with maximum precision, offering the following powerful benefits:

- Immediate detection of loss of continuity (LOC) to ensure sub-50 ms protection switching
- Highly accurate frame loss measurements with live-traffic testing
- Flow-level monitoring enables simultaneous processing of over 1,000 OAM sessions
- Loopback testing at line rate

Its superior processing capabilities make the ETX-5300A an ideal termination and grooming point for Ethernet OAM and performance monitoring sessions.

The ETX-5300A offers advanced SLA assurance tools, including user-defined KPI (key





ETX-5300A as a First Mile and Middle Mile aggregator

performance indicators) threshold configuration for jitter, latency, packet loss and availability. Other tools include real-time SLA violation alerts and per-flow daily statistics reporting.

Service resiliency and protection

The ETX-5300A offers various tools to ensure five nines (99.999%) availability and sub-50 ms restoration in the event of network outages. These include dual homing link redundancy and Link Aggregation (LAG), as well as 1+1 APS protection on the TDM ports. Path protection is supported with Ethernet Linear Protection Switching per ITU-T G.8031, ensuring end-to-end service is maintained when a fault is detected in one of the logical EVCs. In addition, the ETX-5300A supports Ethernet Rings Protection Switching (ERPS) per G.8032.

Synchronization and Timing over Packet

Incorporating RAD's SyncToP synchronization and Timing over Packet feature set, the ETX-5300A utilizes standard technologies to ensure highly accurate clock recovery and distribution over both the physical and packet layers:

- Synchronous Ethernet (Sync-E) master and slave clock support per ITU-T G.8261-G.8266, with primary/secondary clock redundancy
- 1588v2 Precision Time Protocol master, transparent and slave clock with hardware-based timestamping as well as ToD (time of day) synchronization
- 1 pps, 10-MHz signal phase and frequency synchronization

The ETX-5300A's exceptional SyncToP capabilities also include a built-in input/output clock interface and support for multiple clock domains. These provide exceptional value for wholesale mobile backhaul service providers, ensuring the required service quality – such as +/-16 ppb (parts per billion) accuracy – while eliminating the need for costly dedicated hardware.

Management and security

The ETX-5300A features flexible management capabilities, including local management via an ASCII terminal (RS-232). In addition, remote management can be performed 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-5300A 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, RADIUS and Terminal Access Controller Access-Control System (TACACS+), as well as management access control list (ACL).

3

Mobile Backhaul

The transition to packet-based mobile backhaul and all-IP radio access networks enables operators and transport providers to curb their OpEx and better accommodate the massive increase of mobile broadband traffic, especially with the rollout of HSPA+ and LTE. However, high volume "pipes" are not enough to satisfy operators' demand for tight SLAs with guaranteed reliability and service quality. Backhaul providers are expected to meet performance commitments for packet loss, delay, jitter, and availability to ensure the hard QoS required for mobile services.

The only way for transport operators to control service KPIs (key performance indicators) and guarantee end-to-end SLAs over PSNs (packet switched networks) is by deploying a mobile demarcation device (MDD) at each service hand-off point, such as a cell-site, hub-site or aggregation node.

RAD's ETX-A (see pages 72-76) MDDs support sophisticated traffic management and service assurance capabilities over Ethernet-based backhaul to provide end-to-end visibility across the entire service path. By featuring advanced SLA management, performance monitoring and OAM diagnostic capabilities, the ETX-A MDDs help providers segment their backhaul network to localize problems and determine their origin – without requiring expensive truck rolls or service shut-downs to do so.

RAD's MDDs provide statistics analysis capabilities, in addition to guaranteeing service resiliency and sub-50 ms switchover with a variety of standard linear and ring protection switching mechanisms.

Multi-generation, multi-technology support

With the transition to packet technology already under way, mobile operators and transport providers still need to ensure service continuity for 2G and 3G voice traffic, while guaranteeing the quality requirements for emerging data-intensive and rich-media applications. In addition, many carriers and network operators are reluctant to initiate major forklift upgrades to fiber and native packet transport, but rather continue using their existing installed base instead.

RAD's cell-site and aggregation-site gateways deliver 2G, 3G and 4G traffic over any transport network, efficiently handling real-time voice and best-effort data with cross-generation support, regardless of the underlying physical layer. This includes support for fiber, copper and point-to-point microwave (TDM and Ethernet), as well as for PDH, DSL (SHDSL.bis, ADSL2/2+ and VDSL), ATM, SDH/SONET, GPON, and Carrier Ethernet.

The ACE (see pages 77-85) and IPmux (see pages 150-154) product lines support TDM pseudowire standards to ensure "SDH/SONET or better" performance levels and backward compatibility for legacy service continuity over new networks. In addition, the ACE gateways also support ATM pseudowire.

High precision synchronization over packet

As asynchronous packet networks introduce packet delay, delay variation and packet loss, they require robust synchronization solutions for mobile backhaul services, to eliminate the risk of service disruptions and impaired call hand-offs.

RAD's SyncToP platform of high performance clock recovery and distribution techniques feature powerful frequency, phase and ToD (time of day) alignment capabilities. These are incorporated into a variety of mobile demarcation devices, as well as into cell-site and aggregation-site gateways, to ensure reliable transmission of real-time traffic without the need for costly external synchronization devices.

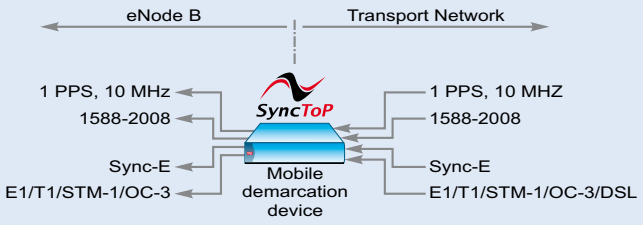
Supported technologies include IEEE 1588v2 Precision Time Protocol (PTP), Synchronous Ethernet, NTR (network timing reference) over SHDSL, and adaptive clock recovery (ACR).

These enable highly accurate, seamless delivery of 2G, 3G and 4G traffic over packet backhaul, ensuring QoS

priorities for clock traffic and meeting mobile backhaul's stringent requirements, including definite frequency accuracy of 50 ppb (parts per billion) for GSM and 16 ppb for 2G CDMA and 3G UMTS.

Extending coverage to underserved areas

RAD's dedicated solution portfolio for extending mobile coverage to outlying areas, includes a full gamut of affordable solutions that can be quickly and cost-effectively deployed to backhaul mobile traffic over copper, fiber or wireless links. Most popular solutions include the ASMi-54 SHDSL.bis modem (see page 128) with an integrated router or multiplexer, the Optimux-108L fiber optic multiplexer (see page 117), the Airmux-400 broadband wireless multiplexer (see page 134), and the IPmux-xL fiber TDM pseudowire gateways (see page 152). Working opposite the Megaplex-4100 multiservice access platform (see page 88), the LRS-102 fiber and copper mux rack (see page 126), or the IPmux-155L hub-site pseudowire access gateway (see page 154) at the operator POP, these devices enable providers to utilize any available infrastructure to connect remote 2G and 3G base stations to their respective controllers.



SyncToP-enabled mobile demarcation device

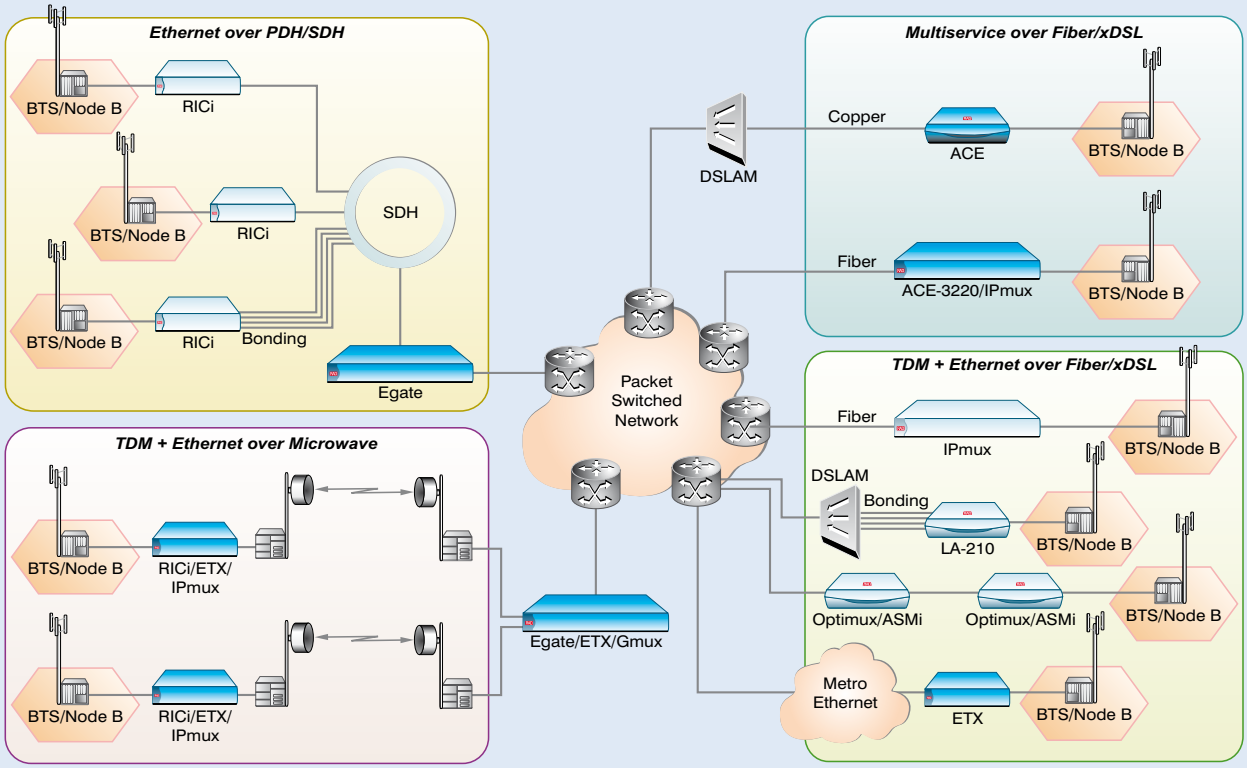
IP Node B and LTE backhaul over PDH

The RICi Ethernet demarcation devices (see pages 44-48) transport HSPA and voice traffic from IP Node Bs to their controllers over widely available TDM infrastructure. This allows operators to maximize investments in existing infrastructure while guaranteeing QoS for new services.

Ethernet Aggregation

RAD has also introduced a series of Ethernet aggregation solutions, which provide up to 10 Gbps connectivity to packet switched networks and up to STM-16/OC-48 for SDH/SONET transport. Working opposite RAD's Carrier Ethernet demarcation and mobile demarcation devices, they offer an integrated end-to-edge system for highly reliable and resilient access, backhaul and transport with comprehensive SLA assurance mechanisms.

For further information, see the Next Generation Aggregation chapter, pages 64-69.



Cellular backhaul solutions over any network

ETX-204A

Carrier Ethernet Mobile Demarcation Device

EtherAccess

- **Demarcation point for SLA-based mobile backhaul services**
- **Supports HSPA, HSPA+ and LTE traffic; MEF-22 compliant**
- **Multi-rate FE/GbE UTP/SFP combo ports with auto detection**
- **Supports Sync-E, 1588v2 slave and TC, 1 PPS**
- **Enhanced traffic management with multiple shapers and H-QoS per EVC/ EVC.CoS**
- **Ethernet OAM, performance monitoring and built-in RFC-2544 tester capabilities; L2/L3 diagnostic loopbacks**
- **ITU-T G.8031 Ethernet Linear Protection Switching**
- **Temperature-hardened enclosure; AC/DC redundancy**
- **RADview-EMS management; CLI configuration**

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Mobile demarcation device for cellular backhaul

The ETX-204A Carrier Ethernet demarcation device combines cell-site gateway with Ethernet demarcation functionalities to provide end-to-end service control and performance management across packet backhaul.

Supporting 3G, HSPA and LTE services, the ETX-204A is installed at cellular tower and controller sites to help backhaul and transport providers, as well as fixed-mobile carriers, guarantee differentiated SLAs for mobile operators. As an all-in-one device, it cuts down provider costs by minimizing equipment needed for timing and demarcation.

The ETX-204A features two Gigabit Ethernet network ports and two or four GbE user ports. All ports are SFP and UTP compatible with auto-detection of fiber and copper connections.

Synchronization and Timing over Packet

Synchronization and timing accuracy is critical for the quality of mobile services over asynchronous packet networks. These introduce packet delay variation and packet loss, which may lead to service disruptions, impaired cell hand-offs and excessive dropped calls.

Incorporating RAD's SyncToP synchronization and Timing over Packet feature set, the ETX-204A utilizes standard technologies to ensure highly accurate clock recovery and distribution over both the physical and packet layers:

- Synchronous Ethernet (Sync-E) master and slave clock support per ITU-T G.8261-G.8264, with primary/secondary clock redundancy
- 1588v2 Precision Time Protocol slave and transparent clock with hardware-based timestamping
- 1 PPS, E1/T1 and 2 MHz signal frequency extracted from Sync-E, E1/T1 or 1588v2 slave

The ETX-204A also supports simultaneous use of multiple timing and synchronization technologies, to reconcile different methodologies used in various network segments, thereby eliminating the need for costly upgrades. Such powerful clock transfer capabilities allow backhaul providers to ensure SDH/SONET-level performance, including frequency accuracy of 16 ppb (parts per billion) or better, without investing in dedicated hardware.

Hardware-based Ethernet OAM and performance monitoring for SLA assurance

The ETX-204A combines Ethernet demarcation with test-head functionalities, featuring a complete Ethernet OAM suite that includes Ethernet Link OAM (IEEE standard 802.3-2005, formerly 802.3ah), Ethernet Service OAM (IEEE 802.1ag) and Performance Monitoring (ITU-T Y.1731). These are enhanced with a built-in RFC-2544 test generation engine for unidirectional and bi-directional testing of throughput, latency and frame loss. In addition, the device features Layer 1, 2 and 3 diagnostic loopback capabilities with MAC and IP address swap.

Incorporating ultra-fast, hardware-based processing capabilities, the ETX-204A performs OAM and PM measurements in under 1 microsecond with maximum precision, offering the following powerful benefits:

- Immediate detection of loss of continuity (LOC) to ensure under 50 ms protection switching
- Highly accurate frame loss measurements with live-traffic testing
- Flow-level monitoring enables simultaneous processing of hundreds of OAM sessions
- Loopback testing at line rate

The ETX-204A offers advanced SLA assurance tools, including customer-defined KPI (key performance indicators) threshold configuration, real-time SLA violation alerts and per-flow daily statistics reporting. The latter allows backhaul wholesalers to execute effective capacity planning to overcome the "peak to mean" gap, such that bandwidth is added only when needed based on actual usage trends.

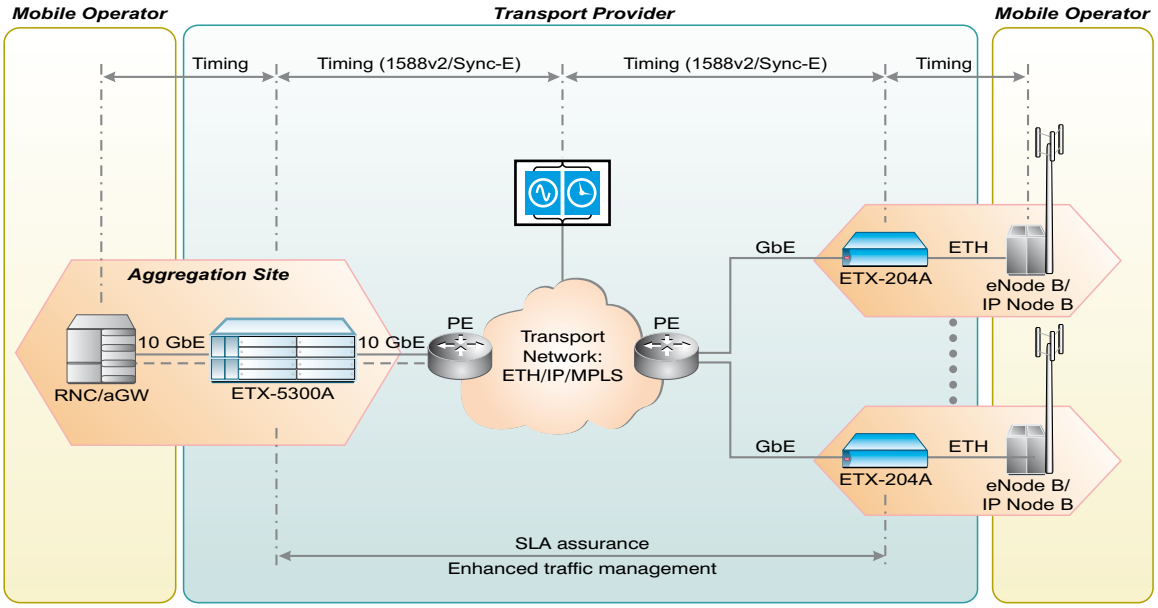
Fault propagation mechanisms include subscriber port shutdown, as well as alarm indication signal (AIS) and remote defect indication (RDI) per Y.1731, to allow immediate notification and containment of service-affecting problems.

The ETX-204A provides end-to-end visibility across the entire service path to help backhaul providers localize service-affecting faults and determine their origin – without requiring expensive truck rolls or service shut-downs to do so.

Remote provisioning and traffic management

The ETX-204A features advanced softcore architecture for efficient handling of multi-priority traffic on a per-flow basis. The device enables multi-criteria traffic classification as well as metering, policing and shaping to help carriers rate-limit user traffic according to pre-defined CIR (committed information rate) and EIR (excess information rate) profiles.

Enhanced quality of service is further supported by a hierarchical scheduling mechanism that



Service demarcation, SLA assurance and synchronization over packet solution for 3GPP and LTE networks

combines Strict Priority (SP) and weighted fair queue (WFQ) scheduling to efficiently handle real-time, premium and best-effort traffic. The ETX-204A also uses weighted random early detection (WRED) policy for intelligent queue management and congestion avoidance. Packet editing functionalities, such as color-sensitive P-bit re-marking, ensure metering continuity across color-aware and color-blind networks.

Uplink resiliency and protection

The ETX-204A offers various tools to ensure five nines (99.999%) availability and speedy restoration in the event of network outages. These include dual homing link redundancy and Link Aggregation (LAG) using 802.3ad LACP. In addition, path protection is supported with Ethernet Linear Protection Switching per ITU-T G.8031 to ensure end-to-end service is maintained when a fault is detected in one of the logical EVCs.

Management and security

The ETX-204A features flexible management capabilities, including local management via an ASCII terminal (RS-232). In addition, remote management can be performed 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-204A also supports a variety of access protocols, including CLI over Telnet, SNMP, and TFTP. Incorporated security features include Secure Shell (SSH), Web-based Secure Socket Layer (SSL), SNMPv3, RADIUS and Terminal Access Controller Access-Control System (TACACS+), as well as management access control list (ACL).

The ETX-204A can also be easily integrated in a third-party OSS.

ETX-212A

Modular Carrier Ethernet Mobile Demarcation Device

EtherAccess

- **High capacity demarcation point for SLA-based mobile backhaul**
- **Supports HSPA, HSPA+ and LTE traffic; MEF-22 compliant**
- **Dual GbE network port; up to eight multi-rate FE/GbE user ports**
- **Expandable capacity with two pluggable modules, each supporting TDM or Ethernet interfaces:**
  - **Eight or 16 E1/T1 pseudowire connections**
  - **Two 10-Gigabit Ethernet XFP/SFP+ ports for G.8032 ERPS**
- **Supports Sync-E, 1588v2 slave and TC, 1PPS**
- **Enhanced traffic management with multiple shapers and H-QoS per EVC/ EVC.CoS**
- **Ethernet OAM, performance monitoring and built-in RFC-2544 tester capabilities; L2/L3 diagnostic loopbacks**
- **ITU-T G.8031 Ethernet Linear Protection Switching; ITU-T G.8032 Ethernet Rings Protection Switching**
- **Temperature-hardened enclosure; AC/DC redundancy**

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Mobile demarcation device for cellular backhaul

The ETX-212A high capacity Carrier Ethernet mobile demarcation device combines an aggregation-site gateway with Ethernet demarcation functionalities to provide end-to-end service control and performance management across packet backhaul.

Supporting 3G, HSPA and LTE services, the ETX-212A is installed at cellular tower and controller sites to help backhaul and transport providers, as well as fixed-mobile carriers, guarantee differentiated SLAs for mobile operators. As an all-in-one device, it cuts down provider costs by minimizing equipment needed for timing and demarcation.

The ETX-212A features two Gigabit Ethernet network ports and up to eight GbE user ports. All ports are SFP compatible. In addition, two pluggable modules feature up to 16 E1/T1 ports each for TDM pseudowire emulation over packet. Alternatively, one of the modules can be equipped with two 10-GbE ports for G.8032 ERPS.

Synchronization and Timing over Packet

Synchronization and timing accuracy is critical for the quality of mobile services over asynchronous packet networks. These introduce packet delay variation and packet loss, which may lead to service disruptions, impaired cell hand-offs and excessive dropped calls. In addition to frequency and timing accuracy, LTE requires phase synchronization between neighboring eNode Bs and between eNode Bs and aGWs.

Incorporating RAD's SyncToP synchronization and Timing over Packet feature set, the ETX-212A utilizes standard technologies to ensure highly accurate clock recovery and distribution over both the physical and packet layers:

- Synchronous Ethernet (Sync-E) master and slave clock support per ITU-T G.8261-G.8264, with primary/secondary clock redundancy
- 1588v2 Precision Time Protocol slave and transparent clock with hardware-based timestamping
- 1 PPS, E1/T1 and 2 MHz signal frequency extracted from Sync-E, E1/T1 or 1588v2 slave

The ETX-212A also supports simultaneous use of multiple timing and synchronization technologies, to reconcile different methodologies used in various network segments, thereby eliminating the need for costly upgrades. Such powerful clock transfer capabilities allow backhaul providers to ensure SDH/SONET-level performance, including frequency accuracy of 16 ppb (parts per billion) or better, without investing in dedicated hardware-based.

Ethernet OAM and performance monitoring for SLA assurance

The ETX-212A combines Ethernet demarcation with test-head functionalities, featuring a complete Ethernet OAM suite that includes Ethernet Link OAM (IEEE standard 802.3-2005, formerly 802.3ah), Ethernet Service OAM (IEEE 802.1ag) and Performance Monitoring (ITU-T Y.1731). These are enhanced with a built-in RFC-2544 test generation engine for unidirectional and bi-directional testing of throughput, latency and frame loss. In addition, the device features Layer 2 and 3 diagnostic loopback capabilities with MAC and IP address swap.

Incorporating ultra-fast, hardware-based processing capabilities, the ETX-212A performs OAM and PM measurements in under 1 microsecond with maximum precision, offering the following powerful benefits:

- Immediate detection of loss of continuity (LOC) to ensure under 50 ms protection switching
- Highly accurate frame loss measurements with live-traffic testing
- Flow-level monitoring enables simultaneous processing of hundreds of OAM sessions
- Loopback testing at line rate

The ETX-212A offers advanced SLA assurance tools, including user-defined KPI (key performance indicators) threshold configuration, real-time SLA violation alerts and per-flow daily statistics reporting. The latter allows backhaul wholesalers to execute effective capacity planning to overcome the "peak to mean" gap, such that bandwidth is added only when needed based on actual usage trends.

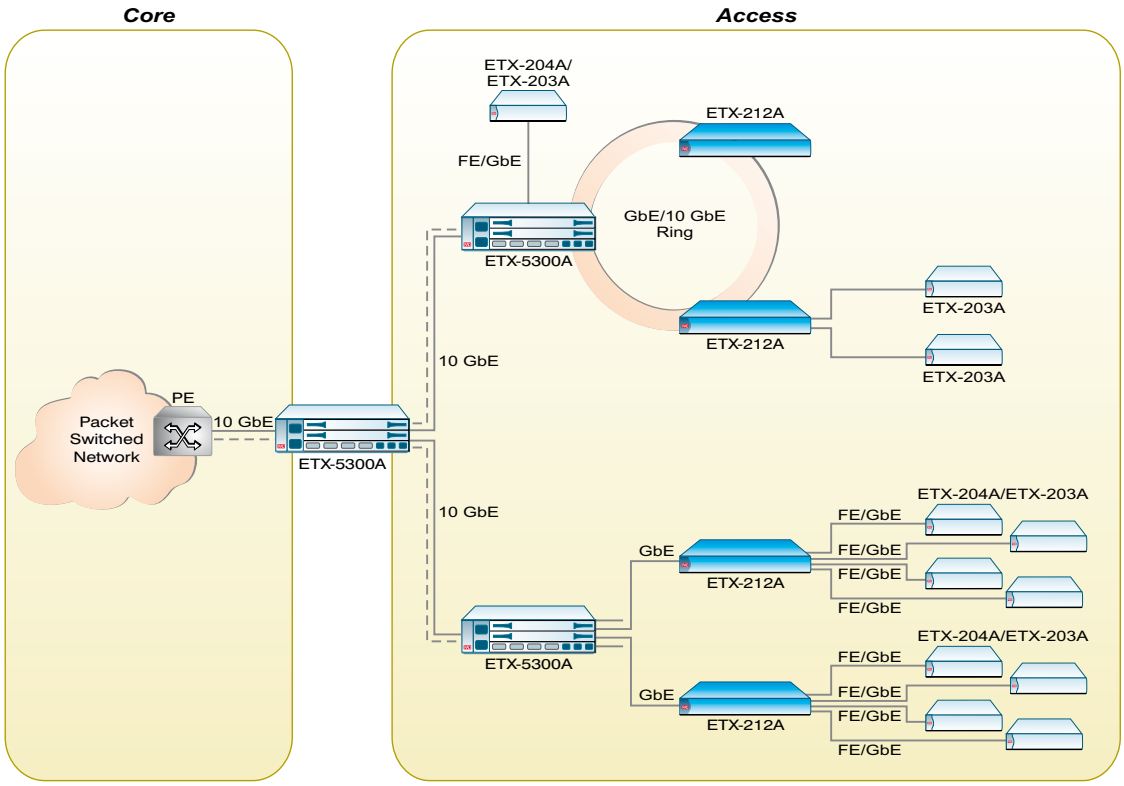
Fault propagation mechanisms include subscriber port shutdown, as well as alarm indication signal (AIS) and remote defect indication (RDI) per Y.1731, to allow immediate notification and containment of service-affecting problems.

The ETX-212A provides end-to-end visibility across the entire service path to help backhaul providers localize service-affecting faults and determine their origin – without requiring expensive truck rolls or service shut-downs to do so.

Remote provisioning and traffic management

The ETX-212A features advanced softcore architecture for efficient handling of multi-priority traffic on a per-flow basis, with ultra-high capacity that enables simultaneous processing of hundreds of service flows. The device enables multi-criteria traffic classification as well as metering, policing and shaping to help carriers rate-limit user traffic according to pre-defined CIR (committed information rate) and EIR (excess information rate) profiles.

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-212A also uses weighted random early detection (WRED) policy for intelligent queue management and congestion avoidance.



Service demarcation, SLA assurance and synchronization over packet solution for 3GPP and LTE networks

Packet editing functionalities, such as color-sensitive P-bit re-marking, ensure metering continuity across color-aware and color-blind metro networks and WANs.

Uplink resiliency and protection

The ETX-212A offers various tools to ensure five nines (99.999%) availability and speedy restoration in the event of network outages. These include dual homing link redundancy and Link Aggregation (LAG) using 802.3ad LACP. Path protection is supported with Ethernet Linear Protection Switching per ITU-T G.8031, to ensure end-to-end service is maintained when a fault is detected in one of the logical EVCs. In addition, the ETX-212A supports 1-GbE or 10-GbE Ethernet Rings Protection Switching (ERPS) per G.8032.

Management and security

The ETX-212A features flexible management capabilities, including local management via an ASCII terminal (RS-232). In addition, remote management can be performed 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-212A also supports a variety of access protocols, including CLI over Telnet, SNMP, and TFTP. Incorporated security features include Secure Shell (SSH), Web-based Secure Socket Layer (SSL), SNMPv3, RADIUS and Terminal Access Controller Access-Control System (TACACS+), as well as management access control list (ACL).

ETX-220A

10G Carrier Ethernet Mobile Demarcation Device

SyncToP

MEF

EtherAccess

- **10-GbE demarcation point for SLA-based mobile backhaul services**
- **Supports HSPA, HSPA+ and LTE traffic; MEF-22 compliant**
- **Two redundant 10-GbE network ports and a 10-GbE user port**
- **Designed to support Sync-E, 1588v2 slave and TC, 1 PPS**
- **Enhanced traffic management with multiple shapers and H-QoS per EVC/EVC.CoS**
- **Ethernet OAM, performance monitoring and built-in RFC-2544 tester capabilities; L2/L3 diagnostic loopbacks**
- **ITU-T G.8031 Ethernet Linear Protection Switching**
- **Temperature-hardened enclosure; AC/DC redundancy**
- **RADview-EMS management; CLI configuration**

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The ETX-220A 10G Carrier Ethernet mobile demarcation device combines an aggregation-site gateway with Ethernet demarcation functionalities to provide end-to-end service control and performance management across packet backhaul.

Supporting 3G, HSPA and LTE services, the ETX-220A is installed at controller sites to help backhaul and transport providers, as well as fixed-mobile carriers, guarantee differentiated SLAs for mobile operators.

The ETX-220A features two 10-Gigabit Ethernet network ports and a 10-GbE user port (hardware ready for 1+1 redundancy). All ports are SFP+ or XFP compatible.

Synchronization and Timing over Packet

Designed to support RAD's SyncToP synchronization and Timing over Packet feature set, the ETX-220A is hardware-ready for the following clock recovery and distribution capabilities:

- Synchronous Ethernet (Sync-E) master and slave clock support per ITU-T G.8261-G.8264, with primary/secondary clock redundancy
- 1588v2 Precision Time Protocol slave and transparent clock with hardware-based timestamping 1 PPS, E1/T1 and 2 MHz signal frequency extracted from Sync-E, E1/T1 or 1588v2 slave

Hardware-based Ethernet OAM and performance monitoring for SLA assurance

The ETX-220A combines Ethernet demarcation with test-head functionalities, featuring a complete Ethernet OAM suite that includes Ethernet Link OAM (IEEE standard 802.3-2005, formerly 802.3ah), Ethernet Service OAM (IEEE 802.1ag) and Performance Monitoring (ITU-T Y.1731). These are enhanced with a built-in RFC-2544 test generation engine, as well as Layer 2 and 3 diagnostic loopback capabilities with MAC and IP address swap.

Incorporating ultra-fast, hardware-based processing capabilities, the ETX-220A performs OAM and PM measurements in under 1 microsecond with maximum precision.

The ETX-220A offers advanced SLA assurance tools, including user-defined KPI (key performance indicators) threshold configuration, real-time SLA violation alerts and per-flow daily statistics reporting.

Traffic management

The ETX-220A features sophisticated softcore architecture for efficient handling of multi-priority traffic on a per-flow basis, with ultra-high capacity that enables simultaneous processing of hundreds of service flows. The device enables multi-criteria traffic classification, as well as metering, policing and shaping, to help carriers rate-limit user traffic according to pre-defined CIR (committed information rate) and EIR (excess information rate) profiles.

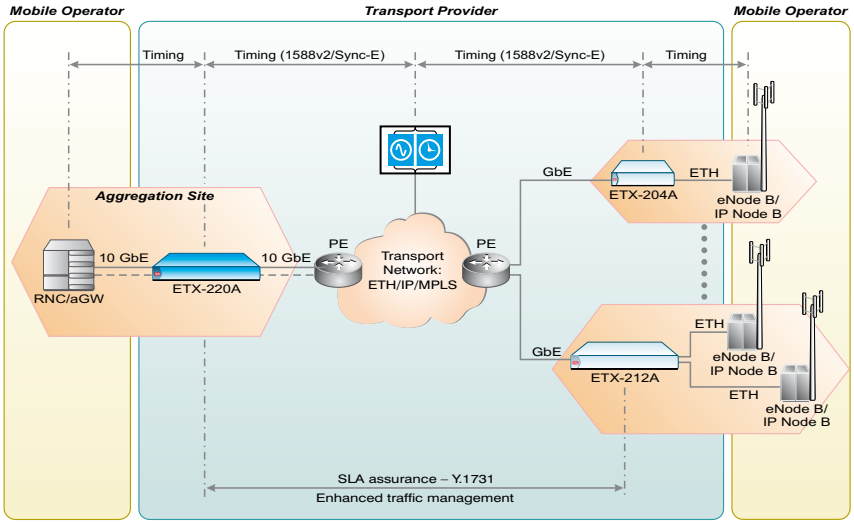
Enhanced quality of service is further supported by a hierarchical scheduling mechanism that combines Strict Priority (SP) and weighted fair queue (WFQ) scheduling, as well as weighted random early detection (WRED) policy and color-sensitive P-bit re-marking packet editing.

The ETX-220A supports dual homing link redundancy and Link Aggregation (LAG) using 802.3ad LACP. Moreover, path protection is supported with Ethernet Linear Protection Switching per ITU-T G.8031.

Management and security

The ETX-220A features flexible management capabilities, including local management via an ASCII terminal (RS-232). In addition, remote management can be performed 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-220A also supports a variety of access protocols, including CLI over Telnet, SNMP, and TFTP. Incorporated security features include Secure Shell (SSH), Web-based Secure Socket Layer (SSL), SNMPv3, RADIUS and Terminal Access Controller Access-Control System (TACACS+), as well as management access control list (ACL).



Service demarcation, SLA assurance solution for 3GPP and LTE networks

ACE-3600

RNC-Site Gateway

RAD's ACE-3600 is a carrier-class multiservice aggregator, specifically designed to accommodate the rapid expansion in cellular traffic resulting from the widespread deployment of new mobile broadband services. It ensures the most economical allocation of backhaul resources in delivering UMTS and HSPA traffic over packet networks. Typically located at RNC sites, the ACE-3600 works opposite the ACE-310x and ACE-32xx cell-site gateways and aggregates STM-1/OC-3c (ATM) traffic over Ethernet, IP or MPLS networks.

The ACE-3600 is a modular platform housing a variety of interfaces, including STM-1/OC-3c UNI and GbE. Its advanced carrier-grade features include full system, power, link, and module redundancy for enhanced service protection.

Advanced pseudowire, QoS and OAM features

The ACE-3600 enables operators to converge multi-generation traffic, including voice and HSPA services, over an all-IP RAN by using standard ATM pseudowire (PW) encapsulation per RFC 4717. These attributes are enhanced with various QoS schemes, including VLAN priority (802.1p), EXP or ToS/DSCP, as well as comprehensive monitoring and diagnostic capabilities, including pseudowire VCCV-BFD and ITU-I.610 ATM OAM.

The advanced shaping and scheduling capabilities of the ACE-3600 permit operators to implement overbooking strategies, enabling them to optimize network utilization, conserve existing resources and reduce the number of leased services required to support their network.

Full range of standard synchronization options

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, the ACE-3600 ensures highly accurate delivery of 3G 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 ACE-3600's synchronization capabilities include packet timing distribution using adaptive clock.

SNMP management

The ACE-3600 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. Advanced

- **Multiservice support for ATM and Ethernet traffic delivery over packet networks**
- **Modular carrier-grade platform with full system redundancy**
- **Multi-standard pseudowire encapsulation over Ethernet, IP and MPLS networks**
- **Highly accurate clock distribution from RNCs to cell sites and hub sites over packet**
- **ATM switching and traffic management**
- **Advanced management system**

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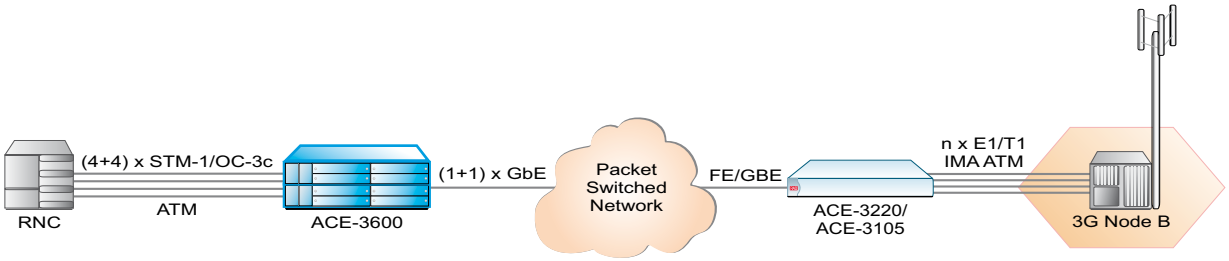
FCAPS (Fault, Configuration, Administration, Performance, Security) and diagnostic tools are provided by RADview-EMS, RAD's carrier-class element management system, via an SNMP-based GUI.

The ACE-3600 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).

The ACE-3600 is a 2U-high, 19-inch chassis with a rack-mount option. Its compact dimensions enable easy installation in limited spaces.



Mobile backhauling of 3G Node B RNC over PSN

ACE-3400

ACE-3400, ACE-3402

Aggregation-Site Gateways

- **Multiservice support for ATM, TDM and Ethernet traffic delivery over packet networks**
- **Modular carrier-grade platform with full system redundancy**
- **Multi-standard pseudowire encapsulation over Ethernet, IP and MPLS networks**
- **Highly accurate clock distribution from BSCs/RNCs to cell sites and hub sites over packet**
- **ATM switching and traffic management**
- **Advanced management system**
- **Designed for 2G, 3GPP, and WiMAX**

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RAD's ACE-3400 and ACE-3402 are carrier-class multiservice aggregators, specifically designed to accommodate the rapid expansion in cellular traffic resulting from the widespread deployment of new mobile broadband services. They ensure the most economical allocation of backhaul resources in delivering GSM, UMTS and next-generation 3GPP traffic over ATM, SDH/SONET and packet networks.

Typically located at hub sites or BSC/RNC sites, they work opposite the ACE-310x and ACE-32xx cell-site gateways. Their advanced carrier-grade features include full system, power and link redundancy for enhanced service protection. Featuring any-service-any-port flexibility, the ACE-3400 and ACE-3402 are modular platforms housing a variety of interfaces, including E1/T1, STM-1/OC-3c UNI, channelized STM-1/OC-3 and GbE.

Advanced pseudowire, QoS, and OAM features

The ACE-3400 and ACE-3402 enable operators to converge multi-generation traffic, including voice and HSPA services, over an all-IP RAN by using IMA/UNI or standards-based CES/SAToP pseudowire (PW) encapsulation. These are enhanced with various QoS schemes, including VLAN priority (802.1p), EXP or ToS/DSCP, as well as comprehensive monitoring and diagnostic capabilities, including pseudowire VCCV-BFD and ITU-I.610 ATM OAM. In addition, they support Ethernet pseudowires over MPLS per RFC 4448 and end-to-end redundancy for PW service protection.

The advanced shaping and scheduling capabilities of the ACE-3400 and ACE-3402 permit operators to implement overbooking strategies, enabling them to optimize network utilization, conserve existing resources and reduce the number of leased services required to support their network. Typical applications for RAD's aggregation-site gateways include grooming ATM traffic and aggregating VC-12/VT 1.5 circuits into a single IMA, channelized STM-1/OC-3 or Gigabit Ethernet uplinks. Additionally, the ACE-3400 aggregates TDM (CES) or ATM (UNI/IMA) E1/T1 traffic over STM-1/OC-3c links.

Full range of standard synchronization options

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, the ACE-3400 and ACE-3402 ensure highly accurate delivery of 2G, 3G and 4G traffic over packet backhaul. They enable 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. They also ensure 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 devices' synchronization capabilities include packet timing distribution using adaptive clock, as well as physical clock distribution via the TDM and Ethernet links.

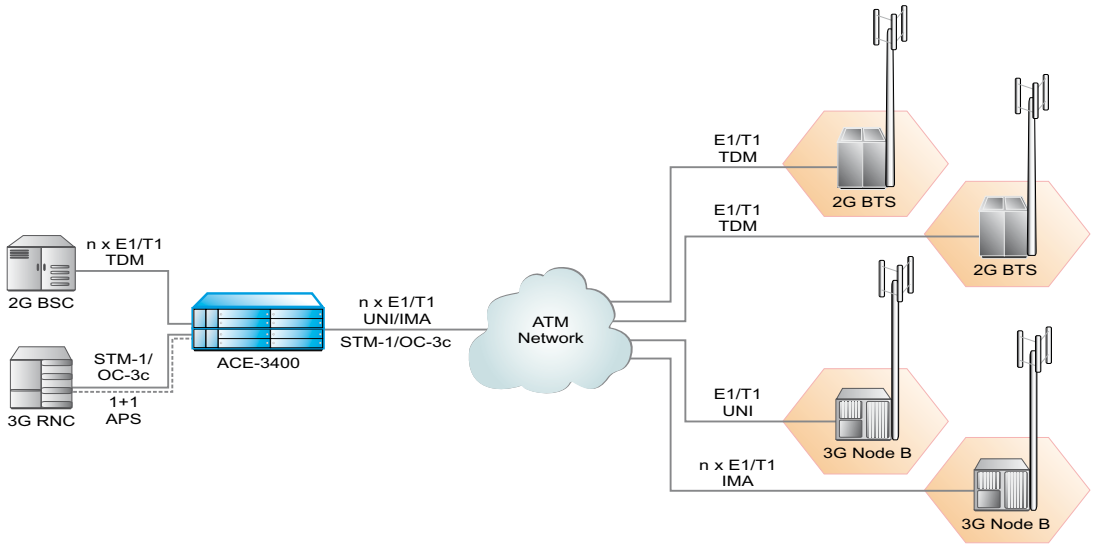
SNMP management

The ACE-3400 and ACE-3402 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, or the dedicated management port. 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.

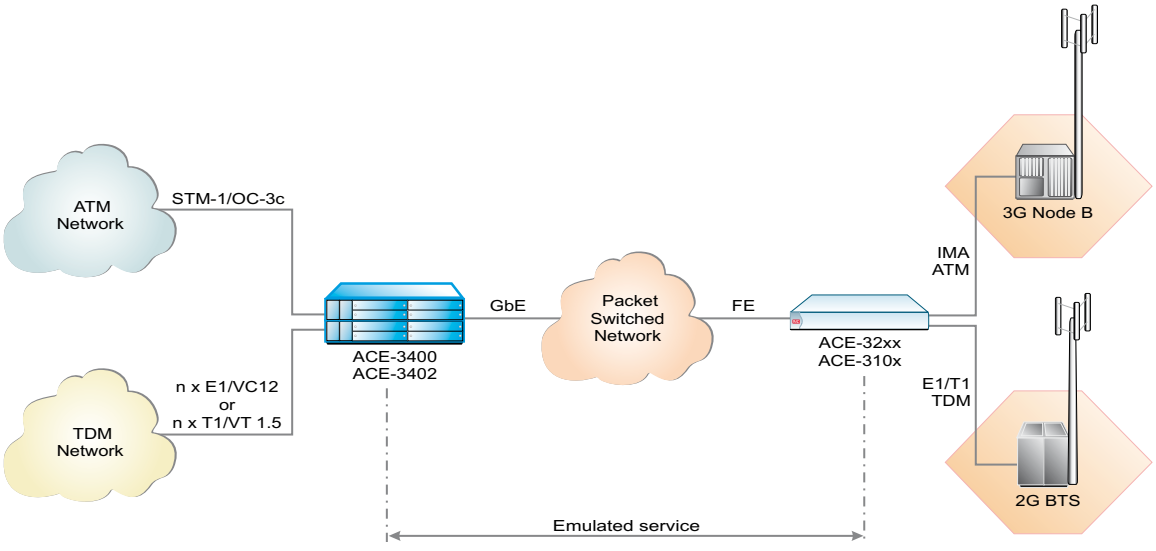
The ACE-3400 and ACE-3402 also support a variety of access protocols, including CLI over Telnet, SNMP, Web server, and TFTP. Incorporated security features include Secure Shell (SSH), Web-based Secure Socket Layer (SSL), SNMPv3, and RADIUS, as well as management access control list (ACL).

The ACE-3400 and the ACE-3402 fit 19-inch racks and enable easy installation in limited spaces.

Features	ACE-3400	ACE-3402
Optional interfaces:		
• E1/T1	32/63	N/A
• VC-12/VT 1.5	63/84	63/84
• STM-1/OC-3c UNI	1+1	1+1
• Channelized STM-1/OC-3	1+1	1+1
• Gigabit Ethernet uplink	1+1	1+1
Management Fast Ethernet interface	✓	✓
Station clock (2 Mbps)	✓	✓
Height	3U	2U



Aggregation at the controller site



Emulated TDM and ATM service

ACE-3220

Cell-Site Gateway

- **Best-of-breed cell-site gateway, enabling IP RAN access over multimode copper xDSL, as well as over fiber and microwave links**
- **Multiservice support for GSM, GPRS, EDGE, UMTS, HSPA+, LTE, and WiMAX traffic delivery over packet networks**
- **Highly accurate clock regeneration using major industry standards**
- **QoS and traffic management**
- **Multi-standard pseudowire encapsulation over Ethernet, IP and MPLS networks**
- **Interoperable with multiservice aggregation devices from leading vendors with seamless EMS/NMS integration**
- **Small form factor for limited-space installations**
- **Optional temperature-hardened enclosure for outdoor installations (-20°C to 65°C)**

For latest updates visit www.rad.com

RAD's ACE-3220 multiservice cell-site gateway is specifically designed to accommodate the rapid expansion in cellular backhaul traffic resulting from the widespread deployment of new mobile broadband services. It simplifies service provisioning and control by enabling seamless delivery of multi-generation traffic – from 2G to 4G – over the same transport network to ensure continuity for ongoing services while moving to an all-IP RAN (radio access network), thus avoiding the cost and operational complexity of maintaining separate networks. Working opposite the ACE-340x and ACE-3600 aggregation-site gateways, as well as third-party aggregation devices, the ACE-3220 simultaneously supports SHDSL.bis and ADSL2+ to minimize capital investment and shorten service rollout times by leveraging available DSL infrastructure to access SDH/SONET, ATM and high capacity, economical packet switched transport networks.

Any-service-any-port flexibility

The ACE-3220 allows operators to use a variety of interfaces:

- Four UTP/SFP Fast Ethernet network or user ports
- Eight or 16 UNI/IMA E1/T1 ports
- Optional STM-1/OC-3c ATM port

In addition, it accommodates up to two modular interfaces, including:

- Gigabit Ethernet network or user port
- Two ADSL2/2+ ports/VDSL2*
- Four SHDSL ports (IMA, M-Pair and EFM)

Advanced QoS, pseudowire and OAM features

The advanced shaping and scheduling capabilities of the ACE-3220 permit operators to implement overbooking strategies, enabling them to optimize network utilization, conserve existing resources and reduce the number of leased services required to support their network.

The device also enables operators to converge multi-generation traffic over an all-IP RAN by using standards-based pseudowire (PW) modes, including ATMoPSN, CESoPSN, SAToP, and Ethernet pseudowire, as well as Ethernet bridging and Ethernet-to-ATM bridging according to RFC 2684. These are enhanced with various QoS schemes, including VLAN priority (802.1p), EXP or ToS/DSCP. In addition to ensuring service resiliency, the ACE-3220 features comprehensive monitoring and diagnostic capabilities, such as pseudowire VCCV-BFD, IP-BFD and GRE Keep-Alive, as well as Ethernet and ATM OAM.

Full range of standard synchronization options

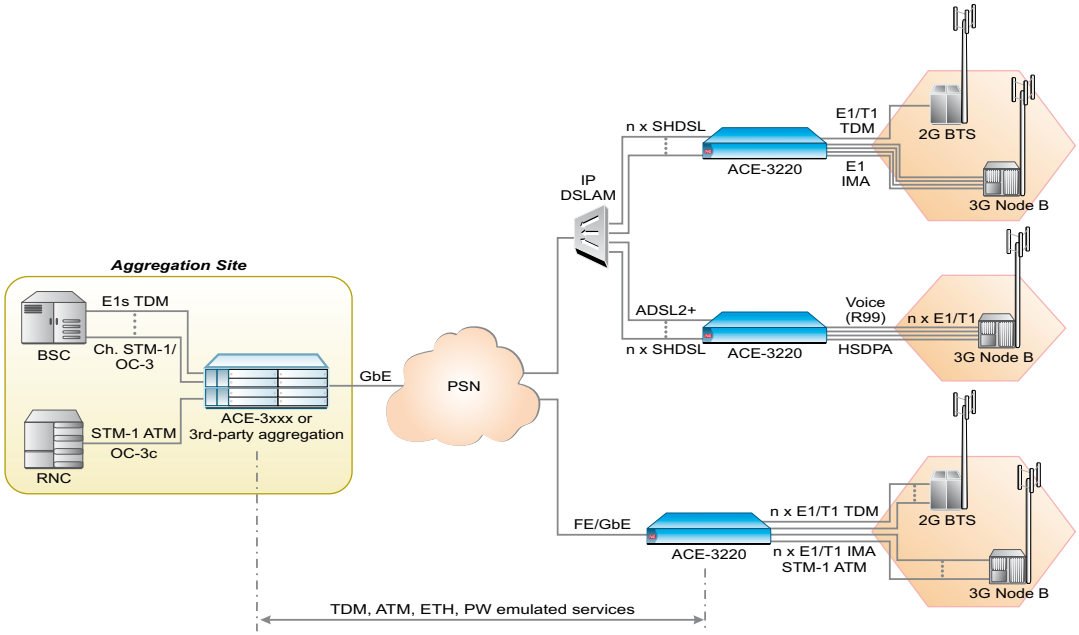
The ACE-3220's SyncToP™ suite enables clock recovery either from the TDM links, the DSL link or from the Ethernet links, using PTPv2 (IEEE 1588v2), Synchronous Ethernet (Sync-E), NTR recovered clock over xDSL, or adaptive clock recovery (ACR). In addition, it features a built-in input clock interface. The ACE-3220 also enables packet timing distribution, using adaptive clock or IEEE 1588v2, as well as physical clock distribution via the TDM and Ethernet links. 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.

SNMP management

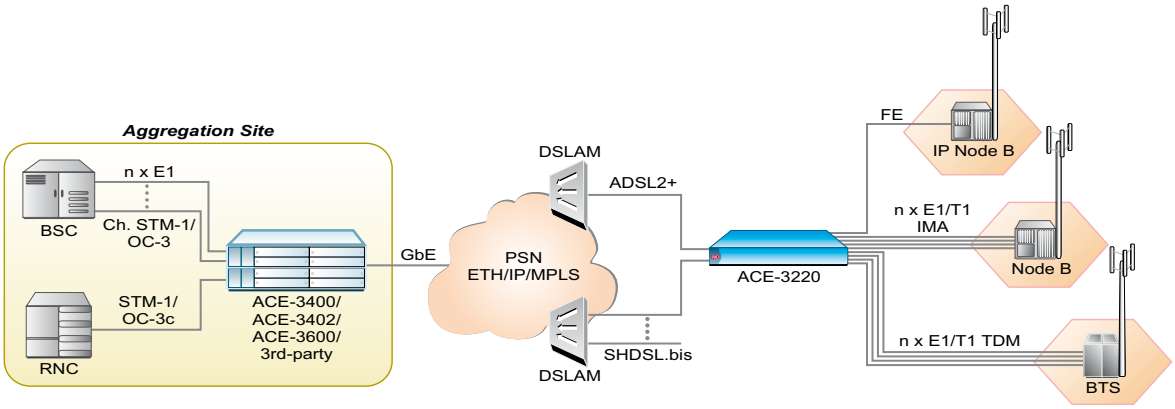
The ACE-3220 features flexible management capabilities, including local management via an ASCII terminal (RS-232). In addition, remote management can be performed either inband or out-of-band, using the network or user ports. Advanced FCAPS (Fault, Configuration, Administration, Performance, Security), and diagnostic tools are provided by RADview-EMS, RAD's carrier-class element management system, via an SNMP-based GUI.

The ACE-3220 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).

* Requires software upgrade



Colocation of 2G-3G base stations with PSN access



Hybrid model: voice over SHDSL, data over ADSL2+

ACE-3100

ACE-3100, ACE-3200

Cell-Site Gateways

- **Multiservice support for ATM, TDM and Ethernet traffic delivery over packet networks**
- **Any-service-any-port flexibility**
- **Highly accurate clock regeneration using major industry standards**
- **ATM switching and traffic management**
- **Multi-standard pseudowire encapsulation over Ethernet, IP and MPLS networks**
- **Interoperable with BSS from major vendors**

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RAD's ACE-3100 and ACE-3200 multiservice cell-site gateways are specifically designed to accommodate the rapid expansion in cellular backhaul traffic resulting from the widespread deployment of new mobile broadband services. They simplify service provisioning and control by enabling simultaneous delivery of GSM, UMTS and HSPA traffic over the same transport network.

Working opposite the ACE-340x and ACE-3600 aggregation-site gateways, as well as opposite third-party multiservice aggregation devices, the ACE-3100 and ACE-3200 minimize capital investment and shorten service rollout times by leveraging available infrastructure to access ATM, SDH/SONET and high capacity, economical packet switched transport networks.

The ACE-3100 and ACE-3200 incorporate flexible port configuration to allow aggregation of circuit-emulated (CES/SAToP) TDM E1/T1s, fractional E1/T1 UNIs or several IMA links into a single network interface.

Advanced QoS, pseudowire and OAM features

The advanced ATM shaping and scheduling capabilities of the ACE-3100 and ACE-3200 permit operators to implement overbooking strategies, enabling them to optimize network utilization, conserve existing resources and reduce the number of leased services required to support their network.

The devices also enable operators to converge multi-generation traffic over an all-IP RAN by using IMA/UNI or standards-based CES/SAToP pseudowire (PW) encapsulation, as well as Ethernet-to-ATM bridging according to RFC 2684 (ACE-3200). These are enhanced with various QoS schemes for delivering ATM and TDM traffic over Layer 2 and Layer 3 networks, including VLAN priority (802.1p), EXP or ToS/DSCP. Comprehensive monitoring and diagnostic capabilities include VCCV-BFD and ITU-I.610 ATM OAM, as well as IP-BFD and GRE Keep-Alive (ACE-3200). In addition, the ACE-3200 supports Ethernet pseudowires over MPLS per RFC 4448.

Full range of standard synchronization options

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.

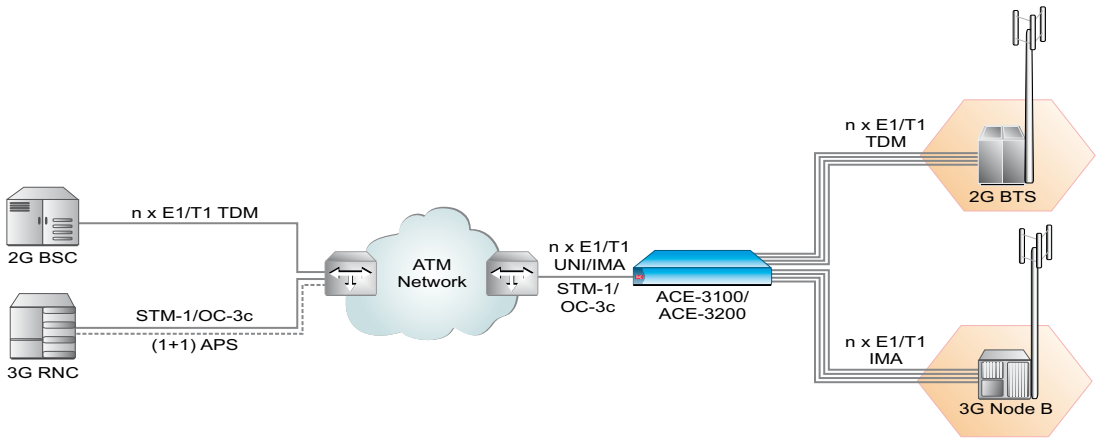
With powerful synchronization capabilities, the ACE-3100 and ACE-3200 ensure highly accurate delivery of 2G and 3G traffic over packet backhaul. They enable mobile operators and transport providers to eliminate the risk of service disruptions, impaired cell hand-offs and excessive dropped calls, thereby supporting reliable transmission of real-time traffic over PSNs. They also ensure QoS priorities for clock traffic and support "SDH/SONET or better" performance requirements for voice and video traffic, such as up to 16 ppb (parts per billion) frequency accuracy. The devices' synchronization capabilities include clock recovery from the TDM links or from the Ethernet links, using adaptive clock recovery (ACR). In addition, they support adaptive clock distribution.

SNMP management

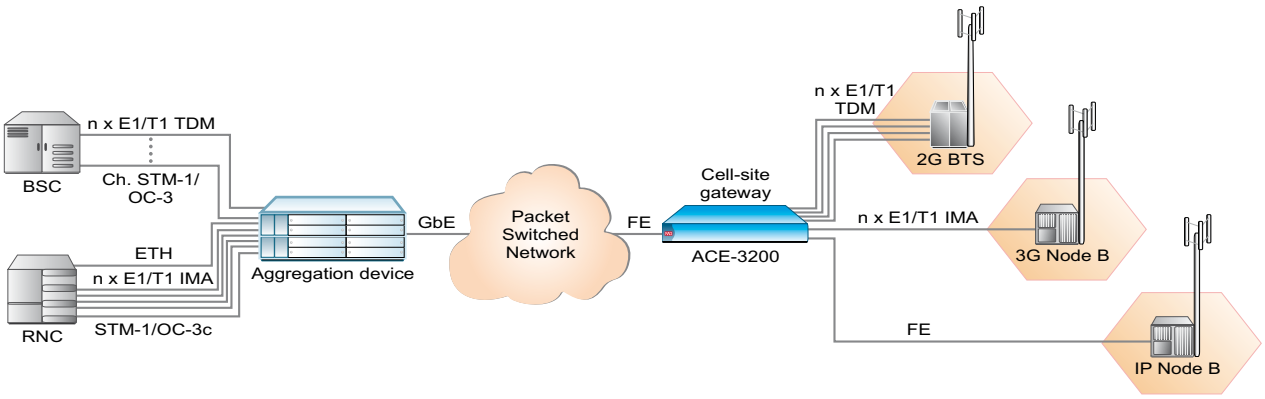
The ACE-3100 and ACE-3200 feature flexible management capabilities, including local management via an ASCII terminal (RS-232). In addition, remote management can be performed either inband or out-of-band, using the network or user ports. Advanced FCAPS (Fault, Configuration, Administration, Performance, Security) and diagnostic tools are provided by RADview-EMS, RAD's carrier-class element management system, via an SNMP-based GUI.

The ACE-3100 and ACE-3200 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).

	ACE-3200	ACE-3100
E1/T1 ports	8 or 16	0 or 4
ATM-155 ports (SFP)	0 or 2	1 or 2
Fast Ethernet ports (UTP or SFP)	2 for PSN traffic and/or inband management	2 for PSN traffic and/or inband management
Power supply	Single/dual, fixed	Single, fixed



Cellular backhaul over ATM networks



Cellular backhaul over PSN networks

ACE-3105

Cell-Site Gateway

- **Multiservice support for ATM, TDM and Ethernet traffic delivery over packet networks**
- **Supports ADSL2/2+ or SHDSL.bis (IMA, M-Pair and EFM bonding)**
- **Highly accurate clock regeneration using major industry standards**
- **ATM switching and traffic management**
- **Multi-standard pseudowire encapsulation over Ethernet, IP and MPLS networks**
- **Interoperable with multiservice aggregation devices from leading vendors with seamless EMS/NMS integration**
- **Small form-factor for limited-space installations (half 19-inch)**
- **Optional temperature-hardened enclosure**

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RAD's ACE-3105 multiservice cell-site gateway is specifically designed to accommodate the rapid expansion in cellular backhaul traffic resulting from the widespread deployment of new mobile broadband services. It simplifies service provisioning and control by enabling simultaneous delivery of GSM, UMTS and HSPA traffic over the same transport network.

Working opposite the ACE-340x and ACE-3600 aggregation-site gateways, as well as third-party aggregation devices, the ACE-3105 minimizes capital investment and shortens service rollout times by leveraging available DSL infrastructure to access ATM, SDH/SONET and high capacity, economical packet switched networks.

Advanced QoS, pseudowire and OAM features

The advanced ATM shaping and scheduling capabilities of the ACE-3105 permit operators to implement overbooking strategies, enabling them to optimize network utilization, conserve existing resources and reduce the number of leased services required to support their network.

The device also enables operators to converge multi-generation traffic over an all-IP RAN by using IMA/UNI or standards-based CES/SAToP pseudowire (PW) encapsulation, as well as Ethernet bridging and Ethernet-to-ATM bridging according to RFC 2684. These are enhanced with various QoS schemes, including VLAN priority (802.1p), EXP or ToS/DSCP. Comprehensive monitoring and diagnostic capabilities include pseudowire VCCV-BFD, IP-BFD and GRE Keep-Alive, as well as ITU-I.610 ATM OAM.

In addition, the ACE-3105 supports Ethernet pseudowires over MPLS per RFC 4448.

The device uses PPP over Ethernet (PPPoE) protocol to allow HSDPA connectivity in a variety of DSL-based cellular backhaul applications.

Full range of standard synchronization options

With powerful synchronization capabilities, the ACE-3105 ensures highly accurate 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 ACE-3105's SyncToP™ suite enables clock recovery from the TDM links or from the DSL link, using PTPv2 (IEEE 1588v2), NTR recovered clock over xDSL or adaptive clock recovery (ACR). In addition, it supports adaptive clock distribution.

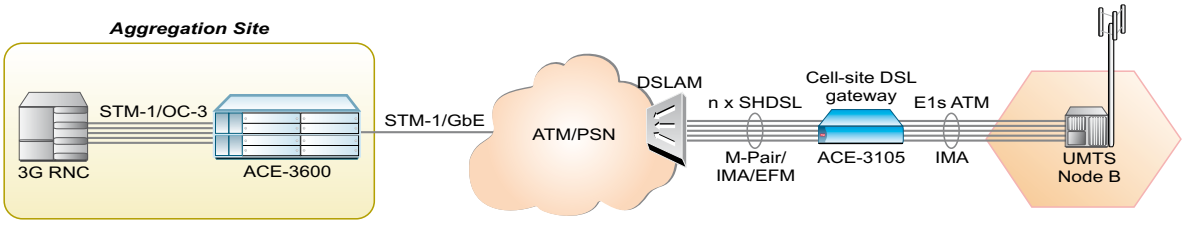
SNMP management

The ACE-3105 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, Administration, Performance, Security) and diagnostic tools are provided by RADview-EMS, RAD's carrier-class element management system, via an SNMP-based GUI.

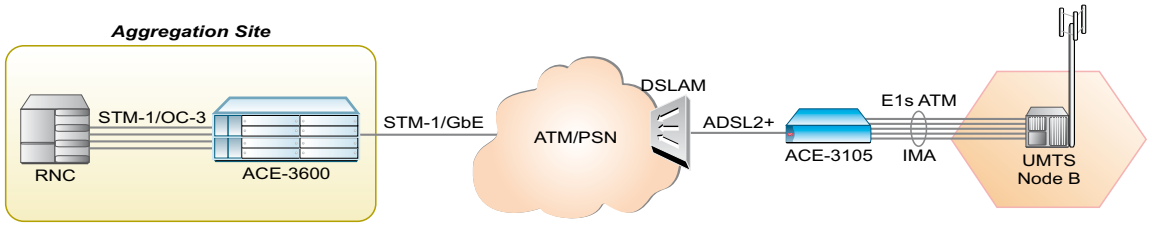
The ACE-3105 also supports a variety of access protocols, including CLI over Telnet, SNMP, Web server, and TFTP. Incorporated security features include Secure Shell (SSH), Web-based Secure Socket Layer (SSL), SNMPv3, and RADIUS, as well as management access control list (ACL).

Available configurations

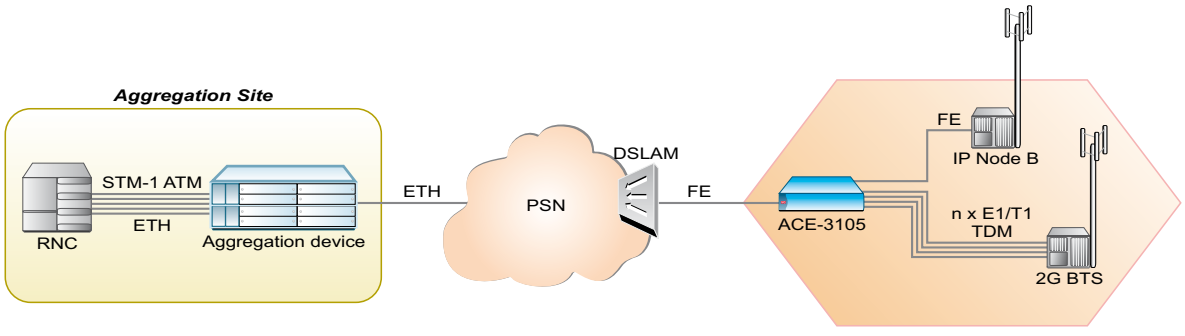
The ACE-3105 incorporates up to two Fast Ethernet ports for PSN traffic and/or for inband management. In addition, it features up to four E1/T1 ports in UNI, IMA, CES or SAToP modes. The device is available either with four SHDSL.bis interfaces or with an ADSL2/2+ port.



HSDPA offload over ATM or PSN



HSDPA offload over ADSL2+ over ATM or PSN



Colocation of IP Node B and 2G E1/T1 BTS over PSN

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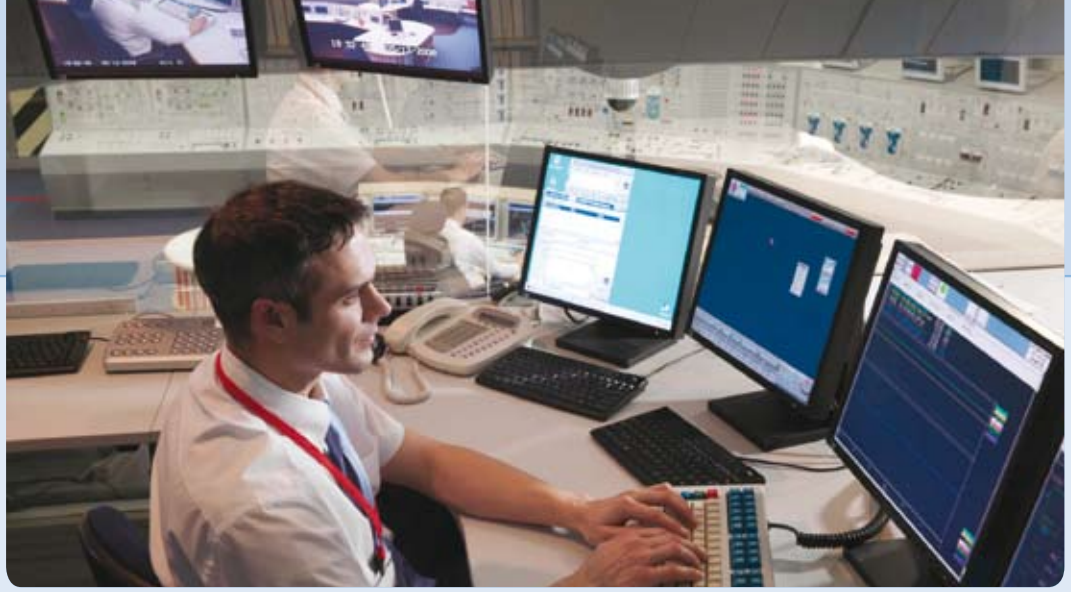


AXCESS+
Multiservice Access Platform

RAD's AXCESS+ offers a complete solution for carriers, service providers, and private network owners (utility, transportation and government telecoms). The ecosystem consists of a full range of customer-located equipment, central site devices and an integrated management system, facilitating co-existence of legacy and next-generation network infrastructures for the deployment of both TDM and new Ethernet services.

Access That Lasts

The AXCESS+ platform features a built-in NGN architecture for easy service migration, enabling carriers, service providers and private network owners to benefit from packet transport's ultra-high throughput and substantial cost savings (lower OpEx & CapEx). With AXCESS+ they can expand their service portfolio to include new Ethernet services, which were not available previously to their customers or required a complete forklift upgrade of their TDM infrastructure.

In addition to native packet access, AXCESS+ offers unsurpassed flexibility by transporting both higher-speed TDM and new Ethernet services over SDH/SONET with great efficiency, while also tunneling legacy services (TDM) over packet switched networks without having to replace either existing customer-located access devices or central office devices.

All products in the AXCESS+ portfolio also address the unique needs of the utility, transportation and government markets:

- Bandwidth-constrained applications
- Multiple interfaces at the customer premises
- Complicated blend of legacy services with new services

Service multiplexers

RAD's Megaplex family of multiservice access multiplexers offers a wide range of data, LAN and voice services. The devices come with a large variety of analog and digital voice connections – PCM, ADPCM, G.723.1, BRI ISDN, and digital E1/T1 interfaces. These include tail-end modems and up to 160 E1/T1 lines for distributing different services over the same infrastructure and splitting these services at the POP. They also encompass built-in fiber optic, SHDSL and SHDSL.bis modems.

The Megaplex-4100 next-generation multiservice access node offers a future-proof migration path to packet switched networks and Ethernet services. It serves as a central solution for Ethernet access devices as well as for TDM CPEs. The NGN multiplexer also combines STM-4/OC-12, STM-1/OC-3 and IP pseudowire capabilities with switching and DS0 cross connect.

Completing the service multiplexer portfolio is RAD's Kilomux subrate service multiplexer for data, voice, fax, and LAN. It integrates a variety of traffic types over leased lines, ISDN, IP, and fractional E1/T1, over copper or fiber, at data rates from 9.6 kbps to 1,536 kbps. Combining award-winning, high quality voice compression techniques with maximum bandwidth utilization and a wide range of network and user interfaces, the Kilomux provides reliable point-to-point and drop-and-insert data/voice integration solutions at an affordable price, particularly attractive to the transportation, utilities and government markets.

Cross connects

RAD offers a comprehensive product family of non-blocking, high capacity DS0 cross connects. The DXC family consists of modular multiservice access nodes, providing non-blocking DS0 cross connect for up to 688 E1/T1 lines. Most of the DXC units support built-in Local Loop solutions. The DXC devices are the most compact and high density cross connects of their kind. Plug-in interface modules supporting n x 56/64 kbps, ISDN U, E1 or T1 transmission with built-in IDSL, SHDSL and fiber optic modems, E3/T3, and STM-1/OC-3 are available. Inverse multiplexing capabilities for up to eight E1/T1 lines support high speed data, native LAN connectivity and video streaming applications.

Fiber multiplexers

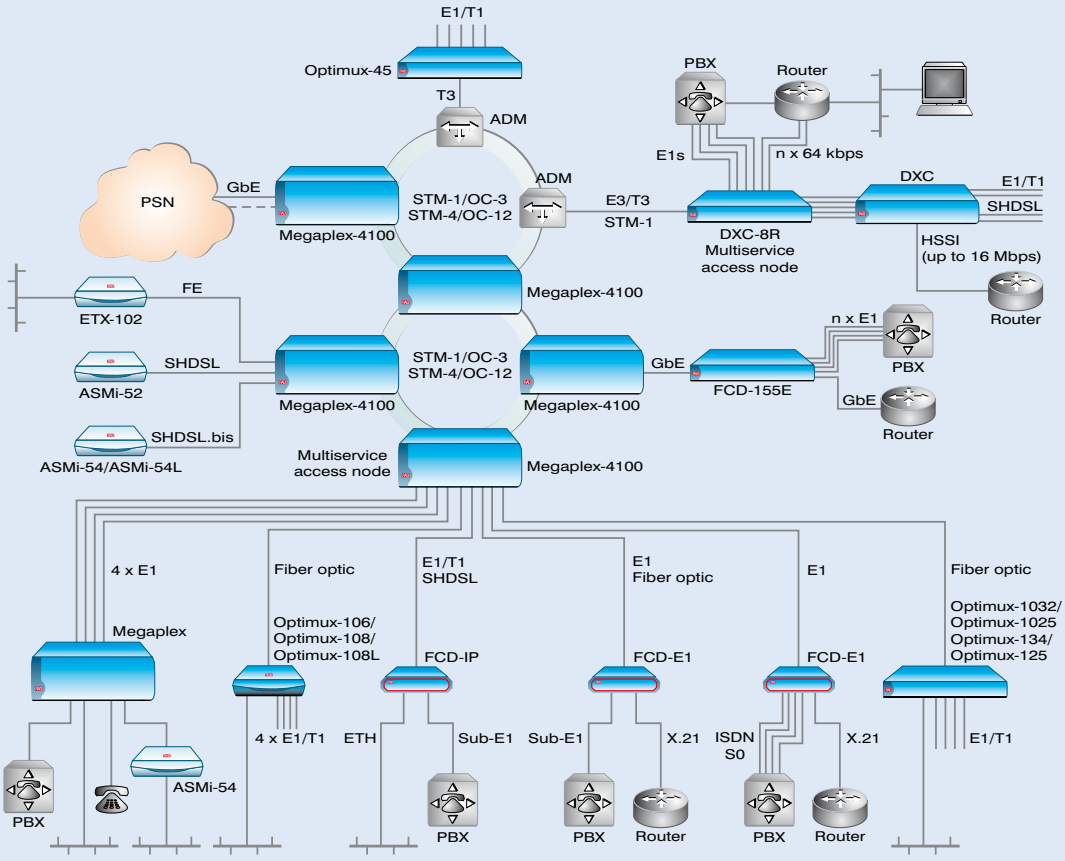
With government incentives encouraging carriers and service providers to extend their service to rural regions and as private network owners increase the bandwidth requirements at remote sites, RAD's Optimux fiber multiplexers enable easy Ethernet and PDH service extension over fiber (up to 120 kilometers/75 miles) or coax links. Supporting up to 63 E1/84 T1 links, full 10/100/1000 Mbps Ethernet traffic throughput and high speed data, all multiplexed into a fiber optic uplink, the Optimux products offer a solution for every service extension scenario.

TDM NTUs

The FCD family of compact, multiservice network termination units (NTUs) extends the E1/T1 network to the customer premises, enabling carriers and service providers to create a flexible, service-independent access model while offering a competitive and wide service portfolio for voice, data and Ethernet.

SDH/SONET ADMs

The FCD-155E and FCD-155 offer STM-1 ADM or terminal capabilities. They provide a robust and resilient next-generation solution to access network extension in the carrier environment, offering bandwidth-efficient provisioning of Ethernet services on top of traditional TDM interfaces. It is a quick, cost-effective alternative for service deployment for utilities and transportation authorities.



Multiservice TDM access

Megaplex-4100

Next-Generation Multiservice Access Node

- **Transports voice, data and advanced Ethernet services over PDH/SDH/SONET and packet networks**
- **Non-blocking cross connect of up to 7,872 DS0 channels**
- **Four STM-4/OC-12 or STM-1/OC-3 ports**
- **Four GbE ports**
- **SHDSL access platform with up to 80 SHDSL ports**
- **160 E1/T1 ports**
- **30 Fast Ethernet ports**
- **120 n x 64 kbps or sub-DS0 rate data ports**
- **160 analog voice ports**
- **Supports up to 20 fiber links for multiplexed TDM and Ethernet traffic**
- **Modular 4U-high, 19-inch unit with 10 slots for I/O modules**

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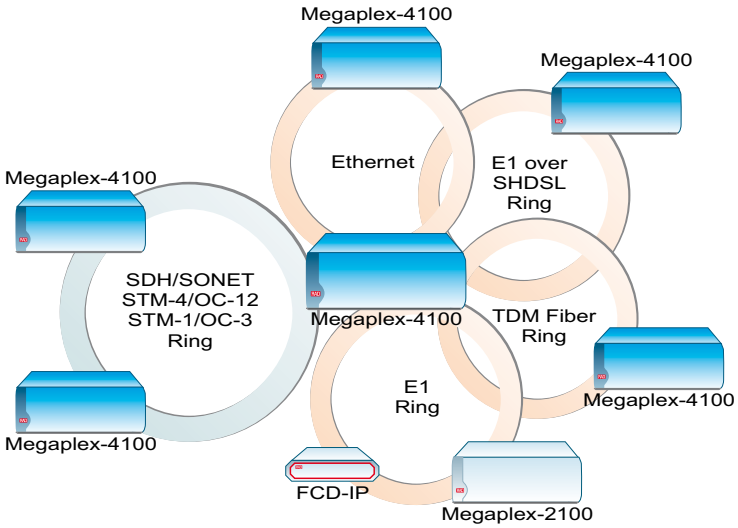


Megaplex-4100 as a hub of multiple resilient rings

Part of the AXCESS+ portfolio of multiservice access and First Mile solutions, the Megaplex-4100 is a carrier-class, high capacity multiservice access concentrator, for transporting legacy and next-generation services over fiber or copper PDH/SDH/SONET, or over packet switched networks (PSN).

Its ability to handle a broad range of Ethernet, data and voice services, as well as a large variety of network technologies in a single compact managed node, makes the Megaplex-4100 an ideal core/edge solution for carriers and service providers. It also provides a perfect fit for large enterprises, utilities and transportation companies, who require an efficient way to transport and provision multiple legacy and next-generation services over their high capacity pipes.

As a multiservice access node, the Megaplex-4100 provides an efficient and cost-effective solution for integrating various interfaces, data rates and user services. These include Fast Ethernet and Gigabit Ethernet as well as low speed sub-64 kbps data, serial n x 64 kbps data, high speed data up to STM-4/OC-12, digital voice, analog voice, ISDN, and additional industry specific interfaces.

Furthermore, the Megaplex-4100 functions as a carrier-class TDM and Ethernet aggregator, as well as a high capacity DS0 cross connect, as detailed below.

Parallel TDM and Ethernet processing

The Megaplex-4100 features dual-star connection architecture with hybrid TDM-Ethernet modules, which allow native TDM and Ethernet traffic handling with minimal encapsulation delays and zero bandwidth overhead.

Ethernet traffic is handled by a multiport Gigabit Ethernet aggregation engine, designed for Carrier Ethernet capabilities, such as flow-based or port-based traffic management, performance monitoring and Ethernet OAM.

Ethernet traffic can be terminated by any of the following:

- Fast Ethernet ports located on I/O modules
- Internal Ethernet ports of I/O modules
- Gigabit Ethernet ports
- Ethernet over SDH/SONET

TDM traffic can be cross connected at a DS0 level, DS1 (framed/unframed) level, or SDH/SONET (high/low order) level, with per-port cross connect operation mode selection.

DS0 cross connect

The Megaplex-4100 features an internal DS0 cross connect matrix of up to 7,872 DS0 channels. Traffic from any channel can be cross connected directly to any other channel.

These capabilities enable the Megaplex-4100 to function as a service differentiation point at the central office, handing off TDM voice and data services to the transport network.

The device can also be deployed at remote locations or the customer premises to effectively fan out multiple voice and data services.

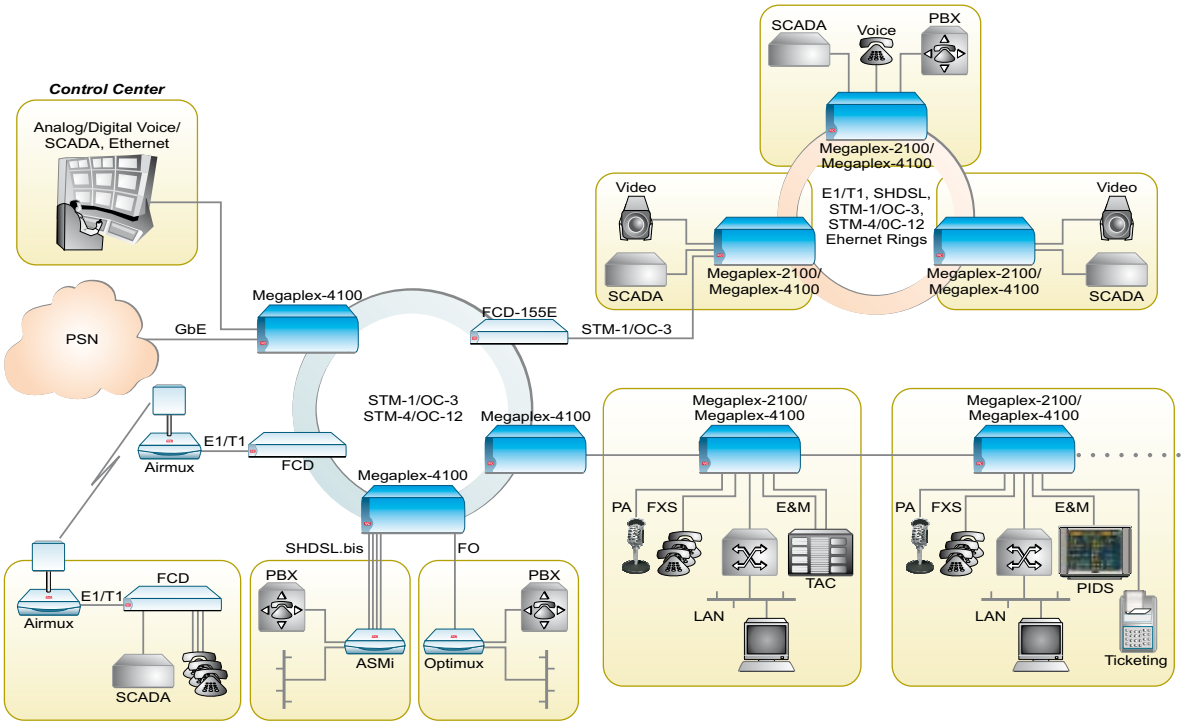
Next-generation ADM terminal

The Megaplex-4100 supports STM-1/OC-3 and STM-4/OC-12 add/drop multiplexing for grooming LAN and TDM traffic over SDH/SONET networks. It eliminates the need for separate ADM and multiplexer units for private networks where voice, Ethernet and data services are required.

By implementing VCAT protocols to carry Ethernet traffic efficiently and minimize wasted bandwidth, the Megaplex-4100 brings Ethernet economics and packet switching efficiency to existing SDH/ SONET infrastructure. It enables utilities and other private fiber network owners to reduce both OpEx and CapEx, while service providers can leverage existing equipment to support clear channel data streams and the latest high bandwidth services.

Ethernet traffic can be mapped into n x VC-12/VC-3/VC-4 or n x VT 1.5/STS-1/STS-3C virtual containers.

Megaplex-4100 back panel



Single-box solutions for multiservice connectivity over copper, fiber and wireless

Ethernet and TDM aggregation

The Megaplex-4100 can terminate TDM and Ethernet traffic carried over E1/T1 links, fiber, or SHDSL, as well as over VCGs in STM-1/OC-3 and STM-4/OC-12 links. This traffic can then be switched either to a different PDH/TDM trunk or to the Fast Ethernet or Gigabit Ethernet ports.

Various users can benefit from this solution:

- SDH/SONET customers who need to continue using their network while maximizing bandwidth utilization
- Subscribers with mixed Ethernet and TDM services
- Subscribers looking for a future-proof migration path for IP connectivity
- Dual network owners using SDH/SONET for voice and packet for data

Smooth migration from TDM to PSN

The Megaplex-4100 supports legacy services over packet switched networks, using the MPW-1 module to convert data stream from other modules to Ethernet, IP or MPLS packets with TDMoIP, CESoPSN, SAToP, and HDLCoPSN pseudowire technologies. The device's ASIC-based architecture provides a robust pseudowire solution with minimal processing delay.

Carrier-class service provisioning and central solution for RAD CPEs

The MP-4100 offers an end-to-end solution as a central aggregation platform for diverse CPE devices, including the DXC, Megaplex, FCD, ASMi, Optimux, ETX, RICi, and IPmux lines. It enables carrier-class service provisioning and end-to-end path management to ensure continuous service availability.

Advanced SNMP management capabilities support control and monitoring of all network elements: SDH/SONET access and ring units, as well as remote POP and First Mile broadband access feeders and CPEs.

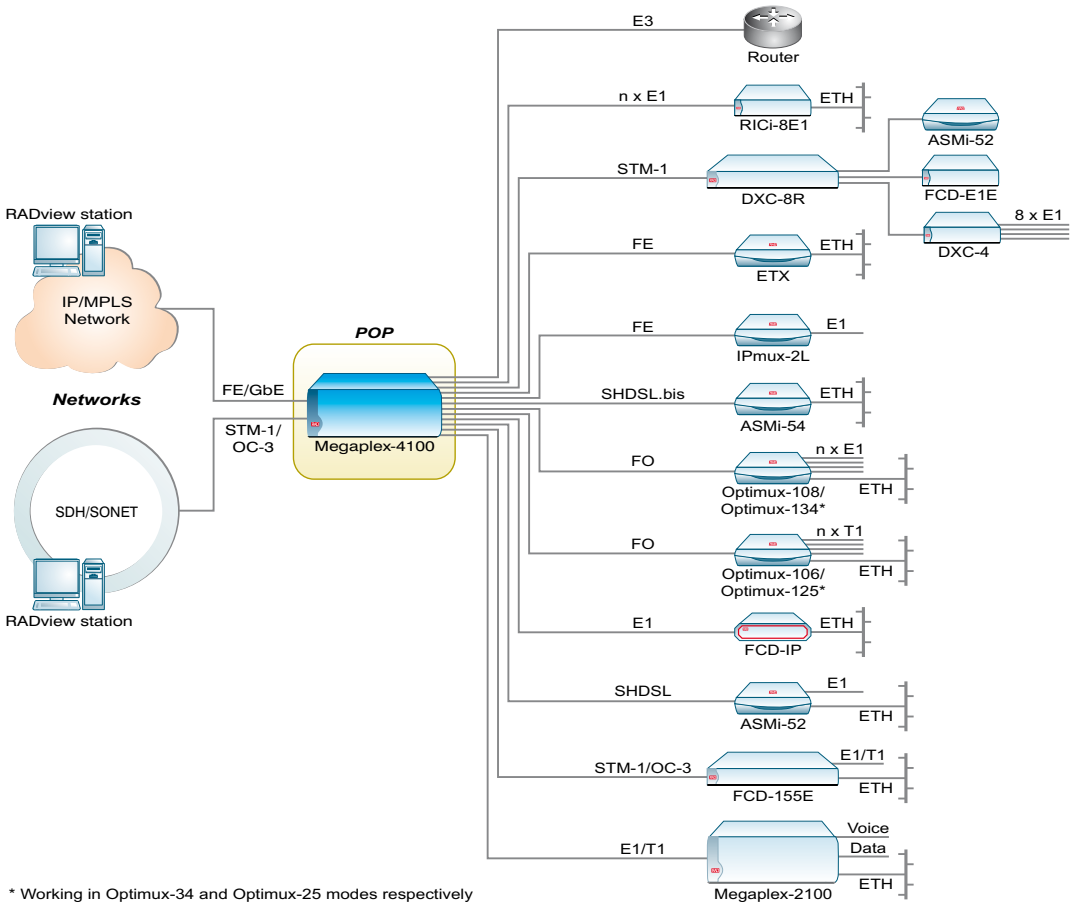
The Megaplex-4100 is managed by the RADview-SC/TDM Center application. Alternatively, configuration and monitoring can be performed via either Telnet or an ASCII terminal using RAD command line interface (CLI).

In addition, the Megaplex-4100 supports the latest security protocols, including SNMPv3, RADIUS and SSH.

Carrier-class service reliability

The modular, distributed architecture of the Megaplex-4100 enables redundancy at the hardware, link and service path levels, providing a resilient system with no single point of failure and under-50 ms switchover time.

Megaplex-4100
(Continued)



Central solution for multiservice aggregation, grooming and First Mile extension

In addition to supporting standard SDH/SONET rings, the Megaplex-4100 can be used to create E1, T1, TDM over SHDSL, TDM over fiber, or a mix of ring topologies.

The Megaplex-4100 features a wide range of diagnostics, performance monitoring and alarm mechanisms.

Modularity and flexibility

The Megaplex-4100 is a 4U-high chassis, housing up to two AC or DC power supplies, two common logic modules and 10 I/O modules. This allows for a "pay as you grow" flexibility and CapEx optimization.

CL.2 modules

The CL.2 modules function as common logic, cross connect and broadband link modules, and are available in a number of port configurations. For direct connection to the SDH/SONET network, CL.2 features two standard network ports with software configurable STM-1/OC-3 or STM-4/OC-12. The dual ports on the CL.2 module can be used for either parallel operation or for redundancy.

For direct connection to packet-based networks, CL.2 has two UTP or SFP-based GbE ports. The UTP interface features auto-negotiation and fast detection capabilities.

Supported I/O modules

The Megaplex-4100 supports up to 10 I/O modules, including selected modules operating in the Megaplex-2100/2104 chassis:

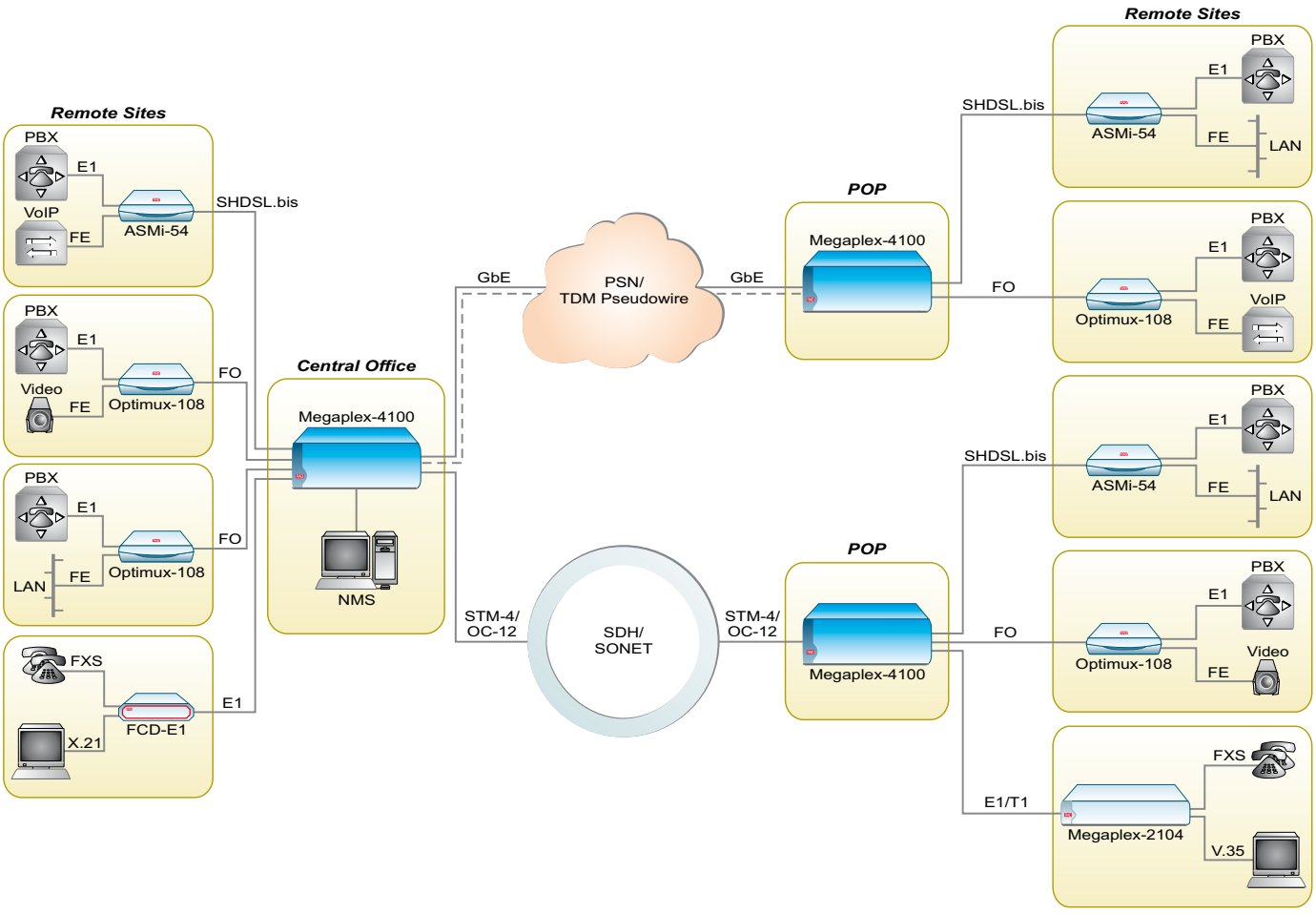
M8E1, M8T1: Eight-port E1 or T1 modules with three Fast Ethernet ports (license-based)

M16E1, M16T1: 16-port E1 or T1 modules

M8SL: Eight-port E1 over SHDSL module with three Fast Ethernet ports (license-based)

MPW-1: TDM pseudowire access gateway with a 256 DS0 capacity and three Fast Ethernet ports

ASMi-54C: Eight-pair SHDSL.bis module with two Fast Ethernet ports



Legacy low speed data and voice over PSN using pseudowire

ASMi-54C/N: Eight-pair SHDSL/SHDSL.bis module with two Fast Ethernet ports and eight E1 ports

OP-108C, OP-106C: Dual 4 x E1/T1 and Ethernet fiber multiplexer modules

OP-34C, OP-25C: 16 x E1/T1 and Ethernet fiber multiplexer modules

HS-6N, HS-12N: Six- or 12-port n x 64 kbps high speed modules

HSU-6, HSU-12: Six- or 12-port IDSL modules

HS-S: Four-channel ISDN S-interface module

HS-703: Four-channel co-directional data module

HS-RN: Four-port sub-DS0 low speed module

HSF-2: Two-port fiber optic Teleprotection interface module

LS-6N, LS-12: Six- or 12-port low speed modules

VC-4/4A/8/8A/16: 4/8/16-port FXS/FXO/E&M PCM and ADPCM analog voice modules

VC-4/OMNI: Four-port PCM Omnibus (multi-party hotline) voice module

ACM: Alarm and diagnostics module with four outbound relays

Megaplex-2100, Megaplex-2104

Multiservice Access Multiplexers

- **Highly flexible modular multiplexer supporting multiple E1/T1 links and IP main link (TDMoIP support)**
- **RFER – Resilient Fast Ethernet Ring or E1/T1 ring protection**
- **Supports Omnibus for teleconference**
- **Teleprotection for power utilities**
- **PSTN, ISDN and data services**
- **Capacity:**
  - **up to 120 analog PCM voice channels**
  - **up to 160 analog ADPCM voice channels**
  - **up to 132 V.24/RS-232 low speed data channels**
  - **up to 124 n x 64 kbps data channels (V.24/RS-232 or ISDN S and U ports)**
  - **up to 44 G.703 low speed data channels**
  - **up to 600 compressed voice channels**
- **Supports multiple alternative routing schemes in event of trunk failure**
- **Integral xDSL modems for subscriber and main link connections**

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The Megaplex-2100 and Megaplex-2104 are flexible, modular TDM multiplexers, enabling integration of multiple voice, ISDN, video, data, and LAN services over multiple E1/T1, Ethernet uplinks, or n x 64 links. The Megaplex main links and user ports incorporate copper, CSU/DSU, LTU, and fiber interfaces and are compatible with RAD's standalone ASMi-31, ASMi-52 and FCD modems. The Megaplex-2100 and Megaplex-2104 are part of the AXCESS+ portfolio of multiservice access and First Mile solutions.

The Megaplex is especially suitable for use as an economical, compact remote multiservice node for utilities and transportation. It is also ideal for small to mid-size business entities, providing mixed services for both business and residential customers. It can be deployed at the carrier's point-of-presence in the exchange, as well as at a remote distribution node, such as in an office building's basement.

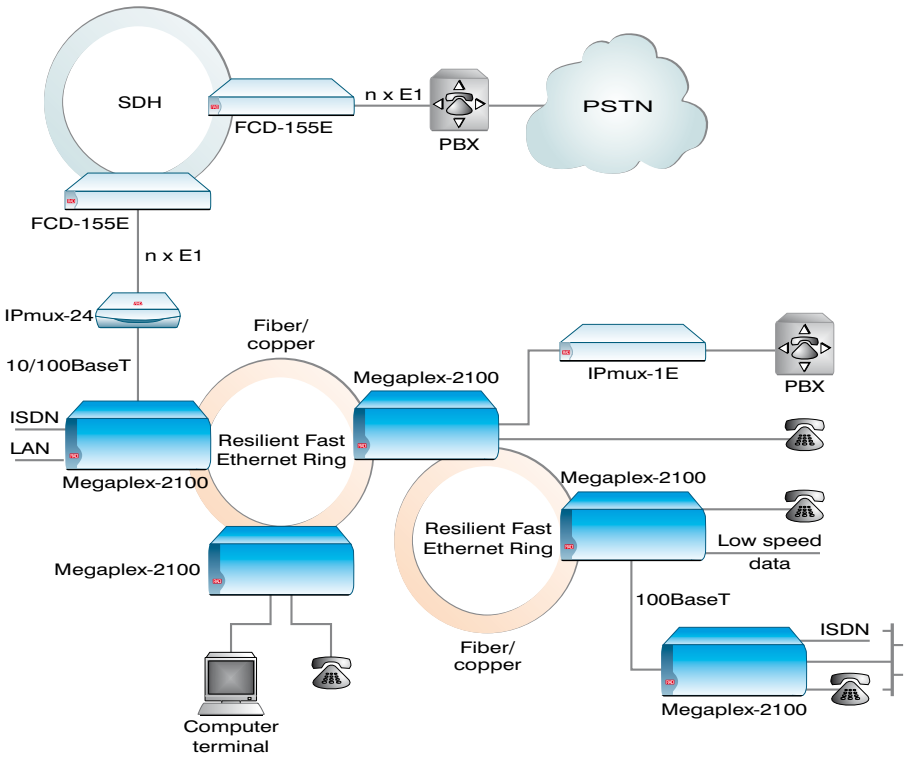
The Megaplex can be mounted in 19-inch or 21-inch racks for carrier and service provider environments.

Wide interoperability

Megaplex is standards-compliant, ensuring compatibility in multi-vendor environments worldwide. The E1 and T1 TDM framing and signaling, PCM/ADPCM voice coding, ISDN, and data interfaces all conform to international standards.

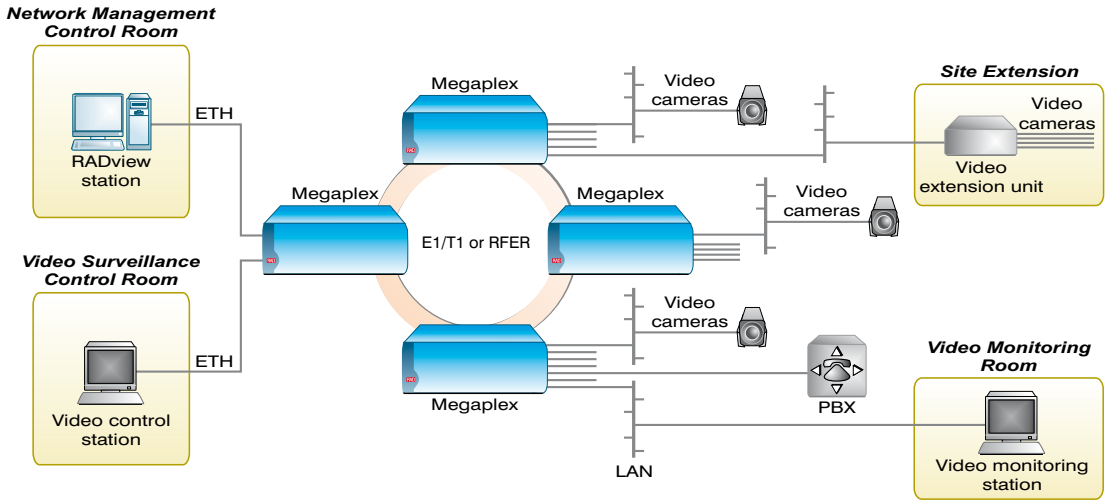
Protection and alternative routing schemes

The single or dual E1/T1 main links support 1+1 and 1:1 protection switching for any E1/T1 or fractional E1/T1 port with non-blocking cross connect capability. This provides drop-and-insert capability between any two links on one module or between two modules. Megaplex devices store up to 10 different configuration databases and can switch between them. This feature enables alternate routing in the event of network or service failure, or at a predetermined time.



Delivering TDM and Ethernet services in a corporate network with Resilient Fast Ethernet Ring reliabilty

Megaplex-2100 back panel



Ring application for video surveillance

Redundancy options

The optional redundancy on common logic, main link and power supply ensures a high level of system reliability on Megaplex hubs.

R2 support

The Megaplex also includes R2 support with transparent MFC/decadic implemented within the main link. This allows the customer to connect a legacy R2-PBX to a digital (E1 CAS) PBX, thus extending the lifespan of existing equipment.

TDM over IP support

Megaplex incorporates RAD's TDMoIP technology in the ML-IP main link module. This enables all existing TDM services to be transported over packet switched networks. With the ML-IP module, the Megaplex can be connected in a daisy-chain topology where multiple Megaplex units can be cascaded together. TDMoIP support also allows the Megaplex to operate opposite the IPmux family of TDMoIP gateways. Along with TDMoIP, Megaplex supports Resilient Fast Ethernet Ring (RFER) with under 50 msec ring restoration capabilities. Up to 40 E1 or 50 T1 TDM circuits can be connected per Fast Ethernet ring or daisy chain.

The addition of TDMoIP functionality further expands the broad scope of solutions supported by the Megaplex family and IPmux family. For more information about the TDMoIP concept, please refer to chapter 7.

Management options

The Magaplex-2100 and Megaplex-2104 feature flexible management capabilities, including local management via an ASCII terminal (RS-232). In addition, remote management can be performed 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, and/or by RADview-SC/TDMoIP, RAD's network management system, via an SNMP-based GUI.

The devices can also be accessed directly, using Telnet.

Diagnostics

Megaplex incorporates test features for rapid fault detection and easy maintenance. Once in operation, all system and I/O modules undergo self-testing, and problems are reported to the management system. Local and remote loops may be performed on each channel and on the main links.

Any timeslot can be selected for BERT/tone injection. In addition, a loop can be initiated per any timeslot.

The ABCD status of any voice channel can be captured with a single click (signaling monitoring).

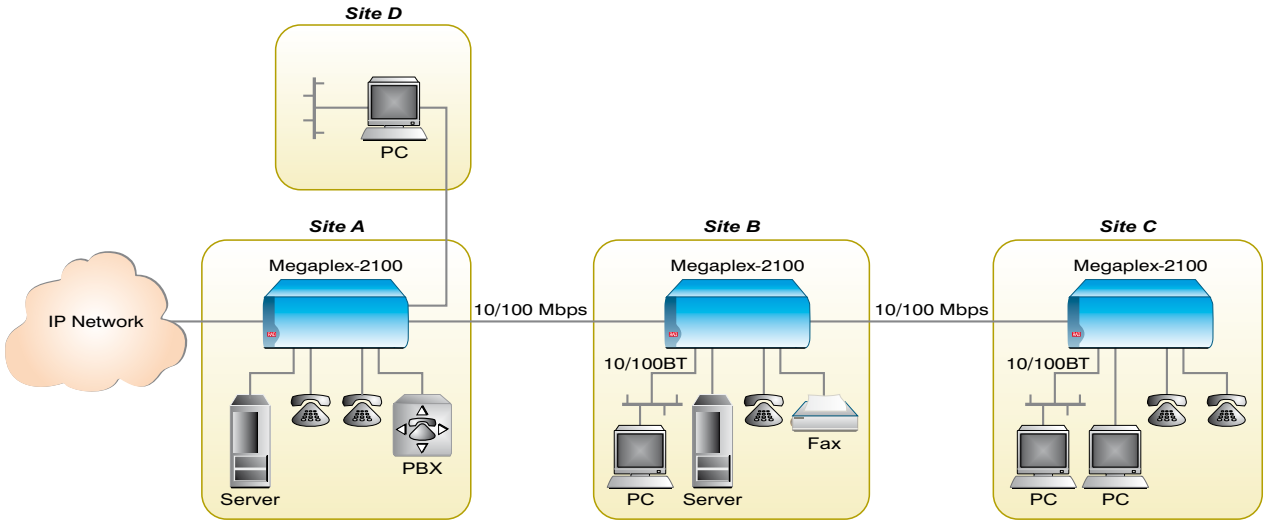
Alarms

Alarm information is stored in the common logic module and is automatically read by the management system from any node. Up to 256 alarms can be stored in a queue, and a maximum of 1,024 alarms can be stored in a file on the PC, to be read by the management system.

System modules

The common logic module stores configuration and event information, and uses a SLIP/PPP or Ethernet connection to communicate with the management station via an SNMP agent. Flash EPROM for remote software download, Telnet and an ASCII craft terminal are also supported.

Megaplex-2100, Megaplex-2104
(Continued)



Megaplex-2100 Ethernet daisy chain

Four timing options are available:

- Link receive clock
- Internal crystal oscillator channel
- Clock from any high speed module (HS-6N, HS-12N, HS-S, HS-U, HS-703, HS-Q/N)
- Station clock

Any clock source can be set as the fallback in the event of primary clock source failure.

Ring support (E1/T1 and RFER)

The Megaplex supports various ring topologies ensuring no single point of failure. E1/T1 ring protection provides self-healing in less than five seconds. Resilient Fast Ethernet Ring provides a 100 Mbps (up to 40 E1/50 T1) Ethernet ring with self-healing in less than 50 msec.

Modular chassis

The Megaplex family consists of the 4U-high Megaplex-2100 with 12 slots and the 2U-high Megaplex-2104 chassis with five slots – for both I/O and main link modules. This allows for a mix of a wide variety of data, voice, fax, and LAN services. All Megaplex-2100 modules fit both Megaplex-2100 and Megaplex-2104 chassis.

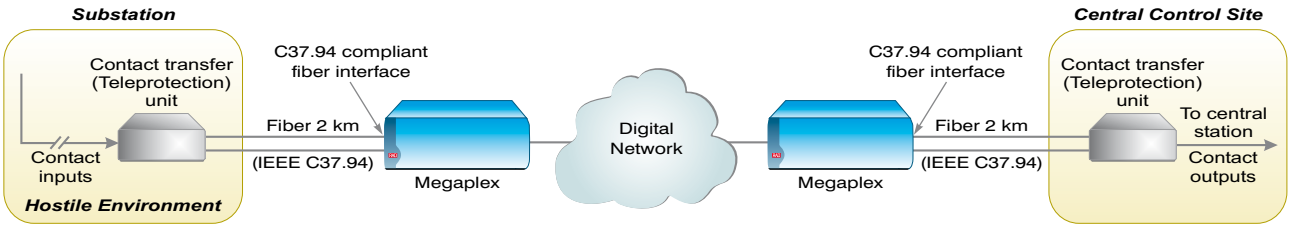
Main link modules

The single or dual E1/T1 and ML-IP main link modules incorporate the DS0 matrix between the I/O channels and each of the E1/T1 trunks. The modules support 8 Mbps non-blocking cross connect for any DS0 coming from either the channels or from the trunks. Multiple fractional E1/T1 ports are supported. These main links support 1+1 protective switching for any E1/T1 port.

The eight E1/T1/DSL main links support a higher capacity of 16 Mbps when used together with the HS-12 module, but do not support redundancy.

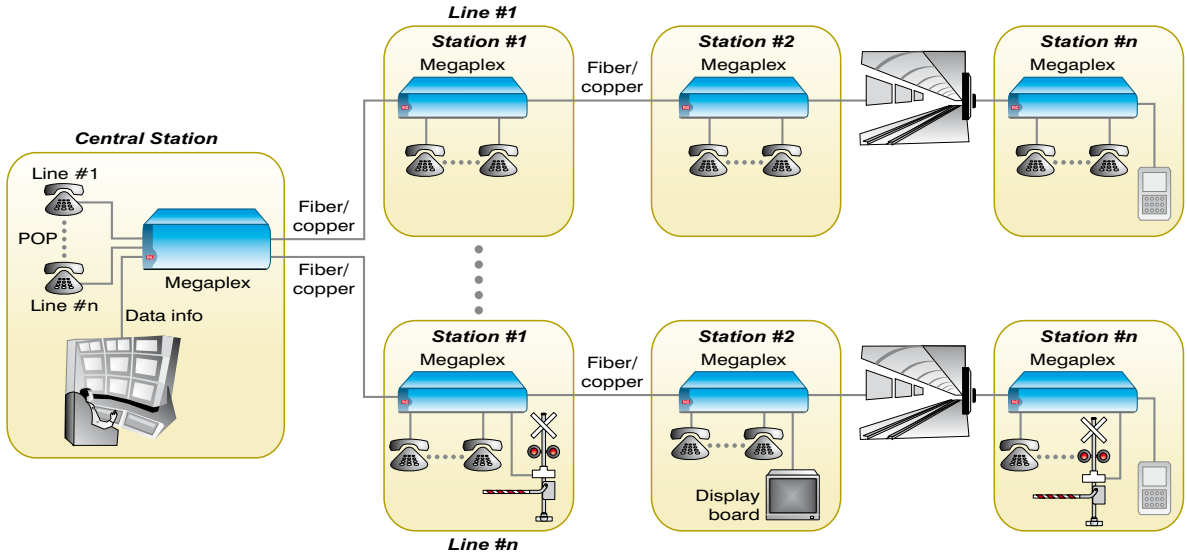
ML-IP

Three-port 10/100BaseT Ethernet uplink module with up to 4 Mbps uplink capacity. This module serves as the main link to the IP network, placing the packetized TDM data stream from the I/O modules onto the IP network in the form of TDMoIP framing. The module is also available with two fiber optic 100BaseFX uplinks.



Teleprotection utility application

Megaplex-2104 back panel



Party-line (Omnibus) dedicated voice application

ML-2E1, ML-1E1, ML-2T1, ML-1T1
Dual/single E1/T1 links with integral, soft-configurable LTU/CSU.

MLF-2E1, MLF-1E1, MLF-2T1, MLF-1T1
Dual/single E1/T1 links with fiber interfaces, eliminating the need for an external fiber optic modem.

ML-20N
Dual/single n x 64 kbps main link with data interfaces such as V.35, X.21 and more.

MSL-8
Eight-port SHDSL module, extending the range up to 10.6 km (3.5 miles) over existing copper lines.

ML-8E1, ML-8T1
Eight-port E1/T1 main link module.

I/O modules

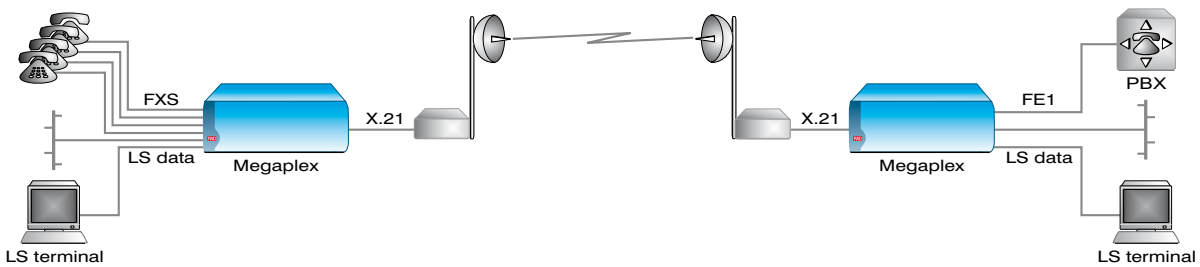
Data modules

HS-ETH/SW
Four 10/100BaseT LAN module with built-in Layer 2 Ethernet switch, featuring VLAN support and static routing capabilities.

HS-DP
OCUDP low speed module with three/six ports.

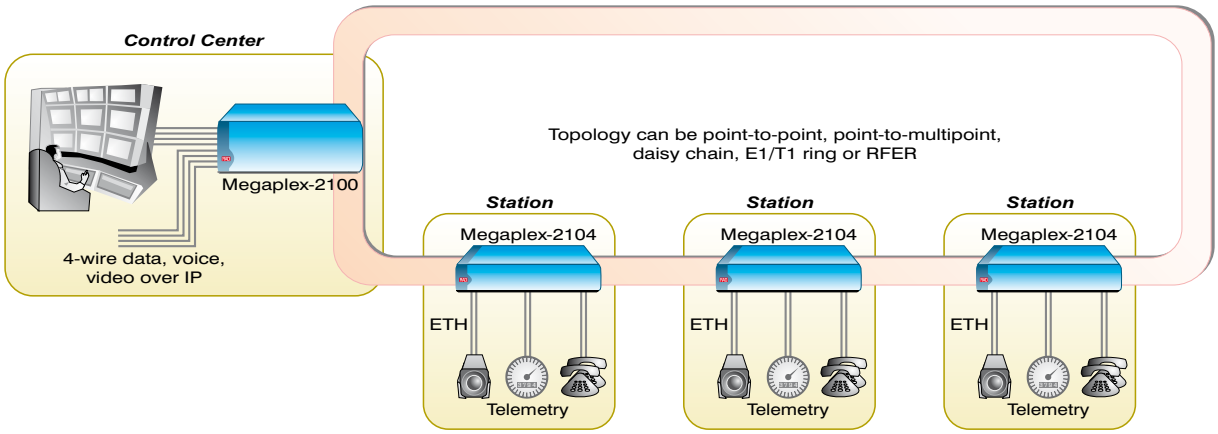
HSF-1, HSF-2
n x 64 kbps fiber data module for transporting Teleprotection signals, IEEE C37.94 compliant.

HS-Q/N, HS-6N, HS-12N
Four, six, or 12 channels, each with independently selectable data rates of n x 64 kbps or n x 56 kbps (n = 1 to 31 for E1, or 1 to 24 for T1). Interface is field-selectable for V.35, V.36/V.11, X.21 or RS-530/RS-422.

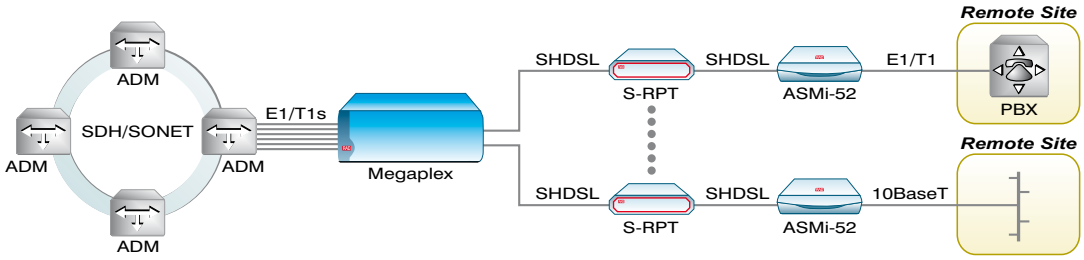


Optimized services over narrowband link using serial interface

Megaplex-2100, Megaplex-2104
(Continued)



Multiple services for railway in a variety of topologies



SHDSL central site solution

HS-703
Four 64 kbps G.703, codirectional channels.

HS-RN
Four V.24/RS-232 low speed channels. Supports channel data rates up to 38.4 kbps async and up to 64 kbps sync, supporting end-to-end control signals. The module provides optional V.110 support, enabling enhanced bandwidth optimization and lower end-to-end delay.

LS-6N, LS-12
Six/twelve sync/async V.24/RS-232 channels with rates from 1.2 kbps baud to 64 kbps, end-to-end control signal and BERT.

HS-U, HS-U-6, HS-U-12
Four, six or twelve U interface channels (2B+D) using 2B1Q line code for full duplex operation over 2-wire. Supports data rates up to 128 kbps and a range of up to 5 km (3.1 miles), and includes power feeding to the remote NT. Includes full duplex mode for management of remote ASMi-31.

HS-S, HS-S-12
Four or 12 ISDN S interface channels (2B+D). Operates as either TE or NT. Each channel supports data rates up to 128 kbps.

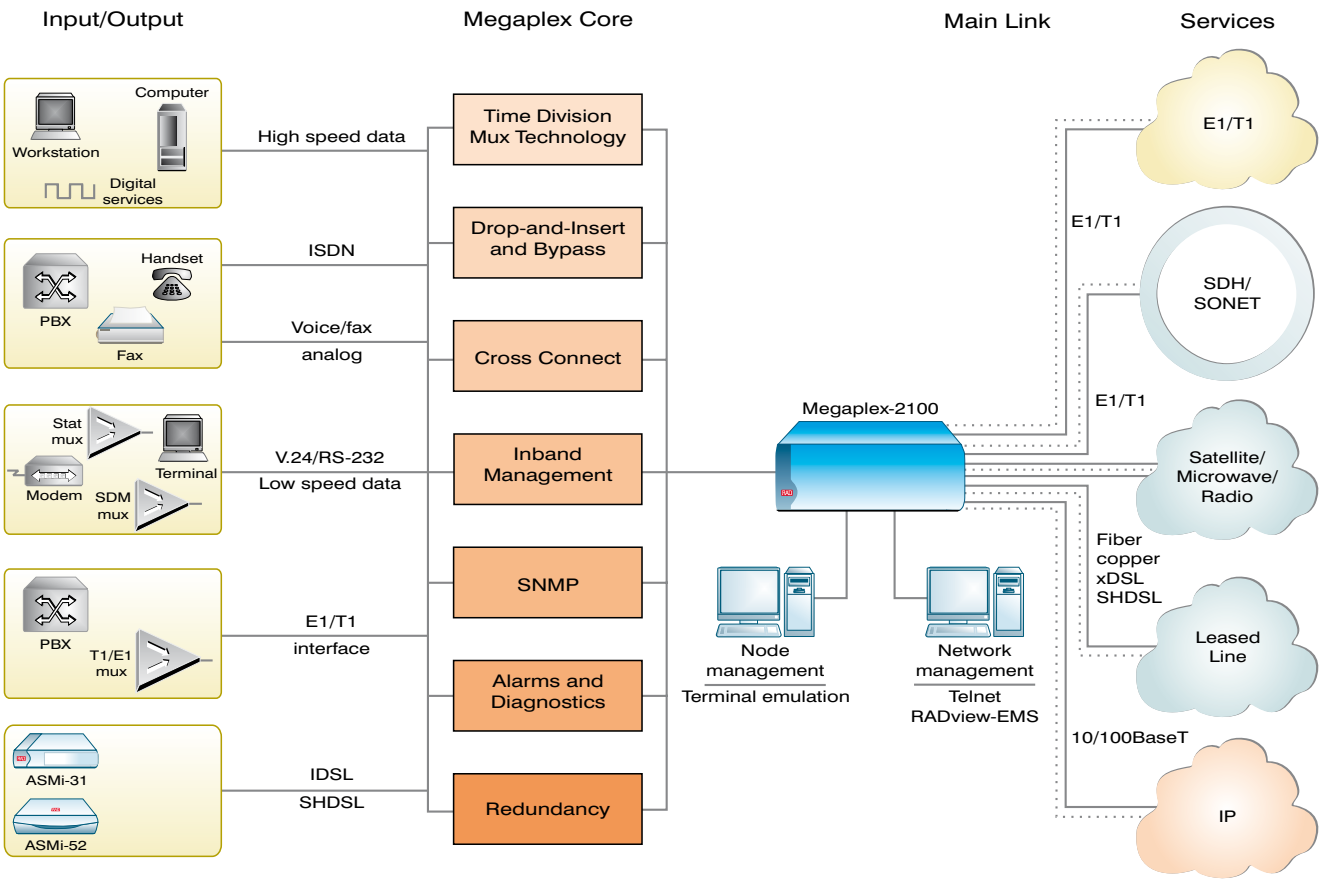
ACM
Alarm and diagnostic module with four outbound relays and eight inbound sensors.

Voice/fax modules

VC-4, VC-8, VC-16
Four, eight or 16 PCM voice channels with optional E&M, FXS and FXO interfaces.

VC-4A, VC-8A
Four or eight analog voice channels using PCM (64 kbps) encoding or ADPCM (24 or 32 kbps) encoding, with E&M, FXS or FXO interface options.

VC-16A
Sixteen toll-quality, PCM/ADPCM (32/64 kbps) non-signaling voice compression channels, enabling two voice channels to be placed on each 64 kbps timeslot.



VC-4/E&M/OMNI
A special Omnibus E&M interface module provides four toll-quality voice channels to support applications where a master site needs to communicate with multiple remote stations simultaneously (such as to broadcast an important message).

VC-6/LB, VC-6/4LB
Four or six voice channels for operation with special local battery (LB) telephone sets (e.g., military field telephones).

VFS-60/48/30/24
Voice compression module with up to 2 x E1 or 2 x T1 capacity, using G.723.1 (6.3 kbps per channel) or G.729.A (8.0 kbps per channel) compression methods, with modem/fax relay, transparent timeslot support, voice activity detection, silence suppression, and comfort noise generation. Voice compression server functionality enables compression of TDM traffic from the Megaplex backplane and compression of analog channels from voice modules.

DXC-100

Multiservice Access Node

- **Carrier-class 3/1/0 non-blocking cross connect**
- **256 Mbps to 1.2 Gbps matrix**
- **Expandable (stackable) 6U-high unit**
- **Modular construction with 11 to 86 I/O slots**
- **Services supported: n x 56/64 kbps, E1, T1, E3, T3 (including G.747), OC-3, STM-1, and channelized router**
- **Built-in E1/T1 conversion, including A-law/μ-law and signaling conversion on E1/T1, E3/T3 and STM-1/OC-3 interfaces**
- **Supports up to 640 n x 56/64 kbps, 688 E1/T1, 80 E3/T3, 32 STM-1/OC-3, as well as 80 channelized router ports**
- **Service redundancy 1:n and 1:1 with optional protection switch (3U-high unit) or on main unit for STM-1 or OC-3 modules**
- **Optional 1:1 system redundancy**

For latest updates visit www.rad.com

DXC-100 is a scalable multiservice access node that enables the incremental deployment of voice and data networks. As the networks grow, up to eight DXC-100 units can be stacked to provide very high density grooming, concentration and cross connect.

Scalable platform with minimal initial investment

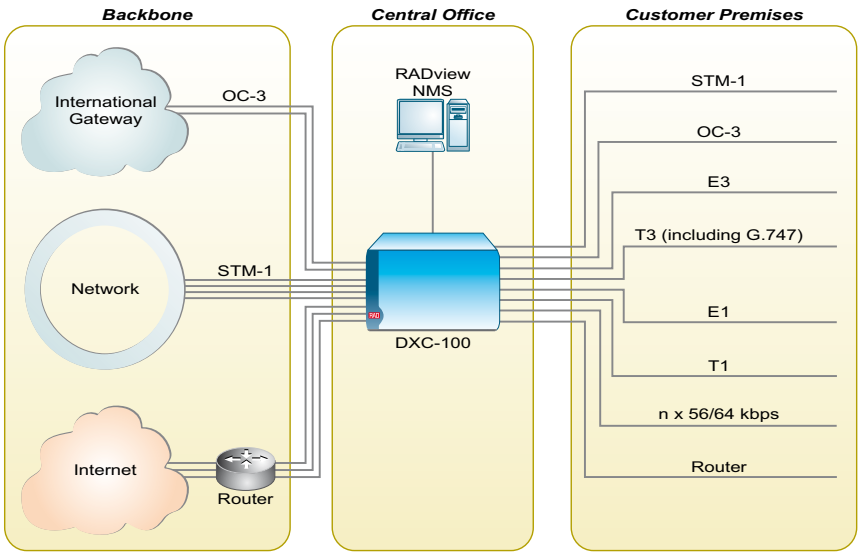
The modular, 6U-high DXC-100 is the newest member of the DXC family of multiservice access nodes. Each high density chassis supports 80 n x 56/64 kbps, 88 E1, 88 T1, 11 E3, 11 T3, four STM-1, or four OC-3 links. Up to eight chassis can be stacked to support up to 640 n x 56/64 kbps, 688 E1, 688 T1, 80 E3, 80 T3, 32 STM-1, or 32 OC-3 lines, for a powerful, central site solution. The scalable platform enables a carrier to deploy a low cost system that meets its current requirements and add more ports as its customer base grows.

Manages bandwidth for diverse voice and data applications

DXC-100 satisfies a wide range of broadband and narrowband applications for carriers, cellular operators, ISPs, utility companies, and enterprises. Applications include E1/T1 conversion, high speed access to a carrier's backbone, grooming fractional trunks into full trunks, maximizing data traffic payload over E3, T3, STM-1 or OC-3 trunks, grooming data traffic from different locations into a channelized Ethernet router, and grooming monitoring signals for quality of service or advanced services. It optimizes the SS7 network by consolidating n x 56/64 kbps and E1/T1 functionality in a single, cost-effective, managed device. The DXC-100 can also aggregate Ethernet traffic from several remote sites via different trunks (for example, ISP or corporate traffic) into one stream by using the channelized router module. Operating as a digital cross connect, the DXC-100 provides 4/3/1/0 non-blocking switching that is comparable to larger, more costly systems.

Protects investment in legacy networks

The DXC-100 can connect copper-based edge devices and networks to a fiber-based core, and performs port concentration and grooming for protocol-based platforms. Therefore, the DXC-100 provides a migration path to optical and packet switched networks. The channelized router enables traffic grooming, saving the cost of additional equipment or ports.



DXC-100 supported services

Management and redundancy capabilities

The DXC-100 features flexible management capabilities, including local management via an ASCII terminal (RS-232). In addition, remote management can be performed either inband using the network or user ports or out-of-band using a dedicated management port. 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 DXC-100 also supports a variety of access protocols, including Telnet, SNMP and Web server.

Modules

DSTM-1 SDH STM-1 module supports up to 63 VC-12 (E1) or 84 VC-11 (T1) embedded links with optional 1:1 redundancy. 155 Mbps long range 1310 nm single mode fiber.

DOC-3 SONET OC-3 module supports up to 84 VT 1.5 (T1) embedded links with optional 1:1 redundancy. 155 Mbps long range 1310 nm single mode fiber.

DE3 supports single E3 link containing 16 embedded E1s plus integral BERT and loopback diagnostics. Optional 1:n redundancy.

DT3 supports single T3 link (containing a mix of up to 28 T1s or 21 E1s per ITU G.747) with M13 or C-bit framing, BZ3S encoding plus integral BERT and loopback diagnostics. Optional 1:n redundancy.

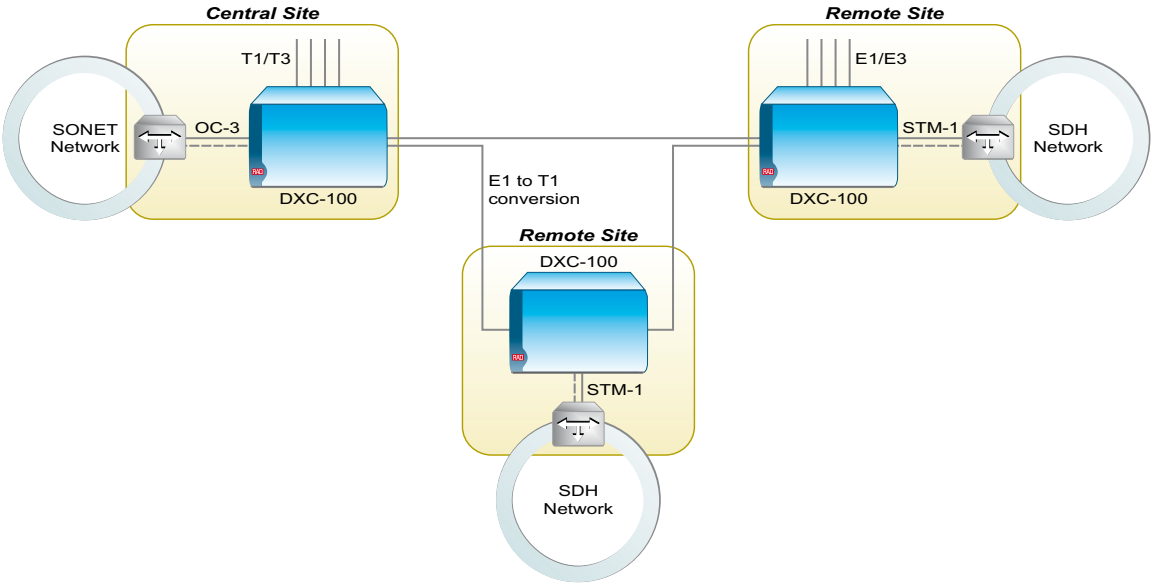
D8E1T1 supports eight T1 (100 ohm) or E1 (120 ohm) balanced interfaces in any combination. D4, ESF or G.70x framing and AMI, B8ZS or HDB3 line coding plus integral BERT and loopback diagnostics. E1/T1 voice encoding and signaling bit conversion included. Optional 1:n redundancy.

DROUTER supports up to 32 individual channels (one to 32 timeslots) and up to 2 Mbps for IP/IPX routing including RIP, RIP-2 and OSPF, plus additional features such as network address translation (NAT). Integral SNMP agent is provided along with external contact closure detection and notification. Supports 10/100BaseT LAN hub functionality. Detects status of up to three external contact closures.

D8HS supports eight synchronous DCE ports operating at n x 56/64 kbps data rates with a maximum speed of 2.048 Mbps plus control signal selection and integral BERT and loopback diagnostics. Eight individual RS-232, RS-422/449, RS-530, RS-530A, V.35 or X.21/27 interfaces in any combination can be supported.

System capacity

Ports	DXC-100 1 unit	DXC-100 8 units (stacked)
n x 56/64 kbps	80	640
E1	88	688
T1	88	688
E3	11	80
T3	11	80
STM-1	4	32
OC-3	4	32
Router	10	80



International gateway

DXC Family

Multiservice Access Nodes

- **Non-blocking cross connect up to 960 time slots**
- **Traffic grooming**
- **Compact 1U or 3U-high enclosure**
- **Modular construction with four, five or 15 I/O slots**
- **Services supported: n x 56/64 kbps, ISDN, IDSL, SHDSL, E1, T1, E3, T3, and STM-1**
- **Optional common logic and power supply redundancy**
- **Optional link and/or hardware protection**
- **Integrated fiber optic, SHDSL and IDSL modems**
- **Built-in E1/T1 converter, including A-law/μ-law and signaling conversion for PCM timeslots**

For latest updates visit www.rad.com

The DXC family consists of modular multiservice access nodes, providing non-blocking DS0 cross connect for up to 120 lines.

Plug-in interface modules can accommodate up to eight links each (see Modules section on page 102). Many services are supported, including n x 56/64 kbps, ISDN, E1, T1, E3, T3, and STM-1.

Cross connect, groomer and broadcast

All DXC modules allow maximum flexibility between ports. A user-programmable connection matrix connects any incoming 56/64 kbps timeslot to any outgoing 56/64 kbps timeslot. It supports cross connect functions, such as drop-and-insert, distribute and collect.

The DXC family enables the grooming of fractional traffic from the user side into full E1/T1, E3/T3 or STM-1 trunks, for connection to the network. Grooming and bandwidth maximization are implemented by placing the n x 56/64 kbps data channels into an E1 or T1 frame (including internal E1/T1 of the E3 or T3 modules or VC-12 containers of the STM-1 module), using only the required number of timeslots. This provides fractional CSU/DSU functionality.

The DXC family can broadcast any traffic combination from a single input to numerous destinations. Channel relocating and half duplex conferencing are also supported.

E1/T1 converter

The DXC family is also capable of converting between E1/T1 ports. A-law/μ-law and signaling conversion are performed according to E1 and T1 standards. DXC-8R, DXC-10A and DXC-30 convert up to 16 ports. T1 traffic can be directly extracted from the STM-1 module (which can act as a converter for up to 30 T1 links).

E3, T3 and STM-1 multiplexer modules

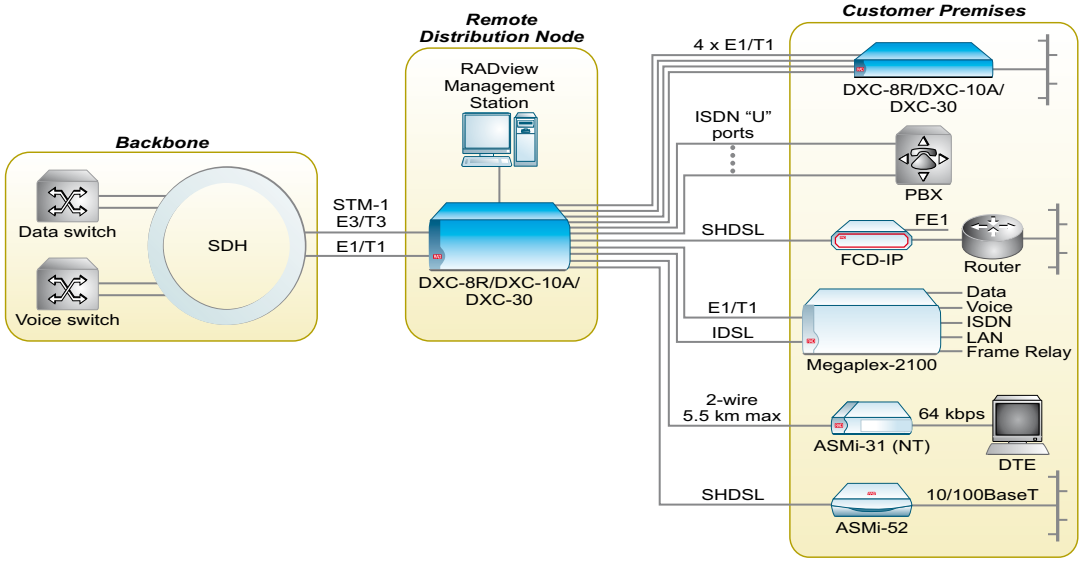
These modules provide full channelization functionality for the multiplexing and demultiplexing of DS0 traffic. Aggregated payload is 34 Mbps for E3; 45 Mbps for T3; and the equivalent of 61 Mbps for STM-1 (one chassis). When chaining a number of units, the aggregated payload is equivalent to 155 Mbps. G.747 is supported by DXC-100 (see page 98).

Redundancy

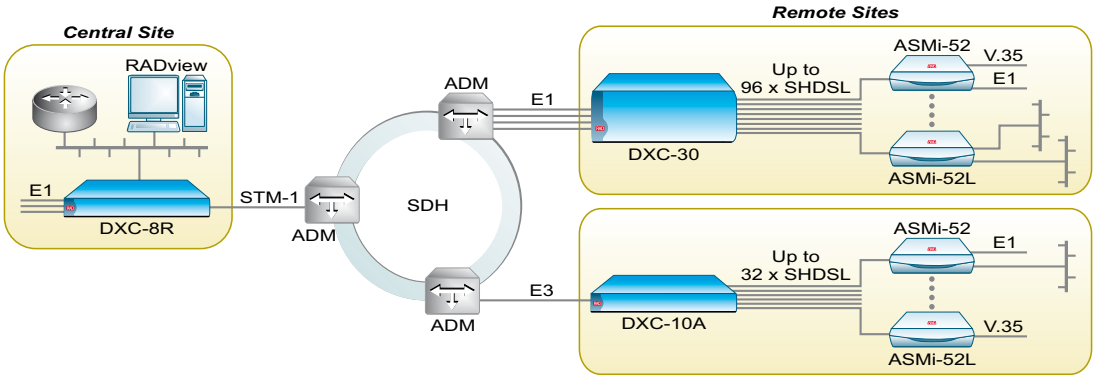
The DXC family provides flexible redundancy and protection to accommodate each user's needs and help minimize service downtime. The modules' link protection is user-programmable. Hardware protection and partial or full redundancy can be added at any time.

Redundancy in each unit:

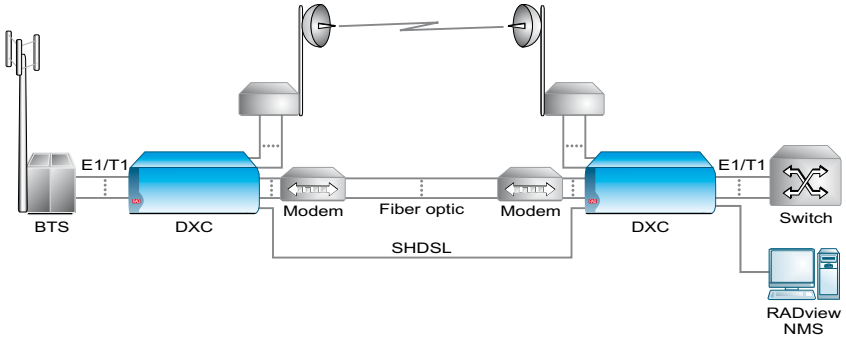
- DXC-30 system redundancy (power supply and common logic) is optional and can be added at any time. Partial redundancy can also be provided.
- DXC-8R has built-in full system redundancy
- DXC-10A has no system redundancy
- Most DXC modules support line redundancy



Multiservice access platform



Extending services over DSL



Main link line protection by different media types

Basic devices

DXC-4

The compact half 19-inch, 1U-high unit grooms timeslots from four or eight E1/T1 links to a single E1/T1 uplink. Optional power supply redundancy (see page 104).

DXC-8R

The compact 1U-high unit can support up to 32 ports. It is fully redundant and includes two power supplies, two common logic modules and four I/O slots for the plug-in interface modules.

DXC-10A

The compact 1U-high unit can support up to 40 ports. It is not redundant and includes one power supply, one common logic module and five I/O slots for the plug-in interface modules.

DXC-30

The space-saving 3U-high unit can support up to 120 ports. The basic unit includes one power supply, one common logic module and 15 I/O slots for the plug-in interface modules. Optional secondary power supply and/or common logic can be ordered at any time for full or partial system redundancy.

DXC-100

The stackable unit can support up to 688 ports and 1.2 Gbps 3/1/0 cross connect capabilities (see page 98). Various timing options cover all timing possibilities for the E1/T1 interface. These include internal clock, external clock and loopback timing sourcing from any selected E1/T1, n x 56/64 kbps, E3/T3, or STM-1 port.

Setup, management and diagnostic tools

The DXC family features flexible management capabilities, including local management via an ASCII terminal (RS-232). In addition, remote management can be performed 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 DXC family also supports a variety of access protocols, including Telnet, SNMP and Web server.

DXC Family
(Continued)

Modules

Most modules listed on this page are supported by all DXC chassis. A variety of port densities are available, from single-port to eight-port modules. Most modules support hardware and/or line redundancy and ensure a protective switching time of under 50 msec.

Additional features include integrated modems (fiber, IDSL and SHDSL), range extenders and powerful, integrated testing capabilities that minimize network downtime. The DXC features built-in BER testing, programmable on any port on a timeslot level, and loopback capabilities.

STM-1 terminal module

DFSTM-1 one-port or two-port standard 155 Mbps STM-1 interface provides direct access to the STM-n SDH ADM at the STM-n level. The STM-1 terminal multiplexer (TM) module grooms up to 61.44 Mbps of traffic to a standard STM-1 frame over fiber or copper. The two-port module can be used in a drop-and-insert daisy chain to expand services or for redundancy. When daisy-chaining units, full payload is supported.

E3/T3 modules

DE3 one-port E3 interface module provides access to a standard E3 frame over an unbalanced coax or fiber link. A user-programmable connection table enables fractional data traffic from various sources to be groomed into full internal E1 trunks.

DT3 one-port T3 interface module provides access to a standard T3 frame over an unbalanced T3 or fiber link. A user-programmable connection table enables fractional data traffic from various sources to be groomed into full internal T1 trunks.

E1 modules

D4E1/D8E1 four-port or eight-port interface modules transmit to a range of up to 2.2 km (1.4 miles) by using the built-in LTU. They have a data rate of up to 2.048 Mbps per port, and support BERT and loopback per timeslot. Resistive attenuation adjustment (10 dB – 30 dB) supports signaling monitoring applications (such as SS7 network maintenance and billing).

DE1B two-port E1 interface module transmits to a range of up to 2.2 km (1.4 miles) with an LTU option. BERT and loopback per timeslot are optional. Automatic traffic bypassing is optional.

T1 modules

D4T1/D8T1 four-port or eight-port interface modules transmit to a range of up to 2.2 km (1.4 miles) by using the built-in CSU. The data rate is up to 1.544 Mbps per port. The module supports BERT and loopback per timeslot. Attenuation adjustment (10 dB – 30 dB) supports signaling monitoring applications (such as SS7 network maintenance and billing).

DT1B two-port T1 interface module transmits to a range of up to 2.2 km (1.4 miles) with a CSU option. BERT, loopback per timeslot and automatic traffic bypassing are optional.

xDSL modules

D8SL eight-port interface module uses standard SHDSL technology to extend the range of E1 connections over 2-wire cable up to 10.7 km (6.6 miles).

D4SL four-port interface module uses standard SHDSL technology to extend the range of E1 connections over 2-wire cable up to 10.7 km (6.6 miles).

D8U eight-port module enables IDSL extension to remote modems at ranges up to 5.5 km (3.4 miles) or as ISDN (U interface) 2B+D channel transmission at ranges up to 5.5 km (3.4 miles). Data rate is up to 128 kbps per port.

Special modules

D8HS eight-port n x 56/64 kbps data module provides eight high speed synchronous data channels, independently selected for V.35, RS-422/V.11, X.21 or RS-530 interface.

DHS two-port n x 56/64 kbps data module provides two high speed synchronous data channels. Each channel is independently selected for 10/100BaseT Ethernet bridge, including VLAN support, 10BaseT Ethernet router, V.35, RS-422/V.11, X.21, or RS-530 interface.

Features	DXC-8R	DXC-10A	DXC-30
Height	1U	1U	3U
Maximum number of ports	32	40	120
Number of I/O slots	4	5	15
System redundancy	Built-in	None	Optional
E1, T1, E3, T3, STM-1 modules supported	All	All	All
ISDN, ISDL, SHDSL modules supported	All	All	All
n x 56/64 kbps	All	All	All
ASCII, SNMP, RADview NMS management supported	All	All	All

Applications

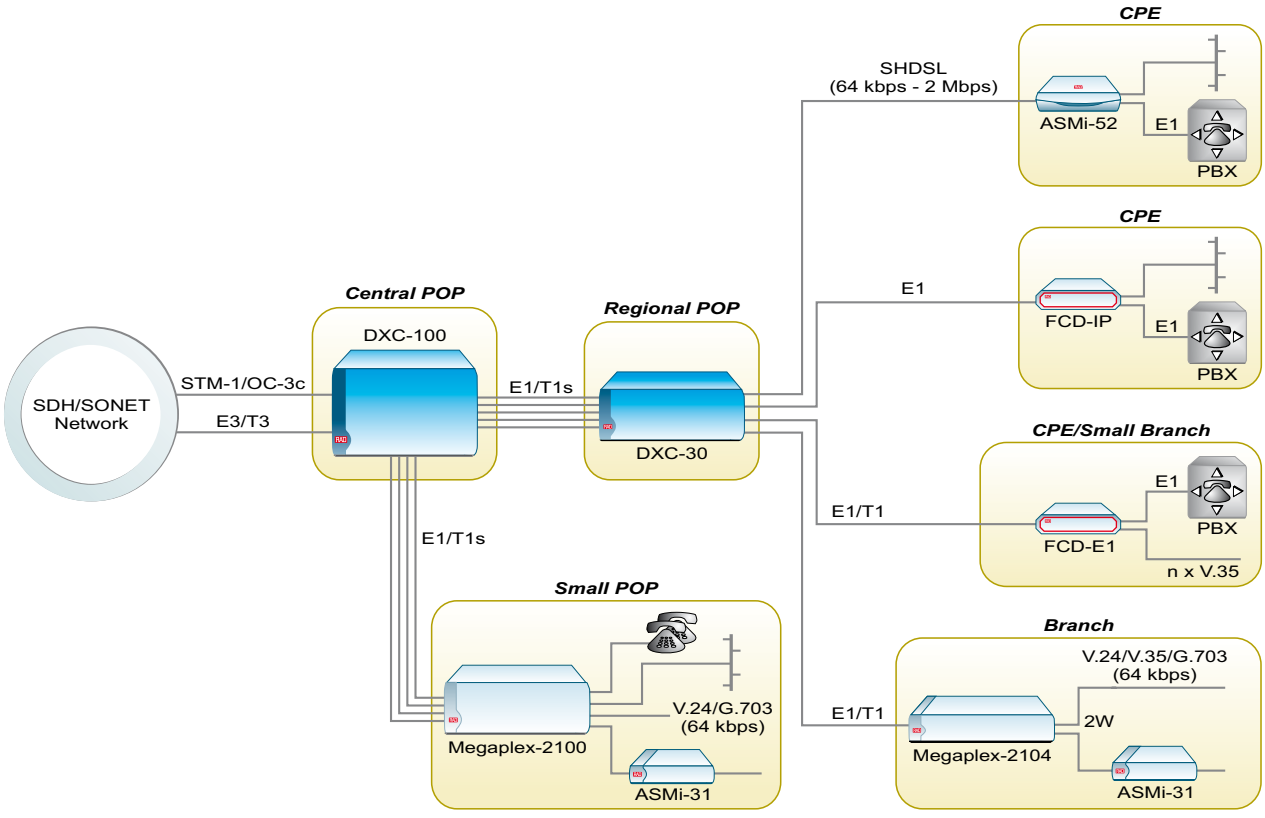
The DXC family acts as the central solution for many RAD or other standards-based products. The DXC-8R and DXC-10A 1U chassis are geared for installations that require a compact unit (e.g., cellular base stations) or lower capacity of up to 40 ports (e.g., a carrier's initial stage of deployment). Typical applications:

- E1/T1 access platform over SHDSL, IDSL, fiber, or copper, featuring data/voice concentration and integrated management
- Providing conversion/gateway between T1 and E1 networks, for both data and voice
- Providing high speed access (e.g., Ethernet, HSSI) to a carrier's high speed digital backbone over n x E1/T1, E3/T3 or STM-1, where n represents one to eight lines
- Splitting data and voice traffic
- Distributing services from an SDH or other network to a wide variety of end users by creating an E1/T1 or STM-1 daisy chain
- Grooming fractional trunks to full trunks
- Maximizing data traffic payload over E3, T3 or STM-1 trunks
- Grooming of monitoring signals (SS7 or other) for advanced services and quality of service
- Broadcasting identical data to multiple destinations
- Cross connecting trunks at the point-of-presence (POP)
- Grooming a variety of services at the POP over n x E1/T1, E3/T3 or STM-1

Target markets

DXC users and markets include the following:

- Cellular operators
- Wireless operators
- Incumbent and alternative carriers
- International carriers
- Utility companies
- Enterprises
- Multi-tenant units (MTUs)
- Transportation
- Ship-to-shore communications
- Test and maintenance operators (SS7 networks)
- Internet service providers (ISPs)



Grooming lower data rate traffic into higher data rate trunks

DXC-4

Fractional E1/T1 Groomer

- **Grooms fractional links onto one E1/T1 link**
- **Four or eight E1/T1 ports**
- **Simple installation and operation**
- **Compact, half 19-inch solution**
- **SNMP management**

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The DXC-4 fractional E1/T1 groomer offers reliable E1/T1 grooming of TDM traffic for up to eight fractional E1/T1 lines onto a single E1/T1 link, saving costs on leased lines and offering quick payback.

Cost-effective grooming for mobile operators

The DXC-4 fractional E1/T1 groomer offers a cost-effective solution for backhauling of TDM traffic from base stations (BTS) to cellular networks. The compact, standalone DXC-4 is widely deployed by cellular, wireless and leased line operators to optimize bandwidth utilization or to maximize services by separating and redirecting TDM traffic according to type.

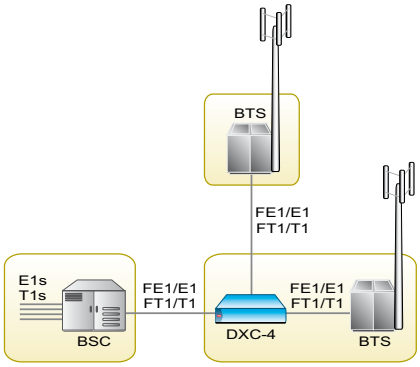
Alternatively, the DXC-4 E1/T1 groomer can groom DS0 timeslots, including the signal information, into a single E1/T1 link. The DXC-4 E1/T1 grooming solution complements RAD's DXC family of cross connects and can also be deployed on any E1/T1 device.

Four or eight ports

The scalable DXC-4 can be ordered with four or eight ports to support four or eight link channels. The DXC-4 E1/T1 grooming device supports user-selectable E1 or T1 links. Internal LTU/CSU is included. The DXC-4 is ETSI-rack installation ready.

The DXC-4 E1/T1 grooming solution has an SNMP agent. A wide range of management options such as ASCII terminal, Telnet and RADview are available via two NMS ports.

The DXC-4 is a compact, half 19-inch non-modular solution. The DXC-4 E1/T1 grooming solution has an optional redundant power supply.



DXC-2

E1/T1 Converter and Timeslot Cross Connect

- **Converts between E1 and T1 data and signaling**
- **Configurable A-law/μ-law and signaling conversion; or transparent conversion at 64 kbps timeslot level**
- **Controlled SLIP for buffer overflow/ underflow**
- **Soft-selectable to comply with ITU Rec. G.802, Annex 2**
- **Optionally available with built-in LTU (E1) or CSU (T1)**

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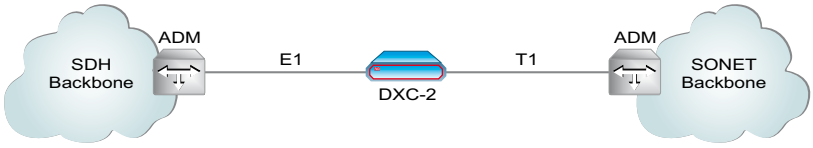

The DXC-2 E1/T1 converter and timeslot cross connect enables conversion between one E1 signal and one T1 signal (24 timeslots). For applications requiring timeslot swapping between two devices operating at the same speed, the unit can also be ordered with two ports of the same type (i.e., two E1 or two T1 ports). An optional built-in LTU (E1) or CSU (T1) is available on either port.

A user-programmable connection table defines the connection of any 64 kbps incoming timeslot to any outgoing timeslot. The DXC-2 can also perform the required A-law/μ-law and signaling conversion in compliance with E1 and T1 standards. The E1-to-T1 conversion method can be soft-selected to comply with ITU G.802.

Diagnostic loopback support for E1/T1 interfaces includes loopback towards the local or remote DTE.

Several clock modes cover all timing possibilities for the E1/T1 interface. These include internal clock and loopback timing for either the E1 or T1 interface.

The E1 interface complies with ITU G.703, G.704, G.732, and G.823, and supports both two and 16 frames per multiframe with or without CRC-4. Line code is HDB3.

The T1 interface complies with AT&T TR-62411 and ANSI T1.403 requirements, and supports both D4 or ESF framing formats and AMI line code. Zero suppression is selectable between transparent transmission, B7ZS or B8ZS.

Setup, control and diagnostics can be performed via the front panel or an ASCII terminal.

FCD-E1, FCD-E1A

E1 or Fractional E1 Access Units

The FCD-E1 is an access unit for full or fractional E1 services. Available with either one or two data ports and an optional sub-E1 drop-and-insert port, data port rates are selectable for any multiple of 56 kbps or 64 kbps, up to 1,984 kbps. Alternatively, one of the data ports can be replaced by an Ethernet bridge, providing direct connection to the LAN. In the FCD-E1A, one of the data ports can also be replaced by four S0 interfaces for ISDN BRI extension, or by an ISDN backup interface.

Internal or external line termination unit

The FCD-E1 is available with or without an internal LTU (line termination unit), allowing direct connection to the E1 network or connection via an external LTU. In the FCD-E1A this capability is built-in and can be configured with or without an LTU by the customer.

Interoperability with the DXC multiservice access node

The FCD-E1 and FCD-E1A can operate with RAD's modular DXC multiservice access node products for multilink star applications, including access to SDH networks.

Programmable timeslot allocation

Timeslot assignment is programmable, allowing data from each data port and from the sub-E1 port to be placed into timeslots on the main link, either consecutively or alternately.

Multiple clock source selection ensures maximum flexibility, enabling the support of different applications.

Immunity to hardware and power failures is provided by bypassing the sub-E1 port to the main E1 link, ensuring uninterrupted service to the sub-E1 port.

Standards compliant

The FCD-E1 and FCD-E1A comply with ITU recommendations G.703, G.704, G.706, and G.732. It supports both two and 16 frames per multiframe, with or without CRC-4. Zero suppression over the line is HDB3. The integral LTU ensures a range of up to 2 km (1.2 miles).

Setup, control and monitoring

Setup, control and monitoring of status and diagnostic information can be activated via:

- Front panel LCD with pushbuttons (menu-driven management)
- ASCII terminal connected to the async control port (command line interpreter)
- SNMP management connected to the async control port
- Inband management through a dedicated timeslot or TS0, supporting proprietary protocol and Frame Relay RFC 1490

Network management

The products support an internal SNMP agent and can be controlled by any generic SNMP station or by the RADview-EMS or RADview-SC/TDM (FCD-E1A only) SNMP network management application.

The units support dial-in/dial-out, which can be used for remote out-of-band configuration and monitoring (dial-in) and for alarms (dial-out).

- **One or two data ports**
- **Selectable sync data rates: n x 56 kbps, n x 64 kbps**
- **Data interfaces: V.35, RS-530, V.36/RS-449, X.21 or four S0 (FCD-E1A only)**
- **Integrated Ethernet bridge/router option**
- **Optional sub-E1 drop-and-insert port for PBX connectivity**
- **Fail-safe sub-E1 ensuring uninterrupted service**
- **Operates with RAD's DXC multiservice access node for multilink star configuration**
- **Main link available with optional integral LTU/CSU or with fiber optic modem**
- **Optional ISDN backup for data (FCD-E1A only)**
- **24-hour performance monitoring storage**

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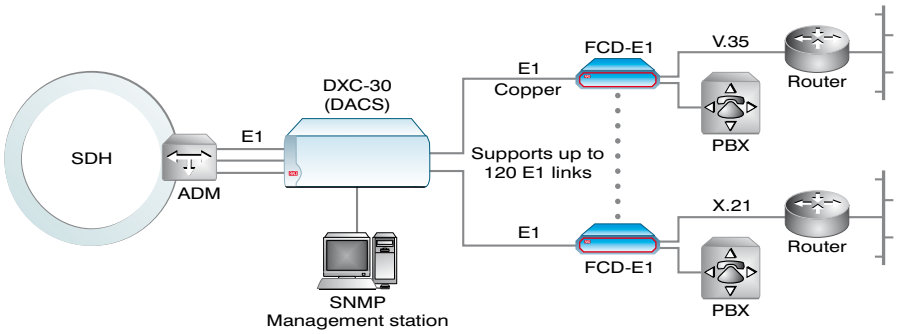
Maintenance capabilities include user-activated local and remote loopbacks and internal BERTs on the main E1 link, sub-E1 link and data ports. The products are standalone units for the desktop or a 19-inch rack shelf.



SDH access solution for multiple sites

FCD-E1L, FCD-E1LC

E1 or Fractional E1 Managed Access Units

- **Single or dual port access to E1 or fractional E1 services**
- **SNMP agent**
- **Out-of-band management via V.24 supervisory port**
- **Selectable sync data rates, n x 64 kbps or unframed E1**
- **Data interfaces: V.35, RS-530, V.36/RS-449, X.21, V.24**
- **Integrated Ethernet bridge, 10/100BaseT VLAN bridge or 10BaseT router options**
- **E1 interface complies with ITU G.703, G.704, G.706, G.732, G.823**
- **Main link diagnostics include loopbacks and BERT**

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The FCD-E1L and FCD-E1LC are managed single or dual port access units for full or fractional E1 services, ideal for use as managed interface converters. Data port rates are selectable for any multiple of 64 kbps up to 1,984 kbps. Alternatively, unframed E1 can be supported up to 2.048 Mbps.

Optional Ethernet port

The basic unit is available with a single data port and an optional second data port. In the FCD-E1L, the second data port can be replaced by an Ethernet bridge, 10/100BaseT VLAN bridge or 10BaseT router for direct connection to the LAN. The FCD-E1LC has sub-E1 drop-and-insert ports for PBX connectivity.

User data is placed into the E1 frame using only the required number of timeslots. Timeslot assignment is performed according to the data port speed and can be consecutive or random, starting from any timeslot.

Plug-and-play

For ease of installation, the FCD-E1L offers plug-and-play connectivity. Upon connection to the E1 link, the unit automatically detects the E1 parameters and autoconfigures. Manual configuration is an option.

The FCD-E1L is available with an integral LTU (line termination unit) to provide a range of up to 2 km (1.2 miles).

Standards compliant

The FCD-E1L and FCD-E1LC meet all requirements of ITU G.703, G.704, G.706, G.732, and G.823. They support both two and 16 frames per multiframe, with or without CRC-4. Zero suppression over the line is HDB3.

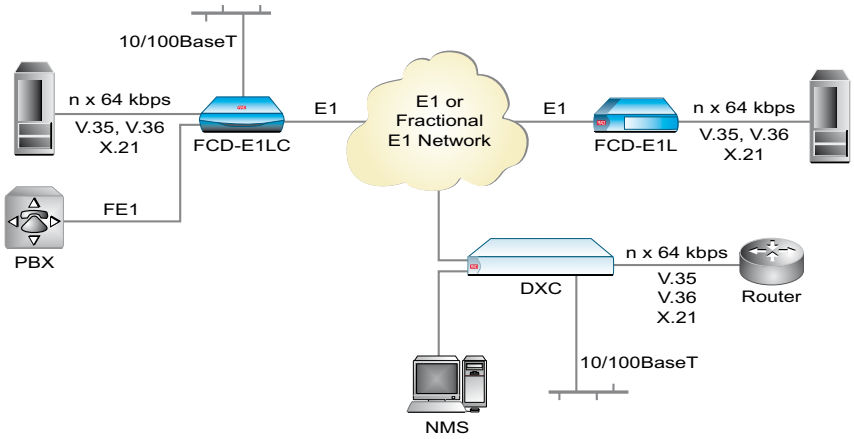
Clock recovery, management, diagnostics

The units may be clocked from the recovered receive clock of the main/sub-E1 link or from an internal oscillator. The data channel interface is RS-530. Adapter cables are available for V.35, V.36/RS-422 or X.21.

All models support an internal SNMP agent and can be managed by any generic SNMP station or by the RADview SNMP network management application. The units support dial-in/dial-out, which can be used for remote out-of-band configuration and monitoring (dial-in) and for alarms (dial-out).

Diagnostics include user-activated local loopbacks on the main/sub-E1 link and DCE data port. A pseudo-random data pattern (BERT) can be used to check the transmission path as well as the local and remote units.

All models are available as standalone units for the desktop or a 19-inch rack shelf.



FCD-IPL

E1 and Fractional E1 Access Unit with Integrated IP Router

The FCD-IPL is a customer-located demarcation router for transporting 10/100BaseT Ethernet traffic over E1 or fractional E1 links. It is ideal for supporting large-scale rollouts of Layer 3 VPN services over E1 lines to small and medium-sized enterprises (SMEs).

The FCD-IPL comes with an integrated IP router supporting PPP. The internal IP router operates in two modes: standard IP routing based on static entries, RIP-1 and RIP-2; and transparent IP, in which frames received via the LAN/WAN interface are routed to the other interface, with the exception of management traffic, which is sent to the FCD-IPL host IP address.

QoS differentiation for VoIP, video and data

The FCD-IPL transports Ethernet traffic at wire-speed, enabling full use of the 2 Mbps link. The IEEE 802.3-compliant 10/100BaseT user port supports auto-negotiation and operates in both full and half duplex modes. Quality of service (QoS) is assured, based on standard class of service definitions according to IP Precedence (ToS) or DSCP. The user traffic is assigned to five distinct priority queues: one Strict Priority queue for VoIP and video applications and four weighted fair queues (WFQs) for data. The Strict Priority queue traffic is forwarded to the WAN link before traffic from any WFQ, minimizing delay and maintaining the quality of the transmission.

Powerful network availability and management features

FCD-IPL features a unique bi-directional fault propagation mechanism that constantly monitors the status of the network and user connections. If a failure is detected on one of the interfaces, the FCD-IPL automatically shuts down the other port.

The FCD-IPL can be managed inband via Telnet, Web-based applications and SNMP or out-of-band via a direct connection to an ASCII terminal.

- **IP router supports PPP WAN over E1 or fractional E1 links**
- **Supports E1 uplink and 10/100BaseT Ethernet user port**
- **Standard and transparent IP routing**
- **QoS for user traffic prioritization**
- **Bi-directional fault propagation**
- **Powerful SNMP, Telnet and control port management capabilities:**
  - **in-band and out-of-band access**
  - **remote software download**
  - **statistics collection**

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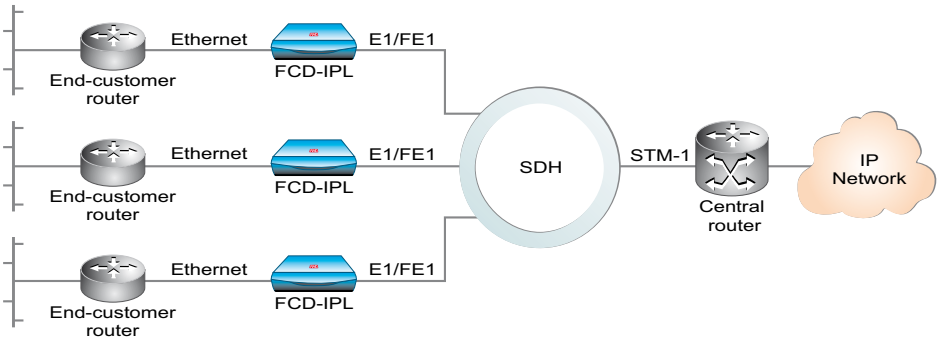
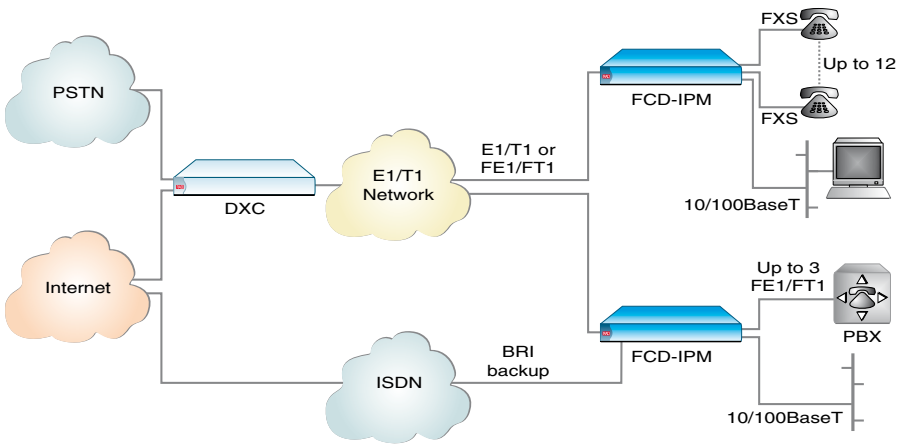


Intelligent demarcation for access to Layer 3 IP VPN services

FCD-IPM

E1/T1 or Fractional E1/T1 Modular Access Device with Integrated Router

- **Modular integrated access device (IAD) for providing bundled services (telephony and Internet access) over E1/T1 lines**
- **E1/T1 access over copper (E1 only) or fiber**
- **One or two independent Ethernet ports**
- **Optional integrated four-port switch**
- **Support for Frame Relay (RFC 1490) and PPP protocols**
- **OSPF support**
- **Data interfaces: V.35, RS-530, V.36/RS-449, V.24, X.21**
- **Fail-safe sub-E1/T1 port ensures uninterrupted service**
- **Supports up to 12 analog voice channels (FXS, FXO, E&M)**
- **Optional dial-up or integrated ISDN backup**



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The FCD-IPM is an E1/T1 or fractional E1/T1 modular integrated access device (IAD) with a built-in router.

The FCD-IPM enables service providers to bundle data and voice services together with Internet access over a single E1 or T1 line.

The modular design enables carriers to adopt and comply with changing customer needs. The modules include:

- Four or eight analog voice ports
- One or two fractional E1/T1 ports
- Universal data port
- Four-port hub/switch module

The FCD-IPM is available with a software-selectable internal line termination unit (LTU), which allows direct connection to the E1 network or connection via an external LTU. A built-in CSU/DSU allows direct connection to a T1 network.

The integrated router supports:

- IP and IPX routing and transparent bridging
- Backup router link capability
- Quick setup and configuration
- Solid Firewall™ (session-based) protection
- NAT and Single IP address translation
- PAP/CHAP security
- OSPF

The FCD-IPM can also be used as a rate and interface converter or as an integrating multiplexer for fractional E1/T1 analog voice and data services.

Interoperability with DXC multiservice access node

The FCD-IPM can operate with RAD's modular DXC multiservice access node products for multilink star applications, including access to SDH networks. The DXC units and FCD-IPM operate under a centralized SNMP network management.

Timeslot assignment is programmable, allowing data from the LAN, sub-E1/T1 port, analog voice ports, and data port to be placed into timeslots, either consecutively or alternately. The FCD-IPM also allows flexible timeslot allocation of the data port timeslots. Each timeslot of the sub-E1/T1 port is placed on the same timeslot of the main E1/T1 link.

Data from the data port can be either assigned transparently to the main link timeslots or routed together with the LAN data.

Immunity to hardware and power failures is provided by bypassing the sub-E1/T1 port to the main E1/T1 link, ensuring uninterrupted service to the sub-E1/T1 port.

The E1 interface meets all requirements of ITU recommendations G.703, G.704, G.706, and G.732.

The T1 interface is compatible with virtually all carrier-provided T1 services.

Management options

Setup, control and monitoring of status and diagnostic information can be performed via:

- ASCII terminal connected to the async control port
- SNMP management
- Inband management through a dedicated timeslot

The FCD-IPM supports dial-in, which can be used for remote out-of-band configuration and monitoring.

Maintenance capabilities include user-activated local and remote loopbacks.

The FCD-IPM is available as a standalone unit for the desktop or a 19-inch rack shelf.

FCD-E1E

Managed E1 and Fractional E1 Access Unit

The FCD-E1E is a multiplexer and rate and interface converter for point-to-point extension of serial data, Ethernet and E1 services or fractional E1 over SDH/SONET networks.

Offering a wide range of serial interfaces (V.35, V.36, RS-530, X.21) with selectable sync data rates of n x 64 kpbs, data port rates are selectable for any multiple of 64 kbps up to 1,984 kbps. Unframed E1 can be supported up to 2.048 Mbps.

The integral LTU ensures a range of up to 2 km (1.2 miles) and is software-selectable.

The unit can be programmed to assign data automatically from the data port into consecutive timeslots or the user can assign timeslots manually.

Multiple clock source selection

Multiple clock source selection ensures maximum flexibility. Timing for the E1 main link and sublink may come from the recovered receive clock, an internal oscillator or the data port.

The unit interconnects with RAD's modular DXC products and E1 equipment from other vendors, to support multilink star applications, such as access to SDH networks, as well as to FCD and Megaplex units.

Ethernet extension

The FCD-E1E's Ethernet interface allows LAN-to-LAN connectivity over TDM.

The product's 10/100BaseT interface supports VLAN frames, auto-negotiation and automatic learning and aging. It transparently connects FCD-E1E to remote LANs over E1 links. It filters Ethernet frames and forwards only frames that are destined for the WAN.

FCD-E1E supports VLAN tagging and priority labeling according to 802.1p&q. Enhanced QoS supports strict/weighted fair queue mechanism, with 802.1p/DSCP/IP Precedence priority.

Standards compliant

The E1 interface is compatible with carrier-provided E1 services. The product complies with ITU recommendations G.703, G.704, G.706, G.732, G.823, and G.826.

Management

The FCD-E1E features an LCD front panel for menu-driven management using three pushbuttons.

Front panel LEDs indicate power, alarms and diagnostic loopback operation. Rear panel LEDs on the E1 interfaces indicate local and remote sync loss.

- **Serial, E1 and Ethernet multiplexer**
- **Rate and interface converter for serial access to E1 services**
- **One serial data port (V.35, V.36, RS-530, X.21) with selectable sync data rates of n x 64 kpbs**
- **Optional sub-E1 drop-and-insert port, including bypass support**
- **Optional 10/100BaseT Ethernet bridge**
- **Optional VLAN support**
- **User-friendly LCD panel with pushbuttons for management**
- **Inband management with SNMP agent**

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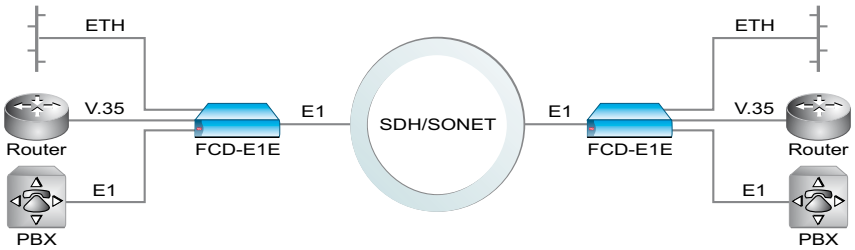
Status and diagnostic information is defined, configured, and monitored using any of the following methods:

- Menu-driven management using the front panel LCD with three pushbuttons
- ASCII terminal connected to the async control port
- Telnet
- RADView element manager

FCD-E1E is a compact standalone unit. A rack mount adapter kit enables installation of one or two (side-by-side) units in a 19-inch rack.



Point-to-point Ethernet, data and fractional E1 over E1

FCD-IP

E1/T1 or Fractional E1/T1 Access Unit with Integrated Router

- **E1/T1 access over copper or fiber**
- **One or two independent Ethernet ports or an integrated four-port switch (10/100BaseT)**
- **IP/IPX routing and transparent bridging**
- **Supports Frame Relay (RFC 1490) and PPP protocols**
- **OSPF support**
- **Data interfaces: V.35, RS-530, V.36/RS-449, V.24, X.21**
- **Selectable sync data rates: n x 56 kbps, n x 64 kbps**
- **Three optional sub-E1/T1 ports or four analog ports (FXS, FXO, E&M) for PBX/ phone connectivity**
- **Self-healing ring and drop-and-insert capabilities**
- **Fail-safe sub-E1/T1 ensures uninterrupted service**
- **Dial backup over ISDN/PSTN**
- **Operates with RAD's DXC multiservice access node for multilink star configuration**

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The FCD-IP is an access unit for full or fractional E1/T1 services with an integrated router. It can be ordered with one or two independent Ethernet LAN ports or alternatively with an integrated four-port switch that can replace an external hub or switch. An optional data port, sub-E1/T1 drop-and-insert port or four analog ports (FXS, FXO, E&M) are also available. The data port rates are selectable for any multiple of 56 kbps or 64 kbps, up to 1,984 kbps.

The FCD-IP is available with a software-selectable internal LTU, and allows direct connection to the E1 network or connection via an external LTU. A built-in CSU/DSU allows direct connection to a T1 network.

Integrated router

The integrated router supports:

- IP/IPX routing and transparent bridging
- Backup router link capability
- Quick setup and configuration
- Solid Firewall™ (session-based) protection
- NAT and Single IP address translation
- PAP/CHAP security
- OSPF, RIP-1, RIP-2

The FCD-IP can also be used as an integrating multiplexer for LAN, data and fractional E1/T1 services.

The FCD-IP operates with RAD's modular DXC multiservice access node products for multilink star applications, including access to SDH networks. The DXC and FCD-IP units operate under centralized SNMP network management.

Timeslot assignment is programmable, allowing data from the LAN, sub-E1/T1, analog voice, and data ports to be placed into timeslots, either consecutively or alternately. The FCD-IP also allows flexible allocation of the data port timeslots. Each timeslot of the sub-E1/T1 port is placed on the same timeslot of the main E1/T1 link.

Ring and drop-and-insert capabilities

FCD-IP provides up to four fractional E1 links with automatic bypass in case of link failure.

This unit can be deployed in ring and daisy-chain applications together with the Megaplex multiplexers, to affordably connect smaller sites to the E1 ring, while offering the same self-healing link protection capabilities as the larger devices.

The E1 unit meets all requirements of ITU recommendations G.703, G.704, G.706 and G.732.

The T1 interface is compatible with virtually all carrier-provided T1 services.

Management and maintenance

Setup, control and monitoring of status and diagnostic information can be done using:

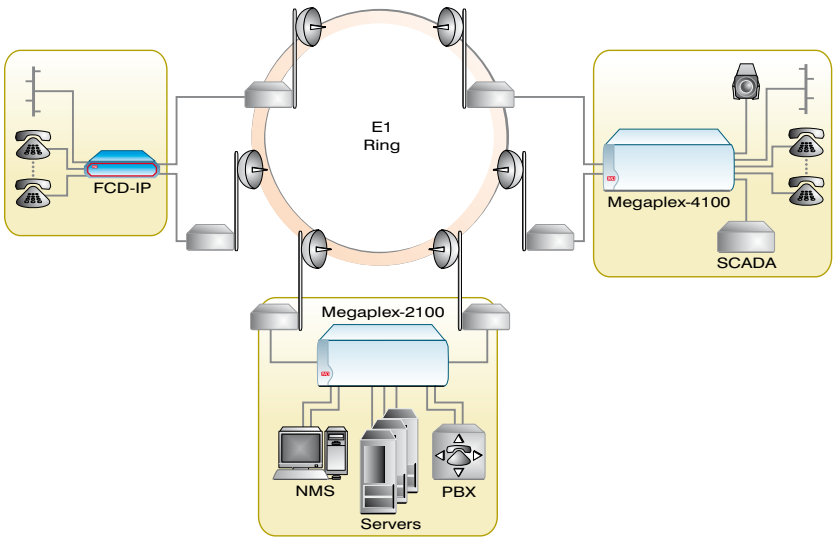
- ASCII terminal connected to control port
- Telnet
- SNMP management
- Inband management via dedicated timeslot

The FCD-IP supports an internal SNMP agent and can be controlled by any generic SNMP station or by the RADview SNMP network management application.

The FCD-IP supports dial-in, which can be used for remote out-of-band configuration and monitoring.

Maintenance capabilities include user-activated local and remote loopbacks.

The FCD-IP is available as a standalone unit for the desktop or a 19-inch rack shelf.



FCD-155E

Ethernet and E1/T1, E3/T3 SDH/SONET ADM

The FCD-155E SDH/SONET add-and-drop multiplexer delivers next-generation Ethernet services as well as E1/T1 and E3/T3 traffic over SDH/SONET networks. Installed at the customer site or directly on STM-1/OC-3 access rings, the FCD-155E leverages the SDH/SONET infrastructure for Internet access and LAN connectivity, while providing continued support for E1/T1 and E3/T3 services.

Improves bandwidth efficiency

The FCD-155E connects LAN traffic by creating an SDH/SONET network. Support for generic framing procedure (GFP) or X.86 encapsulation with virtual concatenation enables configuring the bandwidth of the IP channel in increments of 2 Mbps (VC-12), 1.5 Mbps (VT 1.5) or 50 Mbps (VC-3 or STS-1), up to 100 Mbps wire-speed, for cost-effective adaptation of SDH/SONET infrastructure for LAN connectivity. FCD-155E 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 voice-oriented networks.

Multiservice offering

In addition to transporting next-generation IP services, the FCD-155E continues to support E1/T1 and E3/T3 services. The traffic is mapped into the SDH/SONET frame and can be terminated at any point on the network.

Reduces costs, increases revenues

The FCD-155E acts as a LAN and E1/T1 or E3/T3 terminal as well as an STM-1/OC-3 ADM. Incorporating these functions in a single device reduces the number of units needed and lowers implementation costs.

The FCD-155E brings Ethernet economics and packet switching efficiency to SDH/SONET infrastructure. It thereby enables carriers and service providers, as well as private fiber network owners such as utilities and campuses, to reduce both OpEx and CapEx as they use their optical bandwidth for revenue-generating Ethernet services. For a modest investment, SDH/SONET carriers can tap into new business opportunities while leveraging their existing equipment to support clear channel data streams and the latest high bandwidth services.

Service providers addressing enterprise customers benefit from better utilization of network bandwidth (for example, a user who needs 10 Mbps LAN will require five VC-12 or seven VT 1.5 links instead of a full 48.384 Mbps VC-3 or STS-1 connection), and have the ability to offer service granularity similar to next-generation Ethernet networks. End users benefit from lower costs and a larger selection of services that can better meet their specific connectivity requirements.

- **Standard next-generation STM-1/OC-3 ADM**
- **Grooms Ethernet and E1/T1/E3/T3 traffic over STM-1/OC-3 fiber or copper links**
- **Multiservice functionality in the same box:**
  - **Two or six 10/100BaseT ports or one Gigabit Ethernet port**
  - **Eight or 21 E1/28 T1 ports, one E3/DS3 port or 21 E1/28 T1 and one E3/T3**
- **Optional dual power supply configuration**
- **Available with standard protection on the main links**
- **Compact size**
- **SFP-based STM-1/OC-3 uplinks and Gigabit Ethernet (SFP and UTP)**
- **Advanced management option via DCC and IP tunneling**

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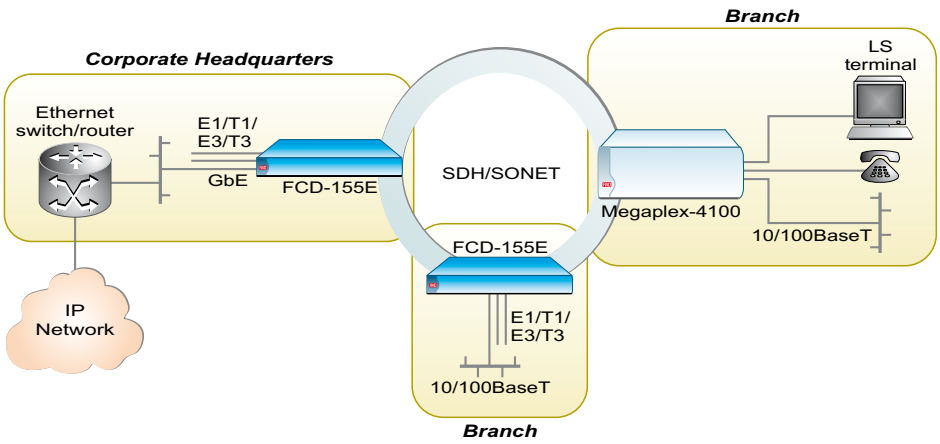

Point-to-point application

FCD-155

STM-1/OC-3 Terminal Multiplexer

- **Standard next-generation STM-1/OC-3 terminal**
- **Grooms Ethernet and E1/T1/E3/T3 traffic over STM-1/OC-3 fiber or copper links**
- **Multiservice functionality in the same box:**
  - **Two or six 10/100BaseT ports or one GbE port**
  - **Four or eight E1/T1 ports or one E3/DS3 port**
- **SFP-based uplinks and Gigabit Ethernet**
- **Advanced management option including DCC and IP tunneling**
- **Available with standard protection on the main link**
- **Compact size**

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The FCD-155 terminal multiplexer delivers next-generation Ethernet services as well as traditional traffic over SDH/SONET networks. Installed at the customer site, the FCD-155 leverages the SDH/SONET infrastructure for Internet access and LAN connectivity, while providing continued support for all E1/T1/E3/T3 services.

Improves bandwidth efficiency

The FCD-155 connects LAN traffic over SDH/SONET networks. Support for generic framing procedure (GFP) or X.86 encapsulation with virtual concatenation enables configuring the bandwidth of the IP channel in increments of 2 Mbps (VC-12), 1.5 Mbps (VT 1.5) or 48.384 Mbps (VC-3 or STS-1), up to 100 Mbps wire-speed, for cost-effective adaptation of the SDH/SONET infrastructure for LAN connectivity. FCD-155 eliminates the rigid bandwidth restrictions usually imposed by SDH/SONET virtual containers, and allows for scalable and efficient next-generation Ethernet services delivery over voice-oriented networks.

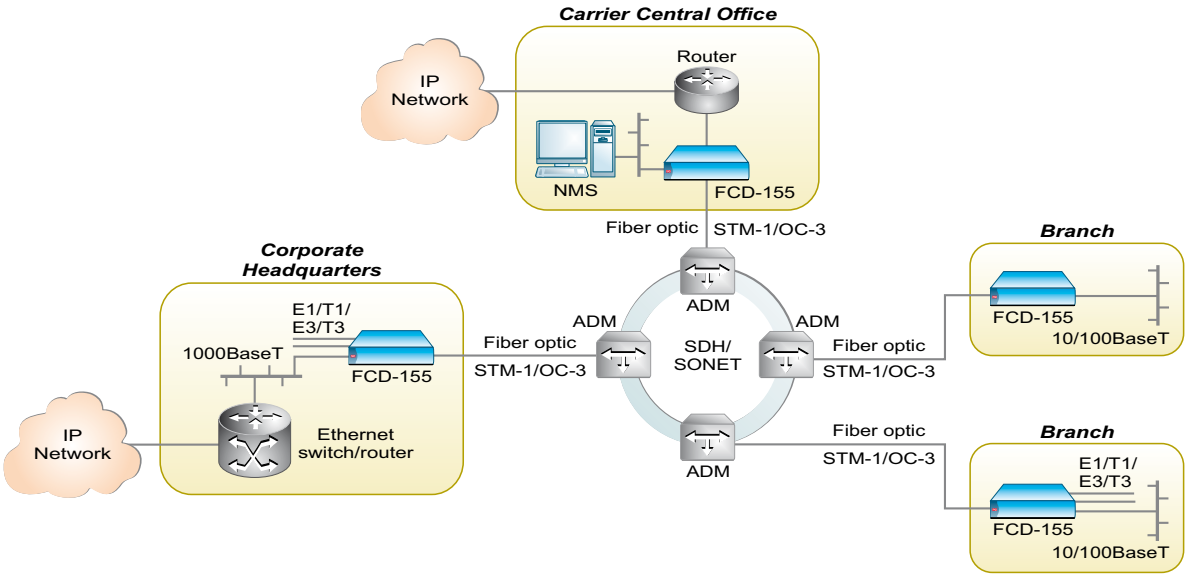
Multiservice offering

In addition to transporting next-generation IP services, the FCD-155 continues to support E1/T1 or E3/T3. The E1/T1 or E3/T3 traffic is mapped into the SDH/SONET frame and can be terminated at any point on the network.

Reduces costs, increases revenues

The FCD-155 brings Ethernet economics and packet switching efficiency to existing SDH/SONET infrastructures. It thereby enables carriers and service providers to reduce both OpEx and CapEx, as they leverage optical bandwidth for revenue-generating, high bandwidth Ethernet services.

A service provider serving enterprise customers benefits from better bandwidth utilization on the network (for example, a user who needs 10 Mbps LAN will use five VC-12 or seven VT 1.5 links instead of a full 48.384 Mbps VC-3 or STS-1 connection), and gains the ability to offer service granularity similar to next-generation Ethernet networks. End users benefit from lower costs and a larger selection of services that can better meet their specific connectivity requirements.



Point-to-multipoint application

Kilomux-2100, Kilomux-2104

Subrate Multiservice Multiplexers

The Kilomux subrate multiservice multiplexers provide an efficient and cost-effective solution for integrating data, voice, fax, and LAN traffic over digital data services, leased lines, IP, ISDN, and other services. Access to the various services is provided over a variety of standard interfaces at data rates ranging from 9.6 kbps to 1,536 kbps.

The low overhead, minimal end-to-end delay and allocated bandwidth of the Kilomux – together with voice compression – ensure quality of service while maximizing utilization of the available bandwidth.

Main link modules

Many interfaces are available on the aggregate links for compatibility with digital data services worldwide. These include V.35, V.36/V.11, RS-530, V.24/RS-232, X.21, and G.703 codirectional. Built-in CSU/DSU, fractional E1/T1, fiber optic, ISDN terminal adapters, and TDMoIP are also available. Soft-selectable timing options from either the link or any channel are standard for all interfaces, as is support for control signals.

Standard 8-bit buffers on both the transmit and receive lines, as well as an optional on-board 256-bit satellite buffer, enable the use of any type of access media. These include leased lines, fiber, radio, microwave, and satellite links.

The Kilomux-2100 supports a secondary link, which can be configured in several ways:

- As a backup link, which can be connected to a dial-up modem, switched digital service or ISDN basic rate line.
- As an active, secondary link with load sharing option providing double capacity. This mode supports "priority bumping," which allows the most important channels to continue functioning in the event of a failure on either link.
- As an additional, active link, thus enabling communication with two independent Kilomux units at different sites. In this configuration, the KDI module can provide drop-and-insert and bypass capabilities between the two links.

Main link modules include:

KML.1/N for V.35 interface

KML.2/N for V.24/RS-232 interface

KML.3/N for V.36/RS-422/RS-530 interface

KML.4/N for X.21 interface

KML.5/N for G.703, codirectional interface

KML.6/N CSU/DSU for standard DDS (US) or built-in short range modem (9.6, 19.2, 56 kbps)

KML.7 for fractional T1 interface

KML.8 for connection to a fractional E1 interface

KML.10 built-in ISDN terminal adapter for one or two "B" channels; supports dedicated or switched connection

KML.F fiber optic main link; eliminates the need for an external fiber optic modem

KML.11 TDM over IP main link; enables the Kilomux payload to be delivered over IP networks

System modules

KCL.2
Common logic module featuring built-in SNMP agent, software download and optional integrated Ethernet port for management

KPS.3, KPS.5, KPS.7, KPS.8
Power supply modules

KDI
Drop-and-insert and bypass module can be used in situations where the Kilomux at the central site is communicating with two remote sites and voice/data communication is required between the remote sites. In addition, it can provide support for ring topologies and a single multidrop channel.

KM-Ringer provides DC feed and ringer voltage for voice modules with FXS interface

KAI
Alarm indication module for rear panel viewing of most front panel indicators

Timing options

Various timing options for both the link and the I/O channels assure integrity of data transfer in any application. DTE, DCE and external DCE clocking are supported by the main link (not applicable on G.703 or CSU/DSU).

I/O modules

I/O modules are available for many types of traffic. Low and high bit rate data (sync and async) channels can be combined with voice and fax circuits for maximum bandwidth utilization. Advanced technology in voice compression allows a choice between toll-quality ADPCM, PCM or high quality, low bit rate compressed voice, at rates as low as 4.8 kbps. In addition, internetworking modules provide LAN (Ethernet) connectivity.

Any combination of up to four or 12 I/O modules can be configured in the Kilomux-2104 and Kilomux-2100 chassis respectively.

- **Connects to leased lines, IP, ISDN, radio, satellite, and DDS links**
- **Link data rates from 9.6 kbps to 1,536 kbps**
- **High quality, low bit rate voice/fax from 4.8 kbps to 14.4 kbps**
- **Two chassis types:**
  - **Kilomux-2100 with 12 I/O slots**
  - **Kilomux-2104 with four I/O slots**
- **Optional redundant power supply and link interface**
- **Supports up to 180 digital voice or fax channels and 96 analog channels in one box**
- **Supports up to 48 async or 24 sync data channels**
- **Drop-and-insert capability**
- **Ethernet IP/IPX router/bridge module for LAN connectivity**
- **Flexible timing options**

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Kilomux-2100, Kilomux-2104
(Continued)

Data modules

KLS.1/N
Low speed module supports two sync or async RS-232/V.24 data channels. Selectable data rates from 300 bps to 64 kbps.

KLS.2
Statistical multiplexing data module supports four async RS-232/V.24 channels. Selectable data rates from 300 bps to 19.2 kbps.

KHS.1
High speed module supports two sync data channels with V.35, RS-449/RS-422 or X.21 interface. Supported data rates are 32, 48, 56, 64, 128, 192, 256, and 384 kbps.

KHS.2
High speed module supports two sync data channels with V.35/RS-530, V.36/RS-530 or V.24/RS-232 interface. Supported data rates:

- n x 2.4 kbps for link rates up to 192 kbps
- n x 4.8 kbps for link rates of 256 kbps and 384 kbps
- n x 9.6 kbps for link rates of 512 kbps and higher

KHS.U
High speed module with one data channel, supports ISDN basic rate services even over non-ISDN facilities such as dedicated leased lines. The KHS.U operates either as NT (network termination) or LT (line termination).

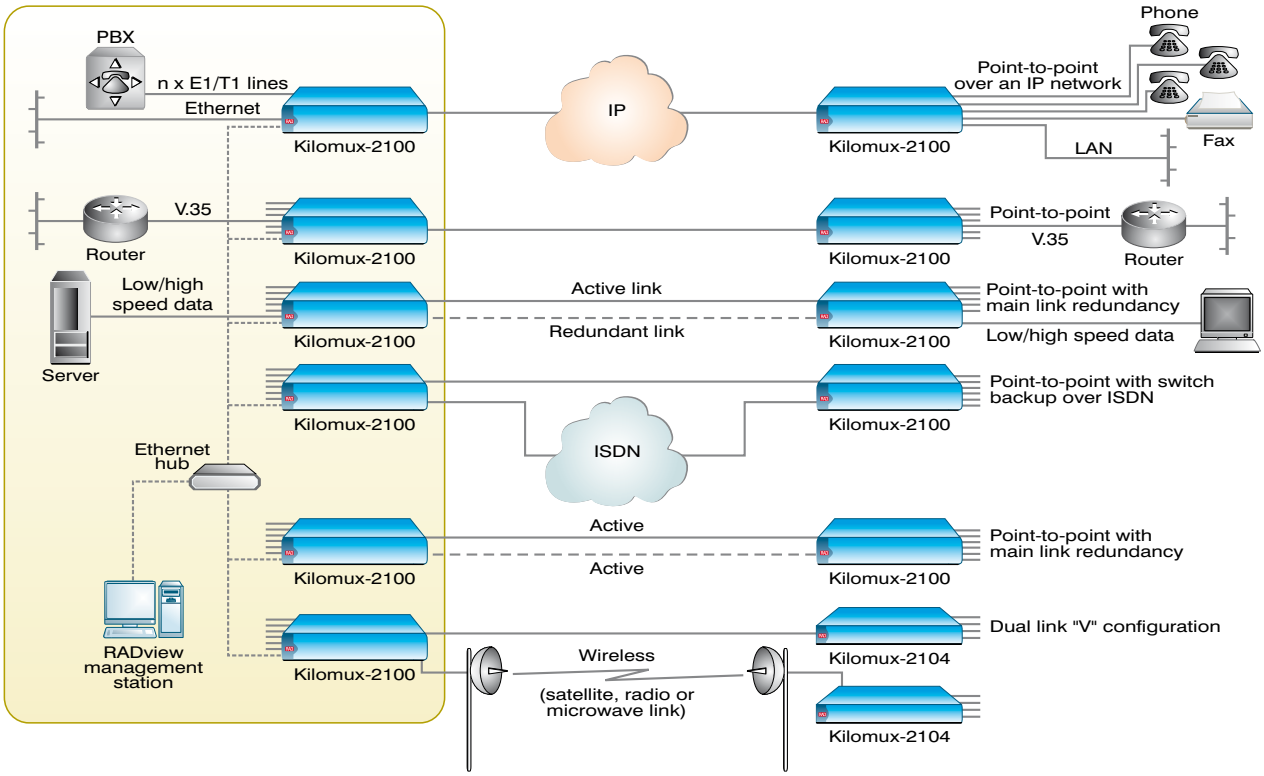
KHS.703
High speed module supports two 64 kbps G.703 codirectional channels.

Voice modules

KVC.1M
Voice module supports two analog voice channels with ADPCM encoding at 16, 24 or 32 kbps. Also supports PCM encoding at 64 kbps (A-law). Modular analog interfaces are 2/4-wire E&M, 2-wire FXS, FXO, and FXSP. Additionally, it offers pulse metering at 16 or 12 kHz and polarity reversal, as well as optional echo cancellation.

Voice/fax modules

KVF.4
Voice/fax low bit rate module uses the ITU G.723.1 voice digitizing technique to provide toll-quality voice at 6.4 kbps for two analog channels or an ISDN S interface channel (including D-channel compression). The card can digitize voice at rates from 4.8 kbps to 12.8 kbps and offers pulse metering at 16 or 12 kHz and polarity reversal as well as integral echo canceller. Analog interfaces supported are E&M, FXO, FXS, and FXSP.



KVF.6

Voice/fax low bit rate module uses the ITU G.723.1 voice compression algorithm to provide toll-quality voice at 6.4 kbps for a full E1 or T1 trunk. The card can digitize voice at rates from 4.8 kbps to 16 kbps and supports inband transparent fax transmission at rates of up to 14.4 kbps. The dual-slot module supports both CAS (DTMF, R2) and CCS (SS7, PRI) signaling methods.

KVF.8

Voice/fax low bit rate module uses the G.723.1 digitizing technique to provide toll-quality voice at 6.4 kbps for eight analog channels. The card can digitize voice at rates from 4.8 kbps to 16 kbps and supports inband transparent fax transmission rates of up 14.4 kbps. The card offers pulse metering at 16 or 12 kHz and polarity reversal, as well an integral echo canceller.

All KVF modules support inband fax for transparent fax transmission as well as V.22 and V.22bis modem data transmission. KVF.6 and KVF.8 also support V.32bis modem data transmission.

Interworking module

KMBE

Ethernet IP/IPX router/bridge module supports the connection of up to 256 remote workstations to a main Ethernet LAN in bridge mode, and to an unlimited number of workstations in router mode. Bandwidth from 9.6 kbps to 1,280 kbps is supported on the link. Interface can be AUI, thin coax or UTP (10BaseT). The module includes features such as Single IP, Solid Firewall™ and RADview SNMP management.

Management options

The Kilomux offers three management options:

- **ASCII terminal** – an ASCII terminal can be connected locally or remotely, using a dial-up modem.
- **Telnet** – a Telnet client can be used to control the Kilomux via its Ethernet management port or via an inband management channel.
- **RADview management station** – enables complete monitoring and control from a central management station. RADview provides direct online supervision, configuration and diagnostics.

The Kilomux devices include an SNMP agent and can be managed using RADview-EMS graphical user interface (on a UNIX platform). This provides terminal access to remote devices from any management station on the network for configuration and troubleshooting.

Online supervision

Audio and visual indicators provide the status of alarms and tests at the network, multiplexer, card, and port levels and include all links connected to the Kilomux. Alarms are automatically logged and presented upon request unless otherwise masked.

Sanity check

Configurations are automatically checked for validity before being downloaded or upon user request. This check can be performed at three different levels: the whole network, one single rack, or per module or channel.

Manual timeslot allocation and bypass

Network-level operations enable easy activation of drop-and-insert applications. An existing configuration can be copied to a desired destination within the same Kilomux or to any other Kilomux. This operation can be performed at the Kilomux, card or channel level.

Database

All configuration parameters are stored in non-volatile memory to ensure data integrity in the event of a power failure. A secondary database may also be programmed for time-of-day bandwidth allocation or switched backup operation. Alarm information is collected and stored in memory for easy reading by the management system.

Diagnostics

The Kilomux incorporates numerous test features for easy maintenance and rapid fault detection. Upon operation and during normal use, automatic self-test and link-test are performed, and all problems are reported to system management.

Local and remote loops can be performed for each main link and every I/O channel. A built-in BERT can be used for testing any I/O data channel and a built-in tone injection can be used for testing any voice channel. These extensive diagnostic tests ensure quick fault discovery and recovery.

Compact chassis models

For applications requiring a small number of I/O channels, the compact Kilomux-2104 model is available. This modular unit, packaged in a 1U-high enclosure, supports four I/O modules. It accommodates up to 16 asynchronous data channels, up to eight synchronous data channels, or up to 32 analog/60 digital voice or fax channels over a single link interface. The Kilomux-2104 is fully compatible with the Kilomux-2100.

Optimux-108, Optimux-106

Fiber Multiplexers for 4E1/T1 and Ethernet or Serial Data

- **Multiplexes E1/T1 and Ethernet channels over a single fiber optic link**
- **Simple plug-and-play installation**
- **Range extension up to 120 km (74.5 miles)**
- **Full 100 Mbps Ethernet data rate (user)**
- **Redundant power supply and uplink**
- **Hot-swappable uplink interfaces**
- **Temperature-hardened enclosure**
- **Card version for the LRS-102 modem rack and for the Megaplex-4100**
- **Management via an ASCII terminal, Web server, Telnet, or RADview-EMS**

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Optimux-108 and Optimux-106 multiplexers transport four E1/T1 channels and optional Ethernet or serial data traffic (V.35) over a fiber optic link. The Optimux-106 and Optimux-108 are part of the AXCESS+ portfolio of multiservice access and First Mile solutions.

A pair of Optimux-108/106 units offers plug-and-play low cost connectivity for distances up to 120 km (74.5 miles).

Redundancy options

The Optimux transmits each of the E1 or T1 signals independently. The Ethernet user interface supports full line rate at 100 Mbps.

An optional secondary link provides backup using automatic switchover upon link failure, and an optional secondary power supply provides power redundancy and fail-safe operation.

Various optical interfaces are available:

- 850 nm VCSEL for use with multimode fiber
- 1310 nm for use with multimode fiber
- 1310 nm or 1550 nm short or long haul laser for extended range over single mode fiber
- Single mode over a single fiber (WDM) option

Central site solutions

For grooming applications, the product can be supplied in card form for deployment in Megaplex-4100. In such applications, the E1/T1 and Ethernet traffic is carried over the fiber uplink and switched to the SDH/SONET PSN backbone, respectively (see page 88).

For transparent rack solutions, a card form can be deployed in the LRS-102 (see page 126). This provides fully transparent transmission of all types of voice and data traffic, with an option to set each channel to a different clock source. As an additional feature for mixed environments, the LRS-102/Megaplex-4100 provides a one-box solution for transmitting over copper modem, including SHDSL.bis, alongside fiber.

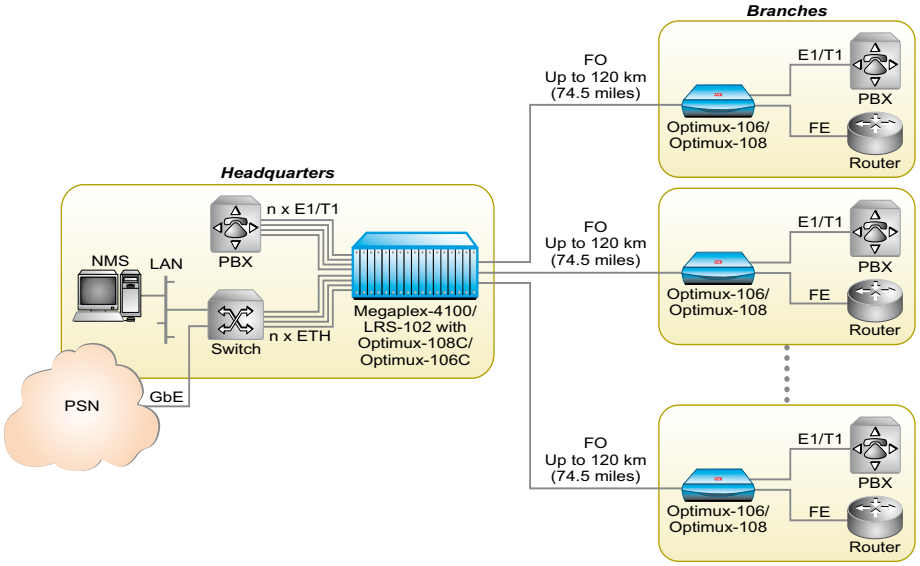
Management options

The Optimux-106 and Optimux-108 feature flexible management capabilities, including local management via an ASCII terminal (RS-232). In addition, remote management can be performed 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.

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 Optimux-106 and Optimux-108 also support a variety of access protocols, including Telnet, SNMP and Web server.

The standalone units are supplied in a half 19-inch, 1U-high compact device available in a plastic or metal enclosure with extended temperature range.



Service extension over fiber

Optimux-108L

Fiber Multiplexer for 4E1 and Ethernet

The Optimux-108L multiplexer transports four E1 channels and Ethernet traffic over a fiber optic link. The Optimux-108L is part of the AXCESS+ portfolio of multiservice access and First Mile solutions.

The tributary channels can be balanced or unbalanced E1s, providing transparent delivery of user data and clock signals with an option to set each channel to a different clock source. In addition, the Optimux-108L includes two 10/100 BaseT Fast Ethernet ports, one for user traffic with data rate of 100 Mbps, and the other for management traffic.

The Optimux-108L features the following optical interface options:

- 850 nm VCSEL for multimode fiber
- 1310 nm LED for multimode fiber
- 1310 nm or 1550 nm short or long haul laser diode for extended range over single mode fiber
- Single mode over single fiber (WDM) option

Central site solutions

For grooming applications, the product can be supplied in card form for deployment in Megaplex-4100. In such applications, the E1/T1 and Ethernet traffic is carried over the fiber uplink and switched to the SDH/SONET PSN backbone, respectively (see page 88).

For transparent rack solutions, a card form can be deployed in the LRS-102 (see page 126). This provides fully transparent transmission of all types of voice and data traffic, with an option to set each channel to a different clock source. As an additional feature for mixed environments, the LRS-102/Megaplex-4100 provides a one-box solution for transmitting over copper modem, including SHDSL.bis, alongside fiber.

Diagnostics

The Optimux-108L features test and diagnostics capabilities that include local and remote loopbacks on each E1 tributary link, as well as on the fiber optic uplink, sent by the corresponding Optimux-108 card in an LRS-102 or a Megaplex-4100 chassis. In addition, a local or remote loopback can be generated using the DIP switch of the local or remote Optimux-108L unit.

Management options

The Optimux-108L features flexible management capabilities, including local management via dedicated Ethernet port. In addition, remote management can be performed either inband using the network or user ports or out-of-band using a dedicated management port.

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 Optimux-108L also supports a variety of access protocols, including Telnet, SNMP, Web server, and TFTP.

The Optimux-108L standalone unit is a half 19-inch, 1U-high compact device available in a plastic or metal enclosure.

- **Multiplexes four E1 channels and Fast Ethernet traffic over fiber optic link**
- **Simple plug-and-play installation**
- **Range extension up to 120 km (74.5 miles)**
- **Full 100 Mbps Ethernet data rate (user)**
- **Dedicated 10/100BaseT Ethernet management port or dual in-line package (DIP) switches for full or basic management capabilities**
- **Management via Web server, Telnet or RADview-EMS**
- **Metal enclosure for outdoor deployments**

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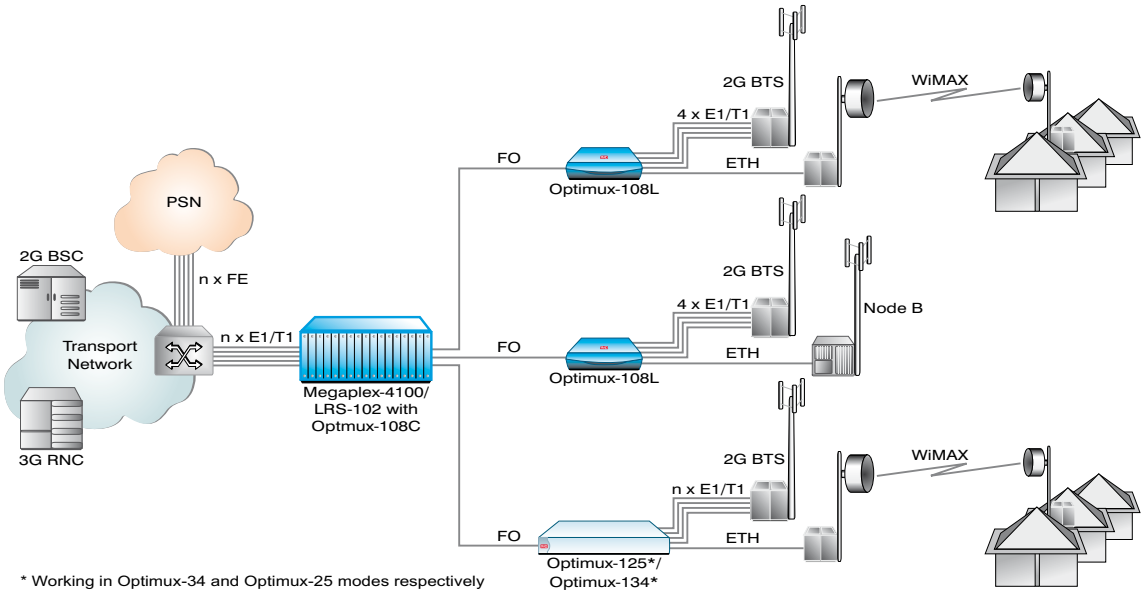

* Working in Optimux-34 and Optimux-25 modes respectively

Point-to-multipoint service extension

Optimux-134, Optimux-125

Fiber Multiplexers for 16E1/T1 and Ethernet

- **Multiplexes up to 16 E1/T1 channels over a fiber link with optional support for high speed data (V.35) and Ethernet user traffic**
- **Simple plug-and-play installation**
- **Range extension up to 110 km (68 miles)**
- **Full 100 Mbps Ethernet data rate (user)**
- **Backward compatible with Optimux-34 and Optimux-25**
- **Small form-factor pluggable (SFP) uplink fiber interfaces**
- **Redundant hot-swappable power supplies and uplink**

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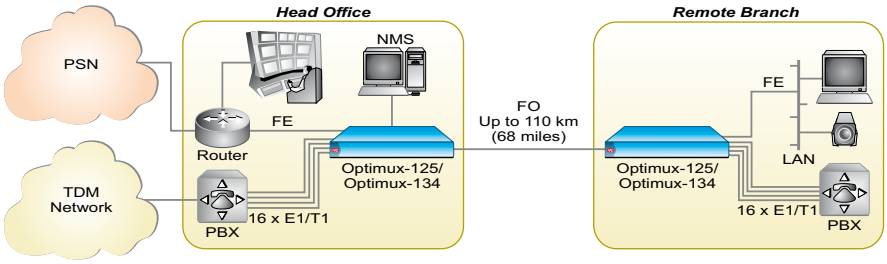


Sharing campus services over a fiber optic link

The Optimux-134 and Optimux-125 provide a simple and cost-effective solution for transporting multiple E1 or T1 links, as well as serial data or Ethernet, for distances up to 110 km (68 miles).

Optimux-134/125 supports up to 16 E1/T1 channels, and a single 10/100BaseT Ethernet user port. The Optimux-134 and Optimux-125 are part of the AXCESS+ portfolio of multiservice access and First Mile solutions.

The Optimux-134 and Optimux-125 devices transmit each of the E1 or T1 tributary channels independently, so that the clock and data over each of the E1 or T1 are sent transparently. The user Ethernet interface supports full line rate at 100 Mbps.

The Optimux-134 and Optimux-125 are backward compatible with Optimux-34 and Optimux-25, respectively.

Redundancy options

The Optimux-134 and Optimux-125 offer modular, redundant power supply and secondary link options, enhancing system reliability. The optional secondary link provides backup using automatic switchover upon main link failure.

The main link interface of the Optimux-134 and Optimux-125 is a fiber optic SFP-based interface. The following optical interfaces are available:

- 1310 nm and 1550 nm laser for extended range over single mode fiber
- 1310 nm and 1550 nm long haul for extended range over single mode fiber
- Single mode over single fiber (WDM) option

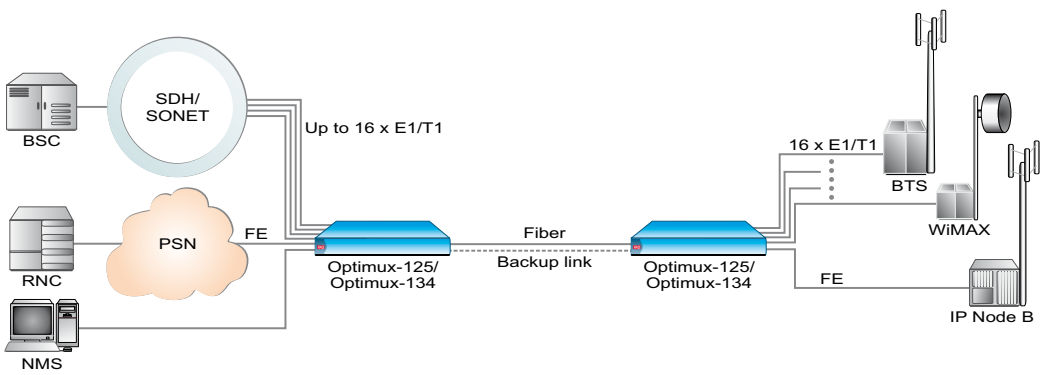
Management options

The Optimux-125 and Optimux-134 feature flexible management capabilities, including local management via an ASCII terminal (RS-232). In addition, remote management can be performed 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.

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 Optimux-125 and Optimux-134 also support a variety of access protocols, including Telnet, SNMP and Web server.

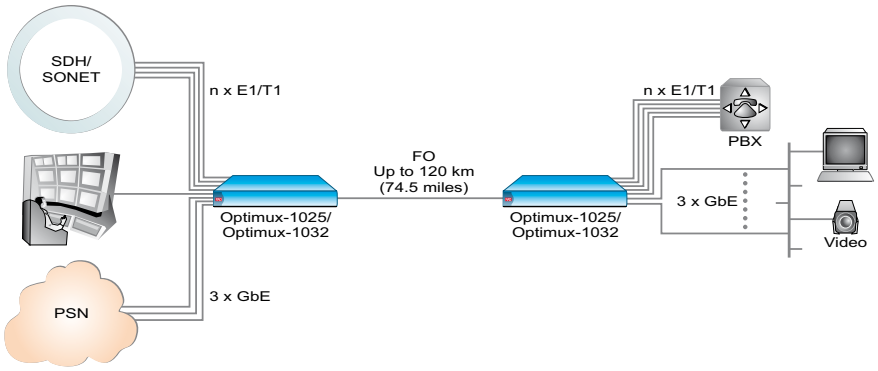
The Optimux-134 is available as a compact 1U-high or 2U-high (E1 unbalanced only) unit, while the Optimux-125 is a 1U-high unit.



Mobile backhaul extension over dark fiber

Optimux-1032, Optimux-1025

Fiber Multiplexers for 16E1/T1 and Gigabit Ethernet



Carriers/service providers extending the reach of TDM and Ethernet services over dark fiber

- **Multiplexes up to 16 E1/T1 with up to three Gigabit Ethernet user ports over fiber optic**
- **Simple plug-and-play installation**
- **Range extension up to 120 km (74.5 miles)**
- **Total fiber uplink capacity of 1,000 Mbps**
- **Redundant hot-swappable uplink interfaces and power supplies**
- **Management via RADview-EMS, CLI, ASCII terminal, SNMPv3**
- **RADIUS, SSH**
- **Temperature-hardened enclosure**

The Optimux-1032 and Optimux-1025 provide a cost-effective solution for transparently delivering multiple E1 or T1 links, as well as Gigabit Ethernet traffic, over a fiber optic link for distances up to 120 km (74.5 miles). The Optimux-1032 and Optimux-1025 are part of the AXCESS+ portfolio of multiservice access and First Mile solutions.

Savings of CapEx and OpEx

The single-box solution for TDM and Ethernet offers "pay as you grow" flexibility by supporting initial deployments at partial capacity, with license-based upgrades when needed. The plug-and-play functionality allows carriers, service providers, mobile operators, and large organizations to extend their service reach at lower costs.

Redundancy options

The Optimux-1032 and Optimux-1025 offer modular, redundant power supply and secondary link options, enhancing system reliability. The optional secondary link provides backup using automatic switchover upon main link failure.

The Optimux-1032 and Optimux-1025 feature an SFP-based uplink interface supporting one of the following optical alternatives:

- 1310 nm and 1550 nm laser for extended range over single mode fiber
- 1310 nm and 1550 nm long haul for extended range over single mode fiber
- Single mode over single fiber (WDM) option

Management options

The Optimux-1032 and Optimux-1025 feature flexible management capabilities, including local management via an ASCII terminal (RS-232). In addition, remote management can be performed 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 devices also support a variety of access protocols, including CLI over Telnet, SNMP, Web server, and TFTP. Incorporated security features include Secure Shell (SSH), SNMPv3 and RADIUS.

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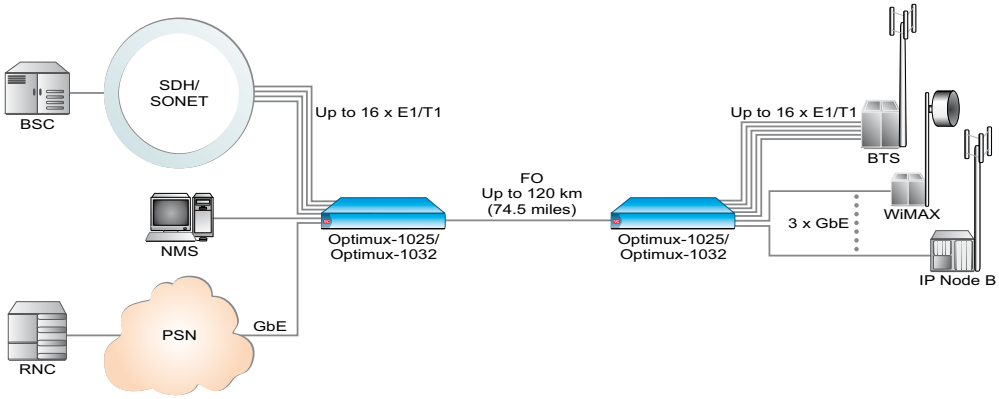

Cellular backhaul 2G/3G/WiMAX fiber extension

Optimux-45, Optimux-45L

Multiplexers for 21E1/28T1 over Fiber or T3

- **Cross connect capabilities for drop-and-insert and ring applications**
- **Multiplexes up to 21 E1 or 28 T1 channels over a single T3 (45 Mbps) or fiber link**
- **Simultaneous multiplexing of E1 and T1 channels (according to G.747 standard recommendations)**
- **T3 transmission over coax, fiber optic**
- **Range up to 110 km (68 miles)**
- **Optional redundant power supply**
- **Full management support for fault, configuration, performance, and security via RADview – RAD's network management system**

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Optimux-45 and Optimux-45L are manageable multiplexers that provide a highly cost-effective and simple solution for transporting multiple E1 and T1 links, as well as a combination of E1 and T1 (according to ITU G.747), over a standard T3 electrical signal or fiber link. They provide flexible solutions to meet the specific requirements of a broad range of applications.

The Optimux-45 is an add-and-drop multiplexer, enabling it to support a wide range of applications. When deployed in a ring application, Optimux-45 provides a complete path protection mechanism that prevents any service failure, even if a fiber link is damaged or disconnected. In addition, the Optimux-45 can provide ring connectivity over microwave radio links.

Optimized for E1/T1 line quantity

To improve the price/performance ratio of the product, partial assemblies with four, eight or 12 ports are available, reducing the price significantly in nodes requiring only a small number of E1/T1 lines.

The Optimux-45 supports both balanced and unbalanced interfaces:

- Balanced version has RJ-45 connectors and supports up to 28 T1 channels (balanced 100Ω), up to 21 E1 channels (balanced 120Ω) or mixed E1 and T1 channels
- Unbalanced version has up to 21 mini-BNC connectors and supports up to 21 E1 channels (unbalanced 75Ω)

The Optimux-45L is a low cost version of the Optimux-45 with Telco connectors as the user interface. The Optimux-45L is optimized for point-to-point or point-to-network applications only. This unit provides low cost connectivity of 21 E1 or 28 T1 lines or any combination of E1 and T1.

All versions are non-modular and offer redundant power supply, enhancing system reliability. In addition, an optional secondary link provides backup using automatic switchover upon main link failure.

Supports both electrical and optical interfaces

The products' main link supports both electrical and optical interface options. The electrical interface has BNC connectors in conformance with G.703 standards.

The optical interface supports the following options:

- 850 nm for multimode fiber
- 1310 nm for multimode fiber
- 1310 nm and 1550 nm laser for extended range over single mode fiber
- 1310 nm and 1550 nm long haul
- Single fiber option (WDM)
- Single fiber/wavelength option

To facilitate system diagnostics, the Optimux-45 and Optimux-45L feature LED status indicators, AIS alarm generation and recognition, as well as dry contact closure upon link failure. In addition, setup, control and diagnostics can be performed through a supervisory port using an ASCII terminal, Telnet host, Web terminal, or from an SNMP management station via a dedicated management port (Ethernet or RS-232).

Standards compliance

The Optimux-45 and Optimux-45L conform to ITU G.703, G.747, G.823, G.824, ANSI T1.107, ANSI T1.404, RFC 3895, and RFC 3896.

Management options

The Optimux-45 and Optimux-45L feature flexible management capabilities, including local management via an ASCII terminal (RS-232). In addition, remote management can be performed either inband using the network or user ports, or out-of-band using a dedicated management port.

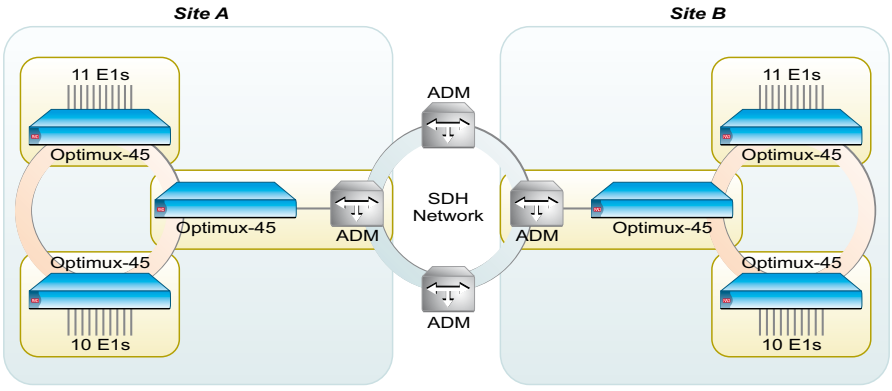
Advanced FCAPS (Fault, Configuration, Administration, Performance, Security) and diagnostic tools are provided by RADview-EMS, RAD's carrier-class element management system, via an SNMP-based GUI. When working in ring topology (Optimux-45), the application is managed via RADview-EMS.

The Optimux-45 and Optimux-45L also support a variety of access protocols, including CLI over Telnet, SNMP, Web server, and TFTP.

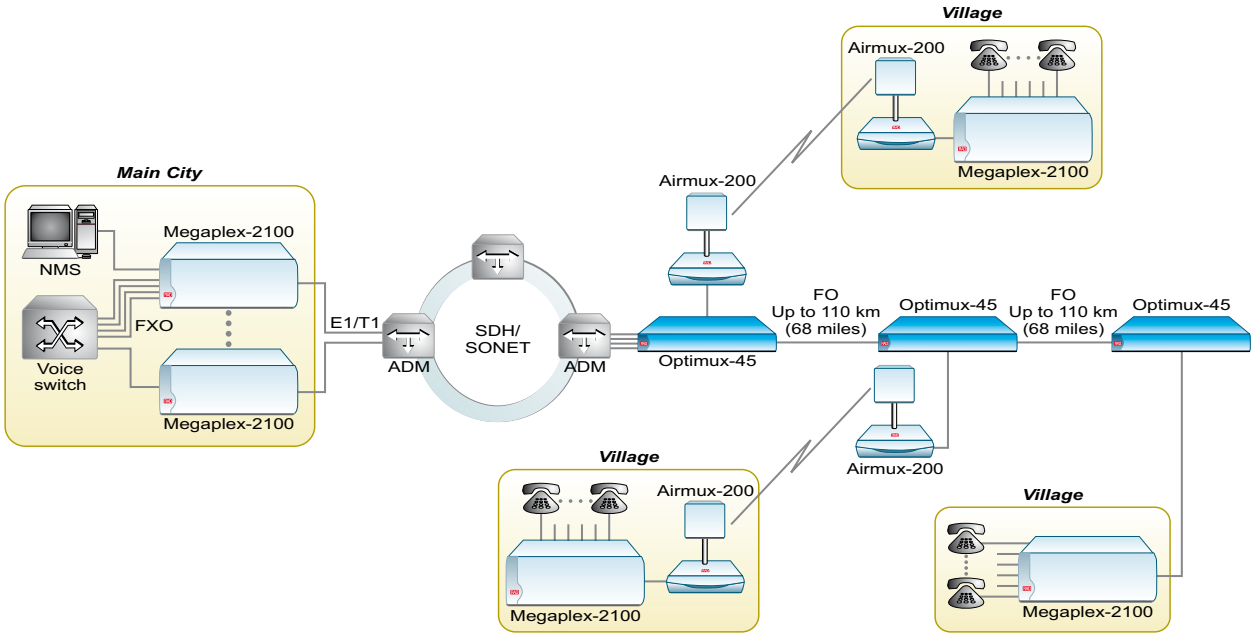
The T3 link via an optional clock interface can be locked onto an external station clock.

The products support various performance statistics on the E1, T1 and T3 lines.

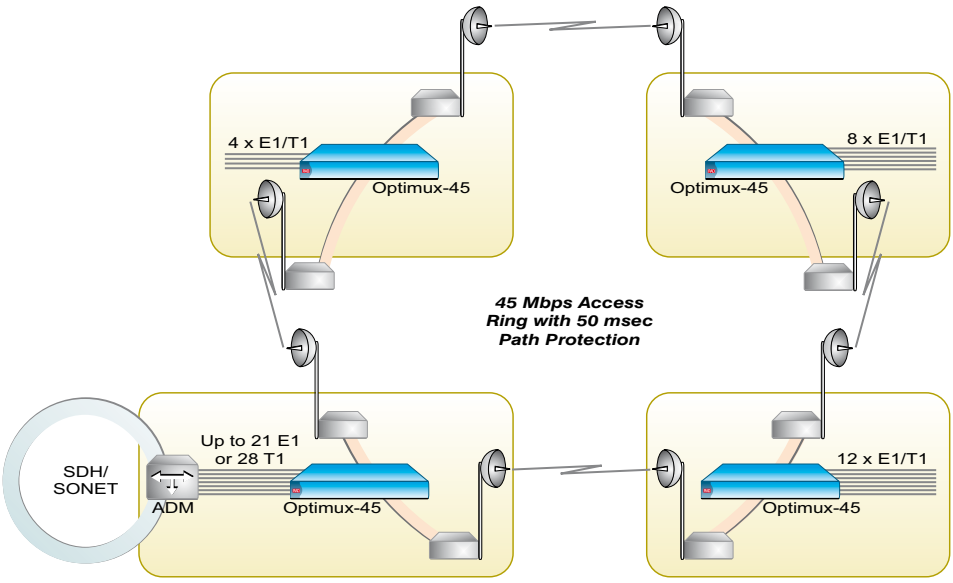
The Optimux-45 and Optimux-45L are available as compact 1U-high units for mounting in a 19-inch rack.



Ring topology



Drop-and-insert service extension



Wireless T3 ring application

Optimux-1551

Optimux-1551, Optimux-1553

Fiber Multiplexers for 63E1/84T1 or 3E3/T3 over STM-1/OC-3

- **Plug-and-play SDH/SONET terminal multiplexers connecting low rate PDH services over a single STM-1/OC-3 (155 Mbps) link**
- **Optimux-1551 multiplexes up to 63 E1 or 84 T1 tributary channels over an STM-1/OC-3 uplink**
- **Optimux-1553 multiplexes three E3 or three T3 tributary channels over an STM-1/OC-3 uplink**
- **Channelized STM-1/OC-3 main link with standard fiber optic (single mode, multimode and WDM) or coaxial interface**
- **Supports 1+1 uni-directional automatic protection switching (APS) on STM-1/OC-3 uplink; 1+1 protection on DS1 or DS3 tributaries and power supply modules**
- **Provides a demarcation point between the carrier network and the customer network**
- **Full management support for fault, configuration, performance, and security via RADview – RAD's network management system**
- **Range up to 80 km (50 miles)**

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Optimux-1551 and Optimux-1553 terminal multiplexers deliver traditional PDH services over existing SDH/SONET networks. They combine the high capacity associated with SDH/SONET add-and-drop multiplexers (ADMs) with the simplicity and low cost of a terminal multiplexer, significantly reducing operating and capital expenses (OpEx and CapEx).

High capacity in a compact unit

The 2U-high Optimux-1551 provides connectivity for up to 63 E1 or 84 T1 lines, and the 1U-high Optimux-1553 provides connectivity for three E3 or three T3 lines. The products comply with all SDH/SONET standards, and interface with existing SDH/SONET backbones through a single or redundant STM-1, OC-3 or STS-3 interface.

To improve the price/performance ratio of the product, partial assemblies are available, reducing the price significantly in nodes requiring only a small number of E1/T1 lines. Therefore, the Optimux-1551 can be ordered with 21 x E1/28 x T1 channels, 42 x E1/56 x T1 channels or 63 x E1/84 x T1 channels.

Carrier-class design

Designed for the rigorous requirements of carriers and service providers, Optimux-1551 and Optimux-1553 devices offer a high level of reliability and manageability. Hardware redundancy is designed into the system without the need for custom Y-cables or external devices. This 1+1 redundancy is provided for all user interfaces through an optional second, hot-swappable multiplexer card. 1+1 redundancy is also available for the STM-1/OC-3 main link (uni-directional APS/MSP) and power supply modules. This reliable platform maximizes uptime for mission-critical applications. A fully equipped Optimux-1551 fits in a single 2U-high 19-inch shelf while the Optimux-1553 occupies a 1U-high shelf.

Higher revenues at lower cost

The Optimux devices allow service providers to extend their network to remote customers, thereby enlarging their customer reach and increasing revenues, without the expenses associated with deploying high-end ADMs, which add unnecessary cost and complexity in point-to-network connections. Compared to the alternative of deploying PDH multiplexers at customer sites, the Optimux devices interface directly with the existing SDH/SONET TDM infrastructures and consolidate traffic at the edge of the network. This enables service providers to save the cost of fiber deployment and multiple ports on the ADM.

Plug-and-play operation

Easy to install, maintain and operate, Optimux products require no training or expertise. As completely plug-and-play units, the products allow carriers to extend the benefits of SDH/SONET networks to the customer premises or central office in a quick and inexpensive manner.

Typical applications

Optimux devices are especially suitable for extending SDH/SONET network services to remote and suburban locations such as industrial areas and business parks. They are also ideal for delivering multiple E1/T1 or E3/T3 services, in a fan-out topology.

The Optimux units can be deployed in point-to-point applications, connecting two sites over fiber, to distances of up to 80 km (50 miles).

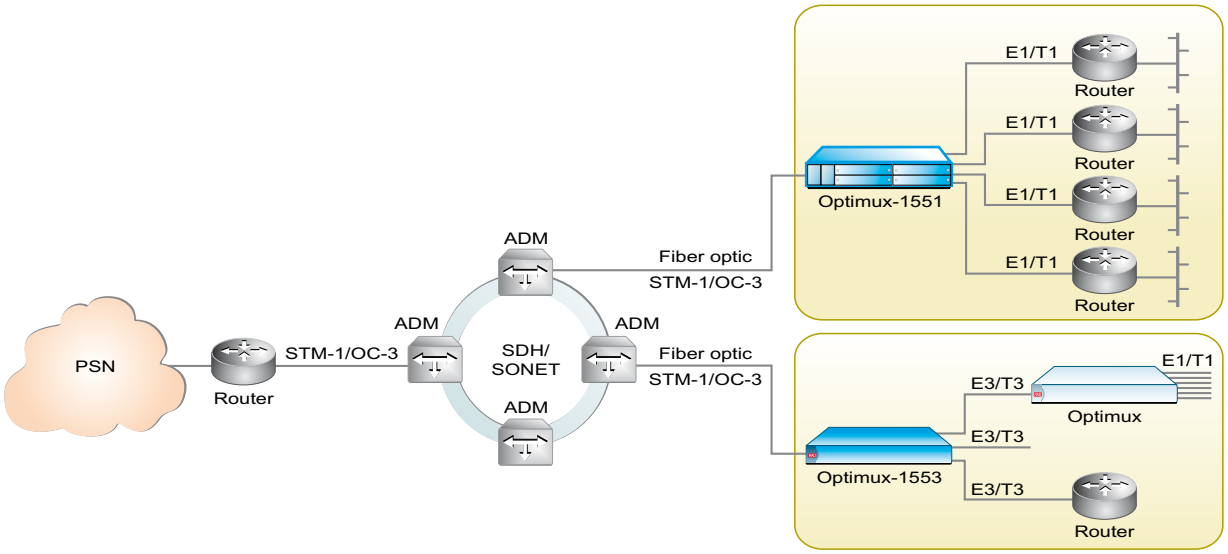
A service provider can use Optimux-1551 to deliver E1/T1 services and Internet access to multiple customers, and use Optimux-1553 to provide E3/T3 lines to large enterprises with higher bandwidth requirements.

Management options

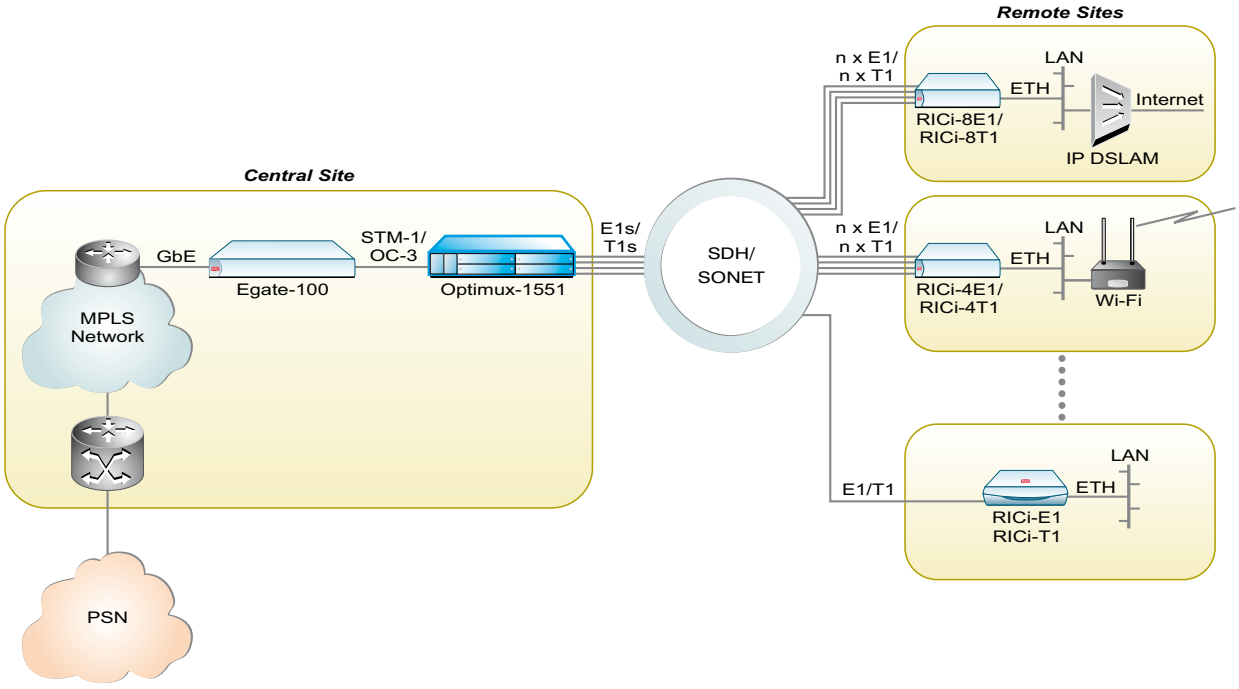
The Optimux-1551 and Optimux-1553 feature flexible management capabilities, including local management via an ASCII terminal (RS-232). In addition, remote management can be performed either inband using the network or user ports, or out-of-band using a dedicated management port, while maintaining separation between management and use. 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 Optimux-1551 and Optimux-1553 also support a variety of access protocols over Telnet, SNMP and Web server.

The units are 19-inch wide, and 2U-high for the Optimux-1551 and 1U-high for Optimux-1553.



Delivering E1/T1, E3/T3 and Internet access to multiple customers



End-to-end Ethernet over SDH/SONET/PDH

AXCESS+
First Mile (Local Loop) Solutions

RAD's AXCESS+ portfolio offers an array of First Mile product solutions for extending multiple services transparently end-to-end over copper, fiber and wireless access infrastructure from DSLAMs, SDH/SONET or packet switched networks. RAD's AXCESS+ portfolio also includes aggregation capabilities for handing off traffic to SDH/SONET and packet switched networks.

In applications where end customer locations are situated at distances beyond the service providers' Local Loop plant or where wireline access is limited, the AXCESS+ portfolio provides a comprehensive solution for high capacity TDM and Ethernet service extension over any infrastructure or topology:

- Over copper – using the advantages of SHDSL.bis technology to offer higher data rates and longer distances over multiple bonded pairs
- Over fiber – extending services to remote sites
- Over wireless – where no infrastructure exists at all, or as a backup to wired services

Copper solutions

RAD's AXCESS+ copper solutions offer a large variety of interfaces, unmatched by the competition. This diversity allows service providers to leverage their copper resources to roll out:

- Multiple services, integrating voice channels, data, LAN, and Internet over a single link
- Increase the range of their DSL services by 30% or more
- Offer high bandwidth up to 22.8 Mbps
- Provide symmetrical services – ensuring the same data rate upstream and downstream
- Ensure DSLAM interoperability with third-party DSLAM providers

Fiber solutions

RAD's AXCESS+ fiber solutions range from high speed modems to fiber multiplexers and integrated multiplexer racks.

Wireless radio solutions

RAD's AXCESS+ wireless radio solution is built around RAD's carrier-class Airmux broadband wireless products, which deliver native Ethernet and TDM services over a single wireless link in various sub-6 GHz frequencies (unlicensed). Combining a flexible combination of Ethernet with up to 16 E1/T1 interfaces, the high capacity radio system provides net throughput of up to 100 Mbps full duplex (200 Mbps aggregated) and a range of up to 120 km (75 miles).

The Airmux product line incorporates advanced features, such as MIMO and OFDM for optimal performance and unmatched robustness in all environments, making it ideal for different market segments and a wide variety of applications:

- Service providers and ISPs
- IP backhaul of 4G/broadband services in point-to-point and multiple point-to-point topologies to offer broadband access for remote, rural and underserved communities
- Access for large corporate clients to eliminate the recurring fee of incumbent leased line services while maintaining secure dedicated capacity per site

Private networks

RAD's multiservice access solutions enable high capacity interbranch connectivity for university campuses, health care organizations, government institutions, large enterprises, and public establishments with high communications traffic requirements.

Mobile carriers

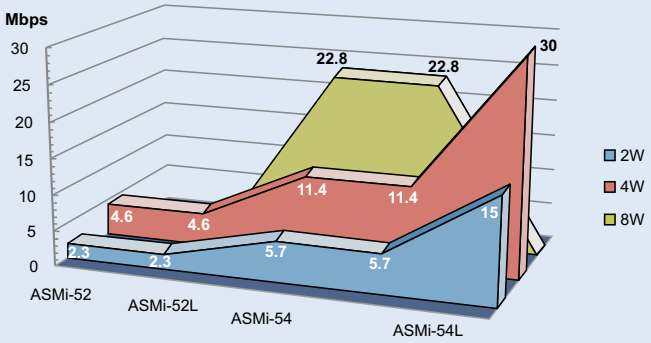
RAD's AXCESS+ portfolio provides rural-to-urban cellular backhaul, extending mobile reach to rural locations with carrier-grade, long-haul point-to-point E1/T1 and Ethernet services. In addition, they support backhaul of 3G services in an urban environment with an easy migration path from converged TDM/IP networks to all-IP networks, such as WiMAX, LTE/4G.

Security and surveillance

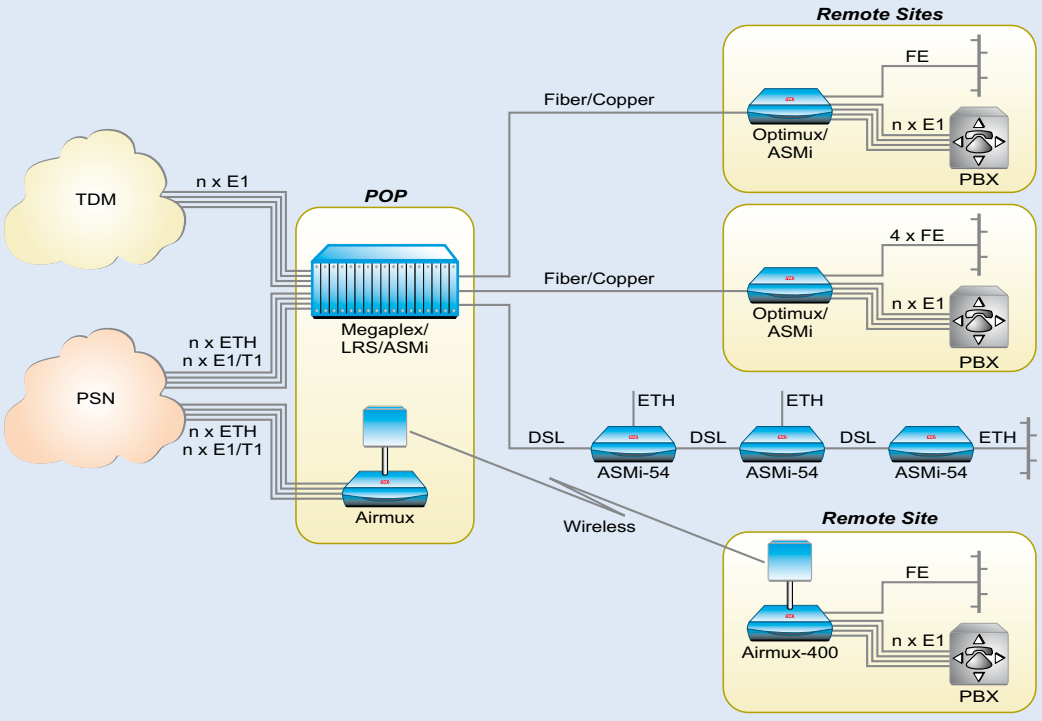
The AXCESS+ products provide traffic aggregation and backhaul from multiple colocated megapixel video cameras suitable for homeland security applications, municipal 'safe city' projects and border control installations.

Remote management

All AXCESS+ solutions are managed by RAD's management system (RADview) and can be integrated with other management systems as well. A management channel enables the user at the central site to configure the unit at the customer premises, remotely activate diagnostics and receive real-time alerts on the system status. The management channel can operate in parallel to the data channel over the same wire or fiber link.



Modem selection guide



Extending Ethernet and legacy services over copper, fiber and wireless media

LRS-102

Fiber and Copper Mux Rack with SNMP Management

- **Transports any traffic over fiber optic or SHDSL.bis links**
- **Modular chassis with 12 I/O slots**
- **Up to 24 Optimux-108 and/or Optimux-106 modems in a single chassis**
- **Up to 96 ASMi-54 modems in a single chassis**
- **Transports up to 96 E1/T1s and 24 x 10/100BaseT Ethernet links**
- **Hot-swappable, redundant uplinks**
- **Redundant power supplies**
- **Supports single mode, multimode and single mode over single fiber (WDM)**
- **RADview SNMP management**

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The LRS-102 is a cost-effective, modular central rack solution for RAD's Optimux fiber or ASMi-54/ASMi-54L SHDSL.bis mux products, extending E1/T1s, data and Ethernet traffic up to 120 km (74.5 miles) over fiber optic links, or up to 2.9 km (1.8 miles) over copper. The LRS-102 fiber mux rack provides optional redundant power supplies, optional redundancy of the common logic and 12 I/O slots. 12 dual-port Optimux-108/108L and/or Optimux-106 modules support 24 remote units. In addition, the ASMi-54 module enables the device to work opposite up to eight remote units, supporting a total of 96 ASMi-54 remote units.

The unit has central management via the common logic module and occupies one-third of the space of the equivalent number of standalone units.

The rack is managed using a single IP address. It supports an SNMP RADview application running on an HP OpenView UNIX or PC platform, enabling full management of the LRS-102 and the remote units.

Multiple fiber modes

As a central solution for Optimux fiber optic (WDM) products, LRS-102 supports single mode, multimode and single mode over single fiber optic types, as well as different connectors, such as SC, FC or ST.

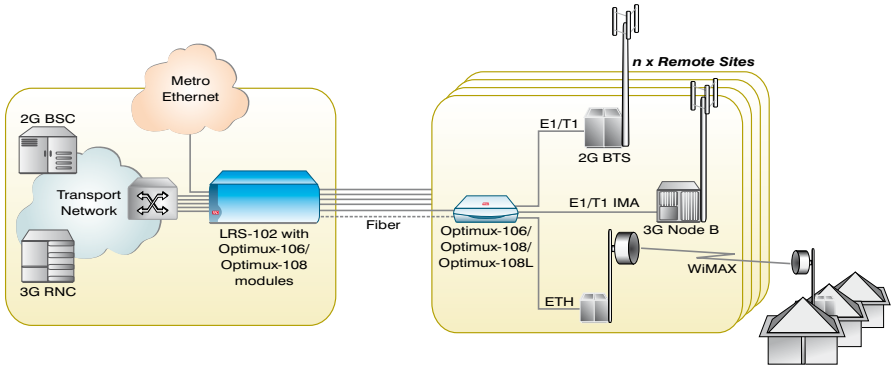
Cost-effective central solution

By deploying the LRS-102 as a central solution, users save colocation costs, avoid multiple IP addresses in the network, and benefit from a higher port density chassis, resulting in a lower price per port.

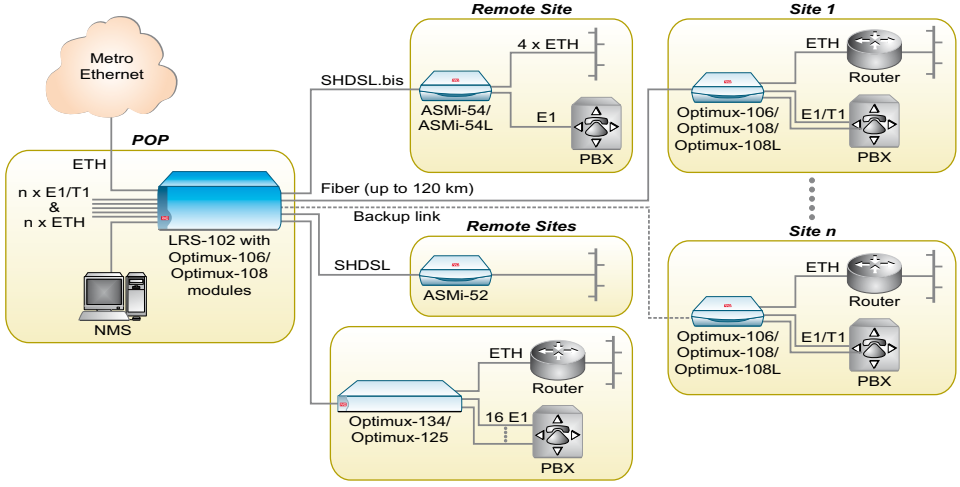
LRS-102 applications include:

- Campus service sharing
- Ethernet, data and voice range extension
- Cellular backhaul extension
- Video conferencing
- Surveillance cameras connectivity

LRS-102 comes in a 4U-high chassis, mountable in a 19-inch ETSI or ANSI rack.



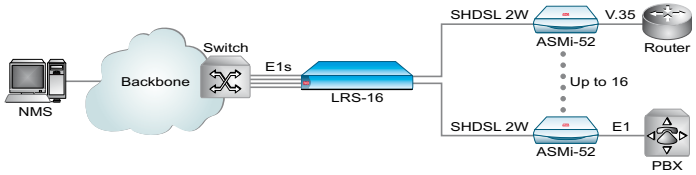
Cellular backhaul extension



Ethernet and legacy services extension over fiber and copper

LRS-16

Managed SHDSL Modem Concentrator



- **Transparent modem concentrator**
- **Operates 16 SHDSL, E1 modems on 2-wire**
- **Multiple data rates: between 64 kbps and 2,048 kbps**
- **ITU-T standards: G.703, G.704**
- **Compact unit**

For latest updates visit www.rad.com

The LRS-16 is a managed SHDSL modem concentrator presenting a cost-effective central-site solution for point-to-point extension of E1 services in the Local Loop.

The concentrator can operate opposite 16 ASMi-52 SHDSL modems at remote locations, providing E1 services over 2-wire lines. Each one of the 16 fixed ports inside the LRS-16 can have its own separate clocking.

Extended range

LRS-16 employs standard SHDSL TC-PAM 16 technology to extend the transmission range, thus enabling carriers to reach more customers at lower costs. The device uses an embedded operation channel (EOC) for controlling and monitoring the remote unit. The management channel uses SHDSL overhead bits in compliance with ITU-T G.991.2 requirements, and operates without interfering with the data transmission.

Power supplies

LRS-16 operates with single or dual power supplies. A power supply can be hot-swapped (replaced) during operation, without affecting system performance.

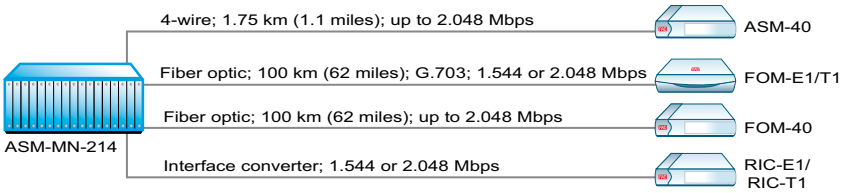
Management

The LRS-16 features flexible management capabilities, including local management via an ASCII terminal (RS-232). In addition, remote management can be performed 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 LRS-16 also supports a variety of access protocols, including SNMP, Web server, and Telnet.

LRS-16 is supplied in a 1U-high 19-inch enclosure.

ASM-MN-214

Chassis for Short Range Modems



- **High density 19" modem rack (up to 14 cards)**
- **Central solution for copper and fiber modems**
- **Compact – 4U-high**
- **Hot-swappable cards and power supplies**
- **Indicator LEDs on each card**
- **Fully redundant power supply**
- **Optional power feeding from different power sources (AC or DC)**

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The ASM-MN-214 versatile modem rack is a high density unit capable of housing any combination of up to 14 cards.

The ASM-MN-214 accommodates two separate power supplies. Each power supply supports a full rack of any combination of cards. The power supplies can be either AC or DC and are suitable for power redundancy. Replacement during operation (hot-swapping) is possible, with no effect on the modems and their data transmission.

Cards that are currently supported: ASM-10/8/R, ASM-31/R, ASM-40-1/R, FOM-20/R, FOM-40/R, FOM-E1T1/R, FCD-2L/R, RIC-E1/R, RIC-T1/R.

The ASM-MN-214 has a terminal block for the line interface and a 25-pin connector for the digital interface. The terminal block is a snap-type connector for easy replacement.

An optional mechanical adapter, the CIA, is used to convert the 25-pin connector to the required physical connector for either V.35 or X.21 interfaces.

ASMi-54, ASMi-54C, ASMi-54L, ASMi-54LRT

SHDSL.bis Modems with Integrated Router or Multiplexer

- **Point-to-point E1 and Fast Ethernet extension over multiple SHDSL.bis lines**
- **Standards-compliant SHDSL (ITU-T G.991.2 and ETSI 101524)**
- **11.4 Mbps over 2-wire; up to 30 Mbps over 4-wire**
- **EFM (Ethernet in the First Mile) bonding per IEEE 802.3-2005; M-Pair bonding for HDLC per G.991.2**
- **TC-PAM 16 or TC-PAM 32 line coding**
- **Ethernet bridging and routing**
- **VLAN prioritization and Ethernet QoS support**
- **Daisy-chain or ring topology with STP support per IEEE 802.1D**
- **Managed via SNMP, Telnet and ASCII terminal**
- **Optional rail mountable metal enclosure for extreme temperatures (ASMi-54)**

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The ASMi-54 product line includes a range of cost-effective, managed devices for extending E1 and mid-band Ethernet services over multi-pair bonded copper links. Ensuring reliable performance over poor quality or noisy lines, the ASMi-54 SHDSL.bis modem and ASMi-54C module operate in full duplex mode over 2-wire, 4-wire or 8-wire lines, achieving variable data rates of up to 22.8 Mbps. The ASMi-54L and ASMi-54LRT provide access rates of up to 11.4 Mbps over 4-wire connections. The devices can achieve an extended service range of up to 2.6 km (1.825 miles) for each 5.7 Mbps pair at 26 AWG. The ASMi-54 line is part of the AXCESS+ portfolio of multiservice access and First Mile solutions.

The ASMi-54 modems are ideal for carriers, service providers and mobile operators, as well as corporate, utilities and transportation companies looking for economical delivery of voice and broadband data traffic in point-to-point or hub and spoke communications. In addition, ASMi-54's ruggedized design ensures reliable operation in industrial applications and harsh environments.

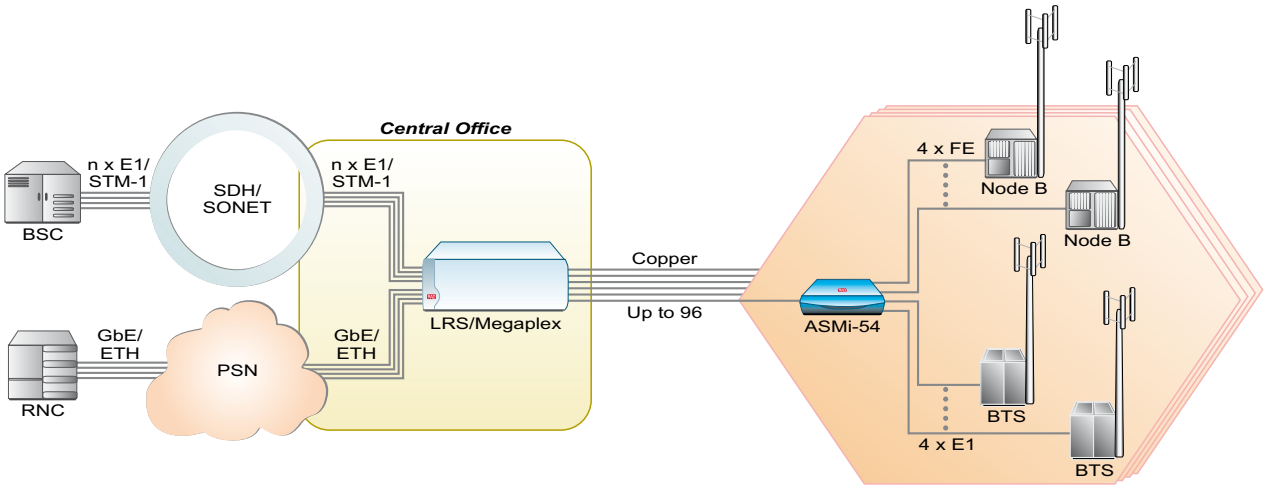
Alternatively, RAD's high performance SHDSL technology supports increased throughput for Ethernet services of 11.4 Mbps over 2-wire and up to 30 Mbps over 4-wire.

Ethernet capabilities and QoS support

Featuring a built-in Ethernet switch, the ASMi-54 SHDSL.bis modems include up to four 10/100BaseT user ports and support VLAN-aware and VLAN-unaware bridging. VLAN stacking (Q-in-Q) and stripping functionalities enable transparent traffic delivery over packet switched networks with optimal efficiency.

QoS (quality of service) levels are defined according to VLAN priority (802.1p), IP Precedence, DSCP, or per port, offering users flexibility in differentiating traffic handling depending on application requirements. Up to four priority queues are supported using Strict Priority (SP) scheduling.

Fault propagation enables the units to shut down the Ethernet user port when an SHDSL line failure is detected and to switch traffic to an alternate route. EFM bonding capabilities ensure that a failure or addition of a link does not drop the traffic being transmitted over the other wires in the group. Capacity is also maintained when a new link is added at a lower rate during Ethernet transmission.



Mobile backhaul over DSL infrastructure

IP routing functionalities

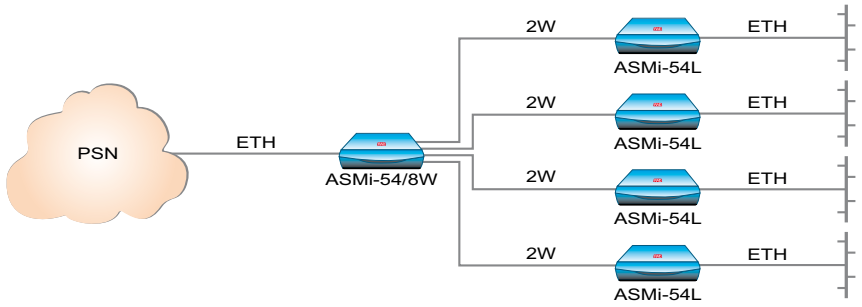
In addition to its Ethernet bridging attributes, the ASMi-54LRT incorporates a built-in router to allow secure and efficient Layer 3 IP connectivity over packet switched networks. The device enables port forwarding whereby packets are delivered according to a static NAT/PAT (network address translation/port address translation) table. This allows multiple LAN devices to share a single public IP address, so that outgoing traffic appears to originate from a single device – the ASMi-54LRT.

Solid Firewall™ protection for the LAN and WAN interfaces, as well as for the DMZ sub-network, provides security against unauthorized network access, including malicious denial of service (DoS) attacks. Protective measures include rate limiting for ingress packets of vulnerable types, stateful packet inspection (SPI) and service authorization, among others.

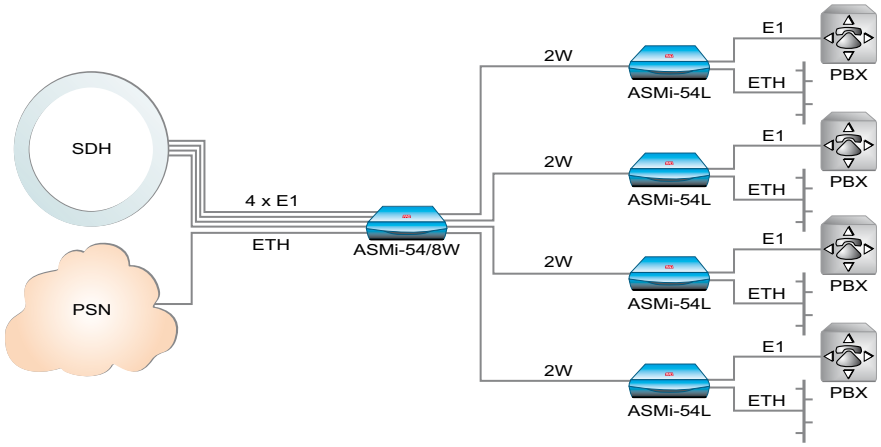
The ASMi-54LRT supports QoS differentiation for IP applications with four priority queues, Strict Priority scheduling and user-configurable classification according to DSCP values.

Pico-DSLAM functionality

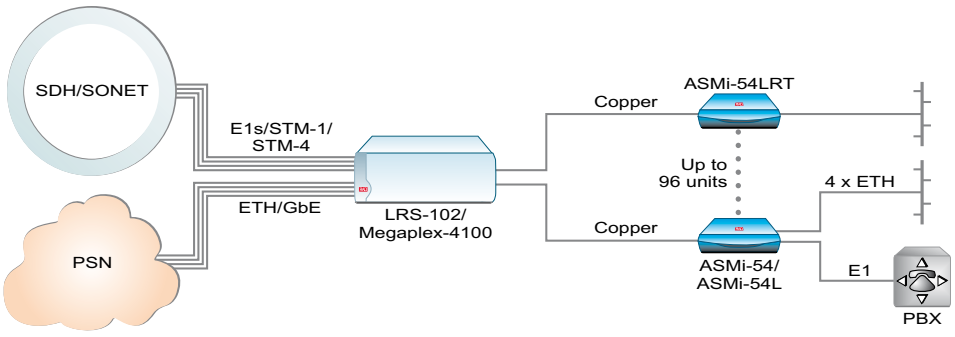
The ASMi-54 supports multipoint connectivity for E1 and Ethernet services when working opposite four modems or ASMi-54L devices. As a pico-DSLAM, it aggregates Ethernet traffic from remote ASMi-54L units over a fiber or copper Fast Ethernet connection to the PSN.



SHDSL.bis pico-DSLAM – cost-effective solution for Ethernet connectivity



Multipoint topology for E1 and Ethernet over rural areas



Deploying Ethernet and E1 services over SHDSL.bis

Metal case version

ASMi-54, ASMi-54C, ASMi-54L, ASMi-54LRT
(Continued)

High flexibility with daisy-chain and ring topologies

The ASMi-54 supports drop-and-insert (daisy-chain) applications, enabling bi-directional delivery of high rate Ethernet traffic over DSL lines by connecting multiple locations in a multidrop network.

Alternatively, the device can be deployed in ring architecture, featuring spanning tree protocol (STP) support to ensure high availability and service resiliency in the event of link failure. The ASMi-54L meets EN-50121-4 industry standard for high electromagnetic reliability.

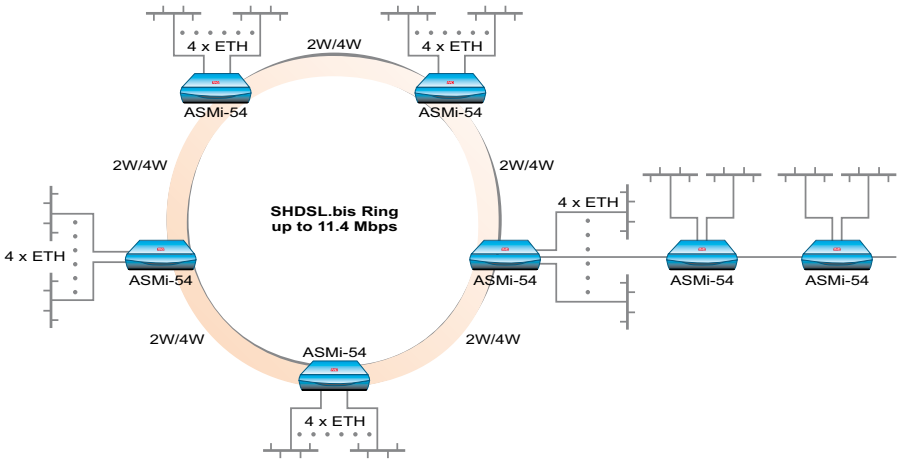
Card version for modem rack

The ASMi-54C is a card version for mounting in a central LRS-102/Megaplex-4100 rack. The ASMi-54C SHDSL.bis module multiplexes E1 and Ethernet over one, two or four pairs of SHDSL.bis copper lines. It is installed in an LRS-102 chassis which can contain up to 12 card modules, each with eight E1 interfaces and/or two 10/100BaseT Ethernet ports, to provide a cost-effective central-site solution for up to eight ASMi-54 standalone units over 2-wire or any other combination up to 8-wire. Alternatively, the ASMi-54C can work opposite remote ASMi-52/52L 2/4-wire SHDSL modems in applications requiring lower rates over SHDSL lines. Management traffic for all remote units is delivered via one of the ASMi-54C's Fast Ethernet ports, using a dedicated management VLAN. By supporting both E1 and Ethernet access at the central office (CO), the ASMi-54C modules enable an easy migration from TDM to IP networks.

Management options

The ASMi-54 standalone units support the following management connections for configuration, monitoring and diagnostics:

- Local RS-232 terminal
- Telnet server, SNMP (ver.1)
- RADview-EMS Web server
- Network links for Inband management with a dedicated VLAN



Ring and daisy-chain topology for Ethernet services with link redundancy

	ASMi-54	ASMi-54C	ASMi-54L	ASMi-54LRT
E1 user ports	Up to 4	8	1	1
10/100BaseT user ports	Up to 4	2	4	4
SHDSL.bis network links and associated data rates	5.7 Mbps over 2-wire (1 pair)	5.7 Mbps over 2-wire (1 pair)	5.7 Mbps over 2-wire (1 pair), 11.4 Mbps over 2-wire (1 pair)	5.7 Mbps over 2-wire (1 pair)
	11.4 Mbps over 4-wire (2 pairs)	11.4 Mbps over 4-wire (2 pairs)	11.4 Mbps over 4-wire (2 pairs)	11.4 Mbps over 4-wire (2 pairs)
	22.8 Mbps over 8-wire (4 pairs)	22.8 Mbps over 8-wire (4 pairs)		
Built-in router	-	-	-	✓
Daisy-chain and ring support	✓	-	-	-
Multipoint topology	✓	✓	-	-

ASMi-52, ASMi-52L

2/4-Wire SHDSL Modems/Multiplexer

The ASMi-52 and ASMi-52L modems use TC-PAM 16 line coding SHDSL technology to extend the range of digital interfaces. These devices offer longer distances and variable data rates up to 2.3 Mbps over 2-wire and 4.6 Mbps over 4-wire.

ASMi-52 multiplexer version

The ASMi-52 multiplexer model is equipped with one or two user ports. It can transmit combinations of V.35/X.21/RS-530 data, 10/100BaseT LAN, and E1 traffic over a single SHDSL link at a maximum data rate of 2.3 Mbps.

ASMi-52L version

The economically priced ASMi-52L model is offered for applications requiring a single service, available with a port for E1, V.35, X.21 or Ethernet, or four 10/100BaseT ports with integral switch.

The ASMi SHDSL modems extend the range of 2 Mbps data transmission up to 4 km (2.5 miles) over 2-wire cable and even farther over 4-wire cable, reaching a maximum of 10 km (6.2 miles) for 64 kbps data. All models are compatible with 2/4-wire repeaters, such as RAD's S-RPT, for supporting even longer-range applications.

The products comply with ITU-T G.991.2 and ETSI 101524 standards for SHDSL.

They also work opposite RAD's DXC, and Megaplex SHDSL modules. Monitoring, control and diagnostics of local and remote units are available via a supervisory port. Standards compliance enables the ASMi modems to work opposite third-party TDM equipment that support the SHDSL standard.

Card version

The ASMi-52 is available as a standalone unit or as a card for the LRS-16/LRS-102 19-inch racks with central SNMP management.

The ASMi-52 is also available in a half 19-inch metal enclosure or a rugged metal enclosure designed for easy installation on standard cabinet rail mounts that meet the EN 50121-4 industry standard (also for ASMi-52L with four Ethernet ports).

Management options

The management connection to the standalone unit is via:

- V.24/RS-232 port using SLIP protocol
- Out-of-band Ethernet port (ASMi-52 only)
- Dedicated timeslot using E1/T1 port (ASMi-52 only)

- **Data rates up to 2.3 Mbps over 2-wire and 4.6 Mbps over 4-wire**
- **Extended range up to 10 km (6.2 miles)**
- **Reliable performance over poor quality or noisy lines**
- **Works opposite LRS-16, LRS-102, DXC, Megaplex, and third-party equipment**
- **ASMi-52 user port options: E1, T1, V.35, X.21, RS-530, and 10/100BaseT with bridge or router**
- **ASMi-52 multiplexer version with two user ports integrates V.35/X.21/RS-530 data, 10/100BaseT LAN, and E1 traffic over SHDSL link**
- **ASMi-52L: single V.35, X.21, E1, 10/100BaseT user port, or four 10/100BaseT ports with integral switch**
- **Automatic configuration for fast and easy installation**

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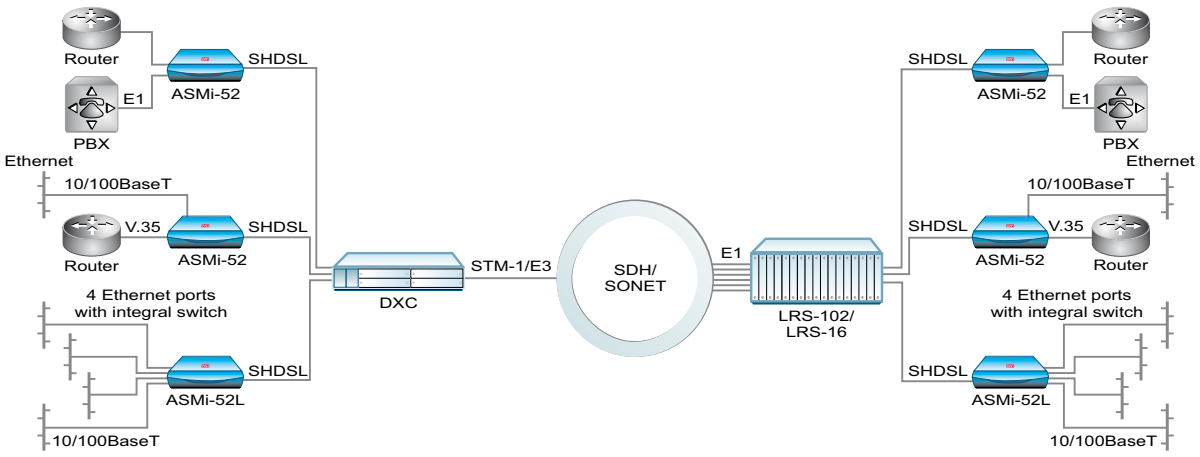

Varied services over SHDSL

ASMi-31

Sync/Async 2-Wire Manageable IDSL Modem

- **2-wire sync/async, all-rate short range modem**
- **Full inband management of local and remote modems**
- **Operating range up to 8 km (5 miles) over 24 AWG cable, independent of data rate**
- **Selectable data rates: 1.2 kbps to 128 kbps**
- **Supports digital interfaces: V.24/RS-232, V.35, X.21, RS-530, V.36/RS-449, Ethernet (bridge) or G.703 codirectional**
- **Optional built-in router**
- **Works opposite Megaplex and DXC IDSL cards**

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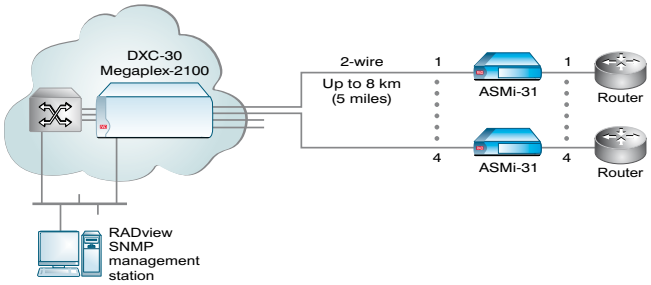

The ASMi-31 manageable IDSL modem operates full duplex over twisted pair, 2-wire unconditioned lines. It has a transmission range of up to 8 km (5 miles) over 24 AWG cable and operates at user-selectable rates from 1.2 kbps to 128 kbps.

The ASMi-31 can also work opposite the DXC with D8U card, or opposite the Megaplex with the U interface module.

SNMP management is available for the cards inside the rack via the management channel and for the customer premises standalone units. The RADview SNMP application running on an HP OpenView UNIX or PC platform supports management of the ASMi-31 and other RAD modems.

The ASMi-31 is an IDSL modem based on 2B1Q technology, which is common to both ISDN and DSL technologies. This line code enables efficient transmission over poor quality lines. Transmit timing is provided internally or recovered externally from the received signal. It can also be derived externally from the digital interface, enabling tail-end applications.

ASM-61

2-Wire Symmetrical VDSL-Based Modem

- **Data rate of 10 Mbps**
- **Range of up to 1 km (0.6 miles) over 24 AWG cable**
- **User interface is a built-in 10/100BaseT Ethernet bridge**
- **Plug-and-play operation**

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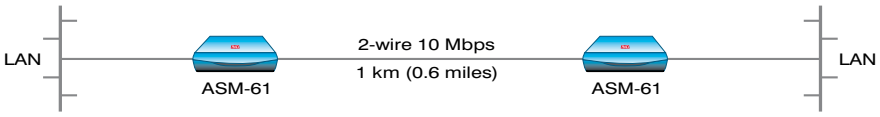


A complete solution for high speed services over existing copper lines, the ASM-61 provides full duplex, symmetrical 10 Mbps Ethernet traffic over 2-wire 24 AWG (0.5 mm) copper cable, for distances of up to 1 km (0.6 miles).

The ASM-61 extends the range of internal LANs using VDSL technology, based on ETSI QAM line coding requirements for the physical medium.

The ASM-61 compensates for line impairments and mixed cabling by using advanced equalization, adaptive filtering and echo cancellation technology.

An internal clock is available. In this mode, the internal clock generator provides the clock for the digital interface and the line.

The ASM-61 is powered by AC voltage. It is available as a standalone unit that can be mounted in a standard 19-inch rack using special hardware.

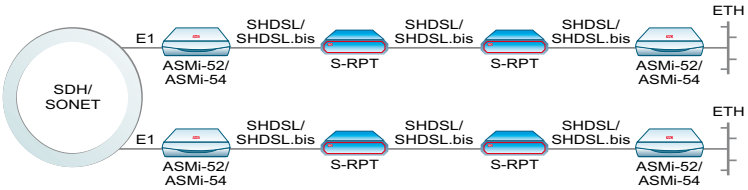
S-RPT, S-RPT/4W

SHDSL or SHDSL.bis Repeaters

The S-RPT and S-RPT/4W extend the transmission range of modems using SHDSL or SHDSL.bis (TC-PAM 16) line coding. Even though SHDSL/SHDSL.bis modems provide superior reach and noise immunity in comparison with other DSL technologies, the maximum range of these modems in simple point-to-point (LTU-NTU) configurations is not sufficient for some applications:

- DSL links alongside railways, pipelines, power lines, and waterways
- DSL transport to remote concentrators in rural areas
- Military applications

The S-RPT and S-RPT/4W repeaters, using TC-PAM 16 line coding, operate over 2-wire or 4-wire lines accordingly. The units support line rates from 192 kbps to 5.7 Mbps and fully regenerate the signal for increasing the transmission distance. The devices can be managed locally via an ASCII terminal, or remotely from the central SHDSL equipment, using standard EOC messages.



- **SHDSL line repeaters for operation over 2-wire or 4-wire lines**
- **Based on the SHDSL standard for higher speeds and longer loop ranges**
- **Locally or remotely powered**
- **Available as a desktop unit or in IP-67 casing for installation in communication ducts**
- **Fully manageable via DSL link**
- **High quality, high performance**

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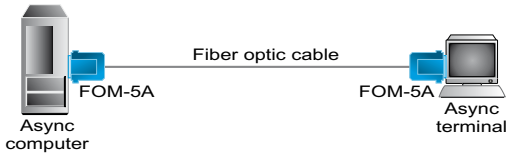
FOM-5A

Asynchronous Fiber Optic Modem

FOM-5A is a miniature fiber optic modem used for local data distribution, connecting full or half duplex async computers and terminals. A pair of modems ensures integrity of data transmission over multimode fiber optic cables for distances up to 3 km (1.9 miles) at data rates up to 19.2 kbps.

Innovative circuitry allows the modem to operate without external power, by drawing low power from the DTE data and control signals.

The FOM-5A has a V.24/RS-232 interface and is available with either a male or female integral 25-pin connector.



- **Asynchronous transmission up to 19.2 kbps**
- **Transmission range up to 3 km (1.9 miles) over multimode fiber**
- **Full or half duplex**
- **Continuous or controlled carrier**
- **DCE/DTE switch**
- **LED indicator for data transmit**
- **No external power required**
- **Available as a card for 19-inch rack**

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Airmux-400

Broadband Wireless Radio

- **Radio system combining up to 16 E1/T1 and up to three UTP and SFP Ethernet interfaces**
- **Point-to-point and multiple point-to-point topologies**
- **100 Mbps full duplex throughput (200 Mbps aggregated)**
- **Transmission range up to 120 km (75 miles)**
- **Sub-6 GHz multi-band operation in a single device: 2.4 GHz, 4.8–5.9 GHz**
- **10, 20, 40 MHz channels; OFDM, MIMO support**

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The Airmux-400 carrier-class radio system delivers native Ethernet and TDM services over a single wireless link in various sub-6 GHz frequencies. These include 2.4 GHz, 4.8 GHz, 4.9 GHz, and 5.x GHz. Featuring up to 16 E1/T1 interfaces and up to three Ethernet ports, the Airmux-400 operates in point-to-point and multiple point-to-point topologies to support a full duplex net throughput of 100 Mbps (200 Mbps aggregated) for distances of up to 120 km (75 miles). The Airmux-400 is part of the AXCESS+ portfolio of multiservice access and First Mile solutions.

The accurate E1/T1 clock recovery, low round-trip delay and high link availability, position the Airmux-400 as a carrier-class wireless transmission system and a perfect solution for mobile, WiMAX and ISP backhaul, as well as for broadband access, video surveillance and remote site connectivity.

Broadband connectivity for private networks

The Airmux-400 is ideal for high capacity inter-branch connectivity for university campuses, health care organizations, government institutions, and large enterprises requiring high traffic volumes, without the added costs of building a network or leasing fixed line services.

Spectral efficiency, link performance and resiliency

The Airmux-400 features advanced space diversity configuration, OFDM (orthogonal frequency-division multiplexing), MIMO (multiple input and multiple output), and ACS (adaptive channel selection) technologies. Providing channel bandwidth options of 10, 20 and 40 MHz, it guarantees optimal link performance to withstand strong RF interference and harsh ambient conditions.

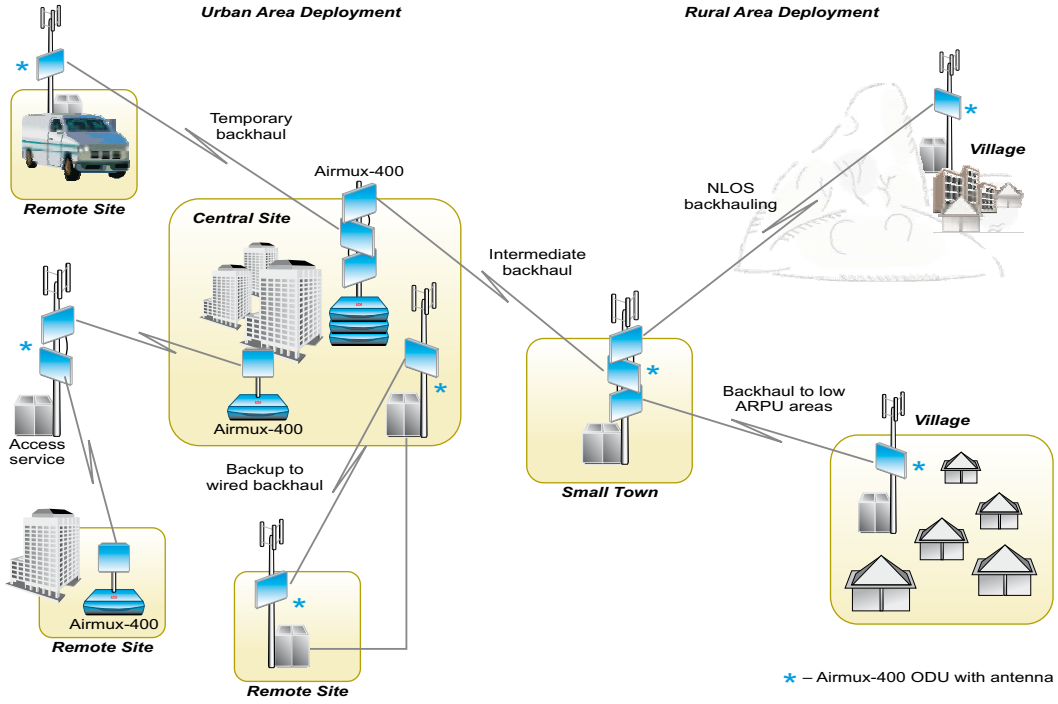
Hub-site synchronization (HSS) ensures simultaneous (multiple point-to-point deployment) data transmission for all colocated radios by eliminating interference caused by multiple ODU (outdoor unit) transmissions at the same site.

Monitored Hot Standby (MHS) 1+1 link redundancy provides TDM service protection with sub-50 ms link switchover in cases of equipment failure or air interface faults.

Management and security

The Airmux-400 employs advanced encryption standard (AES) with a 128-bit data encryption key to protect the data transmitted over the air interface.

The device is managed remotely inband, with separation between management and user traffic achieved via the use of VLANs. Diagnostic tools are provided by RADview-EMS, RAD's carrier-class element management system, via an SNMP-based GUI. The Airmux-400 also supports a variety of configuration access channels, including Telnet, SNMP, Web server, and TFTP.



Wide range of wireless connectivity applications

Airmux-200

Broadband Wireless Radio

The Airmux-200 carrier-class radio system delivers native Ethernet and TDM services over a single wireless link in various sub-6 GHz frequencies. These include 2.3 GHz, 2.4 GHz, 4.9 GHz, and 5.x GHz, as well as licensed 2.5 GHz BRS bands. Featuring up to four E1/T1 interfaces and up to three Ethernet ports, the Airmux-200 operates in point-to-point and multiple point-to-point topologies to support a full duplex net throughput of 18 Mbps (48 Mbps air data rate) for distances of up to 80 km (50 miles). The Airmux-200 is part of the AXCESS+ portfolio of multiservice access and First Mile solutions.

The accurate E1/T1 clock recovery, low round-trip delay and high link availability, position the Airmux-200 as a carrier-class wireless transmission system and an ideal solution for mobile, WiMAX and ISP backhaul, as well as for broadband access, remote site connectivity and video surveillance.

Video surveillance backhaul

The Airmux-200VS optimally suited for video surveillance and security applications, such as perimeter security, license plate monitoring and face recognition. Supporting asymmetric Ethernet throughput of 2/5 Mbps over a distance of up to 20 km, it provides cost-effective support to meet requirements for advanced IP camera communications, including high capacity megapixel transmissions, real-time alerts, minimal quality degradation and high service availability.

Spectral efficiency, link performance and resiliency

The Airmux-200 features advanced space diversity configuration, OFDM (orthogonal frequency-division multiplexing) and ACS (adaptive channel selection) technologies. Providing channel bandwidth options of 5, 10 and 20 MHz, it guarantees optimal link performance to withstand strong RF interference and harsh ambient conditions.

Hub-site synchronization (HSS) ensures simultaneous (multiple point-to-point or deployment) data transmission for all colocated radios by eliminating interference caused by multiple ODU (outdoor unit) transmissions at the same site.

Monitored hot standby (MHS) 1+1 link redundancy protects the wireless transmission with sub-50 ms link switchover in cases of link or air interface faults.

Management and security

The Airmux-200 employs advanced encryption standard (AES) with a 128-bit data encryption key to protect the data transmitted over the air interface.

The device is managed remotely inband, with separation between management and user traffic achieved via the use of VLANs. Diagnostic tools are provided by RADview-EMS, RAD's carrier-class element management system, via an SNMP-based GUI. The Airmux-200 also supports a variety of configuration access channels, including Telnet, SNMP, Web server, and TFTP.

- **Radio system combining up to four E1/T1 and up to three UTP and SFP Ethernet interfaces**
- **Point-to-point and multiple point-to-point topologies; hub-site synchronization (HSS) to prevent interference**
- **18 Mbps full duplex net throughput**
- **Transmission range up to 80 km (50 miles)**
- **Sub-6 GHz multi-band operation in a single device: 2.3–2.7 GHz, 4.9–6.020 GHz**
- **5, 10, 20 MHz channels; OFDM support**

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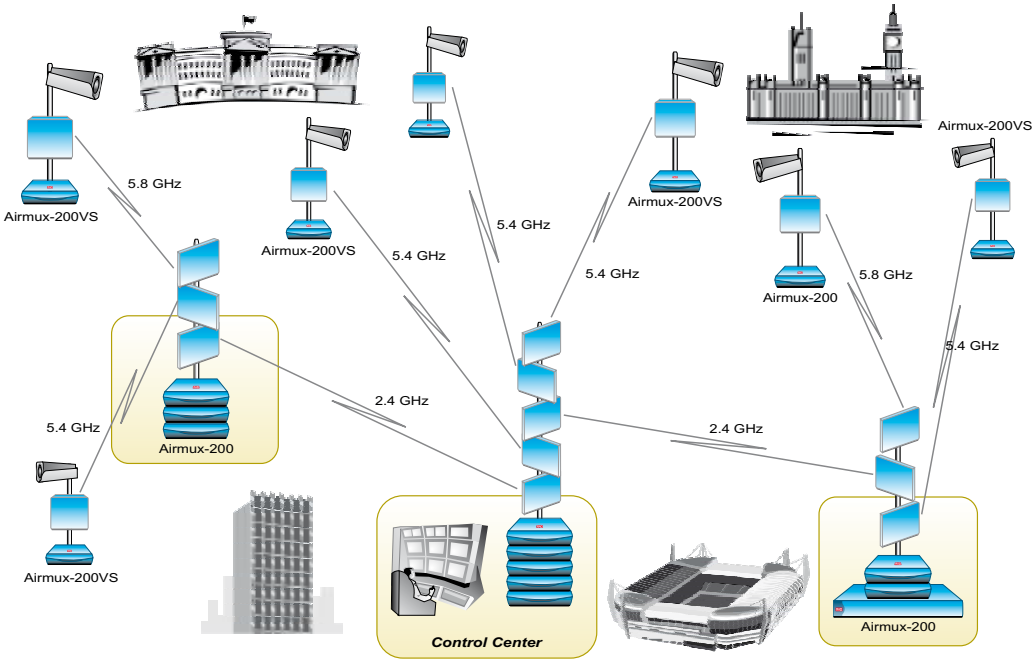

Backhauling urban surveillance video over wireless

FOMi-E1/T1

E1/T1 Fiber Optic Modem with Remote Control

- **Extends the range of equipment with electrical E1 or T1 interfaces over fiber**
- **Inband management of both local and remote units**
- **Supports balanced and unbalanced interfaces**
- **Transparent to framing (ITU G.704)**
- **Laser diode option for extended range**

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The FOMi-E1/T1 extends the limited range of the electrical interface of E1 or T1 equipment over fiber optic links. Range extension is provided for the following interfaces:

- 100 ohms balanced T1 at 1.544 Mbps
- 120 ohms balanced E1 at 2.048 Mbps
- 75 ohms unbalanced E1 at 2.048 Mbps

The modem is transparent to ITU G.704 framed signals.

An inband management channel enables monitoring and control of local and remote units. The management channel is transmitted over the same fiber optic link used for data transfer, with no interference between them.

The FOMi-E1/T1 is available as a standalone unit with a front panel LCD, or with a blank panel and a portable control unit (PCU) to prevent unauthorized operation.

Two BNC coax connectors and an RJ-45 connector are used for connection to coax or twisted pair cables. An additional DB-9 connector is used for external dry contact relay activation in case of major or minor alarms.

FOM-E1/T1

E1/T1 Fiber Optic Modem

- **Extends the range of E1/T1 services over fiber optic cables up to 144 km (89.4 miles)**
- **Transparent to E1/T1 framing**
- **Operates opposite RAD's DXC cross connect system, Megaplex access multiplexers and FCD access units**
- **Conforms to all relevant ITU series standards, including V.54 diagnostics support**

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The FOM-E1/T1 fiber optic modem converts an E1/T1 electrical signal into an optical signal. After the conversion, the signal is transmitted over fiber optic cable, extending the E1/T1 service range up to 144 km (89.4 miles).

The FOM-E1/T1 is transparent to E1/T1 framing (G.704), which enables it to transmit both framed or unframed E1/T1 signals.

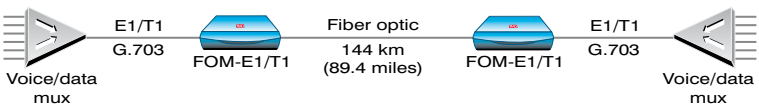
Using the FOM-E1/T1 opposite the DXC cross connect system, Megaplex access multiplexer or FCD access unit reduces the cost of the fiber optic link when accessing the SDH/SONET network.

The FOM-E1/T1 supports various optical interfaces:

- 850 nm for multimode fiber
- 1310 nm for single mode or multimode fiber
- 1550 nm laser diode for extended range over single mode fiber
- WDM for single fiber extension

FOM-E1/T1 operation complies with ITU G.703, G.921 and G.956 standards. The modem supports activation of local and remote loopbacks in compliance with the ITU V.54 standard.

Front panel LEDs indicate system faults in the electrical and fiber optic circuits.



FOM-E3, FOM-T3

E3, T3 Fiber Optic Modems

The high speed FOM-E3 and FOM-T3 fiber optic modems extend transmission range of electrical E3 or T3 signals over fiber optic cables up to 110 km (68 miles).

Two models are available:

- FOM-E3 for E3 rates (34.368 Mbps)
- FOM-T3 for T3 rates (44.736 Mbps)

The FOM-E3 and FOM-T3 support a wide range of fiber optic interfaces, including long haul laser for extended ranges and WDM laser for transmission over a single fiber.

Transparent to E3/T3 framing, the FOM-E3 and FOM-T3 modems operate opposite RAD's DXC cross connect, Optimux-134 multiplexer (FOM-E3) and Optimux-45 multiplexer (FOM-T3). Similarly, they can operate opposite an ACE ATM access device, enabling E3/T3 ATM traffic to be transported over long distances on fiber and connect to an ATM or SDH network device with an electrical E3/T3 port.

FOM-E3 and FOM-T3 operation complies with ITU G.703, G.921 and G.956 standards. In addition, the modems support activation of local and remote loopbacks in compliance with the ITU V.54 standard.

The FOM-E3 and FOM-T3 modems include a dry contact alarm port for relay of alarm conditions to external alert equipment.

- **Extends the range of E3 or T3 signals over fiber optic cable up to 110 km (68 miles)**
- **Wave Division Multiplexing (WDM) module for operation over a single fiber strand**
- **Wide range of optical modules including long haul lasers for extended range**
- **Operates opposite Optimux, ACE and DXC**
- **Built-in diagnostics comply with V.54 standard**
- **Dry contact alarm port for external alert devices**

For latest updates visit www.rad.com

FOMi-E3, FOMi-T3

E3, T3 and HSSI Manageable Fiber Optic Modems

The FOMi-E3 and FOMi-T3 are high speed fiber optic modems that extend the transmission range of electrical E3 or T3 over fiber optic cables:
FOMi-E3 for E3 rates (34.368 Mbps)
FOMi-T3 for T3 rates (44.736 Mbps)

Both modems can optionally support an HSSI DCE interface, which operates at the same rate as the modem type into which it is inserted (E3 at 34.368 Mbps and T3 at 44.736 Mbps). The HSSI option also supports bit rates of one-half and one-fourth of the main link rate. This option enables connection of high speed HSSI routers over backbones at E3 or T3 rates.

The FOMi-E3 and FOMi-T3 can substitute for an ACE, DXC or Optimux unit at the central office that works opposite identical devices at the customer premises, thereby enabling low-cost extension and conversion of E3/T3 fiber interfaces to standard electrical interfaces. When replacing an Optimux device at the central office, the FOMi-E3 or FOMi-T3 enables the use of one E3/T3 port on the ADM rather than using many E1/T1 ports.

The optical interface of the FOMi-E3 or FOMi-T3 is modular. The modems support the wide range of optical modules supported by the Optimux. These modules include multimode, single mode, laser, long haul laser, WDM, and all types of optical connectors. There is an option to install two optical interfaces for full redundancy of the optical link. There is also an option of dual power supplies for additional redundancy.

FOMi-E3 and FOMi-T3 feature flexible management capabilities, including local management via an ASCII terminal (RS-232). In addition, remote management can be performed out-of-band using a dedicated management protocol.

- **Extends the range of equipment with electrical E3, T3 or HSSI interfaces**
- **Inband management on both local and remote units**
- **Redundancy on fiber optic link and power supply**
- **Wave Division Multiplexing (WDM) module for operation over a single-strand fiber optic link**
- **Works opposite Optimux, ACE and DXC**
- **Different clock modes including central system clock**
- **Wide range of modular optical interfaces**

For latest updates visit www.rad.com

FOM-40

High Speed Fiber Optic Modem

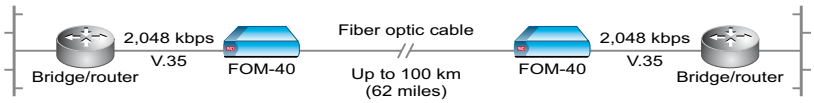
- **Selectable data rates: 56, 64, 112, 128, 256, 384, 512, 768, 1,024, 1,536, 1,544 and 2,048 kbps**
- **Range up to:**
  - **5 km (3 miles) for 850 nm multimode**
  - **20 km (12.5 miles) for 1310 nm single mode**
  - **50 km (31 miles) for 1310 nm laser diode**
  - **100 km (62 miles) for 1550 nm laser diode**
- **V.54 diagnostics and built-in BER tester**
- **Digital interfaces: V.24 (up to 64 kbps), V.35, X.21, RS-530, G.703 codirectional, Fast Ethernet/Ethernet (bridge)**

For latest updates visit www.rad.com

The FOM-40 is a high speed, synchronous fiber optic modem operating full or half duplex over fiber optic cable. It has selectable data rates from 56 kbps up to 2.048 Mbps, and a range up to 100 km (62 miles) using single mode 1550 nm laser diode. The FOM-40 can operate over single mode or multimode fiber using 850 nm or 1310 nm LEDs, 1310 nm laser diode or 1550 nm laser diode.

The large variety of interfaces supported by the FOM-40 facilitates the connection of distant routers to data services. The Ethernet/Fast Ethernet bridge modules enable the connection of remote LANs and VLANs. The FOM-40 extends these services and connections over fiber optic cables and performs the hand-off to the SDH/SONET or IP network.

The FOM-40 features V.54 diagnostics to perform local analog/digital and remote digital loopbacks. Loopback commands are controlled either manually by a front panel switch or via the DTE interface signals. The front panel switch generates an internal pseudo-random test pattern (511) according to the V.52 standard, for testing end-to-end connectivity.



FOMi-40

High Speed Fiber Optic Modem with Remote Control

- **User-selectable data rates from 56 kbps to 2.048 Mbps**
- **Extended transmission range up to 100 km (62 miles)**
- **Local and remote, analog and digital loop backs; V.52-compliant BER testing**
- **Automatic rate detection in tail-end applications**
- **Digital interfaces supported: V.24 (64 kbps only), V.35, X.21, RS-530, V.36/RS-449, Ethernet bridge, Fast Ethernet bridge, G.703 E1, G.703 T1, and G.703 codirectional (64 kbps)**

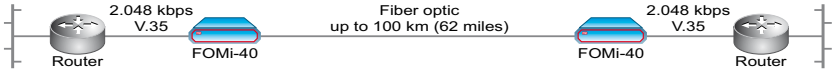
For latest updates visit www.rad.com

The FOMi-40 is a high speed sync fiber optic modem with remote configuration and monitoring. It supports user-selectable data rates from 56 kbps to 2.048 Mbps.

The FOMi-40 supports the common fiber optic wavelengths and connector types, operating over different types of fiber optic links.

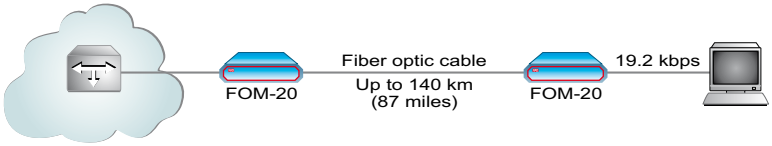
An inband management channel allows the user to monitor, control and configure the remote unit using the same fiber links as for data transmission, with no interference between them.

In tail-end applications, the local FOMi-40 automatically detects the external clock rate and is locked accordingly. It also updates the remote unit's clock rate via the management channel. This enables synchronization of local and remote units to the network clock.



FOM-20

Sync/Async Fiber Optic Modem



The FOM-20 is a sync/async fiber optic modem operating full or half duplex over fiber optic cable. It has 16 selectable data rates from 19.2 kbps up to 256 kbps. Four rates are for asynchronous transmission and 11 rates are for synchronous transmission (19.2 kbps is for both sync and async).

The FOM-20 can operate over single mode or multimode fiber using 850 nm or 1310 nm LEDs and 1310 nm or 1550 nm laser diodes.

The main application for the FOM-20 is point-to-point fiber links at ranges longer than any copper modem can achieve, in noisy environments or when security is a primary concern.

The FOM-20 features V.54 diagnostics to perform local analog/digital and remote digital loopbacks. Loopback commands are controlled either by a manual switch or via the DTE interface signals. The FOM-20 includes a built-in BER tester, which is activated by a front panel switch and generates a 511 pseudo-random test pattern according to the V.52 standard.

- **Wide range of selectable data rates – 19.2 kbps up to 256 kbps**
- **Synchronous or asynchronous data transmission**
- **Range up to:**
  - **8 km (5 miles) for 850 nm multimode**
  - **25 km (15.5 miles) for 1310 nm single mode**
  - **60 km (37.5 miles) for 1310 nm laser diode**
  - **140 km (87 miles) for 1550 nm laser diode**
- **Digital interfaces: V.24 (up to 64 kbps), V.35, X.21, RS-530, V.36/RS-449, Ethernet (bridge), and G.703 codirectional**
- **V.54 diagnostics and built-in BER tester**

For latest updates visit www.rad.com

PFH-4

Power Feeding Hub

Although SHDSL modems provide superior reach in comparison with other DSL technologies, the maximum range of standard SHDSL modems is still not sufficient for some longer-range applications, such as those along railways or pipelines. In such cases, SHDSL repeaters are employed to duplicate and retransmit the signal.

To simplify deployment and save the cost of laying power lines, repeaters can operate on a remote power feeding source. In other words, they can be powered over the same lines that carry the data traffic. RAD's PFH-4 is a remote power feeding hub designed especially to support long range SHDSL applications. It delivers power and data for up to four SHDSL wire pairs (four x 2-wire lines or two x 4-wire lines), eliminating the need for local power sources for modems or repeaters on the line.

The hub runs on 48 VDC power and can supply an output of 120 VDC or 180 VDC to each line.

Each SHDSL wire pair is input to the PFH-4, which then adds power to the original data signal. This power output feeds the repeaters on the line, which retransmit the data signal. Separate terminal block connectors are provided for easy connection of the input and output of each wire pair.

All lines are protected from overload, short-circuiting and leakage to earth. At overload, a current-limiter drops the line, activates an LED alarm and initiates an auto-restart recovery.

Dry contacts relay major and minor alarm warnings via a DB-9 connector.

Front panel LEDs indicate the power feeding status for each line and provide warnings for current and temperature overload conditions. An external DIP switch allows selective power feeding for each individual line.

- **Remote power feeding of up to four SHDSL wire pairs (four x 2-wire or two x 4-wire)**
- **Output power feeding options per line: 120 VDC @60 mA or 180 VDC @60 mA**
- **Terminal block connectors for each line input and output**
- **Current limit protection for each channel (line and earth)**
- **DIP switch allows for selective control for each wire pair**
- **LED line status indicators**
- **Dry contact connectors for alarms**
- **All connectors on front of 1U-high, half 19-inch metal enclosure**

For latest updates visit www.rad.com

ASM-40

High Speed Short Range Modem

- **Selectable data rates: 32 kbps to 2.048 Mbps**
- **Range up to 1.75 km (1.1 miles)**
- **V.54 diagnostics**
- **Digital interfaces: V.24, V.35, X.21, RS-530, V.36/RS-449, Ethernet (bridge) or G.703 (HDB3)**
- **Optional built-in router**

For latest updates visit www.rad.com

The ASM-40 is a high speed synchronous short range modem operating at 13 selectable data rates, from 32 kbps up to 2.048 Mbps with a range up to 1.75 km (1.1 miles).

The modem transmits data to the line at four data rates, depending upon the selected DTE rate or the PCM network. Data rates of 32, 64, 128, 256, 512, 1,024 and 2,048 kbps are transmitted at 2,048 kbps; data rates of 192, 384, 768 and 1,536 kbps are transmitted at 1,536 kbps; the 1,544 kbps data rate is transmitted at 1,544 kbps; and the 1,920 kbps data rate is transmitted at 1,920 kbps.

The modem's line interface is coded using HDB3, AMI or B8ZS (strap-selectable). On the digital side, a choice of V.35, V.36/RS-449, X.21, RS-530, built-in Ethernet bridge, router or G.703/HDB3 interfaces is available. This also enables the ASM-40 to perform as an interface converter, a rate converter or a repeater for G.703.

The ASM-40 features V.54 diagnostic capabilities to perform local analog loopbacks and local and remote digital loopbacks. An internal test pattern complying with the V.52 standard can be generated to provide end-to-end integrity testing.

The ASM-40 is available as a standalone unit or as a card for the 19-inch ASM-MN-214 rack that holds up to 14 cards (see page 127).

ASM-31

2-Wire Multirate Short Range Modem

- **Selectable data rates:**
  - **1.2 kbps up to 128 kbps (sync)**
  - **Up to 38.4 kbps (async)**
- **2-wire full duplex**
- **Adaptive echo canceller**
- **Range up to 8 km (5 miles) over 24 AWG lines**
- **2B1Q line code**
- **DTE interfaces: V.24/RS-232, V.35, V.36, RS-530, X.21, Ethernet (bridge) or G.703 codirectional (64 kbps)**
- **Optional built-in router**

For latest updates visit www.rad.com

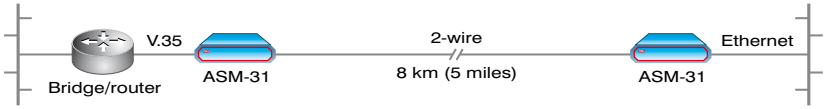
The ASM-31 multirate sync/async short range modem operates full duplex over a 2-wire twisted pair. The ASM-31 can operate at selectable data rates from 1.2 kbps to 128 kbps.

Full duplex operation is achieved using the adaptive echo cancellation technique. This method entails setting one modem as a master and the other as a slave (switch-selectable). 2B1Q line coding provides an operating range of up to 8 km (5 miles) for all data rates, with an internal rate converter that converts all DTE data rates to a line data rate of 128 kbps.

Local and remote loopbacks can be activated from either side of the line, to test both modems and the line. Loopbacks are controlled by a manual switch or from the DTE interface. The modem includes a BER tester for complete end-to-end integrity testing. An error LED indicates each bit error detected. The ASM-31 has line protection circuits against lightning and power surges.

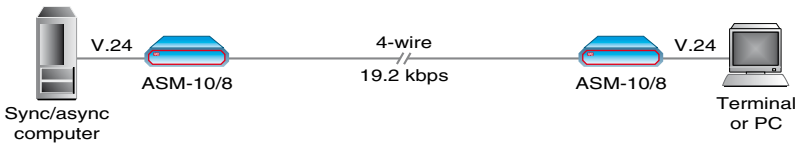
Interface options include V.24/RS-232, V.35, V.36, X.21, RS-530, built-in Ethernet bridge, router, and G.703 codirectional 64 kbps. The analog line connectors are RJ-45 and terminal block.

The ASM-31 is available as a standalone unit or as a card for the 19-inch ASM-MN-214 rack that holds up to 14 cards (see page 127).



ASM-10/8

Sync/Async Short Range Modem



- **Full or half duplex over 4-wire**
- **Data rates up to 19.2 kbps**
- **Range up to 10 km (6.2 miles) at 19.2 kbps**
- **Controlled or continuous carrier**
- **V.54 diagnostics**
- **Automatic equalizer**

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The ASM-10/8 is a sync/async short range modem operating full or half duplex over twisted pair, unconditioned lines in point-to-point applications. It has a range of up to 10 km (6.2 miles) and operates at nine selectable rates up to 19.2 kbps.

The modem uses conditional diphase modulation (EUROCOM Std. D1), which provides immunity to background noise, eliminates normal line distortion and enables efficient transmission over twisted pair. Transmit timing is provided internally, derived externally from the DTE or recovered from the receive signal.

The ASM-10/8 features diagnostic capabilities complying with the V.54 standard to perform local and remote loopbacks.

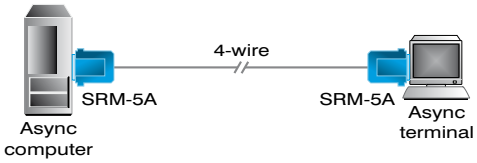
The unit has a V.24/RS-232 interface and is available as a standalone unit or as a card for the 19-inch ASM-MN-214 rack that holds up to 14 cards (see page 127).

Approximate Range for 24 AWG (0.5 mm)

Data Rate (kbps)	km	miles
19.2	10.0	6.0
9.6	13.0	8.0
4.8	16.0	10.0
2.4	21.0	13.1
1.2	28.0	17.5

SRM-5A

Short Range Modem



- **4-wire, full duplex**
- **Internal filter for high noise immunity**
- **Data rates up to 19.2 kbps**
- **DCE/DTE switch**
- **No external power required**
- **Transformer line isolation**

For latest updates visit www.rad.com

The miniature SRM-5A is an asynchronous short range modem connecting full duplex asynchronous terminals to computers. The SRM-5A operates at data rates of up to 19.2 kbps with a range of 4.5 km (2.8 miles) at 9.6 kbps.

The DCE/DTE switch allows operation as a DTE for connection to another DCE, without requiring a cross cable. It operates without external power by drawing low power from the data and control signals.

Connection to the line is through isolation transformers for protection against AC or DC overvoltages.

The SRM-5A modem is available with an internal filter. The filter is designed to overcome radiated and conducted interference for high noise immunity.

Approximate Range for 24 AWG (0.5 mm)

Data Rate kbps	km	miles
19.2	2.0	1.2
9.6	4.5	2.8
4.8	5.0	3.0
1.2–2.4	5.5	3.4

6

Voice Products

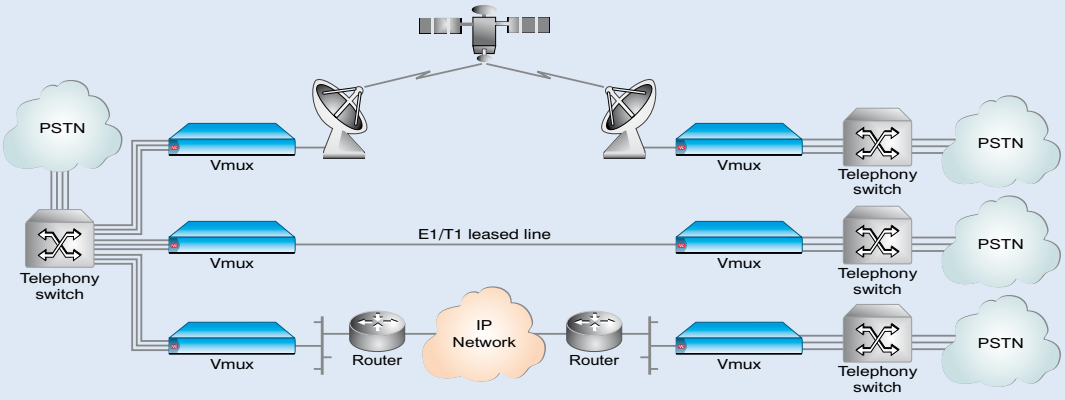
Carriers and enterprises are looking for ways to reduce costs by transporting their voice traffic with greater bandwidth efficiency. This can be achieved by implementing state-of-the-art voice trunking and compression algorithms, and by converging voice and data traffic over packet switched networks using 3G media gateways.

Voice trunking

Long distance and international leased lines are still quite expensive in many parts of the world, especially satellite-based communications. Reducing the amount of bandwidth required for voice transmission can significantly reduce OpEx. RAD's voice trunking gateways use advanced voice compression algorithms, as well as silence suppression and RAD's unique TDMoIP multiplexing, to reduce the amount of bandwidth required for voice transmission by up to 16 to 1. This translates into significant reduction in OpEx, while maintaining toll-quality voice, without compromising signaling, fax and telephony features.

Benefits of RAD's voice trunking solutions

- Significant bandwidth reduction (up to 16:1) translates into significant cost savings
- High quality voice
- Full transparency to signaling and telephony features eliminates the need for additional capital expenditure or retraining of staff
- Future-proof solution, equipped with both TDM and IP network links
- Reduces initial investment with scalable products that are simple to install and maintain



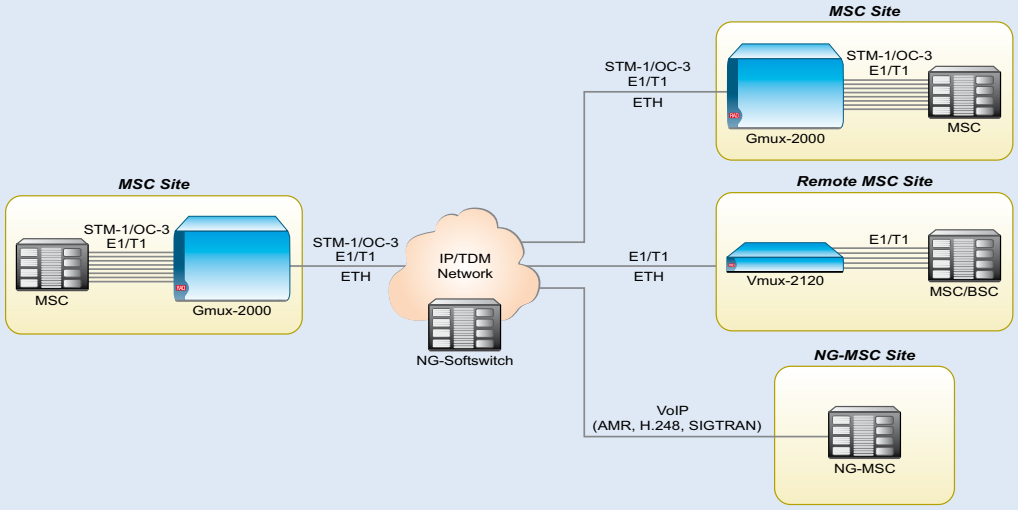
Voice trunking over TDM/IP links

Typical applications

Inter-MSC trunking – Typically hundreds of long haul links are used to transport traffic between MSCs (E-channel) in meshed, star or mixed network topologies. Limiting the number of links translates into immediate cost savings. RAD's Vmux or Gmux voice trunking gateways use advanced voice compression technologies to significantly reduce the number of required leased lines. These savings translate into fast payback. In addition, RAD's Vmux devices serve as 3G media gateways, enabling operators to avoid 2G MSC forklifts when transitioning to 3G services.

PBX extension over satellite – Providing voice services to remote/mobile platforms usually involves satellite communications, which significantly increases OpEx for oil/gas, maritime, broadcasting, emergency response, and government/military applicaitons. RAD's Vmux voice trunking gateways increase the capacity and reduce the cost of extending voice services over satellite.

Using RAD's Vmux voice trunking gateways, providers of offshore call center services can significantly reduce their operational costs, without degrading the level of service they provide.



Business-grade telephony access for alternative carriers and ISPs

Vmux-2120

Voice Trunking Gateway

TDMoIP Driven®

- **Compresses up to 16 E1/T1 voice lines over redundant channelized E1/T1 or Fast Ethernet links**
- **Up to 16:1 voice compression using a wide range of standard codecs**
- **Fully redundant platform**
- **3G media gateway functionality with MEGACO, VoIP and SIGTRAN support**
- **Silence suppression, 128 ms echo cancellation and TDMoIP multiplexing to maximize bandwidth savings**
- **Transparent to all signaling protocols and telephony features**
- **QoS support: Q.50 and bandwidth management**
- **Local and remote management via ASCII terminal, Telnet or RADview-SC/Vmux**
- **Compact, scalable and easy to deploy**

For latest updates visit www.rad.com

RAD's Vmux-2120 carrier-grade voice trunking and 3G media gateway provides compressed voice transmission over both TDM and IP networks. Employing powerful voice compression algorithms as well as TDMoIP multiplexing, the Vmux-2120 compresses up to 16 E1/T1 circuits over redundant E1/T1 or packet-based network access links, with backup between the TDM and IP connections. The device's dual TDM and Ethernet uplinks enable load sharing and simultaneous connections to different locations.

In addition, the fully redundant Vmux-2120 supplies 3G media gateway services, thus enabling operators to avoid 2G MSC forklifts when transitioning to 3G services. The platform is interoperable with NG-MSCs and softswitches.

The Vmux-2120 is ideal for cellular operators looking to replace expensive leased lines between MSCs, or between MSCs and the PSTN, with cost-effective packet transport. In addition, it allows international telecom providers and call centers to reduce the number of international lines they lease, and enables disaster recovery solution providers to save on expensive satellite bandwidth.

Voice compression over TDM and IP transport

The Vmux-2120 employs G.723.1, G.729 Annex A, AMR and G.711 compression algorithms, together with RAD's unique TDMoIP multiplexing, to transmit up to 496/384 voice channels, including transparent CAS and CCS, over a single E1, T1 or IP link.

Compressed voice can be transmitted over both TDM and IP networks by a single Vmux-2120 device. This unique capability enables the Vmux-2120 to easily switch between networks when necessary, without requiring additional equipment. Voice activity detection (VAD) and silence suppression allow Vmux-2120 units to dynamically allocate bandwidth for voice traffic as needed, resulting in highly efficient bandwidth utilization over fewer links and freeing up line capacity for data transport.

In addition, the Vmux-2120 supports transparent delivery of voice band data, enabling the transport of multiple HDLC and SS7 channels, as well as n x 64 kbps streams. All CCS protocols, such as SS7, ISDN and QSIG are supported. The device's full signaling transparency ensures seamless integration that does not involve retraining costs or loss of functionality.

Price performance benefits over VoIP

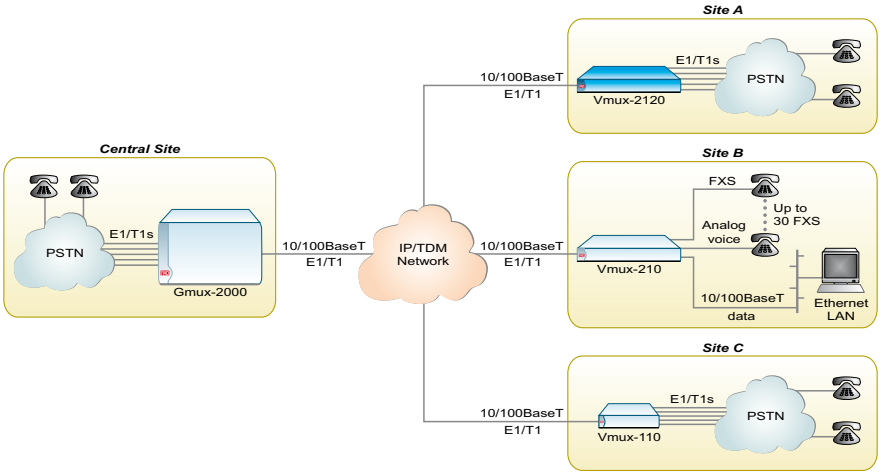
By combining voice/fax capabilities with Ethernet data traffic over a single delivery network, operators can save significantly on the costs of running their networks. The Vmux-2120's TDMoIP capabilities enable higher bandwidth savings (16:1) than any standard VoIP solution, while providing an effective migration path to IP. With super-tandem (transcoder-free operation) support, it ensures a single compression cycle end-to-end for calls connected via multiple Vmux units, thereby avoiding voice degradation and delay. In addition, the Vmux-2120 offers improved resiliency to packet loss and supports bandwidth control mechanisms for congestion avoidance.

Space-saving unit with fully redundant system

The compact, 1U-high Vmux-2120 can be installed in 19-inch racks and features the smallest footprint compared to any TDM voice compression or VoIP product of equivalent capacity. In addition to TDM and Ethernet port redundancy, as well as redundant hot-swappable power supplies, the system supports hot-standby, hot-swappable card redundancy and allows hitless software upgrades.

Pay as you grow

Vmux-2120 can be ordered with only some of the voice ports activated. Software licenses may be added at any time for enabling additional ports, thus allowing easy system expansion.



Voice trunking over IP/TDM in a mesh topology

Vmux-210

Analog Voice Trunking Gateway (Compressed Channel Bank)

TDMoIP Driven®

Vmux-210 is a remote voice trunking gateway for both IP and leased line TDM networks, providing LAN and compressed voice services for corporate applications that require a large number of analog lines for POTS or fax connection. It is a customer-located device that complements RAD's larger modular Vmux-2120 system equipped with E1/T1 voice interfaces.

Voice compression for analog lines

Vmux-210 compresses voice traffic and transports it over a serial link, E1/T1 link, or a 10/100BaseT IP uplink. The device employs G.723.1, G.729 Annex A and G.711 compression algorithms together with RAD's unique TDMoIP multiplexing, including transparent CAS.

Voice activity detection (VAD) and silence suppression

Voice activity detection (VAD) and silence suppression allow Vmux units to dynamically allocate bandwidth for voice traffic. Efficient bandwidth usage leaves more bandwidth for data transport. LAN data traffic can be controlled with rate limiting.

The gateway is transparent to all signaling protocols and telephony features.

Vmux-210 can be configured and monitored via a local ASCII terminal, Telnet or RADview-SC/Vmux.

Vmux-210 is a compact, 1U-high, 19-inch wide unit that can be mounted in standard 19-inch racks. The voice interface options include 12, 15, 24, or 30 FXS analog ports. The unit is available with either AC or DC power supply.

- **Compresses up to 30 FXS voice lines over an E1/T1, serial or IP link**
- **Uses voice compression, silence suppression and TDMoIP multiplexing for maximal bandwidth savings**
- **High quality voice**
- **More bandwidth efficient than standard VoIP**
- **Compatible with all types of VSATs**
- **Transparent to all signaling protocols and telephony features**
- **Additional user LAN port with voice/ data prioritization**

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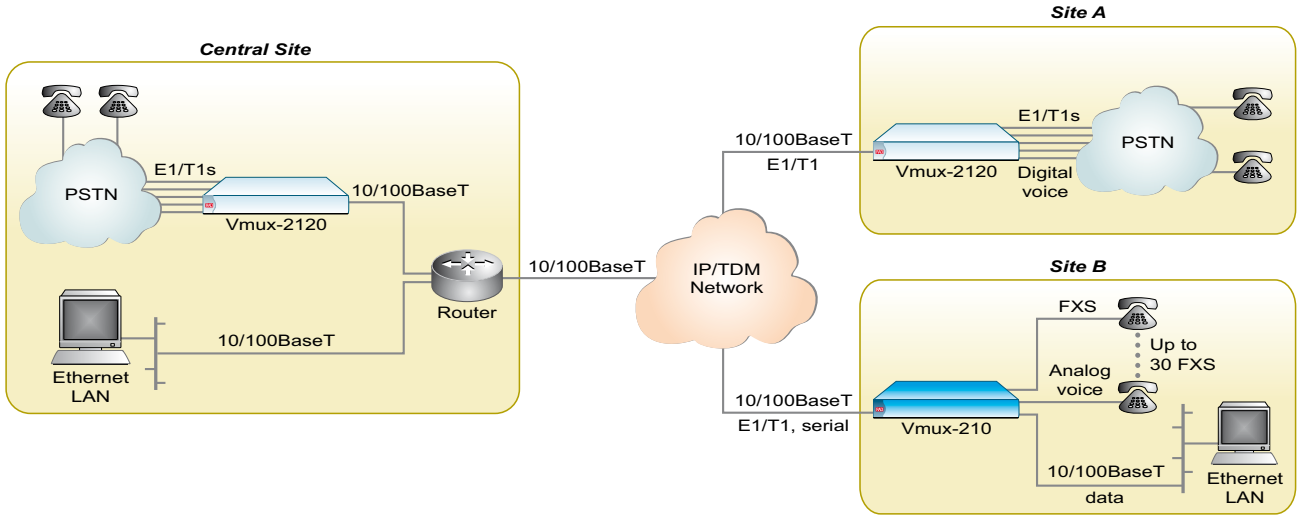


Data and compressed digital/analog voice over IP/TDM networks

Vmux-110

Remote Voice Trunking Gateway

TDMoIP Driven®

- **Compresses four or eight FXS/FXO/E&M voice lines or a single E1/T1 voice line over an E1/T1, serial or IP link**
- **Up to 16:1 voice compression, combined with silence suppression and TDMoIP multiplexing for maximal bandwidth savings**
- **High quality voice**
- **More bandwidth efficient than standard VoIP**
- **Compatible with all VSATs**
- **Transparent to all signaling protocols and telephony features**
- **Additional user LAN port with voice/ data prioritization**

For latest updates visit www.rad.com

The Vmux-110 is a customer-located device that complements the Vmux system, providing LAN and compressed voice transmission over both TDM and Ethernet-based networks. Employing powerful voice compression algorithms as well as TDMoIP technology, the Vmux-110 can compress a full E1/T1 or four or eight analog lines, leaving more bandwidth for data transport.

Reduces line costs

Vmux-110 supports four or eight FXS/FXO/E&M ports or a single full or fractional E1/T1 voice port. It compresses voice traffic and transports it over an n x 64 kbps, E1/T1 or IP link. The device employs G.723.1, G.729 Annex A and G.711 compression algorithms together with RAD's unique TDMoIP multiplexing, and is transparent to all signaling protocols and LAN.

Silence suppression improves bandwidth utilization

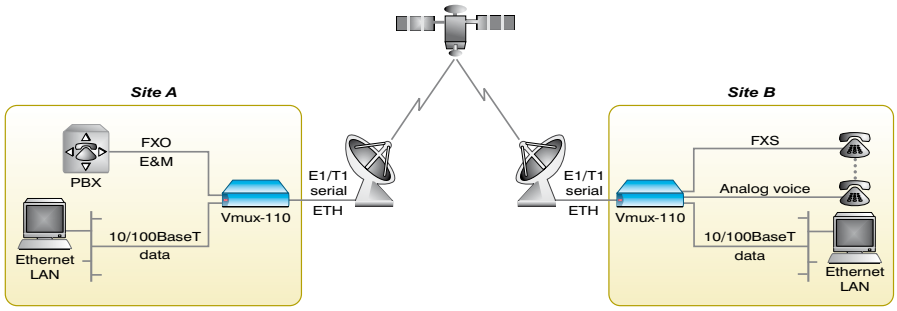
Voice activity detection and silence suppression allow these Vmux units to dynamically allocate bandwidth for voice traffic. This results in very efficient bandwidth usage, leaving more bandwidth for data transport, further controlled with rate limiting capabilities.

Ethernet port for data

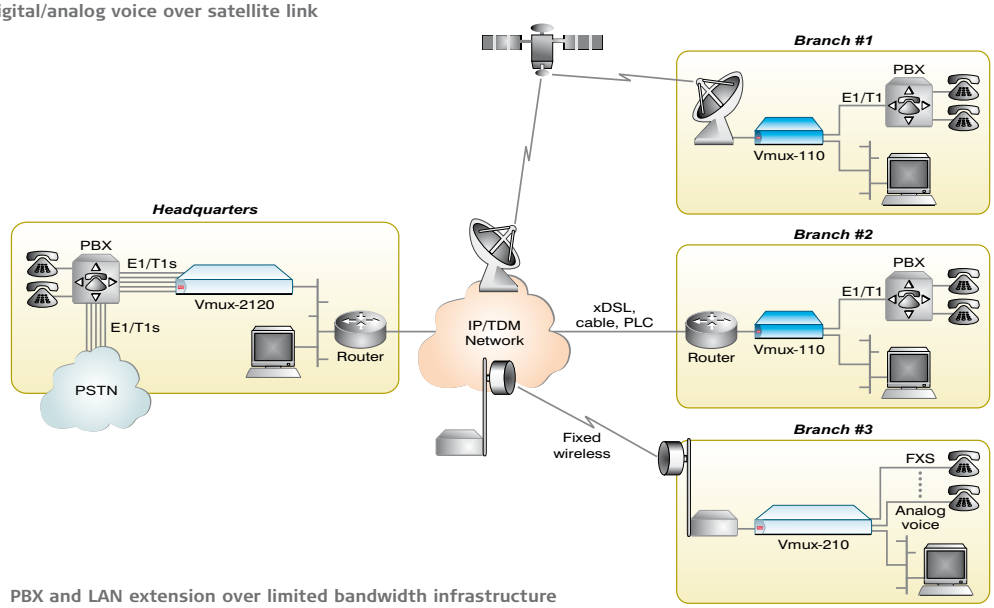
For data connectivity, the customer-located Vmux-110 features a second 10/100BaseT port and an Ethernet switch for integrating the user LAN traffic with the compressed voice over an IP, serial or E1/T1 uplink.

Management

Local and remote management for the Vmux-110 can be performed via ASCII terminal, Telnet or RADview-SC/Vmux. The Vmux-110 is a compact, 1U-high, half 19-inch wide unit that can be mounted in a 19-inch rack. The unit is available with either an AC or DC power supply.



Data and compressed digital/analog voice over satellite link



PBX and LAN extension over limited bandwidth infrastructure

Gmux-2000

Carrier Voice Trunking Gateway

TDMoIP Driven®

The Gmux-2000 is a carrier-class, modular voice trunking gateway that provides a cost-effective high capacity solution for reducing the bandwidth required for voice transmission over TDM, IP or MPLS networks.

Using state-of-the-art voice compression algorithms, as well as voice activity detection, silence suppression and RAD's unique TDMoIP multiplexing, Gmux-2000 can reach a maximum compression ratio of 16:1, transmitting up to 112 E1/T1 links over as few as seven E1/T1s, or over a single Gigabit Ethernet link. Alternatively, Gmux-2000 can compress voice coming directly from an STM-1/OC-3 voice trunk.

By optimizing signaling channels (SS7, PRI, etc.) Gmux-2000 further reduces overall bandwidth.

Gmux-2000 maintains a high quality of voice, while ensuring continued support of inband telephony features, such as fax, modem, IVR, and others.

When the Gmux-2000 is deployed opposite the Vmux-2120, Vmux-110 or Vmux-210, it offers a complete, cost-effective, carrier-class voice trunking solution.

Modules

Gmux-2000 is a 6U-high chassis, mountable in a 19-inch ETSI or ANSI rack, housing the following modules:

- Up to two PSN network uplink modules or inband management modules
- Two control modules
- Three AC or DC power supply modules
- Seven I/O modules (voice compression modules or STM-1/OC-3 interface modules)
- A cooling fans module

Gigabit Ethernet network modules, each with a pair of redundant Gigabit Ethernet (GbE) ports, support Ethernet IEEE 802.3ad, 802.1Q (VLAN tagging) and 802.1p (priority bits).

Voice compression modules perform compression and processing of E1/T1 traffic flows, and transmit the compressed voice over the E1/T1 main link ports on the module itself, or through the internal bus to the GbE network module. Each voice compression module is capable of handling 12 or 16 incoming E1/T1s (ordering option). These modules function as server modules, meaning they can receive the voice directly from the PBX/MSC (via a direct Telco cable), or they can process voice coming in from an STM-1 module. The voice compression modules are capable of functioning in point-to-multipoint topologies as well.

STM-1/OC-3 interface modules perform SDH/SONET multiplexing/demultiplexing of channelized STM-1/OC-3 trunks into separate, internal E1/T1 circuits (for processing by the voice compression modules). Each STM-1/OC-3 interface module provides a pair of ITU-T G.703 coax or G.957, G.958 fiber optic links, supporting 1+1 redundancy according to ITU-T G.783.

Control modules provide the SNMP and management interfaces for configuration and control of the entire Gmux-2000 system. Each control module provides redundant interfaces for connecting external G.812 station clocks and for alarm inputs/outputs.

Power supplies are hot-swappable, plug-in modules. Up to three AC or DC power supply modules can be installed for load sharing and redundancy. Two modules are required to drive a fully equipped Gmux-2000 system.

- **Supports Inter-MSC 2G and 3G networks**
- **Compresses up to 112 full E1/T1 voice lines or a single STM-1/OC-3 voice line over E1/T1, SDH/SONET or GbE links**
- **Up to 16:1 voice compression, combined with silence suppression and TDMoIP multiplexing for maximal bandwidth savings**
- **Modular chassis with full hardware redundancy**
- **High quality voice**
- **Transparent to all signaling protocols and telephony features**
- **Additional optimization of signaling channels**
- **Local and remote management via ASCII terminal, Telnet or RADview-SC/Vmux**

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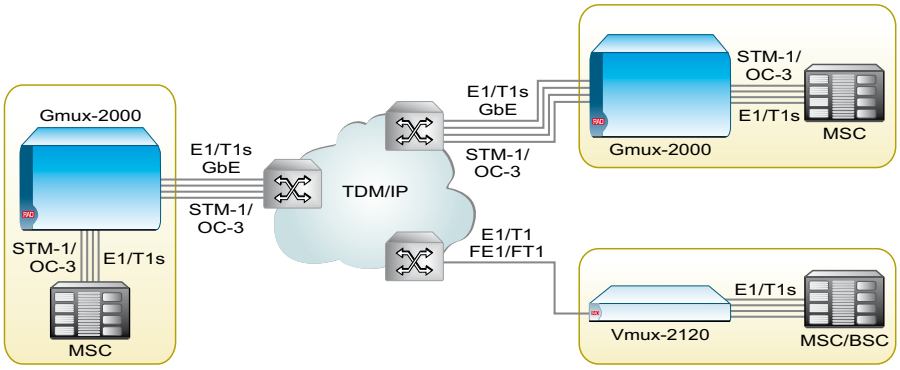
Service center management and security

The Gmux-2000 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 one of the network 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), service provisioning and diagnostic tools are provided by RADview-SC/Vmux, RAD's network management system, via an SNMP-based GUI.

The Gmux-2000 also supports a variety of access protocols, including CLI over Telnet, SNMP, and TFTP. Incorporated security features include Secure Shell (SSH), Secure FTP (SFTP), SNMPv3, and RADIUS, as well as management access control list (ACL).



Voice trunking over multiple E1/T1 streams in a cellular network

7

TDM Pseudowire

During the last decade, pseudowire technology has been established as the de-facto enabler for migrating legacy communications services to economical, higher bandwidth packet switched networks (PSNs). Today, TDM pseudowires are implemented in many mainstream services, transparently carrying voice, video and data traffic end-to-end over Ethernet, IP or MPLS backbones.

What is TDM pseudowire?

Pseudowire (PW) emulation is a method for transmitting any Layer 2 protocol over packet switched networks. It allows a seamless connection between two network elements by creating logical links, or virtual tunnels, across the packet network. In TDM pseudowire, the transmitted E1, T1, E3, or T3 streams are encapsulated in packets upon entering the network and then reconstructed at the pseudowire egress, where clocking information is also regenerated. As a result, real-time traffic is delivered transparently without distortion, avoiding the complexities of translating signaling data, while ensuring that synchronization criteria are met.

The pioneering author of various pseudowire RFCs, recommendations and implementation agreements, RAD has been actively involved in the creation of the industry's major pseudowire standards by the IETF, ITU, MFA, and MEF. Since first introducing TDMoIP pseudowire encapsulation to the market in 1999, RAD has deployed more than 110,000 pseudowire links worldwide. Our vast expertise and industry-leading know-how create field-proven solutions that ensure service continuity for TDM applications, with full support for legacy equipment, such as Class 4 and 5 switches, PBXs and TDM multiplexers.

RAD's TDM pseudowire expert solutions

RAD offers a diverse mix of TDM pseudowire access gateways – from small customer-located equipment, to high-capacity aggregation units for central offices or points-of-presence (POPs). The IPmux family of TDM pseudowire gateways (see pages 150-154) handles full E1/T1, fractional E1/T1 and E3/T3 streams right off the user premises, while the Gmux-2000 (pages 156-157) offers a modular chassis for aggregating and terminating pseudowire traffic. Together, they provide circuit extension over packet with VLAN-based service differentiation, using any media, including fiber, copper, HFC, microwave, and satellite access. In addition, the TDM pseudowire access gateways incorporate dedicated ASICs featuring all standard TDM pseudowire modes, with end-to-end QoS and OAM attributes to meet service-specific performance criteria.

RAD also offers innovative TDM pseudowire gateways in an SFP (small form-factor pluggable) format, maximizing user flexibility with a simple and cost-effective alternative to conversion cards. Designed for quick and simple insertion into any Fast Ethernet device port with a compatible SFP socket, the MiTOP-E1/T1 and MiTOP-E3/T3 simplify management and save on space, power consumption and cabling (see page 158).

Compelling benefits

RAD's TDM pseudowire access gateways offer a high degree of flexibility in determining the migration path to packet transport by allowing access agnostic delivery of all services and transmission protocols. Other benefits include:

- Enabling end users to keep their existing equipment
- Eliminating the need to invest in separate, service-dedicated networks
- Supporting quick and non-disruptive upgrade of legacy services to future-ready networks
- Simplifying network management, maintenance and operations
- Allowing more users to be served by the same infrastructure

Who benefits from TDM pseudowire?

Incumbent carriers cut operating expenditures (OpEx) and minimize customer churn by converging legacy traffic with new revenue generators, such as E-Line and E-LAN services, over cost-effective PSNs.

Alternative service providers and cable operators with packet-based infrastructure grow their customer base by adding traditional leased line and private line services to their Layer 2 portfolio.

Enterprises reduce their IT expenses on PSTN connectivity and branch-to-branch communications by consolidating PBX, ISDN BRI, video, and data traffic over a single, economical Ethernet link.

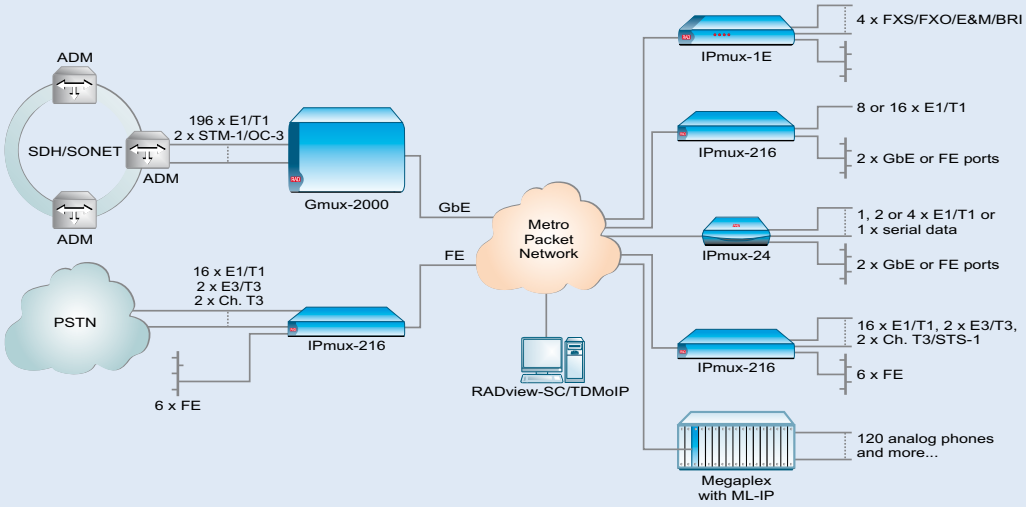
Mobile operators and transport providers reduce backhaul costs and ensure SLA enforcement for colocated towers and tower clusters over Fast/Gigabit Ethernet access rings.

Popular TDM pseudowire applications

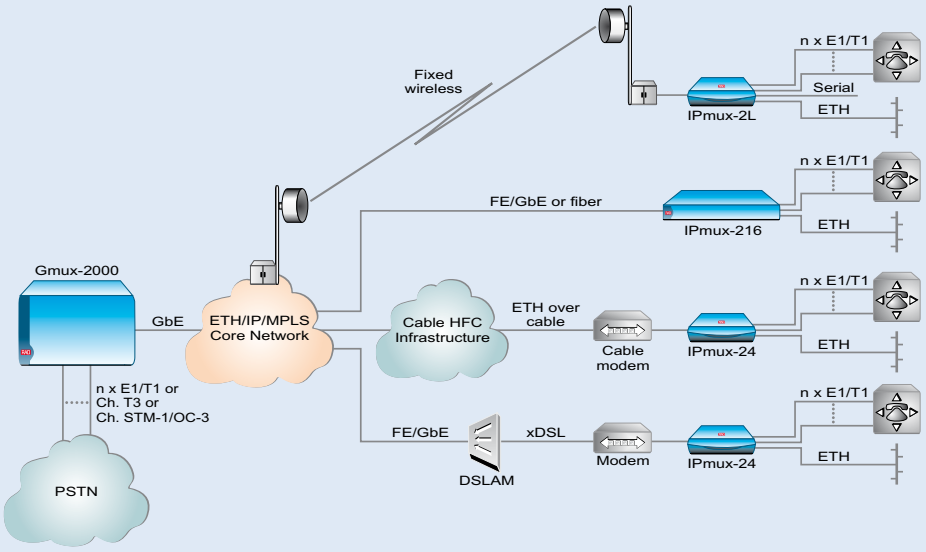
- Leased line services over Ethernet, IP or MPLS
- Service extension over packet access
- Private line and transparent LAN services (TLS) over Metro Ethernet
- Cellular backhaul over packet transport
- Leased line replacement with packet transport for enterprises

Synchronization and clock recovery

Because PSNs are inherently asynchronous, they introduce impairments, such as packet delay, delay variation and packet loss. RAD's TDM pseudowire gateways incorporate adaptive clock recovery (ACR) and synchronization schemes to overcome packet transport's inefficiencies and ensure end-to-end timing accuracy for real-time services. Complying with ITU-T G.823 and G.824 specifications, they facilitate multi-vendor interoperability and support ppb (parts per billion)-level frequency accuracy levels.



E1/T1, E3/T3 and Ethernet services over PSN



Service extension over PSN access

IPmux-24

IPmux-24, IPmux-216

TDM Pseudowire Access Gateways

- **Extends TDM, HDLC and Ethernet services over packet transport**
- **Up to four (IPmux-24), eight or 16 (IPmux-216) E1/T1 TDM user ports**
- **Three SFP-based fiber or copper Fast Ethernet or Gigabit Ethernet interfaces**
- **Multi-standard TDM pseudowire ASIC: TDMoIP, CESoPSN, SAToP, HDLCoPSN, CESoEth**
- **ITU-T G.8032 Ethernet Ring Protection Switching (ERPS) for sub-50 ms restoration; Ethernet link and TDM pseudowire redundancy**
- **Ethernet OAM: IEEE 802.3-2005 (formerly 802/3ah), 802/1ag, ITU-T Y.1731**
- **High precision clock recovery for 2G/3G cellular traffic over PSN**
- **QoS per 802.1p, ToS/DSCP, EXP**
- **MEF-9, MEF-14 certified for EPL, EVPL services**

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The IPmux-24 and IPmux-216 TDM pseudowire access gateways transparently deliver framed or unframed E1 or T1 signals, HDLC-based data streams, and user LAN traffic over packet switched networks, via copper or fiber Fast Ethernet or Gigabit Ethernet uplinks.

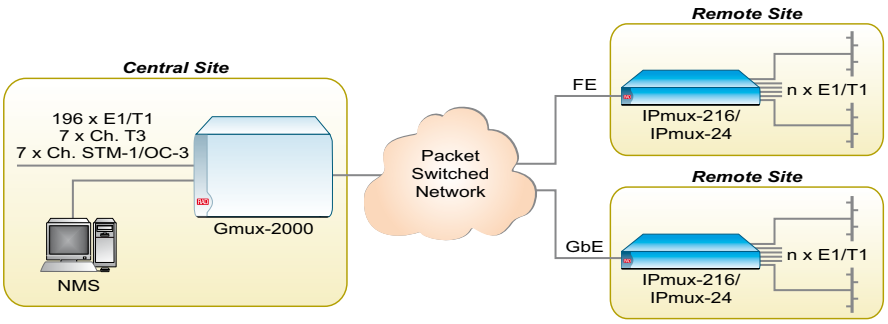
The devices' compact design, ease of installation, and advanced traffic management capabilities enable carriers to extend their services from legacy backbones over greenfield packet networks, without affecting customer experience or replacing existing end-user equipment. They also allow service providers to add traditional leased line services to their Layer 2 portfolio and permit enterprises to reduce their IT expenses on PSTN connectivity and branch-to-branch communications. In addition, they support cellular operators in migrating their services to economical packet switched backhaul.

Advanced pseudowire functionality

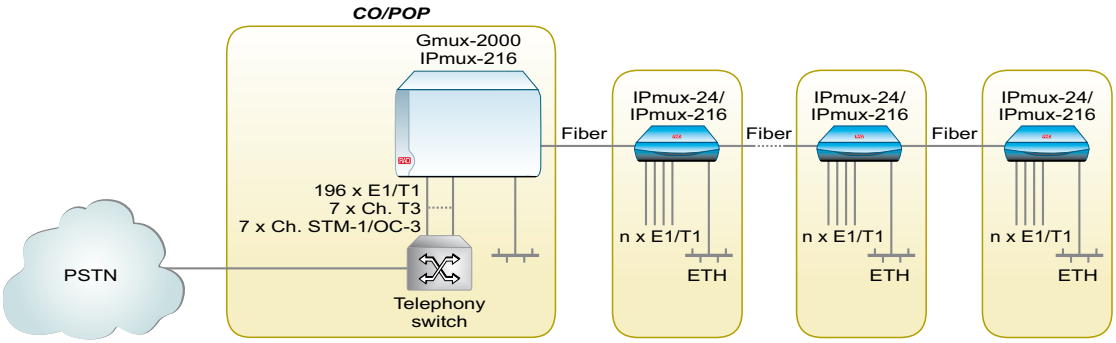
The IPmux-24 and IPmux-216 feature enhanced pseudowire performance with minimal processing delay, including support for all standard TDM circuit emulation modes, such as TDMoIP, CESoPSN, SAToP, HDLCoPSN, and CESoEth (MEF-8). The devices enable each timeslot to be assigned a separately configured pseudowire connection, thereby supporting multiple PW flavors simultaneously, with a 64-circuit pseudowire capacity (IPmux-24), or a 256-circuit pseudowire capacity (IPmux-216). By grooming DS0-level bundles, the devices also facilitate an efficient use of the expensive TDM ports.

Clock recovery and timing

The IPmux-24 and IPmux-216 ensure end-to-end timing accuracy for real-time services across non-deterministic packet networks. Featuring



E1/T1 extension over packet switched network



Daisy-chain application

adaptive clock recovery (ACR) capabilities per port, a remote IPmux-24 or IPmux-216 can accurately regenerate an original clock transmission in varying network load conditions. The IPmux-24 conforms to ITU-T G.823/G.824 traffic and synchronization interface requirements and to G.8261-defined scenarios, providing low latency, attenuating delay variations and enabling service resiliency. Such high precision clocking attributes provide a frequency accuracy level of 16 ppb, guaranteeing a smooth operation of 2G and 3G cellular equipment over PSNs.

Ethernet QoS and VLAN capabilities

The IPmux-24 and IPmux-216 include an internal Ethernet bridge, operating in either VLAN-aware or VLAN-unaware mode. They support VLAN tagging per IEEE 802.1Q and VLAN stacking (Q-in-Q), which allow traffic separation between different users or services. Supporting Ethernet Private Line (EPL) service provisioning, the devices also include enhanced traffic engineering and CIR/CBS rate limitation features, thereby enabling service providers to granularly adjust bandwidth to fit capacity requirements. SLA enforcement and QoS guarantees are supported by four Strict Priority queues, classified by VLAN tags, per port 802.1p bits, IP Precedence, or ToS/DSCP bits.

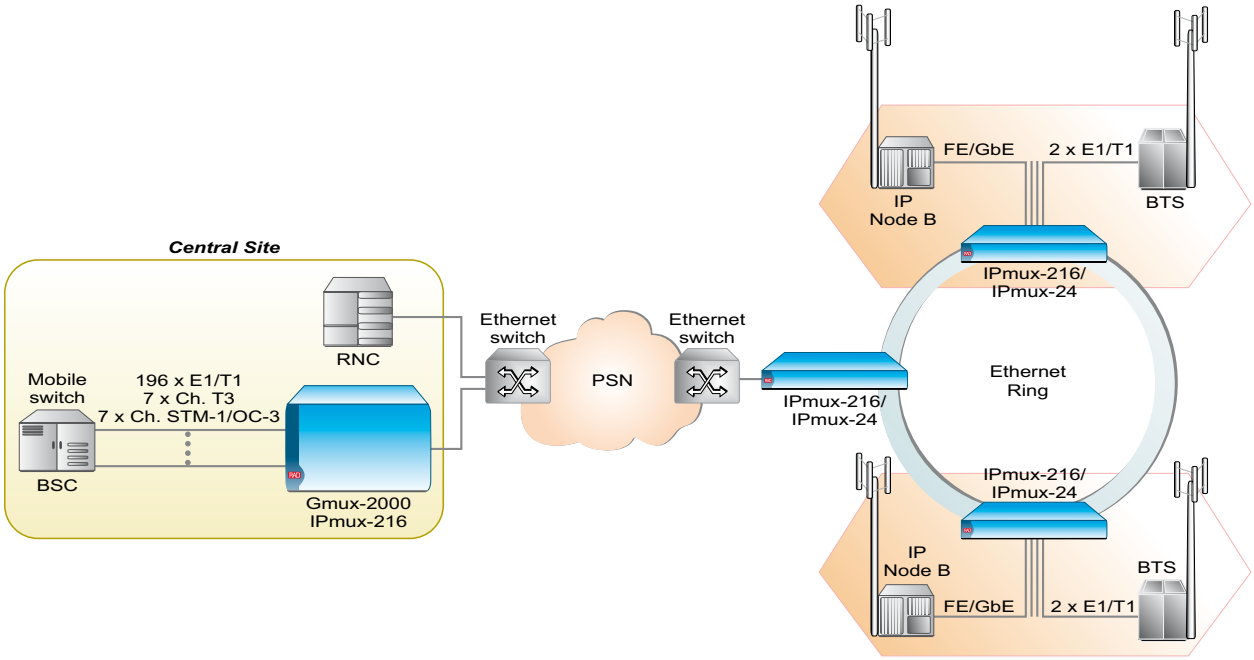
OAM and diagnostics

The IPmux-24 and IPmux-216 incorporate a complete Ethernet OAM suite that includes Ethernet Link OAM (IEEE standard 802.3-2005, formerly 802.3ah), Ethernet Service OAM (IEEE 802.1ag) and Performance Monitoring (ITU-T Y.1731). Diagnostic loopbacks can be remotely activated, while network condition statistics for the LAN and IP layers are also monitored and stored by the device. Performance monitoring parameters include packet loss, packet mismatch and packet delay variation.

Service center management and security

The IPmux-24 and IPmux-216 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), service provisioning and diagnostic tools are provided by RADview-SC/TDMoIP, RAD's network management system, via an SNMP-based GUI.

The devices 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.



Mobile backhaul application over an Ethernet ring

IPmux-2L, IPmux-4L, IPmux-16L

TDM Pseudowire Access Gateways

- **Delivers Ethernet and TDM-based services over fiber and packet switched networks (PSNs)**
- **Up to 16 E1 user ports**
- **Optional serial data port (IPmux-2L)**
- **Single SFP and two UTP/SFP; Fast/Gigabit Ethernet ports**
- **Multi-standard TDM pseudowire ASIC: TDMoIP, CESoPSN, SAToP**
- **QoS support with four priority queues**
- **Pseudowire OAM**
- **Per ITU-T G.823 jitter and wander performance**

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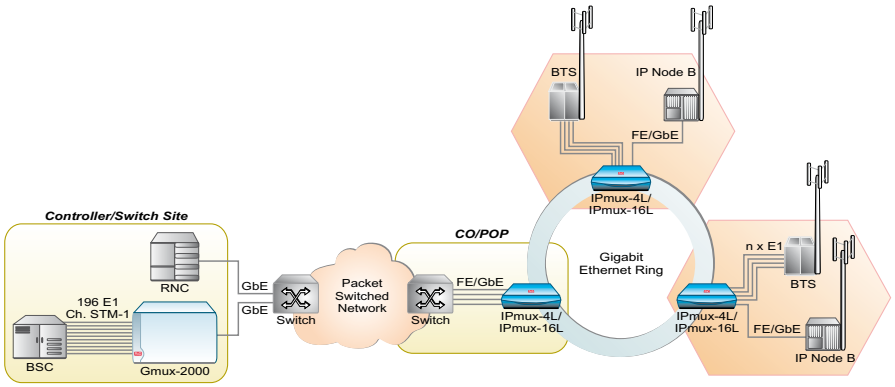

Corporate multiservice communications over a PSN

The IPmux-2L, IPmux-4L and IPmux-16L are cost-competitive TDM pseudowire access gateways, converging framed or unframed E1 streams along with user LAN traffic over dark fiber, IP, MPLS or Ethernet networks. The IPmux-2L also supports serial data delivery over PSN for X.21, V.35, V.36/RS-449, RS-530/RS-422, and V.24/RS-232 traffic. The devices offer an ideal solution for economical PSTN access and TDM trunking over wired and radio packet access. Their extensive TDM pseudowire support enables enterprises and utility companies to take advantage of new packet switched networks for legacy services transport, without replacing their existing equipment or affecting service quality.

Advanced pseudowire functionality

Incorporating RAD's new generation of ASIC processors, the IPmux-xL CPEs deliver enhanced pseudowire performance with minimal processing delay, including support for all standard TDM circuit emulation modes: TDMoIP, CESoPSN, and SAToP. Featuring a 63-circuit pseudowire capacity (IPmux-2L) or 64-circuit pseudowire capacity (IPmux-4L), the devices support individually configured pseudowire connections in timeslot granularity, thereby supporting multiple PW types simultaneously. By grooming E1 bundles in timeslot granularity, the IPmux-xL also facilitates an efficient use of the TDM ports. Configurable packet size balances PSN throughput and delay, while a jitter buffer compensates for packet delay variation (jitter) of up to 200 msec in the network.

Pseudowire timing

The IPmux-xL devices support various clocking options to ensure synchronization as any standard TDM device. These include loopback timing, external clock source or internal, using the devices' internal oscillator.

The devices can also recover the original clock with great accuracy, using per-port adaptive clock recovery. They comply with G.823 traffic interface mask and provide frequency accuracy of up to 100 ppb (parts per billion).

Ethernet capabilities

The IPmux-4L and IPmux-16L feature one or two GbE network ports, four FE user ports and one GbE user port. All ports support both copper and fiber interfaces with auto-negotiation.

The devices' internal Ethernet bridge supports both VLAN-aware and VLAN-unaware modes, as well as port-based rate-limiting, VLAN membership, VLAN tagging and stacking (Q-in-Q), and filtering. Standard IP features supported by the IPmux-4L and IPmux-16L include ICMP (ping), ARP, next hop, and default gateway.

The IPmux-4L and IPmux-16L employ ITU-T G.8032 Ethernet Ring Protection Switching (ERPS) to mitigate against link and node failures and ensure sub-50 ms restoration. Failures in the ring are detected using Ethernet OAM (ITU-T Y.1731) continuity check (CC) messages between adjacent nodes.

The IPmux-2L includes an Ethernet switch featuring three Ethernet ports, whereby one port serves as the network interface and the other two are used for user traffic.

Supported Ethernet attributes include port-based VLAN membership and VLAN tagging, as well as VLAN stacking (Q-in-Q). In addition, the devices support port-based rate limitation, enabling the total transmitted bandwidth to be adapted to the limitations of the transport media. Ethernet QoS features include four priority queues, scheduled by Strict Priority or weighted fair queue (WFQ). Traffic is classified according to IP Precedence, 802.1p, DSCP, or port default priority

EMS management

The IPmux-xL series 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 devices also support a variety of access protocols, including Telnet, SNMP, Web server, and TFTP.

	IPmux-2L	IPmux-4L	IPmux-16L
User Ports:			
E1	1 or 2	4	16
Ethernet (SFP/UTP)	1 or 2 FE	4 FE, 2 GbE	4 FE, 2 GbE
Optional n x 64 Serial Data	1	–	–
Network Ports:			
Ethernet (SFP/UTP)	1 FE	1 or 2 GbE	1 or 2 GbE

IPmux-1E

TDM Pseudowire Access Gateway

Compact TDMoIP gateway for customer premises

RAD's IPmux-1E gateway reduces operating expenses by delivering virtually all TDM, data and LAN services over IP/Ethernet/MPLS networks, while ensuring Strict Priority for the TDMoIP traffic over the network link. End users continue to receive all familiar services, while carriers and service providers maintain revenues from legacy services. The compact size, ease of installation and support for multiple legacy and next-generation Ethernet and IP-based services make it ideal for small and medium-sized enterprises (SMEs).

Ethernet QoS capabilities

IPmux-1E answers the growing need of business customers for transparent LAN services, such as LAN-to-LAN interconnection and Ethernet connectivity to service providers. Enhanced QoS capabilities enable adaption of bandwidth to the transport media. Users can configure the ToS or DiffServ values of outgoing TDMoIP packets, to ensure they receive the required priority by network switches and routers. In addition, TDMoIP frames are assigned dedicated VLAN ID tags to separate user and management traffic and to filter user traffic.

TDM circuit extension

The TDMoIP gateway can connect to any user device with a standard E1/T1 interface. It also offers connectivity for four ISDN BRI S0 channels or four analog voice channels, with optional near-end echo cancellation (up to a full E1/T1) for cases where a large end-to-end delay causes echoes, such as in satellite applications. This device supports alarm detection and insertion along with error statistics, SES/UAS statistics, LOS/AIS physical layer alarms, and remote/Local Loop tests. It supports standard E1/T1 alarms from end to end.

Interfaces

IPmux-1E is equipped with the following interfaces:

- TDM user port options:
  - Single standard E1/T1 port with echo canceller
  - Four analog (FXS/FXO/E&M) ports with optional echo canceller
  - Four ISDN BRI S0 ports
- One Ethernet uplink with 10/100BaseT or 100BaseFX interface
- Optional Ethernet user port with 10/100BaseT interface for LAN connectivity

- **Transmits TDM-based services over Ethernet, IP or MPLS networks**
- **Analog, ISDN BRI and E1/T1 user ports with echo cancellation**
- **Transparent LAN bridging over packet switched networks**
- **Fiber and copper Fast Ethernet uplink interfaces**
- **QoS support**

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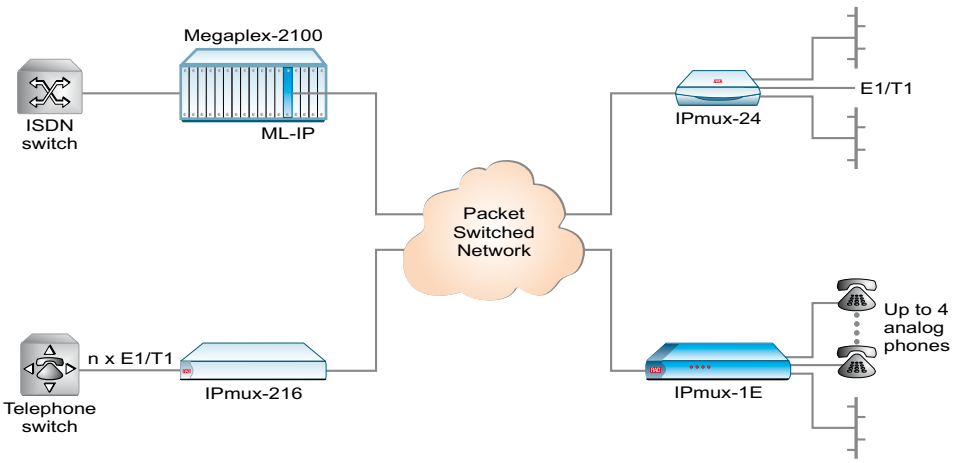
Service center management

The IPmux-1E 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), service provisioning and diagnostic tools are provided by RADview-SC/TDMoIP, RAD's network management system, via an SNMP-based GUI.

The IPmux-1E also supports a variety of access protocols, including Telnet, SNMP, Web server, and TFTP.



Analog extension over a packet switched network, grooming the traffic to n x E1/T1 at the central office

IPmux-155L

Hub-Site Pseudowire Access Gateway

- **High capacity pseudowire gateway, transporting TDM traffic over packet switched networks**
- **Supports IETF, MFA Forum and ITU-T standards for Pseudowire Emulation Edge-to-Edge (PWE3)**
- **Transport a fully populated channelized STM-1 stream or up to 32 E1 channels over PSN**
- **Aggregates 32 Fast Ethernet UTP/SFP connections into four Gigabit Ethernet links**
- **ITU-T G.8032 Ethernet Ring Protection Switching (ERPS)**
- **1U or 2U, 19-inch enclosure**

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The IPmux-155L is a cost-competitive access aggregator, delivering TDM pseudowire and user LAN traffic to packet switched networks. In addition, it performs as a pseudowire termination unit, sending TDM bundles to SDH backbones and Ethernet traffic to packet networks.

Working opposite CPEs, such as the IPmux-2L, IPmux-4L and the IPmux-24, it allows enterprises to replace expensive leased lines with cost-effective packet transport and offers an ideal solution for economical PSTN access and PBX backhaul.

The IPmux-155L includes a wire-speed, non-blocking Ethernet switch. Its high capacity includes the following interfaces:

- 1 + 1 redundant STM-1 ports or 32 E1 ports
- Four Gigabit Ethernet ports
- 32 fiber optic or electrical Fast Ethernet user ports

Advanced pseudowire functionality

Incorporating RAD's new generation of ASIC processors, the IPmux-155L features enhanced pseudowire performance with minimal processing delay, including support for standard SAToP and CESoPSN emulation mode. This allows the extension of TDM services from legacy backbones over greenfield packet networks without affecting service quality or user experience. The IPmux-155L supports separate configuration for up to 63 pseudowire connections. Configurable packet size balances PSN throughput and delay, while a jitter buffer compensates for packet delay variation (jitter) of up to 200 msec in the network.

Timing and synchronization

The IPmux-155L supports various clocking options to ensure synchronization as any standard TDM device. These include loopback timing, external clock source or internal clock, using the device's own oscillator. The IPmux-155L can also recover the original clock with great accuracy, using adaptive clock recovery (ACR). In addition, clock capabilities include holdover and hitless switching.

Ethernet capabilities

The IPmux-155L complies with the IEEE 802.3, 802.1Q and 802.1p requirements. It supports Link Aggregation per 802.3ad, with or without LACP. This enables the operator to use up to four Ethernet links as a single virtual interface, sharing traffic load and providing link resiliency. The device also supports G.8032 ERPS mechanism to protect against link and node failures and ensure sub-50 ms service resiliency.

The IPmux-155L employs Ethernet Link OAM according to IEEE standard 802.3-2005 (formerly 802.3ah), enabling service providers to monitor and troubleshoot the Ethernet network and quickly detect failures.

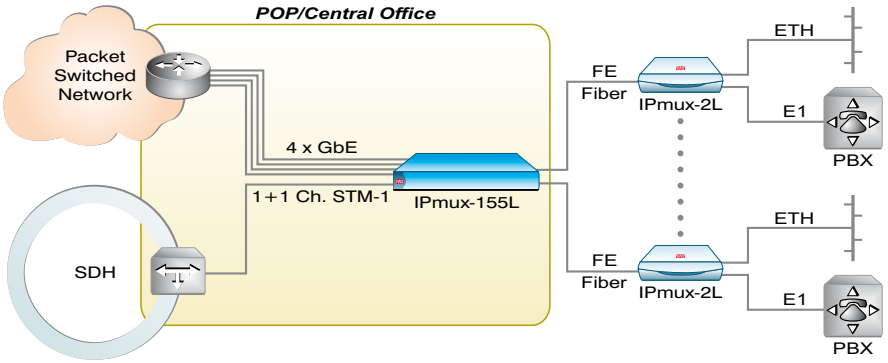
The IPmux-155L includes an internal bridge, operating in either VLAN-aware or VLAN-unaware modes. VLAN stacking (Q-in-Q) can be used for traffic separation between different users or services.

User traffic can be queued and prioritized according to VLAN priority (P-bit) ord ToS/Diffserv. Ingress and egress traffic can be rate limited per user and network ports.

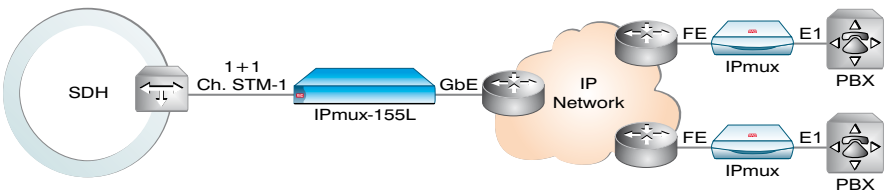
Policing and classification of traffic flows are performed between any ingress and any egress Ethernet port of the device.

EMS management

The IPmux-155L 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 IPmux-155L also supports a variety of access protocols, including Telnet, SNMP, Web server, and TFTP.



IPmux backhaul aggregation and pseudowire termination for E1 and Ethernet traffic over fiber



Remote IPmux aggregation and pseudowire termination over PSN

2G Backhaul
At Your Fingertips...

Finger-Sized Gateways.
SyncToP-Enabled.

MiTOP-E1/T1, MiTOP-E3/T3

Smart SFPs with Pseudowire and Sync-E

- Deliver 2G over PSN without forklifts
- Multi-standard TDM pseudowire: CESoPSN, SAToP MEF 8 or UDP/IP encapsulation
- Synchronous Ethernet for accurate clock distribution to BTS
- No need for dedicated power supply

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Gmux-2000

Hub-Site Pseudowire Access Gateway

- **High density gateway extending TDM-based services over packet switched networks**
- **Transports multiple E1/T1 links, channelized T3 or channelized STM-1/OC-3 over Gigabit Ethernet uplinks**
- **Multi-standard TDM pseudowire ASIC**
- **Fully redundant hardware, including all system and service modules**
- **QoS per 802.1p, ToS/DSCP or EXP**
- **VLAN tagging per 802.1Q, VLAN stacking (Q-in-Q)**
- **Ethernet OAM per 802.1ag and Y.1731**

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The Gmux-2000 is a cost-effective, modular pseudowire access gateway with high capacity for extending TDM PDH and SDH/SONET services over IP, Ethernet and MPLS networks.

Incorporating TDMoIP, CESoPSN, SAToP, and CESoEth (MEF-8) pseudowire emulation standards from the IETF, MFA Forum, ITU-T, and MEF, the Gmux-2000 is an ideal solution for PSTN access, as well as for PBX and mobile backhaul. In addition, it enables transparent delivery of HDLC legacy traffic with HDLCoPSN support.

The Gmux-2000 is available with a choice of interfaces, allowing it to relay, concentrate and groom up to 196 E1/T1, seven channelized T3 or six channelized STM-1/OC-3 links over two Gigabit Ethernet (GbE) network connections.

The Gmux-2000 works opposite RAD's IPmux TDM pseudowire gateways, LA-110 integrated access devices or Megaplex integrated access multiplexers, for cost-effective, carrier-class TDM pseudowire access.

Modules

The Gmux-2000 is a 6U-high chassis, mountable in a 19-inch ETSI or ANSI rack and houses the following modules:

- Up to two PSN network uplink modules
- Two control modules
- Three AC or DC power supply modules
- Seven I/O modules (E1/T1, Ch. T3 and Ch. STM-1/OC-3 interfaces)
- A cooling fans module

Gigabit Ethernet network modules, each with a pair of redundant Gigabit Ethernet (GbE) interfaces, support IEEE 802.3, 802.1Q (VLAN tagging), VLAN stacking (Q-in-Q) and 802.1p (priority/class of service).

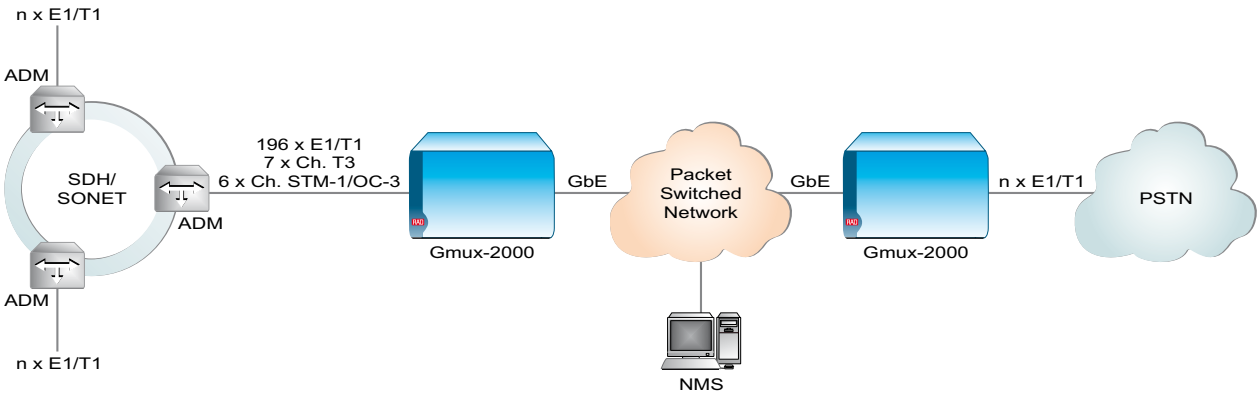
E1/T1 pseudowire (PW) modules encapsulate E1/T1 traffic flows for transmission over packet networks via the GbE network module. The E1/T1 modules include 28 external E1 or T1 interfaces for connecting individual E1/T1 ports.

STM-1/OC-3 PW modules perform SDH/SONET multiplexing/demultiplexing of channelized STM-1/OC-3 trunks into separate, internal E1/T1 circuits. Up to 63 E1 or 84 T1 internal channels are mapped into VC-12 or VT 1.5 streams to or from the channelized STM-1/OC-3 interface.

Each STM-1/OC-3 interface module provides a pair of ITU-T G.957 fiber optic links, supporting 1+1 redundancy according to ITU-T G.783.

Voice compression modules – Gmux-2000 supports up to seven voice compression modules compatible with the Vmux product line (see Gmux-2000 on page 147).

Control modules provide the SNMP and management interfaces, enabling the configuration and control of the entire Gmux-2000 system.



Extending multiple TDM trunks over a packet switched network

Each control module provides redundant interfaces for connecting external G.812 station clocks and for alarm inputs/outputs.

Power supplies are hot-swappable plug-in modules. Up to three AC or DC power supply modules can be installed for load sharing and redundancy. Two modules are required to drive a fully equipped Gmux-2000 system.

Redundancy Options

The following redundancy options are supported:

- GbE port redundancy according to 802.3ad
- GbE dual homing port redundancy
- GbE module redundancy
- STM-1/OC-3 1+1 line redundancy between ports on the same module
- STM-1/OC-3 module redundancy
- 1+1 pseudowire redundancy
- n+1 redundancy for external VMX and E1/T1 pseudowire with NPS-101 modules

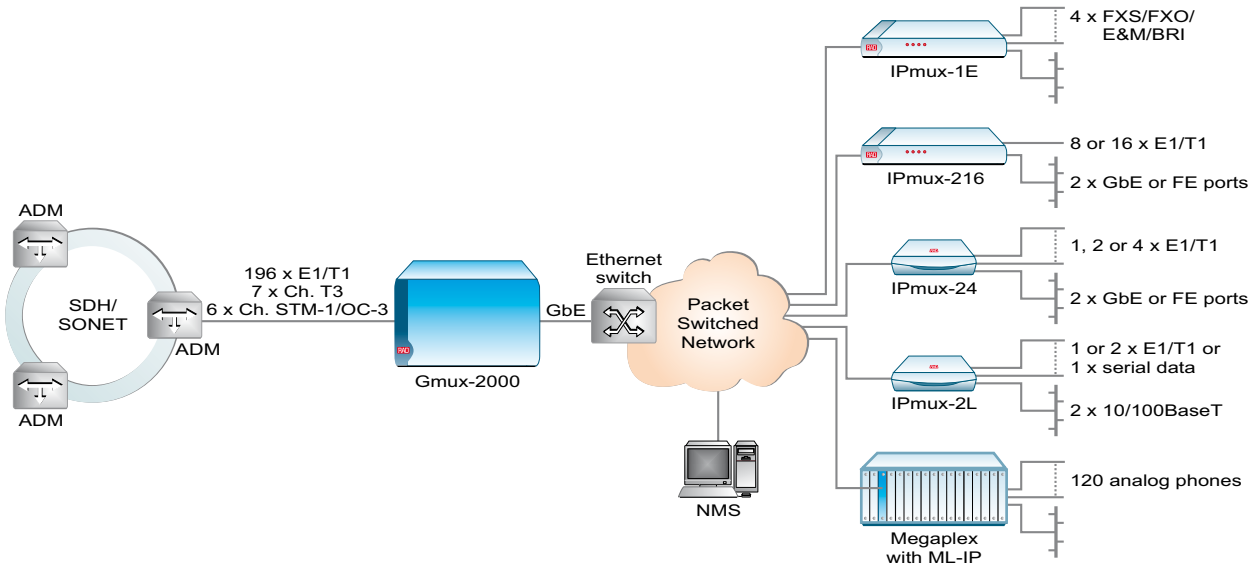
Service center management and security

The Gmux-2000 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 one of the network 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), service provisioning and diagnostic tools are provided by RADview-SC/TDMoIP, RAD's network management system, via an SNMP-based GUI.

The Gmux-2000 also supports a variety of access protocols, including CLI over Telnet, SNMP and TFTP. Incorporated security features include Secure Shell (SSH), Secure FTP (SFTP), SNMPv3 and RADIUS, as well as management access control list (ACL).

The Gmux-2000 incorporates Network Time Protocol version 3 for obtaining time of day information from the network.

It also supports Syslog, to enable system logs to be forwarded to an external network server, which is used as a central repository.



Extending legacy TDM services over a packet switched network

NEW
with Sync-E!

MiTOP-E1/T1, MiTOP-E3/T3

SFP-Format TDM Pseudowire Gateways

System on an SFP

- **Transmits TDM-based services over Ethernet, IP or MPLS networks**
- **Standard encapsulation: CESoPSN, SAToP**
- **A single E1/T1 or E3/T3 TDM user port**
- **Transparent to all signaling protocols**
- **Hot-insertion SFP-format plug, MSA-compliant**
- **Selectable clock source**
- **Basic management of control, status and monitoring**
- **Supports Synchronous Ethernet (Sync-E)**

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The innovative SFP-format MiTOP-E1/T1 and MiTOP-E3/T3 TDM pseudowire gateways provide PSN extension of E1/T1 or E3/T3 traffic. Housed in a small form-factor pluggable (SFP) enclosure, the MiTOP TDM pseudowire gateways are designed for quick and simple insertion into any 100/1000BaseFX Ethernet device port with a compatible SFP socket, making them ideal for providing transparent TDM circuit services over PSN.

Running on power derived from the host device, they require no additional power supply. They offer a simple and cost-effective alternative to external, standalone gateway units or conversion cards, as well as simplify management and save on space, power consumption and cabling.

The low-cost SFP plug format is an ideal and affordable solution for carriers and service providers delivering circuit extension over PSN, as well as for similar applications in enterprise and campus networks. With the addition of support for Synchronous Ethernet, the MiTOP can be used to provide pseudowire transport along with highly reliable clock accuracy for premium leased line and mobile applications.

Pseudowire capabilities

Featuring ASIC-based architecture, the MiTOP-E1/T1 and MiTOP-E3/T3 incorporate multi-standard pseudowire support, including CESoPSN and SAToP. In addition, the devices support MPLS, MEF-8 and UDP/IP network protocols.

The MiTOPs maintain large, configurable jitter buffers to compensate for delay variation introduced by the packet network.

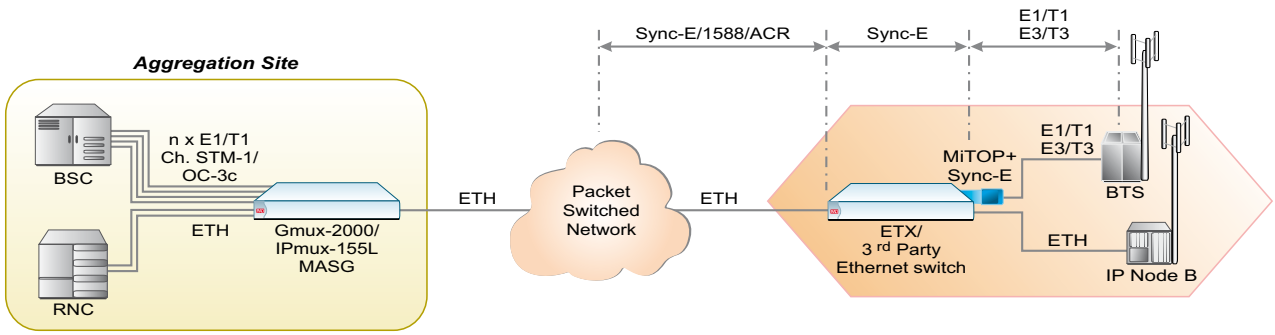
Four clock modes are supported: internal from a local oscillator; loopback timing clock recovered from the TDM network; adaptive clock recovered from the packet network; and external clock provided by a dedicated pin on the SFP edge connector.

The miniature gateways support Multisource Agreement (MSA) product identification codes. They are hot-swappable and feature a special release mechanism for easy extraction from SFP sockets.

Management

The modules can be managed out-of-band via I^2C and inband via dedicated Ethernet frames using a Web browser.

MiTOP can work opposite other MiTOP devices installed in remote equipment. Alternatively, they can work opposite gateways that support CESoPSN and SAToP, such as RAD's IPmux pseudowire gateways and Gmux-2000 central gateways.



Mobile backhaul using smart SFP with timing capabilities

Converters and Connectivity

Many IT users still work in an environment using legacy equipment typically characterized by lower speed data rates and specialized data communications protocols. RAD is one of the few vendors in the market today offering connectivity products for these devices.

Data solutions for Frame Relay and X.25 networks

RAD's packet switching family includes packet assemblers/disassemblers (PADs) and multiprotocol packet switches. All are designed to the latest ITU specifications and ANSI recommendations. They support various protocols, including HDLC, async, SLIP, PPP, IP, and ISDN. The products can be used to transport Frame Relay and X.25 over IP or to construct high performance, private X.25/Frame Relay networks or efficient extensions of public X.25/Frame Relay networks. In addition, RAD offers a wide range of interchangeable interfaces, such as built-in CSU/DSUs and ISDN BRI terminal adapters.

WAN connectivity for SMEs

RAD's WAN connectivity solutions offer a range of products that provide SMEs with the desired transparent connectivity and their corporate network managers with the flexibility to choose the WAN services, port quantities and security features that best suit their applications.

These devices support Ethernet bridging, converged access over DSL and Ethernet to TDM conversion.

Rate and interface converters

RAD's portfolio also includes classic data communications equipment such as baluns, sharing devices and serial converters as well as SFP transceivers. Pluggable transceivers provide for easy conversion between electrical and optical interfaces. RAD has a wide range of factory tested devices for use with the company's own equipment.

RIC-E1, RIC-T1

E1 or T1 Interface Converters

- **Converts between V.35, X.21, V.36, RS-530, or Ethernet or Fast Ethernet bridge to unframed E1 or T1 interfaces**
- **2.048 Mbps bit rate in E1 and 1.544 Mbps in T1**
- **Available as standalone units or as cards for the ASM-MN-214 rack**
- **Receive, internal and external clocking options**
- **AC or DC power supply**

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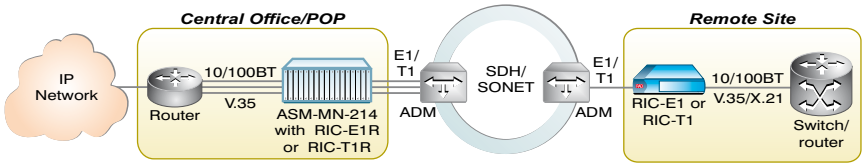
The RIC-E1 and RIC-T1 offer conversion between E1 or T1 interfaces and standard data communications interfaces. The units convert the ITU-T G.703 E1 2.048 Mbps and T1 1.544 Mbps interfaces to V.35, X.21, V.36, RS-530, Fast Ethernet, or Ethernet bridge.

VLAN capabilities

When equipped with an Ethernet interface, RIC-E1 and RIC-T1 transparently connect remote LANs and VLANs over unframed E1/T1 links, utilizing the full E1/T1 bandwidth. All of the above mentioned interfaces are easily interchangeable thanks to the modular design. Operating full duplex at a rate of 2.048 Mbps or 1.544 Mbps, respectively, the RIC-E1 and RIC-T1 have a range of 300 meters (1,000 ft) from the G.703 equipment. They perform a diagnostic loop test in compliance with ITU V.54 standard (loop 3) local analog loop (LLB). The bridge loops are activated by the DTE interface or by a strap jumper on the PCB.

The RIC-E1 and RIC-T1 support receive, external and internal clocking options from G.703 equipment.

The products are available as standalone units in lightweight enclosures, or as cards for the ASM-MN-214 rack. The ASM-MN-214 can hold up to 14 hot-swappable converter cards, allowing mixing and matching any combination of card types.



SPD-703-1

G.703 Codirectional Rate and Interface Converter

- **Interface conversion between G.703 (64 kbps) and V.35, V.36/RS-422, RS-530, or X.21**
- **Selectable data rates: 48, 56 or 64 kbps**
- **Selectable transmit timing source**
- **Analog and digital loopback**
- **56 kbps to 64 kbps rate conversion complies with V.110**

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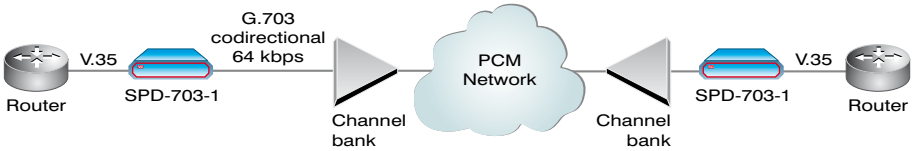
The SPD-703-1 rate and interface converter transfers between the G.703 interface and other data communications interfaces.

The SPD-703-1 codirectional converter converts the ITU G.703 64 kbps codirectional interface to V.35, V.36/V.11, X.21/V.11, RS-530 or V.24.

Operating full duplex at a transmission rate of 64 kbps, the SPD-703-1 has a range of 800 meters (0.5 miles) from the G.703 equipment. It has a built-in BERT complying with the V.52 standard that provides fault isolation capability with the activation and monitoring performed via the front panel.

V.54 diagnostic capabilities provide local analog, local digital and remote digital loopbacks. These may be activated from the front panel or via the interface control signal.

The SPD-703-1 is available as a standalone unit that can be mounted in a 19-inch rack, or as a card for the ASM-MN-214 rack.



RSD-1, RSD-10

4, 8-Channel Programmable Sharing Devices

The RSD digital sharing devices enable any combination of DCEs and/or DTEs to share a modem, multiplexer or computer port in a multipoint environment. RSD-1 supports up to four DCEs/DTEs; RSD-10 supports up to eight. They are completely transparent to the system and the data, and operate with sync or async equipment. The units generate timing signals internally or operate with external clocks, either from the main channel or from subchannel 1.

The main channel broadcasts information to all subchannels in parallel. Subchannels contend to transmit to the main channel by activating RTS/DCD or by data transitions.

The devices can be configured to automatically disable any channel that stays active for longer than a preset time and blocks all other subchannels.

Permanent disabling of a subchannel is possible by setting the front panel switches.

Installation and configuration of the RSD units are easy. All necessary crossover connections are defined internally via a DCE/DTE switch, and only straight-through cables are used to connect the modems or terminals to the RSD-1 and RSD-10. The interfaces are RS-232/V.24 and the connectors are 25-pin D-type, female.

- **RSD-1: four subchannels; RSD-10: eight subchannels**
- **Any combination of modems (DCEs) and terminals (DTEs)**
- **Sync or async, data rates up to 19.2 kbps**
- **RS-232/V.24 interface**
- **Automatic disabling of streaming subchannel**
- **Operates with dial-up or leased line modems**
- **Internal or external clocks**

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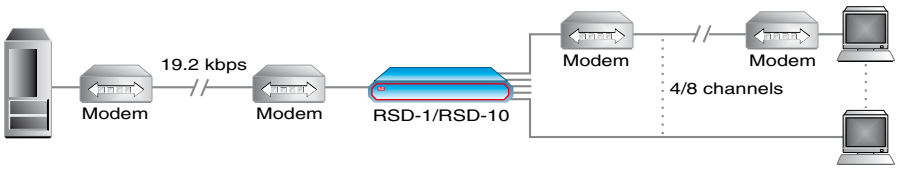

BE-1

Coax-to-Twisted Pair Converter (Balun) for E1

The BE-1 coax-to-twisted pair converter (balun) enables any E1 equipment with an unbalanced (coax) interface to operate over a twisted pair connection instead of over more expensive coax cables.

The BE-1 enables any E1 or ISDN equipment with a balanced twisted pair interface to use existing coaxial cables.

The BE-1 is a miniature, lightweight balun that operates without AC or DC power and provides insulation of up to 100V.

- **Conversion between coax cables and twisted pairs for E1 G.703 applications (2.048 Mbps)**
- **Miniature, lightweight balun**
- **No AC or DC power required**
- **Immediate installation**
- **Not sensitive to the direction of the signals**

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FPS-8

Multiprotocol Fast Packet Switch

- **Eight-port multiprotocol FRAD and packet switch**
- **Two optional built-in Ethernet ports**
- **Protocols supported: Frame Relay, X.25, ISDN, HDLC, SLIP, PPP, MLPPP, RIP, RIP-2, async**
- **IP support**
  - **IP routing**
  - **Standard IP encapsulation over Frame Relay (RFC 1490), X.25 (RFC 1356) or Ethernet**
- **Unique support of legacy services (i.e., X.25, FR) over IP networks**
- **Transparent bridging**
- **Dynamic bandwidth allocation**
- **Data prioritization**
- **Automatic backup facility**
- **Telnet (client and server) support**
- **X.25/Frame Relay multicasting**

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The FPS-8 is a Frame Relay/X.25 switch suitable for headquarters and central sites requiring high throughput. Each port can be configured to one of several protocols: Frame Relay, X.25, RIP, RIP-2, PPP, MLPPP, HDLC, SLIP, or async.

The FPS-8 can perform packet switching between different applications, such as X.25 to X.25; X.25 to Frame Relay; Frame Relay to Frame Relay; and SLIP to SLIP. It can also encapsulate various protocols over Frame Relay and X.25.

Legacy data over IP

The FPS-8 can also offer a unique solution for transmitting legacy data over high speed IP networks by encapsulating the data into IP packets.

Each of the eight sync ports operates at data rates up to 2 Mbps. The FPS provides throughput of more than 3,000 pps in Frame Relay.

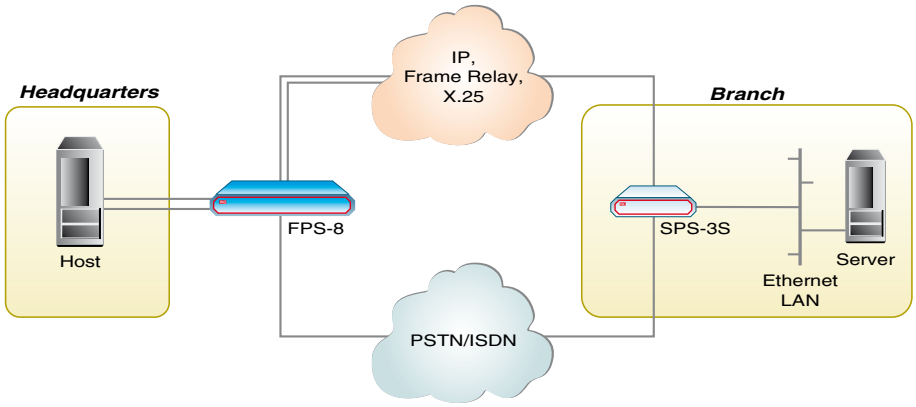
The built-in management agent enables configuration, compilation of statistics and status reports, and diagnostics. The management agent can be accessed from any location in the network. It can be programmed to transmit this information as a result of an alarm event.

SNMP management support via RADview

The SNMP agent enables management by the RADview graphical user interface on a PC or HP OpenView UNIX station, allowing the products to be configured and controlled via the X.25/Frame Relay network.

Link interfaces are modular and can be ordered for RS-232/V.24, V.35, RS-530, X.21, V.36, or Ethernet. Each interface is switch-selectable for DCE or DTE. Both the protocol and the interface can be independently selected on any port.

The FPS-8 offers optional support for ISDN BRI interface.



SPS-3S, SPS-6, SPS-12

Multiprotocol Packet Switches

The SPS-3S, SPS-6 and SPS-12 are high performance Frame Relay/X.25 multiprotocol switches. Each port can be configured to one of several protocols: Frame Relay, X.25, ISDN, RIP, RIP-2, PPP, MLPPP, SDLC, HDLC, SLIP, async, or Ethernet.

The products support an aggregate data rate on three links of up to 2 Mbps. In addition, the products feature a wide range of interfaces, including CSU/DSU and Ethernet.

The SPS-3S, SPS-6 and SPS-12 can perform packet switching between different applications, such as X.25 to X.25; X.25 to Frame Relay; Frame Relay to Frame Relay; and SLIP to SLIP. They can also encapsulate various protocols over Frame Relay and X.25.

Legacy data over IP

In addition, the SPS products offer a unique solution for transmitting legacy data over high speed IP networks by encapsulating the data into IP packets.

The units perform dynamic bandwidth allocation and data prioritization for optimal network results.

Management capabilities

The built-in management agent enables configuration, compilation of statistics and status reports, and diagnostics. The management agent can be accessed from any location in the network. It can be programmed to transmit this information as the result of an alarm event.

The SNMP agent enables management by the RADview graphical user interface on a PC or HP OpenView UNIX station, permitting the products to be configured and controlled via the X.25/Frame Relay network.

Link interfaces are modular and can be ordered for RS-232/V.24, V.35, RS-530, X.21, V.36, as well as ISDN S and U interfaces. Each interface is switch-selectable for DCE or DTE. Both the protocol and the interface can be independently selected on any port.

SPS-3S, SPS-6 and SPS-12 are 1U high, standalone units. The SPS-3S is half 19-inch and SPS-6 and SPS-12 are 19-inch units.

- **Three, six or 12-port multiprotocol FRAD and packet switch**
- **Protocols supported: Frame Relay, X.25, ISDN, SDLC, HDLC, MLPPP, RIP, RIP-2, SLIP, PPP, async, Ethernet**
- **IP support**
  - **IP routing**
  - **Standard IP encapsulation over Frame Relay (RFC 1490), X.25 (RFC 1356) or Ethernet**
- **Unique support of legacy services (i.e., X.25, FR) over IP networks**
- **Transparent bridging**

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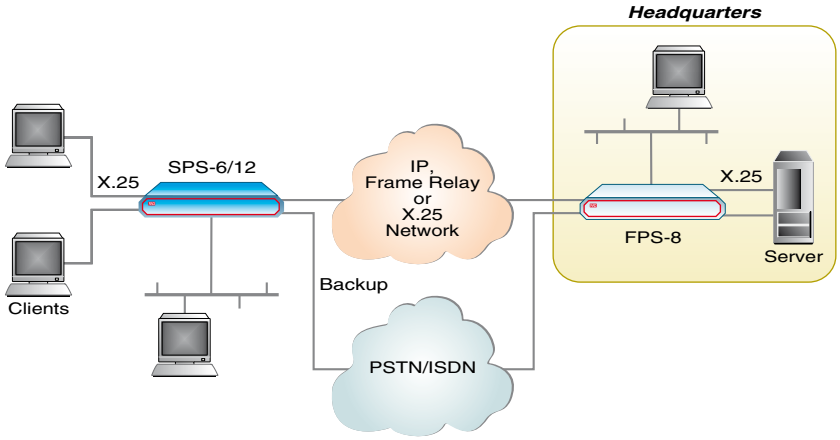
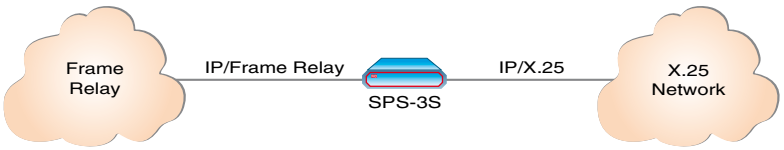


SPS-6 or SPS-12 used to consolidate X.25 and IP for medium-sized branch office



IP transport from X.25 to a Frame Relay network

APD-8

8-Channel FRAD/X.25 PAD

- **Eight-channel async FRAD/PAD with a single synchronous Frame Relay or X.25 link**
- **IP encapsulation over Frame Relay (RFC 1490) or X.25 (RFC 1356) networks**
- **Synchronous link interfaces: V.24/RS-232, V.35, X.21, RS-530, and V.36**
- **Can operate as a terminal server**

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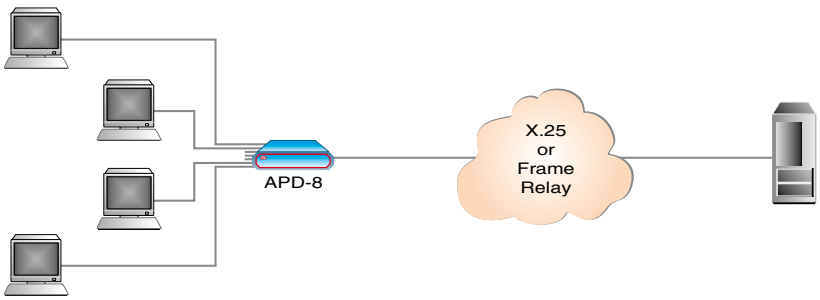


The APD-8 is a FRAD/X.25 PAD that connects up to eight async channels to Frame Relay or X.25 networks.

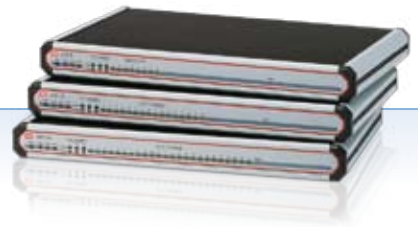
The unit is provided with an integrated ISDN terminal adapter.

The APD-8 offers a synchronous link data rate up to 2 Mbps. The async channel data rate is up to 115.2 kbps.

All channels are configured and monitored by the management agent of the APD-8. All async channels operate according to X.3, X.28 and X.29 profiles or SLIP protocol. Async traffic can be packetized directly over a Frame Relay network, or packetized via X.25 protocol and encapsulated over a Frame Relay network.

The built-in management agent enables system configuration and compilation of statistics, status reports and diagnostics. The units incorporate an SNMP agent, enabling management by RADview on a PC or HP OpenView station.

The APD-8 is available as a standalone unit, measuring 1U in height. Two units can be mounted side-by-side in a 19-inch rack.



APS-8, APS-16, APS-24

8, 16, 24-Channel Multiprotocol FRADs/PADs and Switches

- **FRAD/X.25 PAD with eight, 16 or 24 async channels**
- **Protocols supported: Frame Relay, X.25, ISDN, RIP, RIP-2, HDLC, SLIP, MLPPP, PPP, async, Ethernet**
- **Standard IP encapsulation over Frame Relay (RFC 1490), X.25 (RFC 1356) or Ethernet**
- **Wide range of interfaces including CSU/DSU**

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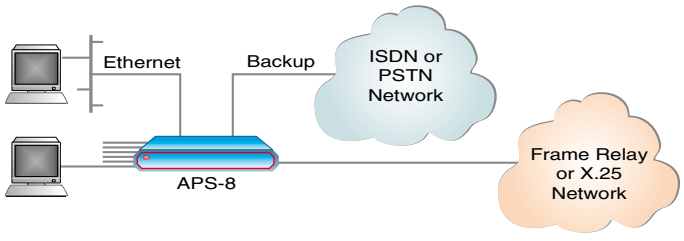

The APS-8, APS-16 and APS-24 are high performance FRADs/X.25 PADs for access to Frame Relay or X.25 networks. All async channels can operate according to X.3, X.28 and X.29 profiles. Async traffic can be packetized directly over the Frame Relay network, or packetized over the X.25 protocol and encapsulated over a Frame Relay network.

The APS is ideal where a large number of async channels is required; in a heterogeneous environment combining async traffic and synchronous or LAN traffic; and in applications that require backup, bandwidth-on-demand or dial-in. The units support X.25/Frame Relay multicasting.

Legacy data over IP

The APS products also offer a unique solution for transmitting legacy data over high speed IP networks by encapsulating the data into IP packets. It also enables secure migration from a terminal/host environment to a distributed client/server environment.

The units are provided with an integrated ISDN terminal adapter.

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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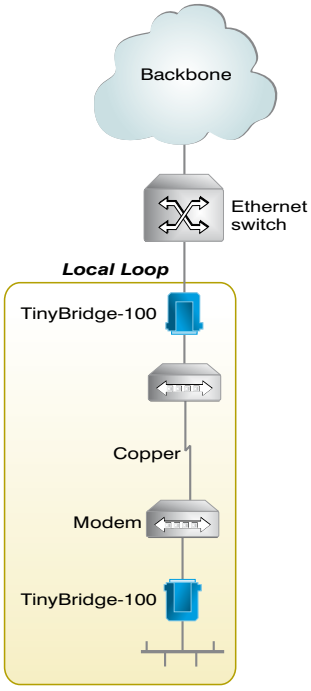
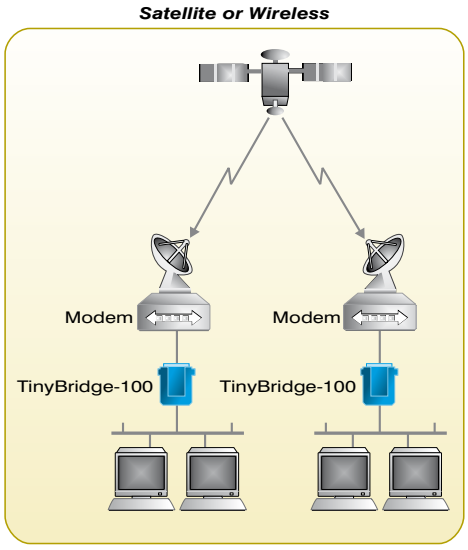


Connecting LANs over Local Loop



Connecting LANs over a satellite connection

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.

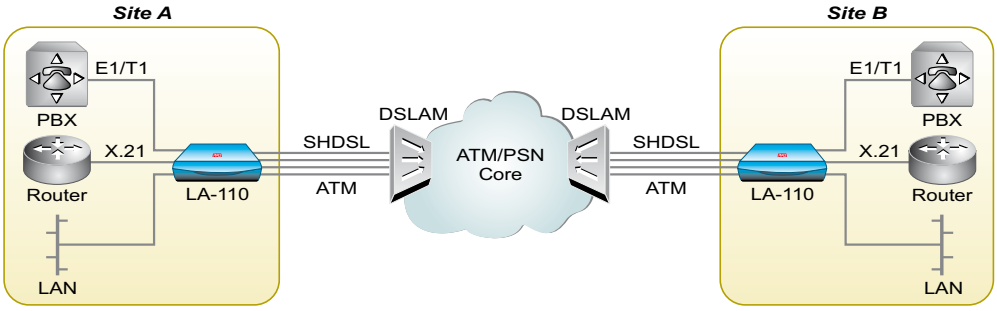
ATM quality of service and OAM

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.

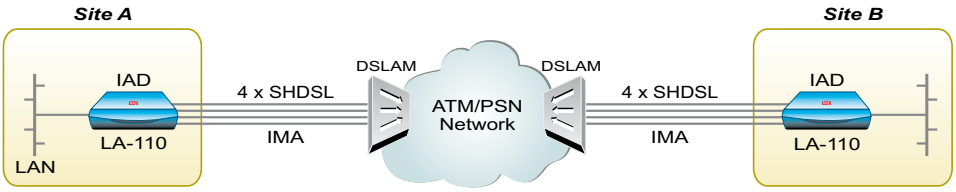
Network management

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.

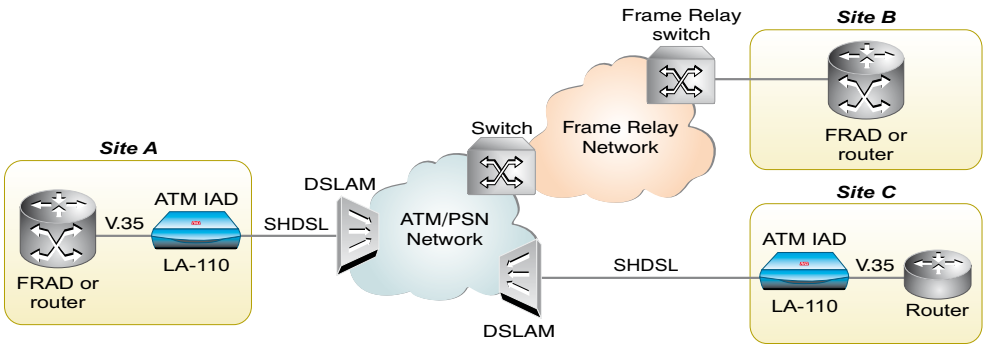
The LA-110 also supports a variety of configuration access channels, including Telnet, SNMP, Web server, and TFTP. Incorporated security features include Secure Shell (SSH), Web-based Secure Socket Layer (SSL), SNMPv3, and RADIUS.



Leased line service



High speed LAN-to-LAN using IMA



Frame Relay-ATM interworking

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 products. 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.

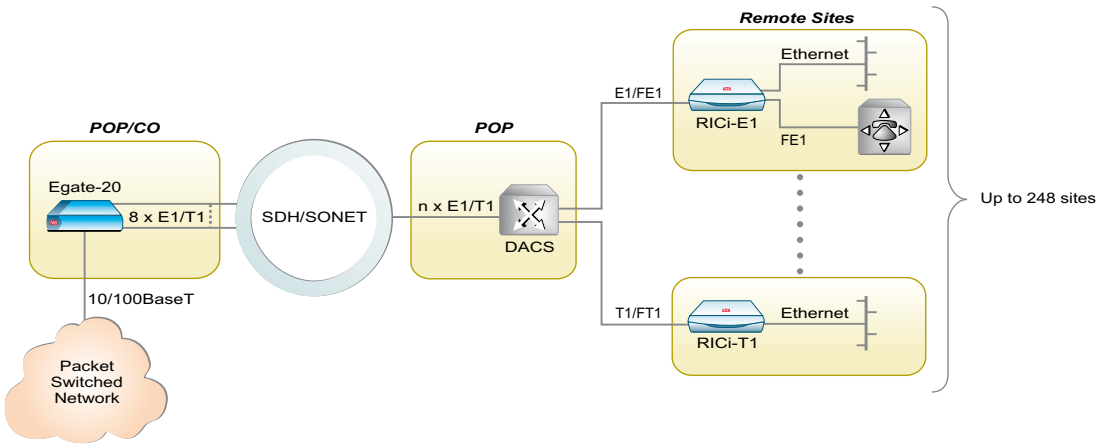
Using the VLAN stacking (Q-in-Q) capabilities, a special provider VLAN is added to the user traffic. This allows transparent delivery of the user traffic, keeping all the user VLAN settings intact, and enables a seamless hand-off to the packet network. VLAN switching permits specific VLANs to be forwarded 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

SPH-16

SFP Patch Hub

The SPH-16 is a managed SFP patch hub that connects 16 Fast Ethernet (100 Mbps) and Gigabit Ethernet (1000 Mbps) copper sockets (RJ-45) to any standard SFP device.

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

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

SNMP management

The 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. It provides SNMP management for I^2C parameters of standard SFP devices and enables software downloads to the SFPs. In addition to enabling flow control via a back pressure mechanism, the SFP patch hub supports major and minor alarm reports, and features LED status indicators to facilitate system diagnostics.

- **Converts 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**
- **Fault propagation from WAN to LAN**

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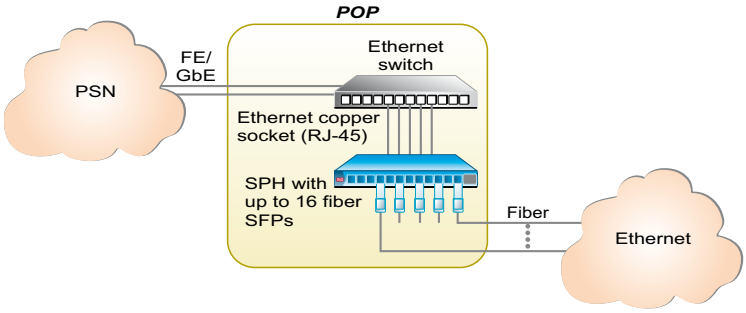
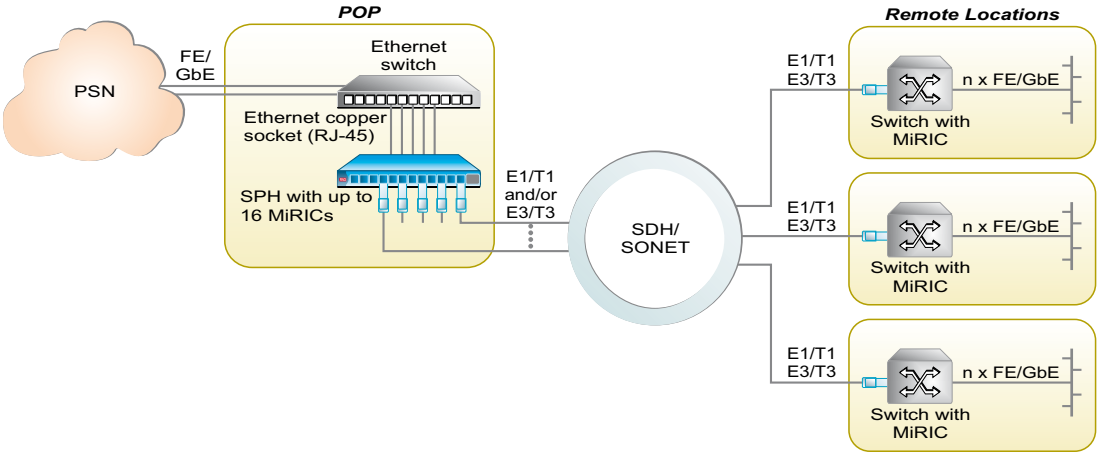


Fiber SFP application



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

SFP Transceivers

Small Form-Factor Pluggable Transceivers

- **Fiber optic or electrical transceiver units, providing pluggable interfaces according to known standards and specifications**
- **MSA (Multisource Agreement) compliance**
- **Fast Ethernet to E1/T1 or E3/T3 remote bridges, connecting Fast Ethernet LANs over E1/T1 or E3/T3 links**
- **TDM pseudowire gateways**

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SFP (small form-factor pluggable) transceivers (SFPs) are hot-swappable input/output optical and electrical transceiver units, each providing a different interface according to known compliance standards and predetermined specifications. The units are plugged into other products to provide the required interface, thus enabling optimal combination of CapEx reduction, ease of network planning and stock flexibility.

RAD's SFP transceivers are fully compliant with the Multisource Agreement (MSA) specifications, and are fully interoperable with third-party standards-based devices.

On account of their small size, SFPs allow higher port densities than with other transceivers, resulting in more efficient host device design.

Note: It is strongly recommended to order RAD devices with original RAD SFPs installed. This will ensure that prior to shipping, RAD has performed comprehensive functional quality tests on the entire assembled unit, including the SFP devices. RAD cannot guarantee full compliance to product specifications for units using non-RAD SFPs. For detailed specifications of the SFP transceivers, see the SFP transceivers data sheet.

Notes:

D DDM internal calibration

H Industrial SFP temperature range –40° to 85°C

- The specified typical range may vary according to the specific product in which the SFP is used. For more information, refer to the data sheet of the specific product.

Fiber Optic Gigabit Ethernet SFPs

Ordering Name, Interface, Connector	Wavelength, Fiber Type [nm], [mm]	Standard	Transmitter Type	Input Power [dBm]		Output Power [dBm]		Typical Max. Range	
				(min)	(max)	(min)	(max)	[km]	[miles]
SFP-5/5D/5H/5DH Gigabit Ethernet, LC	850, 50/125 multimode	1000BaseSX, IEEE 802.3 (GbE)	VCSEL	-17	0	-9.5	0	0.55	0.3
SFP-6/6D/6H/6DH Gigabit Ethernet, LC	1310, 9/125 single mode	1000BaseLX10, IEEE 802.3 (GbE)	Laser	-20	-3	-9.5	-3	10	6.2
SFP-7/7D/7DH Gigabit Ethernet, LC	1550, 9/125 single mode	–	Laser	-22	-3	0	+5	80	49.7
SFP-8/8D/8H/8DH Gigabit Ethernet, LC	1310, 9/125 single mode	–	Laser	-21	-3	-4	+4	40	24.8
SFP-17A/17B Gigabit Ethernet, LC	TX – 1310/1490 RX – 1490/1310, 9/125 single mode (single fiber)	1000BaseBX10, IEEE 802.3 (GbE)	Laser (WDM)	-20	-3	-9	-3	10	6.2
SFP-20 Gigabit Ethernet, LC	1550, 9/125 single mode	–	Laser	-32	-3	0	+5	120	74.5
SFP-20EDH Gigabit Ethernet, LC, DDM, external calibration, industrial hardened	1550, 9/125 single mode	–	Laser	-30	-8	0	+5	120	74.5
SFP-21A/21B Gigabit Ethernet, LC	TX – 1310/1490, RX – 1490/1310 9/125 single mode (single fiber)	–	Laser (WDM)	-24	-3	-5	0	40	24.8
SFP-21AED Gigabit Ethernet, LC, DDM, external calibration	TX – 1310/RX – 1490, 9/125 single mode (single fiber)	–	Laser (WDM)	-24	-3	-5	0	40	24.8
SFP-21BED Gigabit Ethernet, LC, DDM, external calibration	TX – 1490/RX – 1310, 9/125 single mode (single fiber)	–	Laser (WDM)	-24	-3	-5	0	40	24.8

Fiber Optic Gigabit Ethernet SFPs

Ordering Name, Interface, Connector	Wavelength, Fiber Type [nm], [mm]	Standard	Transmitter Type	Input Power [dBm]		Output Power [dBm]		Typical Max. Range	
				(min)	(max)	(min)	(max)	[km]	[miles]
SFP-22A/22B Gigabit Ethernet, LC	TX – 1490/1570 RX – 1570/1490, 9/125 single mode (single fiber)	–	Laser (WDM)	-24	-3	0	+5	80	49.7
SFP-23A/23B Gigabit Ethernet, LC	TX – 1310/1550 RX – 1550/1310, 9/125 single mode (single fiber)	–	Laser (WDM)	-24	-3	-5	0	40	24.8
SFP-23AED Gigabit Ethernet, LC, DDM, external calibration	TX – 1310/RX – 1550, 9/125 single mode (single fiber)	–	Laser (WDM)	-24	-3	-5	0	40	24.8
SFP-23BED Gigabit Ethernet, LC, DDM, external calibration	TX – 1550/RX – 1310, 9/125 single mode (single fiber)	–	Laser (WDM)	-24	-3	-5	0	40	24.8
SFP-24 Fast Ethernet/STM-1, LC	850, 50/125 multimode	–	VCSEL	-25	-2	-10	-4	2	1.2
SFP-47DH Gigabit Ethernet, LC	1470, 9/125 single mode	–	Laser (CWDM)	-24	-3	0	+5	80	49.7
SFP-49DH Gigabit Ethernet, LC	1490, 9/125 single mode	–	Laser (CWDM)	-24	-3	0	+5	80	49.7
SFP-51DH Gigabit Ethernet, LC	1510, 9/125 single mode	–	Laser (CWDM)	-24	-3	0	+5	80	49.7
SFP-55DH Gigabit Ethernet, LC	1550, 9/125 single mode	–	Laser (CWDM)	-24	-3	0	+5	80	49.7
SFP-57DH Gigabit Ethernet, LC	1570, 9/125 single mode	–	Laser (CWDM)	-24	-3	0	+5	80	49.7
SFP-59DH Gigabit Ethernet, LC	1590, 9/125 single mode	–	Laser (CWDM)	-24	-3	0	+5	80	49.7
SFP-53DH Gigabit Ethernet, LC	1530, 9/125 single mode	–	Laser (CWDM)	-24	-3	0	+8	80	49.7
SFP-61DH Gigabit Ethernet, LC	1610, 9/125 single mode	–	Laser (CWDM)	-24	-3	0	+5	80	49.7

Electrical Interface Characteristics

Ordering Name, Interface, Connector	Standard	Cable Type	Impedance [Ω]	Typical Max. Range (Attenuation) [m]	[ft]
SFP-9F* Fast Ethernet, RJ-45	100BaseT, IEEE 802.3	UTP, cat. 5	100	100	328
SFP-9G /9GH (industrial hardened) Gigabit Ethernet, RJ-45	1000BaseT, IEEE 802.3	UTP, cat. 5	100	100	328
SFP-11 STM-1E, mini BNC, DIN 1.0/2.3	G.703	Coaxial	75	135 (12.7 dB)**	442
SFP-12 E3, SMB	G.703	Coaxial	75	135 (12.7 dB)**	442
SFP-30 Gigabit Ethernet, RJ-45, SGMII interface	10/100/1000BaseT, IEEE 802.3	UTP, cat. 5	100	100	328
SFP-E1T1/GbE*** Gigabit Ethernet, E1/T1, remote bridge, RJ-45	1000Base-x, IEEE 802.3 (GbE), G.703 (E1/T1)	UTP, cat. 5 (AWG-22)	120/100	2550/1829	8202/6000
SFP-E1T1/FE*** Fast Ethernet, E1/T1, remote bridge, RJ-45	100BaseFX, IEEE 802.3 (Fast Ethernet), G.703 (E1/T1)	UTP, cat. 5 (AWG-22)	120/100	2550/1829	8202/6000
SFP-E3T3/FE*** Fast Ethernet, E3/T3, remote bridge, SMB	100BaseFX, IEEE 802.3 (Fast Ethernet), G.703 (E3/T3)	Coaxial (RG59)	75	275	900
SFP-E3T3/GbE*** Gigabit Ethernet, E3/T3, remote bridge, SMB	1000Base-x, IEEE 802.3 (GbE), G.703 (E3/T3)	Coaxial (RG59)	75	275	900
SFP-PWE1T1*** TDM to Ethernet pseudowire gateway	100BaseFX, IEEE 802.3 (FE), G.703 (E1/T1)	UTP, cat.5	120/100	–	–

Notes:

* SFP-9F includes an LED indicator, along with an underside DIP switch which controls the auto-negotiation mode.

** With SFP-11 and SFP-12, 135m range is attainable when using RG59 B/U (at 78 MHz, in accordance with the square root of frequency law).

*** These SFPs are designed to work with RAD products only. An internal mechanism in these SFP units checks whether the hosting device is a RAD product.

Fiber Optic Interface Characteristics

Ordering Name, Interface, Connector	Wavelength, Fiber Type [nm], [mm]	Standard	Transmitter Type	Input Power [dBm]		Output Power [dBm]		Typical Max. Range	
				(min)	(max)	(min)	(max)	[km]	[miles]
SFP-1/1D Fast Ethernet/STM-1, LC	1310, 62.5/125 multimode	100BaseFX, IEEE 802.3 (FE), ANSI T1 646-1995 (STM-1)	LED	-30	-14	-20	-14	2	1.2
SFP-2/2D/2H Fast Ethernet/STM-1, LC	1310, 9/125 single mode	100BaseLX10, IEEE 802.3 (FE), G.957 S1.1 (STM-1)	Laser	-28	-8	-15	-8	15	9.3
SFP-3/3D/3H Fast Ethernet/STM-1, LC	1310, 9/125 single mode	G.957 L1.1 (STM-1)	Laser	-34	-10	-5	0	40	24.8
SFP-4/4D Fast Ethernet/STM-1, LC	1550, 9/125 single mode	G.957 L1.2 (STM-1)	Laser	-34	-10	-5	0	80	49.7
SFP-10A/10B/10AD/10BD Fast Ethernet/STM-1, LC	TX – 1310/1550 RX – 1550/1310 9/125 single mode (single fiber)	100BaseBX10, IEEE 802.3 (FE), G.957 (STM-1)	Laser (WDM)	-28	-8	-14	-8	20	12.4
SFP-14D STM-4, LC,	1310, 62.5/125 multimode	–	Laser	-28	-14	-20	-14	0.5	0.3
SFP-15 STM-4, LC	1310, 9/125 single mode	G.957 S4.1	Laser	-28	-8	-15	-8	15	9.3
SFP-16 STM-4, LC	1550, 9/125 single mode	G.957 L4.2	Laser	-28	-8	-3	+2	80	49.7
SFP-18A/18B Fast Ethernet/STM-1, LC	TX – 1310/1550 RX – 1550/1310 9/125 single mode (single fiber)	–	Laser (WDM)	-28	-8	-5	0	40	24.8
SFP-18AED Fast Ethernet/STM-1, LC, DMM, external calibration	TX – 1310/RX – 1550 9/125 single mode (single fiber)	–	Laser (WDM)	-28	-8	-5	0	40	24.8
SFP-18BED Fast Ethernet/STM-1, LC, DMM, external calibration	TX – 1550/RX – 1310 9/125 single mode (single fiber)	–	Laser (WDM)	-28	-8	-5	0	40	24.8
SFP-19A/19B Fast Ethernet/STM-1, LC	TX – 1490/1570 RX – 1570/1490 9/125 single mode (single fiber)	–	Laser (WDM)	-30	-8	0	+5	80	49.7
SFP-24 Fast Ethernet/STM-1, LC	850, 50/125 multimode	–	VCSEL	-25	-2	-10	-4	2	1.2
	850, 62.5/125 multimode	–	VCSEL	-25	-2	-10	-4	1	0.6

9

Network Management

As the world becomes more dependent on advanced computerized systems for managing operations in real time, the demand for control and monitoring is surging. The existence of heterogeneous networks creates a challenge for network managers, who must manage networks consisting of many types of equipment from different vendors.

The result is that network management becomes an arduous and complex task for network administrators, and the effectiveness of managing the network is reduced.

RAD's network management portfolio meets these challenges, offering an integrated network and system management solution that adheres to TMN standards and operates in a multi-vendor system environment. RAD's management systems help the network manager supervise, monitor and provision RAD-based networks varying in size and product mix, as well as basic management of third-party devices, thereby reducing OpEx. The solution architecture is scalable, affordable for small installations, yet flexible to accommodate the network administrator's future needs.

TMN logical layers

ITU-T Telecommunications Management Network (TMN) defines a layered model where each layer is responsible for different management functions, while interfacing with underlying and overlying layers, to provide a complete and comprehensive set of tools:

- NEL, Network Element Layer, implementing logical entities within a device
- EML, Element Management Layer, implementing device level configuration, fault and performance management functions
- NML, Network Management Layer, implementing path management, topology management and fault isolation
- SML, Service Management Layer, implementing mechanisms to assure service level agreements and maintaining QoS
- BML, Business Management Layer, implementing strategic enterprise management functions, such as budgeting and billing

TMN FCAPS model

RAD's network management solution conforms to the ITU-T Telecommunications Management Network (TMN) recommendations for SNMP management systems and supports the following functions (also known as the FCAPS model):

- **Fault management** detects and correlates faults in network devices, isolates faults and initiates recovery actions
- **Configuration management** provides the ability to track changes and configure, install and distribute software across the network for all network devices
- **Administration management** manages individual and group user accounts and passwords, generating network usage reports to monitor user activities
- **Performance management** offers a continuous source from which to monitor network performance (QoS, CoS) and resource allocation
- **Security management** provides the ability to control the access to network resources

RAD's network management portfolio

Network Element Layer

All RAD manageable products feature built-in SNMP agents, supporting relevant standard MIB and RFC, in addition to a RAD proprietary MIB. The RAD MIB is implemented in accordance with ASN.1 and can be compiled and incorporated into any SNMP platform to allow access to RAD devices via SNMP. Additionally, many RAD devices have a variety of management access protocols, including CLI or menu-driven Telnet, 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).

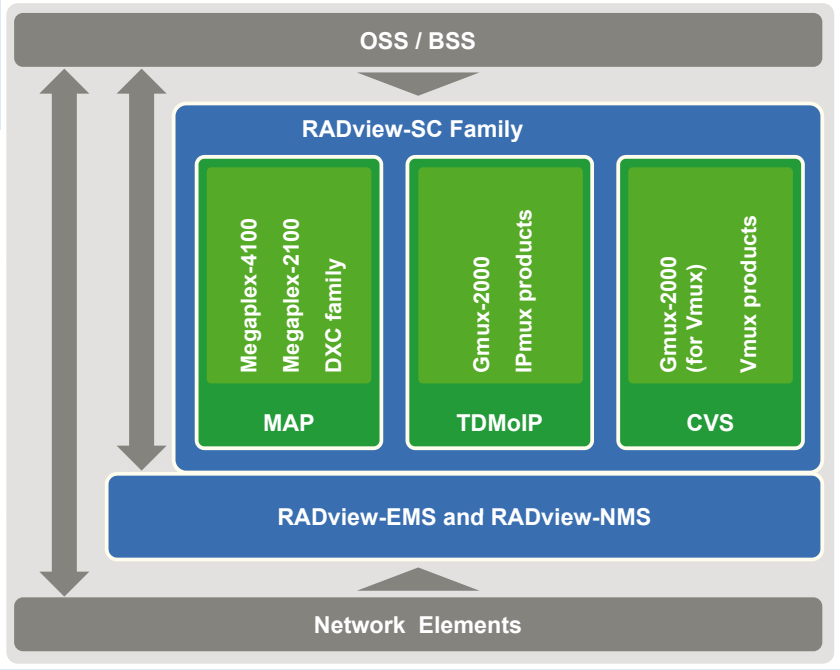
Element Management Layer

RADview-EMS, RAD's flagship element management system, is based on the ITU-T Telecommunications Management Network (TMN) model with advanced FCAPS capabilities. It provides a Java-based, carrier-class element management system for deployment over Windows and UNIX environments. The system is designed for high scalability for easy expansion of new network elements and optimized load sharing. The client-server architecture provides multi-user support for network operations, maintaining a centralized database and network partitioning. RADview-EMS includes an open CORBA northbound interface, facilitating integration with third-party NMS or umbrella systems.

RADView-EMS provides security, configuration, fault, performance, and administration management, including extensive network level functions.

Network Management Layer

RADview-SC/Vmux is a powerful management tool for provisioning and monitoring compressed voice services, providing control and monitoring of end-to-end circuits for networks comprising the Vmux product family. RADview-SC/TDMoIP is a powerful management tool for provisioning and monitoring TDM over IP (TDMoIP) services, providing control and monitoring of end-to-end circuits for networks comprised of the IPmux family of products. RADview-SC/TDMoIP includes an open CORBA northbound interface, facilitating integration with third-party NMS or umbrella systems. RADview-SC/TDM is the cornerstone of the RAD family of network management solutions, simplifying service provisioning and end-to-end path management of multiservice access and First Mile devices. The system includes automatic optimal path detection and configuration, as well as path protection and re-route upon network resource failure, thus automating network maintenance and minimizing downtime. RADview-SC/TDM includes an open CORBA northbound interface, facilitating integration with third-party NMS or umbrella systems. RADview-SC/TDM includes an SLA (service level agreement) module for checking that every provisioned service conforms to the SLA promised to the end user.



The RADview network management layers according to the TMN model

RADview-EMS

Carrier-Class Element Management System

- **Monitors device health, optimizes network operations and minimizes mean time to repair (MTTR)**
- **Fully compliant with TMN standards**
- **Client/server architecture with multi-user support and seamless handover of user privileges**
- **Advanced FCAPS functionality**
- **Wide range of northbound application programming interfaces (API)**
- **Interoperable with third-party NMS and leading OSS/umbrella systems**
- **IBM Tivoli's Netcool®/OMNIbus™ plug-in**
- **High Availability and Disaster Recovery support**
- **Change management automation**

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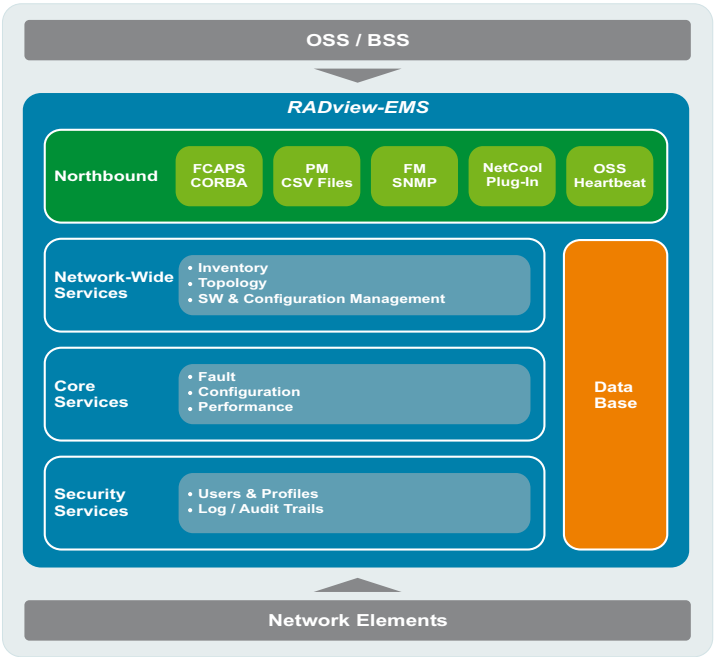
RADview-EMS main view

RADview-EMS is a Java-based, carrier-class element management system for Windows and UNIX environments. It manages RAD's devices (see compatibility table on page 182) using a variety of access protocols, including SNMP, HTTP/S, TFTP and Telnet/SSH. In addition, it features third-party device monitoring capabilities.

Designed for high scalability, optimized performance and load sharing, it includes an embedded Oracle/Informix database that allows easy addition of new network elements as the network expands.

RADview-EMS operates optimally in standalone mode and enables visual network representation with an intuitive GUI, including map topology per region, network links, zoom-in to individual devices, as well as logical group and domain management. Alternatively, it can be integrated with SNMPc or HP OpenView NNM. The system is fully interoperable with third-party EMS/NMS applications from leading vendors.



RADview-EMS system architecture

Easy OSS integration

As a modular management system, RADview-EMS enables easy integration with OSS and umbrella systems. By serving as a mediation layer between the various network elements (NEs) and the umbrella system, RADview-EMS minimizes the integration costs associated with new NE additions and ensures synchronization of essential information between the NEs and OSS.

In addition to featuring a plug-in for **IBM Tivoli's Netcool®/OMNIbus™** fault management application, the system allows seamless communication with network-wide platforms for inventory (resource) management, performance management and service provisioning, as well as with carriers' proprietary OSS.

Supporting northbound interfaces, such as CORBA, SNMP and CSV, as well as OSS heartbeat mechanism, RADview-EMS smoothly interacts with higher management levels to communicate essential network information to service, operations and business management functions.

Advanced FCAPS functionality

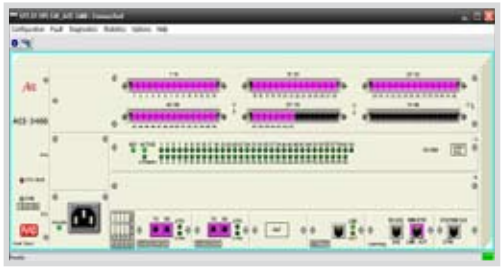
RADview-EMS features advanced FCAPS (Fault, Configuration, Administration, Performance, and Security) capabilities based on the ITU-T Telecommunications Management Network (TMN) model. These capabilities are accessible via a Web- or an SNMP-based agent and provide, among others, actual device shelf view to allow easy configuration, troubleshooting, diagnostics, and statistics reporting by remote operators.

Fault management: RADview-EMS detects and isolates faults in network devices, displaying a clear analysis of probable causes and suggested instructions for corrective measures. Following link failures, the system ensures all trap messages are synchronized as communication with the NE is restored*. In addition, RADview-EMS distributes alarm messages to other management entities in the network.

*Selected devices only

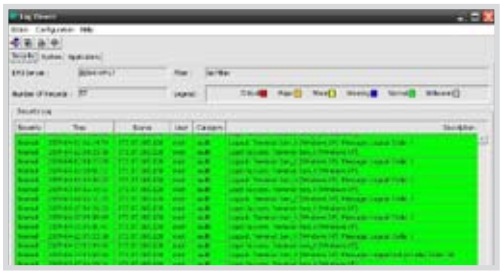
Event browser

Configuration management: The system enables operators to install and distribute software and configuration files to all devices across the network and to collect configuration files for backup and recovery. It also enables baseline configuration setup and roll back, as well as side-by-side CLI configuration comparison. Easy device management and provisioning is supported by a user-friendly, "point-and-click" GUI, allowing operators to modify system, ports and alarms configuration, as well as to view diagnostics and status information.



Device shelf view

Administration management: RADview-EMS enables management of individual and group user accounts and passwords, generating network usage reports to monitor user activities. In addition, it provides audit trails for RADview-EMS' security, system and application activities, tracks and logs user activities performed in shelf-view, and manages server settings.



Audit trail

Performance management: RADview-EMS supports real-time monitoring of QoS (quality of service) per class of service (CoS) with current and interval-based statistics reporting. Device statistics can be collected in a compressed format to minimize bandwidth usage for management traffic. The system retrieves data lost due to connection failures and exports CSV ASCII files to OSS or third-party management systems. In addition, long-term performance monitoring trend reports per EVC can be displayed in the RADview statistics portal.

Flow statistics

Security management: Using the security management console, network administrators can create an unlimited number of security profiles and groups and manage complex security access rights down to the parameter level. Access to network resources is controlled with a choice of security features, including SSH (Secure Shell), Web-based SSL (Secure Socket Layer), SNMPv3, RADIUS, and ACL (access control list).

Security policy

RADview-EMS
(Continued)

Distributed system architecture

RADview-EMS is based on distributed client-server architecture, which optimizes the use of network resources while improving overall system performance and resilience. Load sharing among master and slave servers enables flexible allocation of management tasks, according to specific needs without affecting user experience. The RADview-EMS client-server architecture offers an adaptable management solution fitting diverse network sizes, performance requirements and user volumes.

Business continuity

RADview-EMS provides the following scalable tools to ensure high system availability and optimized disaster recovery so that critical applications remain available to users while meeting network managers' RPO (recovery point objective) and RTO (recovery time objective) targets:

Backup and Restore: This cost-effective solution requires no additional software tools or expensive storage equipment. Data is periodically backed up by the primary (active) NMS station via the RADview-EMS' Backup/Restore function. In the event of failure on the primary NMS station, the data can be restored on the secondary (standby) station.

Disaster Recovery: The 1+1 DR procedure is ideal for organizations willing to separate their network control facilities in order to protect against severe network- and service-affecting disasters. In this case, two geographically separated NMS servers are constantly synchronized, so that when the primary site is disabled, the backup NMS server is available for switchover with up-to-date data.

High Availability (Local Clustering): This solution ensures the recovery of the RADview-EMS server in the event of operating system or hardware failure in a single site, using a single cluster of two nodes (active and standby) interconnected to external storage equipment. Automatic failover eliminates effects on service and minimizes loss of monitoring data.

High Availability-Disaster Recovery: The highest protection level. In addition to Local Clustering protection, data is also replicated between NMS servers located at geographically separated sites. In the event of an outage at the primary site, all services can be readily moved to the backup site.

RADview-Server
Turnkey Network Management System

- **Based on Windows Server® 2008SP2**
- **Intel® Xeon® process or 5500 series; reliable Dell hardware**
- **Scalable configurations for managing 1,000, 3,000 or 5,000 network elements**
- **Optional High Availability and Disaster Recovery configurations**
- **39-months hardware warranty**
- **1U-high, 19-inch rack-mount unit**

The RADview-Server is a carrier class network management server, factory-installed with the latest RADview-EMS and Oracle releases. The plug-and-play system is easy to use and releases network operators from the complex and time-consuming process of installing and configuring the RADview-EMS application.

RADview-SC/Vmux

Service Management Application for Voice Trunking Gateways

The RADview-SC/Vmux service center application is a powerful tool for provisioning and monitoring the Vmux family of voice trunking gateways (Vmux-2120, Vmux-110, Vmux-210, and Gmux-2000) using SNMP.

The intuitive GUI interface and easy-to-follow wizards increase the efficiency and accuracy of the service provisioning process. The application includes an element management and performance analysis solution that monitors the status, configuration and resource availability of the Vmux voice trunking gateways.

Running on SNMPc, it enables simple integration with other vendors' management applications.

Automated service provisioning

The RADview-SC/Vmux voice trunking application performs automatic provisioning and deployment of the Vmux voice trunking gateways at their respective sites. The ability to perform automated service provisioning from a central site, rather than manual provisioning in the field, improves system uptime, reduces on-site visits and lowers customer support costs. RADview-SC/Vmux defines connections between Vmux voice trunking gateways at associated sites. Several intelligent termination options are provided for deactivating, disconnecting and removing services. Since the configuration information for a deactivated service remains in the RADview-SC/Vmux database, the circuit can be reactivated with a single mouse click.

- **Automatic node and configuration discovery**
- **Service association to network hierarchy level for ease of control and fault isolation**
- **Provisioning from a central workstation**
- **Java-based application enables platform independence (Windows or UNIX)**
- **Maintenance of configuration parameters in database allows for immediate reactivation of deactivated circuits**
- **User-friendly, intuitive graphical user interface**

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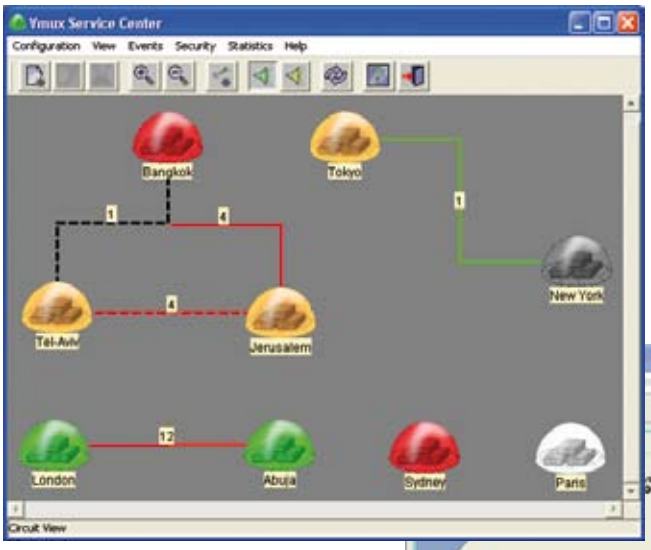

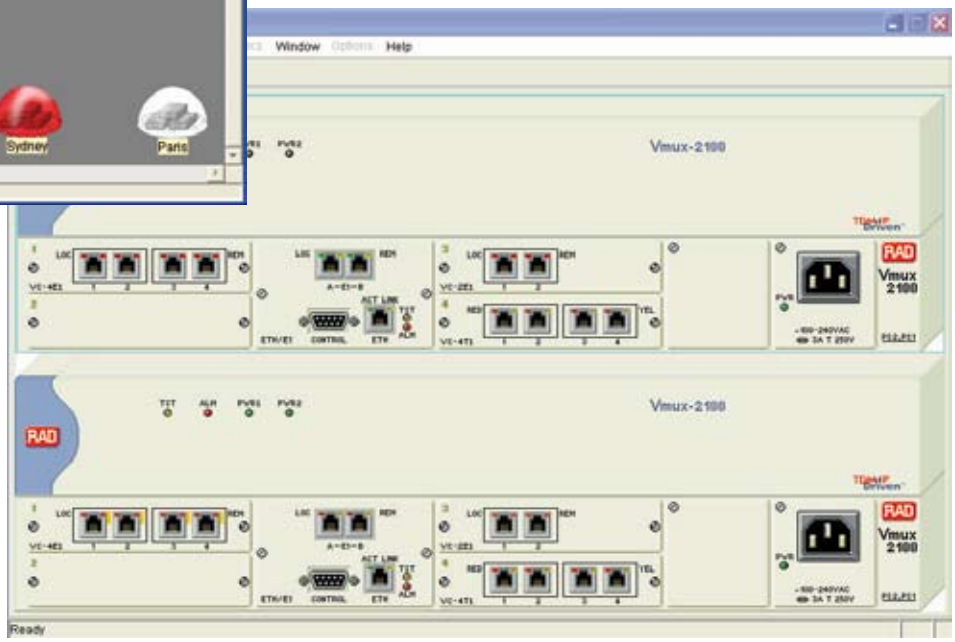

RADview-SC/TDM

Path Management for Multiservice Access Platform

- **End-to-end management over SDH/SONET and PDH networks**
- **Simplifies and automates service monitoring and provisioning for error-free and efficient bandwidth and inventory utilization**
- **Maximizes service assurance with application level protection**
- **Discovers network services and reports on SDH/SONET and PDH network configuration problems**
- **Embeds other vendor's devices via sophisticated network cloud**

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The RADview-SC/TDM enables end-to-end service management of RAD's Multiservice Access Platform devices for simplified service provisioning. An intuitive GUI, "point-and-click" functionality, and easy-to-follow wizards facilitate provisioning and monitoring over combined SDH and PDH networks.

The open, scalable, multi-access management capabilities allow network operators to add new services while minimizing overall operating costs, reducing provisioning times and maximizing efficiency of the network infrastructure.

RADview-SC/TDM offers full interoperation with element management applications, using CORBA-based client-server architecture.

Network monitoring

RADview-SC/TDM displays graphic and alphanumeric network inventory representations from nodes up to services level. Dynamic network status indication and alarms are displayed per node, link, SDH/SONET trail, frames, and service. Only service-affecting alarms are displayed, focusing the user on relevant information.

Online maps display various types of parameters, including services, network nodes and links, clouds and CE equipment, logical PDH rings and SDH/SONET trails, faults on nodes and links, clock source flow, bandwidth utilization, and security authorizations.

Network discovery

The system's capability to discover existing network services, as well as potential network configuration conflicts, assures the best utilization of existing network resources and easy migration steps, in addition to generating network configuration problem reports for PDH and SDH/SONET levels.

Automated service management

RADview-SC/TDM supports automatic service routing based on efficient bandwidth resource analysis of user-configurable cost per link, service priority and protection level.

An intuitive GUI increases the efficiency and accuracy of the service provisioning process, aided by "point-and-click" functionality and easy-to-follow wizards, with tip and hint bubbles throughout the process.

Network uptime is maximized using Provision Carrier Class Service protection with PDH rings, SDH/SONET path protection, and automatic N:1 software service protection. In case of failure while provisioning a new configuration, full rollback to the original configuration is provided.

Automatic service rerouting ensures network resilience and maximizes the uptime of a critical service. This important capability enables the service provider to uphold service level agreements (SLAs) per provisioned service.

Service level reporting allows service providers to quickly and efficiently determine the uptime (in percentage) of a provisioned customer circuit.

For user-friendly maintenance, existing services can be edited and expanded, while simulator mode enhances network and service design, optimization and planning.

Fault management

RADview-SC/TDM fault management correlates incoming events to service and helps present the actual status of the provisioned services.

It includes a history log that allows the filtering of events according to event types and users.

To maximize integrity, faulty services are automatically and periodically self-healed and repaired using priority-based repair of multiple services and periodical attempts, in addition to manually initiated repairs.

Security

Network access security is based on authorization rights by access level (administrator, operator, technician, and monitor), device level and user-profile architecture.

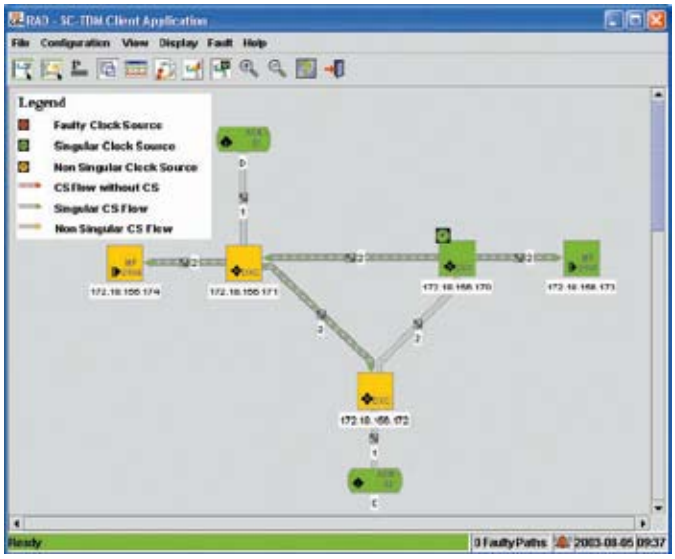
Third-party integration

RADview-SC/TDM uses CORBA-based architecture as a northbound interface that can be integrated with the carrier's front and back office systems and any third-party application.

All system events published as CORBA events allow an OSS application to listen for well-filtered and relevant events from one central system.

Network cloud

Third-party devices can be embedded using a special cloud node that can be set up to include various end points and linked to other MAP devices. A sophisticated cross connect wizard allows the replication of third-party device cross connect data.



RADview-SC/TDMoIP

Service Management Application for TDM over IP

The RADview-SC/TDMoIP is a powerful tool for provisioning and monitoring TDM over IP (TDMoIP) gateways using SNMP. The intuitive GUI interface and easy-to-follow wizards increase the efficiency and accuracy of the service provisioning process.

RADview-SC/TDMoIP includes an element management and performance analysis tool that monitors the status, configuration and resource availability of the TDMoIP gateways.

The application is based on an open, Java-based client-server architecture. Using CORBA-based APIs, the server application can be easily integrated with the carrier's front office and back office systems (any third-party application).

Running on either HP OpenView Network Node Manager (NNM) or on SNMPc, it enables simple integration with other vendors' management applications.

Automated service provisioning

The RADview-SC/TDMoIP application performs automatic provisioning and deployment of the TDMoIP gateways at their point of deployment. It supports two types of services: regular service, which consists of a hierarchy of central and branch sites; and mesh service, enabling any-to-any connections between gateways.

The ability to perform automated service provisioning from a central site, rather than manual provisioning in the field, improves time-to-market, reduces the number of required on-site visits and lowers customer support costs.

RADview-SC/TDMoIP detects all TDMoIP gateways installed on the specified sub-network, performs site association and defines circuits between TDMoIP gateways at associated sites. The application automatically generates a suggested configuration based on the parameters entered by the network manager.

Several intelligent termination options are provided for deactivating, disconnecting and removing circuits. Since the configuration information for a deactivated circuit remains in the RADview-SC/TDMoIP database, the circuit can be reactivated with a single mouse click.

- **Automatic node and configuration discovery**
- **Service association to network hierarchy level for ease of control and fault isolation**
- **Provisioning from a central workstation**
- **Open system design based on client-server architecture and CORBA APIs**
- **Java-based application enables platform independence (Windows or UNIX)**
- **Maintenance of configuration parameters in database allows for immediate reactivation of deactivated circuits**
- **User-friendly, intuitive graphical user interface (GUI)**
- **Easy integration with third-party NMS products via CORBA**

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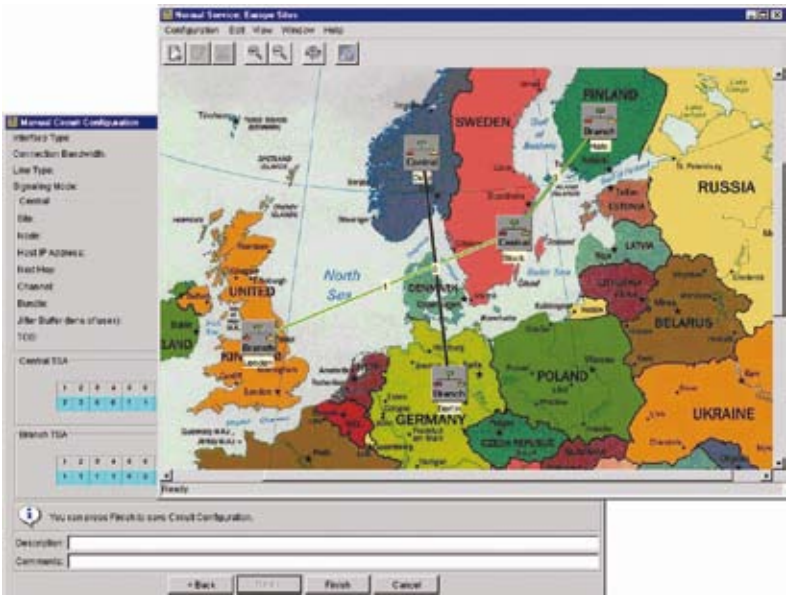

RADview Agent Compatibility

RADview-EMS		RADview-SC/Vmux	RADview-SC/TDM	RADview-SC/TDMoIP
ACE-3100	IPmux-24	Gmux-2000	ASMi-52/52L	IPmux-155L
ACE-3105	IPmux-216	Vmux-110	ASMi-54/54L	IPmux-1E
ACE-3200	IPmux-2L/4L/16L	Vmux-210	DXC-100	IPmux-24
ACE-3220	Kilomux-2100/2104	Vmux-2120	DXC family	IPmux-216
ACE-3400	LA-110		FCD-155/155E	IPmux-2L/4L/16L
ACE-3402	LA-210		FCD-E1L	Gmux-2000
ACE-3600	LRS-16		FCD-E1A	
Airmux-200	LRS-102		FCD-E1LC	
Airmux-400	Megaplex-2100/2104		FCD-IP	
APD-8	Megaplex-4100		FCD-IPM	
APS-8/16/24	Optimux-45/45L		Megaplex-2100/2104	
ASMi-52/52L	Optimux-106		Megaplex-4100	
ASMi-54/54L	Optimux-108/108L			
DXC-100	Optimux-125/134			
DXC family	Optimux-1025/1032			
DXC-4	Optimux-1551/1553			
Egate-100	PL-1000/1000E *			
Egate-20	PL-400/400E *			
Egate-2000	RIC-155GE			
ETX-1002	RIC-155L			
ETX-102	RICi-4E1/4T1			
ETX-201	RICi-8E1/8T1			
ETX-202	RICi-16			
ETX-203A	RICi-622GE			
ETX-212A	RICi-E1/E3			
ETX-220A	RICi-T1/T3			
ETX-5300A	RIC-LC			
FCD-155/155E	SPH-16			
FCD-E1A	SPS-3S			
FCD-E1E	SPS-6			
FCD-E1L	SPS-12			
FCD-E1LC				
FCD-IP				
FCD-IPM				
FOMi-E3/T3				
FPS-8				
Gmux-2000				
IPmux-155L				
IPmux-1E				

* PacketLight product

RADcare Global Professional Services

Peace of Mind, Where and When You Need It.

Introducing RADcare Global Professional Services

No business or organization can afford downtime in their communications network. Rapid resolution of network problems is a top priority everywhere. The best way to avoid interruption of critical business processes is to plan the network for optimal operating efficiency and deploy communications equipment that guarantees high availability.

Occasionally, even the best designed network can experience problems. That's why you require a resource that can resolve the issue as quickly as possible to maintain business continuity. But technical support is not only about fixing what's broken. Real-time service guidance is invaluable during planned upgrades or service configuration changes (which normally take place outside of normal business hours).

RADcare Global Professional Services is RAD's new comprehensive package of service, support and training options. United under the popular RADcare brand name, RAD's revamped Global Professional Services program provides you with expert consulting and troubleshooting assistance, online tools, regular training programs, and various equipment coverage options. All of these vital services are available from authorized RAD Partners backed by a highly dedicated and professional team of regional support associates at internationally located TACs (Technical Assistance Centers), together with pre-sales engineers, project management staff, and training professionals at RAD headquarters. By subscribing to one or all of the RADcare Global Professional Services' elements, you increase your ability to profit from RAD's formidable wealth of industry expertise and international experience.

RADcare Pre-Sales Consulting

Whether identifying a market or client opportunity, or evaluating a current customer's network expansion options, authorized RAD Partners and their customers can consult with RAD's Pre-Sales Consulting team to benefit from their vast knowledge of current technology and hands-on experience with global market requirements. The consulting service is offered free-of-charge as part of the basic and contracted service programs. (Note – onsite support is not included.) Technical support for customer demonstrations and Proof of Concept are available free-of-charge for up to three months for holders of the RADcare Basic Package and for the life of the service package for holders of renewable contract-based services.

Program features

- Client evaluation
- Solution consultation and planning
- Demonstration and Proof of Concept (POC)
- Bill of Materials (BOM)
- Tenders and quotations

RADcare Professional Services

RADcare Global Professional Services are obtained directly from your local authorized RAD Partners.

RADcare Technical Support

RADcare Technical Support

Follow-the-Sun Service Model

- **Priority handling and escalation procedures**
- **On-site spares**
- **Replacement parts/products**
- **Access to eSupport system**
- **Software downloads**

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Service options include pre-sales support and download access from the RAD database as well as five levels of tiered service options, backed by trained staff at four regional support centers, conveniently manned.

With three regional support centers – APAC, EMEA and the Americas – and a central monitoring staff at headquarters, the sun never sets on your RADcare service team. To ensure optimal customer satisfaction, all RADcare interactions are supervised from a central monitoring post at RAD headquarters. A rules-based system with automatic escalation to a global escalation team guarantees that every trouble ticket gets the attention it mandates, while all tickets – both regional and at headquarters – are kept in the same central CRM database for follow-up and cross referencing purposes.

eSupport system

This simple, user-friendly operation is comprised of a Technical Information Center (TIC) and Technical Assistance Center (TAC), which offer the following tools and services to RAD Partner who hold active RADcare accounts for their customer base:

- Software downloads
- Frequently asked questions (FAQs)
- Technical updates
- Trouble-ticket entry and tracking

Remote configuration

With RAD's remote Configuration Service, an experienced RAD engineer can set up and configure your RAD equipment through a secure Internet connection while you watch.

When the warranty expires

RAD's products are built to last and RAD's warranty program offers basic hardware and software protection for a limited period of time. With any of the RADcare contract-based service programs, however, you are also ensured immediate access to RAD's broad-based product and system knowledge plus the option to receive spare parts when and where you need them.

In addition, you are covered for service issues arising from upgrades and changes of service plans during your planned maintenance windows.

Renewable Contract-Based Services	Software Warranty	Hardware Warranty	FAQ Database	Phone Support (Local Business Hours)	24 x 7 Phone Support	NBD Shipment of Spares	On-Site Spares (RAD-Owned)
RADcare Basic Plus	✓	✓	✓	✓			
RADcare Extended	✓	✓	✓	✓	✓		
RADcare Advanced	✓	✓	✓	✓	✓	✓	
RADcare Premium	✓	✓	✓	✓	✓	✓	✓

RADcare Service Program in North America

The RADcare Service Program in North America is designed to provide timely installation of new network solutions, with flexible support packages for the protection of critical networks. Through a variety of options, the RADcare service program can be tailored to provide the level of support best suited for the user's needs.

Basic Service

RAD's Basic Service includes:

- Technical assistance on general inquiries, Monday through Friday – 9:00 am to 6:00 pm EST
- Parts repaired at no additional charge in compliance with RAD's basic warranty policy

For more information on RAD's basic warranty policy, please contact RAD or a local authorized RAD distributor.

Service Level One

Service Level One builds on RAD's Basic Service support package by offering 24x7x365 priority technical phone support. This service plan offers:

- Dedicated toll-free number for all priority technical support calls on downed, faulty or degraded RAD products: 24 hours a day/7 days a week
- Priority handling of all service calls with escalation management to ensure timely problem resolution
- Parts repaired at no additional charge

Service Level Two

RAD's Service Level Two improves upon Service Level One by guaranteeing next-business-day shipment of replacement parts or products. This service plan includes:

- Dedicated toll-free number for all priority technical support calls on downed, faulty or degraded RAD products: 24 hours a day/7 days a week
- Priority handling of all service calls with escalation management to ensure timely problem resolution
- Replacement parts guaranteed to ship by next business day

Service Level Three

RAD's premier service offering is Service Level Three, which features on-site spares for automatic parts replenishment. This service plan includes:

- Dedicated toll-free number for all priority technical support calls on downed, faulty or degraded RAD products: 24 hours a day/7 days a week
- Priority handling of all service calls with escalation management to ensure timely problem resolution
- On-site spares for automatic parts replenishment:
  - RAD-owned spare products housed at customer site(s) for utilization upon determination by RAD technician. One spare will be provided for every 20 regularly purchased units – minimum of four units required to qualify
- Dispatch of RAD-authorized field technician for on-site support within four hours when necessary

Installation

RAD's installation package includes:

- Single point of contact through the entire install cycle
- Site survey (additional charges apply)
- Statement of work (for larger, complex projects)
- Staging/pre-configuration and testing of all RAD equipment
- On-site installation by a RAD Certified Service Technician
- Testing and acceptance

Staging

RAD Data Communications, Inc. ensures smooth and trouble-free installation by staging user equipment in our facilities. Staging services include:

- Assembly and programming of RAD products in accordance with configuration data and application documentation
- Programmed units undergo extensive testing that closely emulates the external services for which the equipment has been provisioned, whenever possible
- Each staged unit is documented in a package consisting of the following:
  - Hardware, software and firmware revisions
  - Parts and serial numbering
  - Programming and configuration of parameters

Time and materials

For those who have not purchased a service level agreement under the RADcare service program, RAD offers an alternative solution designed to meet a variety of service requests and requirements. Time and materials services include, but are not limited to, the following:

- Out-of-warranty support
- On-site support requests
- Telephone assistance beyond general inquiries

RADcare Training

End-User and Partner Training

- **Regional pre-sales and technical seminars**
- **Training-on-demand**
- **WBT – Web-based training**
- **RAD University**
- **eLAB – on-line self-directed training**
- **RAD certification**

For latest updates visit www.rad.com

Training is a key part of the investment that you are making to ensure that your network operates as specified, and when things go wrong they are fixed speedily. RAD employs the latest thinking on blended learning, amalgamating different training tools and performing training needs analysis, enabling us to design a training solution that meets your customers' needs. RAD training ensures that your engineers gain the maximum benefit from the RAD solution you have implemented; your engineers will gain configuration and maintenance skills and will be confident in their handling of your network.

For the RAD Partner we offer a complete range of services too, including seminars, "Train the Trainer" programs, courses in design fundamentals, and regular Web-based training (WBT) and updates. With this training experience, you are in good hands with a RAD Partner.

RAD's training programs are designed to keep your team up-to-date with the latest RAD products and technologies. RAD courses ensure that your key people get the knowledge they need to perform better. Need to improve or update engineering, design or sales skills? RADcare Training is the answer for you.

Regional pre-sales and technical seminars

RAD's regional pre-sales and technical seminars are an open opportunity for Partners and their end users to gain hands-on experience with RAD products closer to their base of operations. RAD seminars are professionally organized, technically challenging and fun! Each seminar location is chosen to meet our strict criteria and invitations are sent via the local RAD Partners, while an invitation banner on the RAD Web site provides an additional route to these events.

Regional technical seminars combine the use of real products with experienced RAD technical support staff from RAD headquarters. Everyone gets a chance to learn hands-on skills in applications relevant to their region.

The seminars are three- or four-day events, allowing you to really get to grips with the technology and solutions. For more information, please contact your local distributor or write to training@rad.com.

- Hands-on seminars led by RAD technical support engineers
- Hear about the latest technologies and configure the most up-to-date products
- Learn how to implement better networks
- Get RAD certification

WBT – Web-based training

Web-based training has a long history at RAD. This nearly carbon-neutral form of training (no travel, no product shipping) has been in regular use at RAD since 2002. In the last eight years we have logged hundreds of hours of training through this 21st century medium. RAD Partners are invited to weekly update WBT classes, covering everything from product updates to latest technologies. Building on our years of experience, we are now enabling RAD Partners to offer specific WBT training to RAD end users.

During these live sessions, the participants are encouraged to ask questions and to ask for clarifications. Answers are given in real time and this ensures that the training meets the needs of the end user.

Following the training, recordings of all sessions are available, allowing revision and review of the material at any time.

Live training allows your queries to be handled in real time.

- Building on eight years of success
- Simple, friendly, easy to access
- On demand
- Weekly refresher classes

Training-on-demand

RAD is committed to the success of every installation and one of the main ingredients for success is the transfer of knowledge to the user. RAD authorizes Partners as trainers conforming to the same levels of expertise. This authorization gives our highly trained Partners access to a wide variety of support tools from head office. In addition, RAD offers direct training to end users, arranged via RAD Partners, on-site or at RAD headquarters. Our trainers' expertise will ensure that the implementation of this RAD solution will be as smooth as possible.

WBT on demand

Although our main preference is classroom training (either on-site or at a RAD office) we regularly supplement this with training via WBT (our Web-based training system). This allows focus on the heart of the network, while giving

Regional pre-sales and technical seminars take place in different cities in different regions each year.

For the latest information on the seminar nearest you, please see the RAD Web site – www.rad.com

access to RAD expertise at lower cost for specialist knowledge. RAD University provides background material for our training offerings (see below).

- Training designed for your needs
- Classroom or Web-based or a combination
- Hands-on workshops designed around your application
- Professionally presented by RAD authorized trainers
- All participants receive RAD certification

Contact your local distributor or training@rad.com for more information.

RAD University

A key resource on the RAD Web site, RAD University contains tutorials, video guides, audio presentations, and technology backgrounders on telecommunications, data communications and computer networking.

The tutorials that can be reached from the RAD University page include student projects and "The Dean's" own tutorials.

The video guides, audio presentations and technology backgrounders are prepared in-house at RAD and include material on different transport environments and technologies. With access to these free materials, RAD's end users are well placed to understand the fundamental principles that lie behind the technology designed into the RAD solution.

eLAB – on-line self-directed hands-on product knowledge

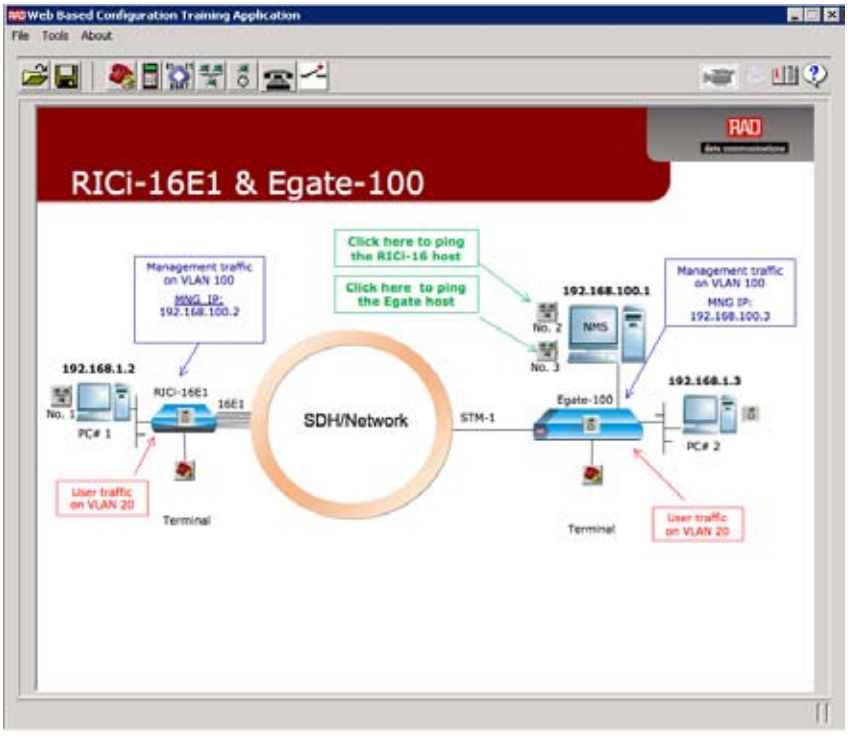
The eLAB online training system is designed to bring training to you without the overhead of shipping equipment. At company headquarters, we've built several applications, and by prior arrangement with RAD, you can use this facility in order to learn how to configure a complete RAD network from a remote location. Unlike other training methods, this is not a simulation. You configure real equipment. This ensures that the training experience is as close as possible to the real world. This unique experience includes the ability to run tests, including BERT, voice and ping, with no need for external equipment. eLAB is available to RAD Partners and via RAD Partners to end users.

- Self-learning basic configuration of RAD products
- No need for any special software on your PC
- Access a complete application over the Internet
- Dedicated equipment assigned to one user at a time
- RAD certification – attests to your qualification in RAD technology

RAD certification

RAD certification proclaims the standard that your staff members have reached in RAD technology. RAD certificates are awarded to RAD Partners (showing their expertise and their commitment to RAD) and to end users. Certified RAD Technical Experts – the recognition awarded to successful RAD Partner participants in the International Technical Seminar (the prime technical training seminar for all RAD Partners) –have gained the know-how to successfully handle many of your customers' queries, improving their satisfaction and getting their equipment working as fast as possible. RAD Authorized Technical Trainer is the certification given to those RAD Partner engineers who have achieved high levels both in RAD technical knowledge and in training skills, earning them direct access to RAD training materials.

End users that complete RAD training programs are awarded the RAD Application Expert certificate if they have completed the optional exam.



eLAB screen-shot: configuration training via the Web

For further information on any training matter, please write to training@rad.com

RADcare
Project Management

RADcare Project Management

- **Single point of contact**
- **Project coordination**
- **Risk management**
- **Periodic meetings**
- **Action item follow-up**
- **Regular progress reports**
- **Test procedure definition**
- **Project specific documentation**

Proactive project management by RAD's professional project management staff ensures that your project will have a timely and smooth implementation from the planning stage through project completion.

Once you've decided to purchase RAD products, RAD's project management program can help you maximize the value of your capital investment all along the project lifecycle.

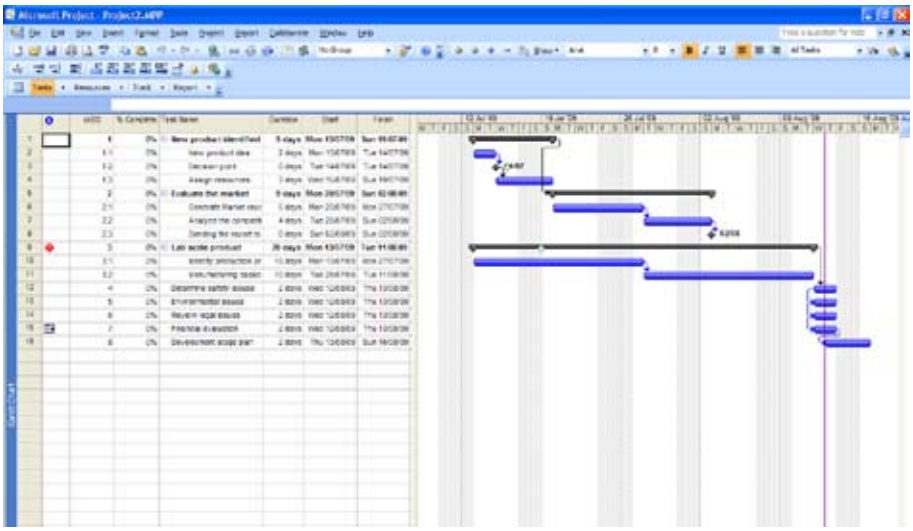
For latest updates visit www.rad.com

RADcare project management service

On receipt of your services order, a project manager is assigned to coordinate all project activities within RAD and to serve as a single point of contact for you to promptly handle and resolve questions and issues that might arise. Moreover, the project manager is trained to use advanced risk management techniques to identify and avoid potential conflicts and issues before they become problems. Project managers conduct periodic meetings with all the project teams to ensure seamless communications throughout the life of the project. In addition to following up on all action items and issuing regular progress reports, the project manager defines test procedures and manages your specific project configuration and documentation.

Wide variety of project management services:

- Project management planning
- Project scope management
- Quality management
- Schedule management (Gantt)
- Cost management
- Risk analysis
- Communication management
- Change/new features request handling
- Periodic meetings
- Action item assignment, follow-up and reporting
- Progress reports
- Application planning and configuration
- Testing and homologation
- Network management administration
- Project lifecycle with milestones
- Configuration and version control
- Tailored solutions
- Responsibility for functional and architectural coherence between the customer application, problem solving and change requests



Gantt charts are one of the tools used by RAD's project management team to track project progress

Acceptance testing

The project manager can produce a full acceptance test procedure, covering factory and application acceptance and ensuring that the products meet your application needs so that your entire network can be certified before sign-off.

Staging

Holding your own stock during a phased installation can prove to be expensive and inefficient. RAD can help by providing staging and pre-configuration services that can ensure that the expected equipment reaches the right site on schedule, fully configured and tested for smooth installation per specific site needs. The staging service includes a complete documentation pack for each site.

Customized documentation

Most large end users have specific tasks allocated to specific teams. RAD can produce team-specific instruction lists, allowing for fast run-up of the required product knowledge and avoiding the waste of resources caused by needlessly forcing engineers to wade through detailed user-manuals. This optional service can include design and production of "short-form" manuals, a boon to the technician in the field.

On-Site Services

Many organizations are looking to outsource their ITC activities to cut costs and better focus on their main line of business. RAD offers a range of on-site services that take the risk out of outsourcing network set-up and management – and enable you to realize your budgetary objectives. Although most are pre-packaged for your convenience, RAD is flexible enough to tailor a proposal to cover your specific requirements.

To aid in your outsourcing decision, we've listed some of the main features and benefits of RAD's on-site services packages.

Site engineering service

This encompasses system configuration review, site consultation, detailed installation specification, equipment inventory lists, and site boilerplate generation for smooth error-free deployment.

Site survey

Following the decision to implement a new network or to upgrade an existing infrastructure, a site survey is required to ensure that the infrastructure meets the requirements of the new network. A site survey starts from the basics and fully documents the installation requirements for your system. Fully documented, your system becomes easier to maintain and future changes are simpler to implement.

Installation

Encompassing site inventory planning, installation, build, and site documentation, professional installation avoids commissioning problems, and in the case of future network growth, provides a standard framework that all new equipment can fit into.

Commissioning

RAD's experience in commissioning networks brings you the peace of mind that all ITC managers are looking for. From the design of the commissioning procedure through to complete implementation, customized testing and acceptance, the RAD commissioning experience will ensure smooth take-up of your network.

NMS installation and administration

NMS (network management system) installation is a highly complex task, as the management software must interface with every other element in the network. With the wide variety of options open to the end user, RAD is happy to offer this service, performed either on-site or remotely. On-site NMS set-up can be combined with on-site training (see below), ensuring that the local engineers are able to start using the system from day one. In addition, RAD can offer to administer the newly installed network, registering all the network elements. RAD's expertise can help you to correctly interface your NMS to higher and parallel management systems.

On-site training

With many years of experience behind us, we at RAD are confident that you will enjoy learning from the experts. Supplying on-site training cuts the costs of starting the network and shortens the learning curve. Following training on dedicated training equipment, we'll move you to the real network safely and securely.

- **Site engineering service**
- **Site survey**
- **Installation**
- **Commissioning**
- **NMS installation and administration**
- **On-site training**

For latest updates visit www.rad.com

RAD on-site services combine parts of RADcare, project management and training into a single unit, focused on the needs of the customer's site.

11

Complementary RAD Group Products

This year we have decided to include in the RAD catalog several complementary products from RAD Group member companies: **PacketLight** Networks and **RADiFlow**.

PacketLight Networks

PacketLight Networks offers reliable, carrier grade CWDM/ DWDM solutions that ensure access to most business critical data while protecting your investment with scalable, pay-as-you-grow architecture.

RADiFlow

RADiFlow provides industrial service-aware Ethernet switches and management tools, which enable the user to handle critical application-level communications requirements in harsh industrial environments.

Products from both companies may be sourced from RAD Data Communications and its network of channel partners around the globe.

RADiFlow Switches 3700/3300

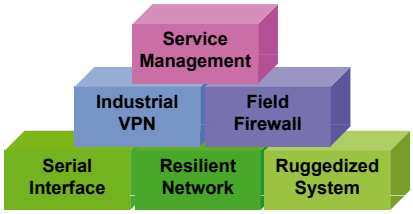
Service-Aware Industrial Ethernet Switches

The RADiFlow switches are unique Industrial Ethernet Switches with integrated service-aware capabilities.

As an Industrial Ethernet switch, RADiFlow switches provide a strong Ethernet and IP feature-set with a special emphasis on the fit to the mission-critical industrial environment: suitability in harsh environmental conditions, robust system design ensuring high reliability of the product, and support for network resiliency schemes to ensure end-to-end high availability.

The RADiFlow switches have unique service-aware capabilities, which enable it to handle critical application-level requirements, such as connectivity of legacy serial devices, implementation of security measures and remote access.

The RADiFlow switches address the application-level requirements in an integrated way, eliminating the need for additional supporting products and resulting in a simple and robust network structure.



High-density modular system

The RADiFlow switches are modular with seven slots for interface modules in the 3700 system and three slots for interface modules in the 3300 system. Each slot can house either an Ethernet module or a serial RS-232/RS-485 module, enabling flexible configuration of interfaces according to the application requirements.

The overall system capacity can scale up to 28 x GbE full-duplex throughput with wire-speed switching for both Ethernet and IP.

When using the service-aware features of the RADiFlow switches, an application processor module should be installed in the rightmost slot of the interface modules.

Robust design for an industrial environment

Industrial networks should operate reliably under extreme conditions, such as high operating temperatures, electromagnetic interferences (EMI), mechanical hazards, and explosive ambient conditions.

The RADiFlow switches are specifically engineered to provide a highly reliable infrastructure in such an industrial environment. Its specs include a DIN-rail mount, IP30 protection level, -40° to +75° C operating temperature range with no fans, ATEX zone 2 hazardous environment, and EMI immunity according to IEC61850-3.

The system is designed for high reliability using industrial hardware components, redundant power supply architecture and security development life-cycle (SDL) processes.

Network resiliency using Ethernet rings

Due to the critical nature of industrial networks, resilient data paths should be used.

The RADiFlow switches support Ethernet rings according to the ITU-T G.8032 standard. This standard-based ring protection is the preferred method of data-path resiliency, ensuring fast failure detection and switchover regardless of the scale of the network.

Service groups segregation using VLANs

In order to use a unified Ethernet network across the factory but still isolate the traffic between different groups of devices, service groups are created using Ethernet VLANs. The RADiFlow switches support implementation of service groups, using the standard IEEE 802.1q VLAN scheme.

Sets of interconnected end-devices can be configured in a service group VLAN so that traffic between them is not shared with devices outside the group.

Such network setup enables the enforcement of quality of service and security measures on each service group regardless of the scale of the network.

- **High-density modular system**
- **Fit for harsh industrial environment**
- **Advanced Ethernet and IP feature-set**
- **Ethernet and serial interfaces**
- **Integrated application-aware firewall per port**
- **Integrated VPN agent**

For latest updates visit www.radiflow.com

Multiservice interfaces

The RADiFlow switches support both Ethernet and RS-232/RS-485 serial interfaces enabling deployment of a modern Ethernet infrastructure in a field-level network with mixed devices.

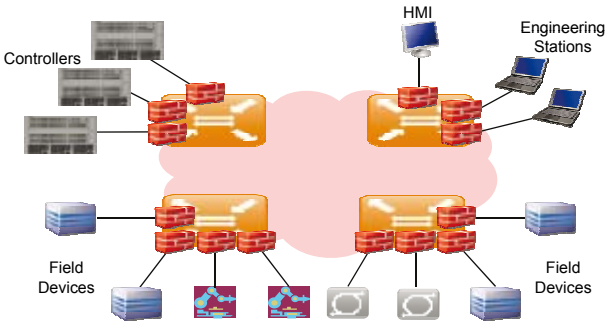
The switches support three operating modes for the transmission of the serial data-streams: transparent tunneling of the traffic between the two remote serial ports, bridge tunneling of the encapsulated industrial protocol between several remote sites, and service translation connecting the serial end-devices to Ethernet-based devices.

Using the RADiFlow switches to bridge serial interfaces brings numerous operational benefits, including topology flexibility, enhanced field-bus diagnostics and easy migration of end-devices to Ethernet.

Distributed application-aware firewall

The RADiFlow switches contain an integrated firewall on each port, providing a network-based distributed security solution equivalent to the use of personal firewalls on all the industrial systems in the factory.

The firewall implemented in the RADiFlow switches is "application-aware", meaning that it inspects the contents of the data packets according to the rules of the industrial protocol used, thus protecting against sophisticated inside attacks.



RADiFlow Switches 3700/3300
(Continued)

Remote operation of the industrial site

The RADiFlow switches contain a VPN gateway which is customized for the remote operations of the critical industrial environment. The communication channel between the local VPN gateway and the service center is SSL-encrypted and requires user authentication and specific access authorizations. After the SSL tunnel has been established and a specific remote user is authenticated, a session to the target device in the industrial network is created. The VPN agent acts as a proxy between the external session and the internal session so that the local network structure is not exposed externally and further on-line security checks are performed.

Based on the multiservice capabilities of the switch, the VPN gateway can also act as a terminal server translating the remote session IP traffic to a serial stream for local serial-based devices.

End-to-end management

The capabilities of the RADiFlow solution are best utilized when implementing the overall infrastructure network using the RADiFlow switches. To facilitate the usage of the network-wide features of the RADiFlow switches, the iSIM central management tool is used. The iSIM supports the operation and maintenance of the network topology, the overlaying service groups and the related security rules, with a minimum of IT knowledge.

See the iSIM page for more details.

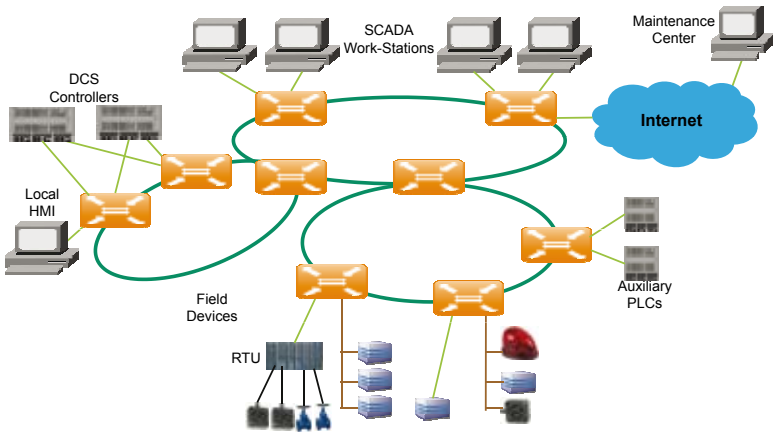
Typical Application

Secured unified infrastructure for a manufacturing facility

Ethernet-based infrastructure is essential for the deployment of advanced manufacturing processes which optimize factory performance.

With the RADiFlow switches you can implement a simple network solution that addresses all the requirements of the manufacturing application:

- Fits industrial environmental conditions
- Support for Ethernet-based and serial-based end-devices over a unified Ethernet network
- Holistic defense-in-depth solution using distributed firewalls in the port connected to each end-device with application-aware security checks
- Secured connection to a remote maintenance center over the Internet using a dedicated industrial VPN gateway
- Intuitive operation and maintenance of the network without expert IT know-how using the iSIM tool, which is dedicated for industrial service management

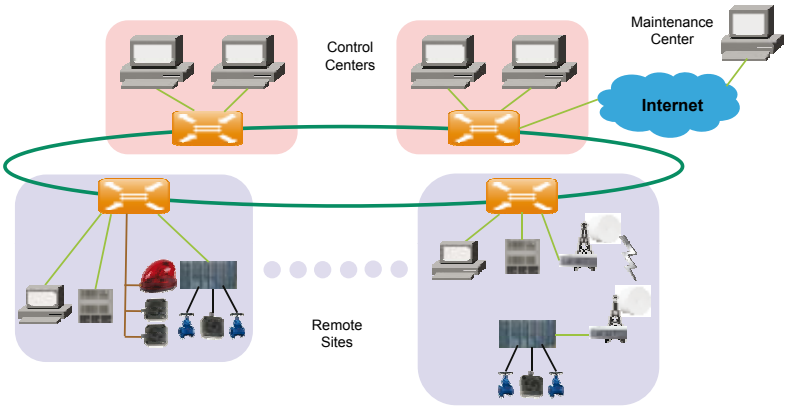


Secured connectivity for utility distributed sites

Communication between distributed utility sites must be resilient and secured. Furthermore, in the remote sites, a variety of end-devices should be accessible in an outdoor environment.

With the RADiFlow switches, you can implement a compact integrated communication center in each site that addresses all the requirements of the distributed application:

- Fit to the outdoor environmental conditions in the remote sites
- Scalable, resilient inter-site connectivity using G.8032 Ethernet rings
- Integrated support for Ethernet-based and serial-based end-devices
- Application-aware firewall in each site to enforce strict access rules



RADiFlow iSIM

Industrial Service Management Tool

Industrial Ethernet networks provide major benefits to the user but it's essential to keep the operational simplicity of the new infrastructure.

The iSIM management tool supports the operation and maintenance of the Industrial Ethernet network consisting of RADiFlow switches without requiring deep IT knowledge.

Network topology management

The iSIM automatically discovers the existing RADiFlow switches in the network and the connecting links. Additional switches can be manually configured before being installed in the network. The iSIM presents the network topology in a logical tree structure and in a graphical map view. Furthermore, the iSIM provides an intuitive wizard for the configuration and operation of G.8032 rings in the network.

Industrial service management

The iSIM is a powerful tool for provisioning of service connections between the industrial end-devices. Service groups are created connecting several industrial end-devices with the industrial protocols used between them.

For secured environments, a security matrix is created for each service group. In the security matrix, the user configures application-aware security rules for each pair of end-devices starting from the protocol level and down to the specific parameters of the industrial protocols.

The iSIM translates the security matrix rules to specific configuration rules for the embedded firewalls in each RADiFlow switch.

Network diagnostic tools

The iSIM provides several tools for easy monitoring of the network status and activation of proper responses.

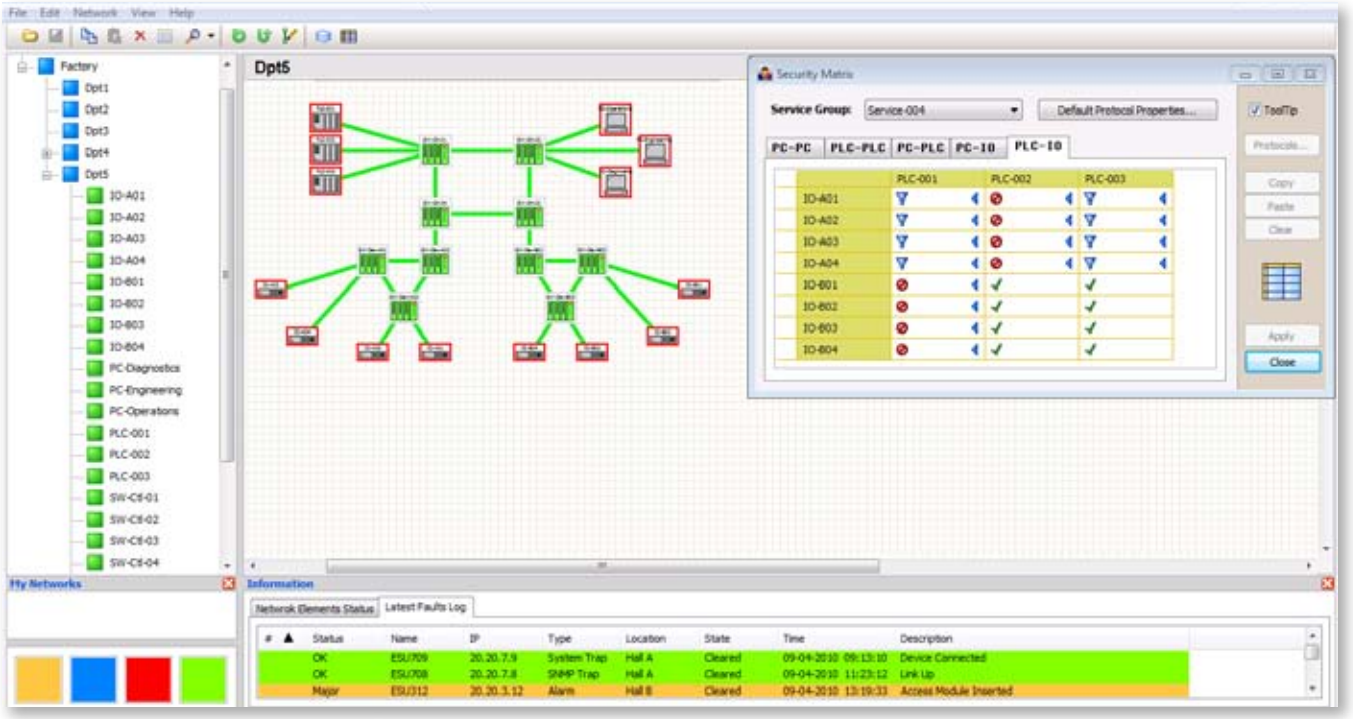
The iSIM gets alarm reports from all the network switches and presents them in an aggregated view with a correlation to the impacted services. In case of a fault alarm, the operator can drill-down to the specific alarm, identify its source and define the corrective measures.

- **Automatic discovery of RADiFlow network switches**
- **Network topology management**
- **End-to-end service provisioning**
- **Security rules configuration**
- **Aggregated network fault monitoring**
- **Network performance analysis**
- **Operator authorization levels**

For latest updates visit www.packetlight.com

Security violation events are also reported with specific analysis tools to help decide whether a true violation occurred and should be acted upon or whether the security rules should be updated to allow such traffic in the future.

For early detection of network failures, the iSIM supports periodic monitoring of traffic statistics of all the network links aggregated into performance graphs with an emphasis on congestion cases.



RADiFlow iSIM main screen with the security matrix configuration menu

PacketLight

Complete Solutions Set for WDM and Dark Fiber Applications

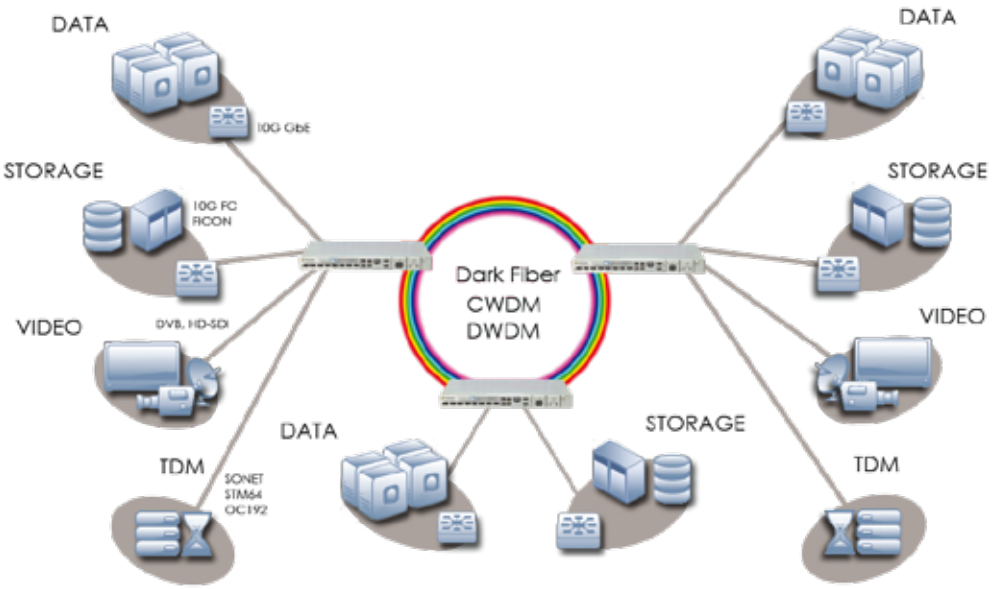
- **Carrier-class feature set**
- **Multirate transponders, 2 Mbps to 10 Gbps**
- **Muxponder for high wavelength utilization**
- **Scales to 40 wavelengths**
- **Amplification over long distances**
- **Performance monitoring**
- **Supports single or dual fiber**
- **Low latency connectivity**
- **Hot-swappable PSU and FAN**
- **Integrated management**
- **Compact 1U devices**
- **Simple to install and maintain**
- **Cost-effective CPE device**

www.packetlight.com

PacketLight's product suite offers the flexibility to build a cost-effective, highly efficient optical network infrastructure for CWDM, DWDM and dark fiber transport connectivity solutions, and satisfy all the challenges faced by the service providers and organization. PacketLight solutions are targeted for a variety of vertical markets such as: Carriers, ISPs, dark fiber providers, data centers, storage facilities, utility companies (railway and power companies), and financial markets.

PacketLight's product portfolio is designed with the following mindset:

- **Carrier grade reliability**
  PacketLight Networks offers reliable, carrier-grade CWDM/DWDM solutions that ensure access to business critical data, offering carrier-class service with guaranteed SLA.
- **Rich high-end feature set**
  PacketLight's unique 1U architecture is feature rich and allows scalability, manageability, and maintenance that support any WDM infrastructure from simple point-to-point networks to carrier-class metro access ring or linear add-and-drop networks.
- **Flexibility and scalability**
  PacketLight's product suite offers multirate transponders, Muxponders, optical amplification, pluggable optics and ROADM, and provides unlimited flexibility to build a cost-effective, scalable, highly efficient optical network infrastructure that fits perfectly for not only carriers, but also for enterprise, campuses and data centers.
- **Compact, low power consumption solution**
  PacketLight products present the leading edge in small footprint WDM products. They have the highest port density in a 1U footprint, thus decreasing the cost of space and power consumption, the two issues that are the biggest challenges for data centers and central offices.
- **Operate your network with ease**
  PacketLight's built-in management tool provides configuration, fault management, pluggable optics and easy administration capabilities that enable any technically savvy employee to quickly adapt to the equipment without a complicated education process and costly spare parts.
- **Solutions that provide solid savings**
  PacketLight's modular design allows customers true pay-as-you-grow architecture, significantly decreasing initial project cost and offering marginal growth capabilities as needed. In addition, simplified operation and remote management eliminates high maintenance cost, decreasing overall OpEx of the organization.



Multirate sub-10G CWDM/DWDM solutions

The PL-400 is a highly flexible metro C/DWDM platform for transport of storage, data, voice, and video applications over dark fiber and C/DWDM networks. PL-400 is designed primarily as an efficient C/DWDM transport device. It is typically deployed as a CLE (customer located equipment) in enterprise campus environments and in central offices, or as a service demarcation point for dark fiber providers and carriers providing a fully managed optical layer.

10G CWDM/DWDM solutions

The PL-1000 is a carrier-class 1U metro C/DWDM platform for transport of 10G data, voice, storage applications and video over dark fiber and WDM networks. The PL-1000's capabilities, dimensions and competitive cost make it the ideal solution for evolving Metro Ethernet networks, enterprise networks, campus environments, and central office connectivity.
The PL-1000 supports up to four high speed 10G services. Each service is configured independently, using PacketLight's user-friendly Web-based management tool. Additionally, by stacking multiple PL-1000s, customers can expand four wavelengths to up to 40 wavelengths, thus achieving a high level of scalability and low initial investment in a pay-as-you-grow architecture.

Combined 10G/sub-10G solutions

PL-1000E is a unique all-in-one optical product, supporting 8G FC, 10G, and sub-10G services in a compact 1U chassis with low power consumption. The PL-1000E supports the full spectrum of FC protocol rates: 1 Gbps, 2 Gbps, 4 Gbps, 8 Gbps, and 10 Gbps. Combining a rich feature set with extremely low latency, low power consumption, a small footprint (1U, ETSI), and affordable cost, the PL-1000E is a best-in-class CWDM/DWDM solution for connecting two data centers or backup sites.

Amplifications and booster solutions

The PL-1000IL is designed to extend the power link budget of DWDM solutions in a cost-effective manner. The PL-1000IL provides amplification for a range of optical solutions starting from four wavelengths to up to 40 wavelengths and incorporates four main types of low-noise EDFAs (Erbium-Doped Fiber Amplifiers): Booster, Inline, Pre-Amplifier and RAMAN. PL-1000IL fully integrates with the PL-400 and PL-1000.

Reconfigurable optical add/drop solutions

PacketLight's PL-1000RO offers ROADM functionality based on the most advanced next-generation WSS (wavelength-selective switching) technology. The PL-1000RO is configured dynamically to add/drop selected wavelengths at any node in the network and seamlessly change the network node capacity as needed. In addition, it automatically maintains the equalization and power balance of the added and bypass wavelengths. The PL-1000RO also integrates EDFA for amplifying the wavelengths and delivering effective long-distance DWDM solutions.

10x1 GbE Muxponder technology

PacketLight's PL-1000EM 10G Muxponder is an ideal solution for efficient and transparent multiplexing of 10 x GbE interfaces over a single protected 10G wavelength. It introduces high density 10 x GbE channels with transparent Layer 1, ultra-low latency mapping to a 10G uplink pipe without packet loss. This elegant, low latency, and easy to deploy 1U box solution fits perfectly for service providers and enterprises as well as the financial markets.

Passive multiplexing solutions

The PL-300 family of products extends PacketLight's optical network solution capabilities by providing a wide range of passive optical modules. The PL-300 provides the needed optical layer functions of 4/8/16/32/40 DWDM wavelength multiplexing and 4/8/16 CWDM wavelength multiplexing.

Fiber Optic Modems

Fiber Optic Modems	Max. Data Rate (kbps)	Interface	Sync/ Async	Carrier Control	Typical Max. Range* (km)	Single Mode Option	Laser Diode Option	Line Connectors		
								ST	FC	SC
FOM-5A	19.2	V.24	A	Yes	3.0	No	No	Yes	Yes	Yes
FOM-20	256	V.24, V.35, V.36, X.21, RS-530, G.703 codirectional, Ethernet	S/A	Yes	140	Yes	Yes	Yes	Yes	Yes
FOM-40, FOMi-40, FOMi-40CD	1544/2048	V.24, V.35, RS-530, X.21 G.703 codirectional, E1/T1, Ethernet	S	Yes#	100	Yes	Yes	Yes	Yes	Yes
FOM-E1/T1, FOMi-E1/T1 FOMi-E1/T1CD	1544/2048	G.703	S	No	144	Yes	Yes	Yes	Yes	Yes
FOM-E3	34,368	G.703	S	No	110	Yes	Yes	Yes	Yes	Yes
FOM-T3	44,736	G.703	S	No	110	Yes	Yes	Yes	Yes	Yes
FOMi-E3	34,368	G.703	S	No	110	Yes	Yes	Yes	Yes	Yes
FOMi-T3	44,736	G.703	S	No	110	Yes	Yes	Yes	Yes	Yes

* Typical ranges. Precise range should be calculated based on optical budget and fiber cable conditions. To derive the number of miles, divide by 1.6
# Only in FOM-40

RAD Rate Converters

Service / Rate	64 kbps G.703	n x 64 kbps	T1	Fractional T1	E1	Fractional E1	E3 & Fractional E3	T3 & Fractional T3	STM-1 & Fractional STM-1	OC-3 & Fractional OC-3
48 kbps or 56 kbps	SPD-703-1									
n x 56/64 kbps			ASM-40 DXC Family	DXC Family	ASM-40 FCD-E1 FCD-E1L FCD-E1LC DXC Family	FCD-E1 FCD-E1L FCD-E1LC DXC Family	DXC Family	DXC Family	DXC Family	DXC-100
E1		DXC Family	DXC-2 DXC Family	DXC-2 DXC Family	ASM-40 FCD-E1 FCD-E1LC DXC Family	DXC-2 DXC Family	DXC Family	DXC Family	DXC Family	DXC-100
T1		DXC Family	DXC-2 DXC Family	DXC-2 DXC Family	DXC-2 DXC Family	DXC-2 DXC Family	DXC Family	DXC Family	DXC Family	DXC-100
E3		DXC Family	DXC Family	DXC Family	DXC Family	DXC Family	DXC-100	DXC-100	DXC-100	DXC-100
T3		DXC Family	DXC Family	DXC Family	DXC Family	DXC Family	DXC-100	DXC-100	DXC-100	DXC-100
STM-1		DXC Family	DXC Family	DXC Family	DXC Family	DXC Family	DXC-100	DXC-100	DXC-100	DXC-100
OC-3		DXC-100	DXC-100	DXC-100	DXC-100	DXC-100	DXC-100	DXC-100	DXC-100	DXC-100

Sync Modem Selection Guide

Synchronous Modems	Max. Data Rate (kbps)	Interface	Wire Number	Approx. Range		Trans-former Isolated	Rack Option	Multipoint	Line Connectors				
				km @ 24 AWG	Data Rate (kbps)				Terminal Block (Default)	RJ-11 or RJ-12	RJ-45	DB-15	Coax BNC
ASM-10/8	19.2	V.24	2/4	13.0	9.6	Yes	Yes	Yes	Yes	No	No	No	No
ASM-31 ASMi-31	128	V.24, V.35, V.36, RS-530, X.21, G.703 codirectional, Ethernet	2	8.0	64	Yes	Yes	No	Yes	No	Yes	No	No
ASM-40	2048	V.24, V.35, V.36, RS-530, X.21, IP, G.703 (codirectional, HDB3), Ethernet	4	1.8	2048	Yes	Yes	No	Yes	No	No	Yes	Yes
ASMi-52/52L	2.3/4.6 Mbps	V.35, X.21, RS-530, E1, Ethernet	2/4	4.0	2048	Yes	Yes	No	Yes (52L)	No	Yes (52)	No	No
ASMi-54/54L	30 Mbps	E1, Ethernet (fiber and copper)	8	2.4	5700	Yes	Yes	Yes	No	No	Yes	No	No
ASM-61	10 Mbps	Ethernet	2	1.2	10,000	Yes	No	No	No	No	Yes	No	No

RAD Interface Converters

DCE / DTE	G.703 2 Mbps	G.703 1.544 Mbps	G.703 (Co-directional)
V.24			SPD-703-1
V.35	ASM-40 RIC-E1	ASM-40 RIC-T1	SPD-703-1
V.36	ASM-40 RIC-E1	ASM-40 RIC-T1	SPD-703-1
X.21	ASM-40 RIC-E1	ASM-40 RIC-T1	SPD-703-1
RS-530	ASM-40 RIC-E1	ASM-40 RIC-T1	SPD-703-1
Ethernet	RIC-E1	RIC-T1	

Glossary

For the complete glossary see **www.rad.com**

A

Abis: A GSM term for an interface linking between the BTS (base transceiver station) and the BSC (base station controller). Other GSM interfaces are the A between the BSC and the MSC (mobile switching controller), and the E between the MSC and the PSTN.

ACR (Adaptive Clock Recovery): A method in which the clock is distributed over the PSN as an inband TDM stream and regenerated using the packets' time-of-arrival information, independently of the physical layer. The clock stream format is a standard pseudowire flow, simplifying interoperability with third-party equipment. In addition, bandwidth consumption can be minimized by using a multicast pseudowire for clock distribution. Today, pseudowire gateways incorporating high performance adaptive clock recovery mechanisms are already deployed and meet stringent GSM/UMTS requirements.

Asynchronous Transmission: A transmission method that sends units of data one character at a time. Characters are preceded by start bits and followed by stop bits, which provide synchronization at the receive terminal. Also called start-stop transmission.

B

Backhaul: Transporting traffic between distributed sites (typically access points) and more centralized points of presence.

Bandwidth: The range of frequencies passing through a given circuit. The greater the bandwidth, the more information can be sent through the circuit in a given amount of time.

Best-Effort: A QoS class in which no specific traffic parameters and no absolute guarantees are provided.

Bridge: A device interconnecting local area networks at the OSI Data Link Layer, filtering and forwarding frames according to media access control (MAC) addresses.

Broadband: Wideband technology capable of supporting voice, video and data, possibly using multiple channels.

BSC (Base Station Controller): Provides the intelligence behind the BTSs. Typically, a BSC has tens or even hundreds of BTSs under its control.

BTS (Base Transceiver Station): The equipment which facilitates the wireless communication between a user's handset and the network. BTS can also be referred to as RBS (radio base station), Node B (in 3G networks) or simply BS (base station).

C

Carrier Ethernet: A ubiquitous service based on standardized equipment and protocols, Carrier Ethernet is characterized by industry-defined attributes for service level agreements, provisioning, system-wide management, and carrier-class OAM.

Carrier Ethernet Deployment: Carrier Ethernet deployment is picking up pace as Ethernet becomes a widely-accepted, carrier-grade service suite. However, it depends on service providers' ability to cost-effectively overcome two key challenges: the diversity of existing access and transport networks, and the need to meet user expectations for SLA accountability.

Central Office (CO): Telephone company switching office. This is where you would find the local Telco switch that connects to your telephone.

Channelized E1/T1: E1 or T1 service that is divided into individual 64 kbps channels (or channels that are multiples of 64 kbps such as a 256 kbps channel made from four 64 kbps channels), as opposed to unchannelized service, which uses the entire bandwidth of the E1 (2.048 Mbps) or T1 (1.544 Mbps). Channelized E1 or T1 lines can consist of switched lines with inband signaling or leased lines.

CIR (Committed Information Rate): Defined in a customer's SLA and represents the average bandwidth that the service provider guarantees to the user, regardless of network conditions.

Circuit Emulation: A connection over a virtual circuit-based network providing service to end users that is indistinguishable from a real point-to-point, fixed-bandwidth circuit. Services based on circuit emulation (Circuit Emulation Services or CES) offer traditional TDM trunking (at n x 64 kbps, fractional E1/T1, E1/T1 or E3/T3) over a range of transport protocols, including ATM, IP, MPLS and Ethernet.

Circuit Emulation Service: New technology for offering circuit emulation services over packet switched networks. The service offers traditional TDM trunking (at n x 64 kbps, fractional E1/T1, E1/T1 or E3/T3) over a range of transport protocols, including IP, MPLS and Ethernet.

Clock: A term for the source(s) of timing used in synchronous transmission.

CO (Central Office): Telephone company switching office. This is where you would find the local Telco switch that connects to your telephone.

CORBA: The acronym for Common Object Request Broker Architecture, OMG's open, vendor-independent architecture and infrastructure that computer applications use to work together over networks. One of its most important uses is in servers that must handle a large number of clients, at high bit rates, with high reliability, such as network management systems.

CPE (Customer Premises Equipment): Generally refers to communications equipment located at the customers' premises for use with communication service providers' services. In some cases, these are customer-owned or leased; in other cases, these are the property of the service provider.

Cross Connect: A network device used by telecom carriers and large enterprises to switch and multiplex low speed voice and data signals onto high speed lines and vice versa. It is typically used to aggregate several E1/T1 lines into a higher speed electrical or optical line, as well as to distribute signals to various destinations.

D

DCME (Digital Circuit Multiplication Equipment): Performs voice compression over TDM and IP networks to reduce bandwidth requirements for microwave, wireline and costly satellite links while preserving voice quality.

DiffServ or DS (Differentiated Services): QoS method to differentiate and control IP traffic so that the traffic's relative priority can be determined on a per-hop basis.

Digital Cross Connects (DACs): Come large and small, handling only a few ports up to a couple of thousand. Narrowband, wideband and broadband cross connects support channels down to DS0, DS1 and DS3 respectively. (See Cross Connect.)

DSCP (Differentiated Services Code Point): A field in the header of IP packets for packet classification purposes.

DS0 (Digital Subscriber Level Zero): A 64 kbps unit of transmission bandwidth. A worldwide standard speed for digitizing one voice conversation, and more recently, for data transmission. Twenty-four DS0s (24 x 64 kbps) equal one DS1.

DS1 (Digital Signal Level 1) Channel: Framing specification used in transmitting digital signals at 2.048 Mbps on an E1 facility or 1.544 Mbps on a T1 facility.

DS2 Channel: For an E1 line, an 8.45 Mbps channel that consists of four DS1 channels; for a T1 line, a 6.312 Mbps channel that consists of four DS1 channels.

DS3 Channel: A 44.736 Mbps line consisting of seven DS2 channels. A DS3 line is also called a T3 line.

E

E&M Signaling: Voice transmission system that uses separate paths for signaling and voice. The "M" lead (mouth) transmits signals to the remote end of the circuit while the "E" lead (ear) receives incoming signals.

E-LAN: MEF-certified services consisting of multipoint connections, in which each EVC connects more than two UNIs. This service type enables any-to-any connectivity among disparate locations across metro or wide area networks. E-LANs also support bandwidth granularity and differentiated services which make them ideal for transparent LAN networking.

E-Line: A MEF-certified service in which each EVC links only two UNIs in a point-to-point connection. E-Line services are available as either one of two service variants: Ethernet Private Line and Ethernet Virtual Private Line.

E-Tree: Also called rooted multipoint, an MEF-certified multicast service in which one or more of the UNIs are classified as "Roots," while all other UNIs are designated as "Leaves." Traffic delivery is permitted between a Root and a Leaf, in both directions, but is prohibited between Leaves. E-Tree services are best suited for IPTV applications.

E1: A 2.048 Mbps line, common in Europe, that supports thirty-two 64 kbps channels, each of which can transmit and receive data or digitized voice. The line uses framing and signaling to achieve synchronous and reliable transmission. The most common configurations for E1 lines are E1 PRI, and unchannelized E1.

E1 PRI Line: An ISDN line that consists of thirty-two 64 kbps channels. This type of line uses 30 B channels for user data, one x 64 kbps D channel for ISDN D-channel signaling, and one framing channel. The B channels can be all switched, nailed up, or a combination of switched and nailed up. This type of PRI line is a standard in Europe and Asia called G.703.

E3: The European standard for high speed digital transmission, operating at 34 Mbps.

Echo Cancellation: Improves the quality of voice transmissions. It eliminates the echo that results from the reflection of the telephony signal back to the caller, which can occur in a 4-wire to 2-wire hybrid connection between the CPE and the telephones or PBX. The longer it takes the signals to return to the caller, the more perceptible the echo.

EFM (Ethernet in the First Mile): Also known as IEEE 802.3ah, a collection of protocols defining Ethernet in the access networks, i.e., First/Last Mile. EFM also addresses other issues required for mass deployment of Ethernet services, such as operations, administration and maintenance (OAM) and compatibility with existing technologies (e.g., spectral compatibility for copper).

EIR (Excess Information Rate): Defines an average rate of Ethernet frames that are allowed into the network on a best-effort basis. Service performance for these frames is not guaranteed and depends on available bandwidth. EIR offerings enable carriers to generate more revenues from a given network capacity without compromising the quality of premium or real-time CIR services by oversubscribing available bandwidth.

Encapsulation: A technique used by layered protocols in which a low level protocol accepts a message from a higher level protocol, then places it in the data portion of the lower level frame. The logistics of encapsulation require that packets traveling over a physical network contain a sequence of headers.

EPL (Ethernet Private Line): A service similar to a leased line that features a single Ethernet virtual connection per physical user interface. It is considered a port-based service, since all the traffic coming into the UNI is mapped to the same EVC. EPL may be delivered as a best-effort service with no performance guarantees, or with SLA-based rate and performance commitments.

Ethernet Converter: Low cost and simple device for connecting Ethernet over E1, T1, E3, T3, STM-1/OC-3 and STM-4/OC-12 access lines.

Ethernet Demarcation: A key element in Carrier Ethernet transport and services, Ethernet demarcation provides a clear separation between the user and the network, allowing carriers to extend network visibility up to the user premises.

Ethernet OAM (Operation, Administration and Maintenance): A set of functions designed to monitor network operation in order to detect network faults and measure its performance. Carrier-class Ethernet services require automated end-to-end management and monitoring, including OAM capabilities such as connectivity verification, fault detection, performance monitoring, and alarm indication.

Ethernet over PDH (Plesiochronous Digital Hierarchy): A method for carrying Ethernet traffic over PDH network lines such as E1/T1 or E3/T3. It is one of several technologies available to service providers who wish to offer new carrier-class Ethernet services over existing legacy infrastructure.

Ethernet over SDH: Although SDH networks were originally engineered to transport voice traffic, many carriers are using their ubiquitous SDH infrastructure to deploy Ethernet services. Recent developments in next-generation SDH have made these networks more cost-effective and user-friendly for Ethernet traffic.

Ethernet over SONET: Although SONET networks were originally engineered to transport voice traffic, many carriers are using their ubiquitous SONET infrastructure to deploy Ethernet services. Recent developments in next-generation SONET have made these networks more cost-effective and user-friendly for Ethernet traffic.

Ethernet QoS: One of the key attributes of Carrier Ethernet services, by which the service provider offers business users bandwidth, delivery, and performance guarantees for selected traffic, and allocates the necessary network resources accordingly. Performance guarantees usually refer to parameters such as frame delay, delay variation, frame loss, and availability.

EVC (Ethernet Virtual Connection): The logical connection between two or more UNIs, in a point-to-point or multipoint-to-multipoint topology. The bandwidth allocated to an EVC cannot exceed the maximum bandwidth of the UNI.

Evolved HSPA (High Speed Packet Access): Also known as MIMO (multiple-input multiple-output) HSPA, HSPA Evolution and HSPA+, an upgrade to the 3GPP's HSPA standard providing theoretical downlink speeds of up to 42 Mbps. HSPA+ is generally regarded as an interim phase between the 3.5G HSPA technology and 4G LTE (long-term evolution).

EVPL (Ethernet VIrtual Private Line): A service where a single UNI supports several EVCs simultaneously. In industry terms, such an attribute is called "service multiplexing" or "flow-based service," as the UNI bandwidth is shared between several EVCs. Each EVC can be assigned a different delivery priority, so that users can prioritize their traffic according to their needs.

F

First Mile: Sometimes referred to as Local Loop, the final leg of delivering communications connectivity to a resident or customer. Typically seen as an expensive challenge because "fanning out" wires and cables is a considerably expensive and physically difficult task.

G

G.8264: An ITU-T standard specifying the Synchronization Status Message (SSM) format for Synchronous Ethernet.

GFP (Generic Framing Procedure): Defined by ITU-T G.7041, it allows efficient mapping of variable length, higher layer client signals, such as Ethernet, over a transport network like SDH/SONET. Recently, GFP has been extended to lower speed PDH networks.

Gigabit Ethernet Converters: Typically link copper cabling (UTP) with fiber optics or multimode fiber with single mode fiber cables, to enable transport of Gigabit Ethernet traffic over diverse media.

Grooming: In telecommunications, the process of separating and segregating channels by combing, such that the broadest channel possible can be assembled and sent across the longest practical link. The aim is to minimize de-multiplexing traffic and reshuffling it electrically.

I

IEEE C37.94: A standard providing plug-and-play transparent communications between different manufacturers' Teleprotection and multiplexer devices using multimode optical fiber. The standard defines clock recovery, jitter tolerances, physical connection method, and the equipment-failure actions for all communications link failures.

Interface: A shared boundary, defined by common physical interconnection characteristics, signal characteristics, and meanings of exchanged signals.

Interface Converters: Devices that convert physical media, data rates and transmission protocols, allowing service interworking between different communication interfaces.

Inverse Multiplexing: A method in which the inverse multiplexer slices the data stream into equal portions and transmits each portion over an available circuit. The receiving end adjusts for network-induced delay and reassembles the data packets into their proper order. Therefore, an inverse multiplexer allows lower speed channels across a network to be combined into a single, higher speed data stream.

IP (Internet Protocol): A networking protocol for providing a connectionless service to the higher transport protocol. It is responsible for discovering and maintaining topology information and for routing packets across homogeneous networks. Combined with TCP, it is commonly known as the TCP/IP platform.

IP Address (Internet Protocol Address): Also known as an Internet address, a unique reference number used by devices attached to a network when sending information through a local LAN, wide area WAN or the Internet networks.

IP DSLAM: A central office (CO) device for delivering digital subscriber line services that link DSL connections to a single high speed broadband (IP) line.

IP Telephony: The transmission of voice over an Internet Protocol (IP) network. Also called Voice over IP (VoIP), IP telephony allows users to make phone calls over the Internet, intranets, or private LANs and WANs that use the TCP/IP protocol.

ISDN (Integrated Services Digital Network): A carrier-provided service that allows a variety of switched digital data and voice transmissions to be accommodated simultaneously. ISDN is available as BRI, PRI and B-ISDN.

J

Jitter: The deviation of a transmission signal in time or phase. It can introduce errors and loss of synchronization in high speed synchronous communications.

Jitter Buffer: Variation in the arrival times between packets, also called jitter, causes unnatural-sounding voice instead of a smooth voice stream. If a packet does not arrive in time to fit into the voice stream, the previous packet is replayed. This can seriously detract from voice quality. Since the jitter buffer adds to the overall delay of voice transmissions, the optimal jitter buffer should fit the network's differential delay. Adaptive jitter buffering continuously monitors the network delay and adjusts the queuing period accordingly.

L

LCAS (Link Capacity Adjustment Scheme): A method to dynamically increase or decrease the bandwidth of virtual concatenated containers in SDH. The LCAS protocol is specified in ITU-T G.7042. It allows on-demand increase or decrease of the bandwidth of the virtual concatenated group in a hitless manner. This brings bandwidth-on-demand capability for data clients like Ethernet when mapped into SDH containers.

Leased Line: A permanent telephone connection between two points that is rented for exclusive use from a telecommunications common carrier. In contrast to a normal dial-up connection, a leased line is always active. Typically, the highest speed data connections require a leased line connection. For example, a T1 channel is a type of leased line that provides a maximum transmission speed of 1.544 Mbps.

Local Loop: Sometimes referred to as First Mile, the physical wires that run from the subscriber's telephone set, PBX, or key telephone system to the telephone company's central office. Increasingly, the Local Loop now goes from the main distribution frame at the customer premises to the telephone company. The subscriber is responsible for connecting his wires from the box at the customer's premises to his phone, PBX, or key system.

Loopback: A type of diagnostic test in which the transmitted signal is returned to the sending device after passing through all or part of a communications link or network.

M

MAC-in-MAC: An IEEE 802.1ah standard for layering the Ethernet network into customer and provider domains with complete isolation among their MAC addresses. It enables service providers to separate customer traffic from management traffic and also save on VLAN IDs.

Master Clock: The source of timing signals (or the signals themselves) that all network stations use for synchronization.

MEF (Metro Ethernet Forum): A non-profit organization chartered with the mission of accelerating the adoption of Carrier Ethernet as the technology of choice in future metro networks worldwide. Ethernet was chosen for its relative simplicity and popularity with end users, as well as for lowering costs of Ethernet equipment.

MLPPP (Multilink PPP): Connects multiple links between two systems as needed to provide extra bandwidth. Remotely accessing resources through MLPPP allows for an increase in overall throughput by combining the bandwidth of two or more physical communication links, such as analog modems, ISDN and other analog/digital links.

N

NMS (Network Management System): The system that controls the network configuration, fault and performance management, and diagnostic analysis.

NNI (Network-to-Network Interface): Marks the demarcation point between two provider networks and defines the responsibility boundaries of each for maintenance and operations purposes. Eventual adoption of E-NNI standards at the hand-off point will provide for more uniform SLAs between off-net and on-net traffic.

NTR (Network Timing Reference): A highly accurate standardized method for frequency distribution in DSL-based First Mile segments. A network reference clock (i.e., a service clock) is distributed from the DSLAM to the CPE by mapping its clock information to the DSL modem transmission. Depending on the specific DSL technology, this is achieved by either directly locking the DSL symbol clock to the reference clock or by mapping to the DSL-frame-phase-difference-bit information between the reference clock and the DSL free-running symbol clock. The advantages of NTR lie in its high level of accuracy and in the fact that it eliminates the need for advanced synchronization hardware in the DSL modem/IAD, thereby reducing the overall cost of the solution.

P

Packet: An ordered group of data and control signals transmitted through a network, as a subset of a larger message.

Packet Switching: A data transmission technique, which divides user information into discrete data envelopes called packets, and sends the information packet by packet.

POP (Point of Presence): An access point to the rest of the network.

Port: The physical interface to a computer or multiplexer, for connection of terminals and modems.

Prioritization: Also called CoS (class of service), classifies traffic into categories such as high, medium, and low. The lower the priority, the more "drop eligible" a packet is. E-mail and Web traffic are often placed in the lowest categories. When the network gets busy, prioritization ensures critical or high-rated traffic is passed first, and packets from the lowest categories may be dropped.

Protocol: A formal set of conventions governing the formatting and relative timing of message exchange between two communicating systems.

Pseudowire: Point-to-point connections set up between pairs of provider edge routers. Their primary function is to emulate (typically Layer 2) native services like ATM, Frame Relay, Ethernet, low rate TDM, or SDH/SONET over an underlying common packet switched network core (MPLS, IP, or L2TPv3).

To achieve this, each of these technologies is encapsulated into a common MPLS format. Pseudowires are defined by the IETF PWE3 (Pseudowire Edge-to-Edge Emulation) working group.

S

SDH (Synchronous Digital Hierarchy): The European standard for using optical media as the physical transport for high speed long-haul networks.

SFP (Small Form-Factor Pluggable): A compact optical transceiver used in telecom and datacom applications. It is a popular industry format supported by most fiber optic component vendors. The primary advantages of this approach are hot pluggability, field replacabilty, and mix and match optical reach and type. Using the SFP platform, RAD has engineered a "System on an SFP" for extension of Ethernet and LAN over E1/T1 and E3/T3 connections and TDM over Ethernet.

Sharing Device: A device that enables sharing of a single resource (modem, mux or computer port) among several devices (terminals, controllers or modems).

SHDSL (Single-pair High-speed Digital Subscriber Line): ITU-T G.991.2 standardized method of extending the range of copper telephone lines for broadband services. SHDSL technology is used to transport data symmetrically at rates of 192 kbps to 2.3 Mbps over 2-wire, or 384 kbps to 4.6 Mbps over 4-wire. The latest SHDSL standard is SHDSL.bis. Based on ITU-T G.991 and ETSI TS 101524, SHDSL.bis uses TC-PAM 16 or TC-PAM 32 line coding and multi-pair bonding technology to reach transmission rates up to 5.69 Mbps on one pair (2-wire) for a rate up to 22.8 Mbps over 8-wire.

Short Haul Modem: A modem designed for use in transmitting over relatively short distances across unloaded metallic circuits. Also called a line driver or limited distance modem (LDM).

Silence Suppression: In a telephone conversation, only about 50% of the full duplex connection is used at any given time. This is generally because only one person talks while the other person listens. In addition, voice packets are not sent during interword pauses and natural pauses in the conversation, reducing the required bandwidth by another 10%. Silence suppression frees this 60% of bandwidth on the full duplex link for other voice or data transmissions.

SIP (Session Initiation Protocol): A real-time signaling protocol for Internet conferencing, telephony, video, events notification and instant messaging. SIP initiates call setup, routing, authentication and other feature messages to endpoints within an IP domain.

SLA (Service Level Agreement): A formal negotiated agreement between customers and their service provider, or between service providers. It records the common understanding about services, priorities, responsibilities, guarantees, etc., with the main purpose to agree on the level of service. For example, it may specify the levels of availability, serviceability, performance, operation, or other attributes of the service like billing and even penalties in the case of violation of the SLA.

SONET (Synchronous Optical Network): A North American standard for using optical media as the physical transport for high speed long-haul networks. SONET basic speeds start at 51.84 Mbps and go up to 2.5 Gbps.

SSH (Secure Shell): A network protocol that allows data to be exchanged over a secure channel between two computers. Encryption provides confidentiality and integrity of data.

Sync-E (Synchronous Ethernet): Defined in ITU-T standards G.8261, G.8262 and G.8264, uses the Ethernet physical layer to accurately distribute frequency, using clock mechanisms similar to those of SDH/SONET. Unlike timing distribution in emulation services, where clocking information is carried in the same flow as the data payload, in Synchronous Ethernet the BITS clock of the Ethernet physical layer is disciplined to a PRC, regardless of the higher layer transmission protocols used. As Sync-E is a link-by-link frequency distribution scheme, it requires the entire clock distribution path (i.e., all the network nodes involved) to be Sync-E compliant.

T

T1: A digital transmission link with a capacity of 1.544 Mbps used in North America. Typically channelized into 24 DS0s, each is capable of carrying a single voice conversation or data stream. T1 uses two pairs of twisted pair wires.

T3: A digital transmission link with a capacity of 45 Mbps, or 28 T1 lines.

TCP/IP (Transmission Control Protocol/Internet Protocol): A protocol platform, known also as the Internet protocol suite, that combines both TCP and IP. Widely used applications, such as Telnet, FTP and SMTP, interface to TCP/IP.

TDM (Time Division Multiplexer): A device which divides the time available on its composite link among its channels, usually interleaving bits (Bit TDM) or characters (Character TDM) of data from each terminal.

TDMoIP® (TDM over IP): A standard TDM pseudowire technology developed and patented by RAD. Other TDM pseudowire technologies are SAToP and CESoPSN.

Telnet: The virtual terminal protocol in the Internet suite of protocols. It lets users on one host access another host and work as terminal users of that remote host. Instead of dialing into the computer, the user connects to it over the Internet using Telnet. When issuing a Telnet session, it connects to the Telnet host and logs in. The connection enables the user to work with the remote machine as though it were a terminal connected to it.

Terminal Adapter: A device that allows analog voice and data devices to work through an ISDN connection. The terminal adapter is a protocol converter that adapts equipment not designed for ISDN, such as phones, faxes and modems.

TETRA (Terrestrial Trunked Radio): A wireless communications standard for Professional Mobile Radio (PMR) and Private Access Mobile Radio (PAMR) applications. It is a digital format, i.e., speech is transmitted as binary data, which makes it far more difficult to monitor or eavesdrop.

Throughput: The amount of information transferred through the network between two users in a given period, usually measured in the number of packets per second (pps).

Timeslot: A portion of a serial multiplex of timeslot information dedicated to a single channel. In E1 and T1, one timeslot typically represents one 64 kbps channel.

Timing over Packet Standards: Various methods and standards developed to ensure that accurate time and frequency is distributed in packet-based networks.

ToS (Type of Service) Field: In a QoS scheme, an eight-bit field that lets values from 0 to 15 be assigned to request special handling of traffic (for example, minimize delay, maximize throughput). The ToS field is being phased out in favor of DSCP.

Traffic Management: Set of actions and operations performed by the network to guarantee the operability of the network exercised in the form of traffic control and flow control.

Traffic Policing: Mechanism whereby any traffic which violates the traffic contract agreed to at connection setup, is detected and discarded.

Traffic Shaping: A method for smoothing the bursty traffic rate that might arrive on an access virtual circuit so as to present a more uniform traffic rate on the network.

Trunk: A single circuit between two points, both of which are switching centers or individual distribution points. A trunk usually handles many channels simultaneously.

U

UNI (User-to-Network Interface): An interface supplied by the service provider that represents the customer's access point to an Ethernet service. It marks the crossover point between the provider's network and the user. A UNI can include one or more EVCs.

V

VCAT (Virtual Concatenation): An inverse multiplexing technique used to split SDH/SONET bandwidth into logical groups, which may be transported or routed independently.

VLAN (Virtual LAN): A network architecture which allows geographically distributed users to communicate as if they were on a single physical LAN by sharing a single broadcast and multicast domain.

VLAN-Aware: A device that is doing the Layer 2 bridging according to the VLAN tag in addition to the standard bridging parameters. A VLAN-aware device will not strip or add any VLAN header.

VLAN Stacking: A mechanism specified in IEEE standard 802.1ad ("Provider Bridges") to extend the IEEE VLAN tagging standard (802.1Q). Also known as double VLAN tagging or Q-in-Q, VLAN stacking allows service providers to assign service VLAN tags (S-VLAN) to Ethernet frames that are already marked with customer VLAN tags (C-VLAN), resulting in hierarchical or "stacked" VLAN tags.

VLAN Stripping: Removal of VLAN tags from a network frame.

Voice Compression: Newer voice compression algorithms try to model 64 kpbs PCM (G.711) more efficiently using fewer bits to reduce the bandwidth required, while preserving the quality or audibility of the voice transmission. Vendors such as RAD support low bit rate voice compression algorithms such as ITU G.723.1 and G.729A to permit the greatest number of simultaneous multiple calls while maintaining high quality voice. In this way, compressed voice systems (CVS) can offer greater bandwidth savings, reduced network congestion and high quality voice transmissions.

VoIP (Voice over IP): Set of facilities for managing the delivery of voice information using the Internet Protocol (IP). Voice information is sent in digital form in discrete packets over the Internet instead of in analog form over the public switched telephone network (PSTN). A major advantage of VoIP is that it avoids the tolls charged by ordinary telephone service.

VPN (Virtual Private Network): A restricted network that uses public wires to connect nodes. A VPN provides a way to encapsulate, or "tunnel," private data cheaply, reliably, and securely through a public network, usually the Internet.

Y

Y.1731: ITU-T standard Y.1731 is an Ethernet OAM (operations, administration and maintenance) standard for testing an Ethernet service and for monitoring its performance.

#

1588-2008: Previously known as pre-standard 1588v2, the latest version of Precision Time Protocol (PTP) for frequency and time of day distribution over packet switched networks. It is based on timestamp information exchange in a master-slave hierarchy.

1588v2: Also known as 1588-2008, the latest version of Precision Time Protocol (PTP) for frequency and time of day distribution over packet switched networks. It is based on timestamp information exchange in a master-slave hierarchy.

802.1ag: IEEE standard also known as "Connectivity Fault Management (CFM)," an Ethernet OAM (operations, administration and maintenance) standard for testing an Ethernet service over any path, whether a single link or end-to-end.

802.3ah: IEEE standard 802.3-2005, also known as 802.3ah clause 57, an Ethernet OAM (operations, administration and maintenance) standard for testing the status of a single Ethernet link within a network. It is also known as Ethernet Link OAM and EFM (Ethernet in the First Mile) OAM.

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www.rad.com

RAD's Dedicated Web Sites*

In addition to our corporate Web site at **www.rad.com**, RAD has developed Web sites which fulfill the needs of specific markets:

Airport Communications

RAD presents end-to-end data communications and telecommunications solutions for air traffic control, security and video surveillance, ground communications, broadband access, and flight information systems.

www.airportcomm.com

Cellular Access

RAD offers flexible cellular backhaul solutions that provide cost-effective transport for 2G, 3G and 4G services over any infrastructure.

www.rad-cellular.com

Ethernet Access

From intelligent Ethernet demarcation devices and smart media converters to channelized Ethernet gateways, RAD offers a wide range of products to enable seamless end-to-end Ethernet connectivity over fiber, copper and wireless.

www.ethernetaccess.com

Fiber Access

The fiber Web site shows RAD's extensive range of fiber access solutions and technologies for SDH/SONET (TDM), ATM and Ethernet/IP networks.

www.radfiber.com

Pseudowire Access

This Web site presents products and solutions dedicated to RAD's innovative pseudowire technology, providing a simple migration strategy to IP/Ethernet-based networks.

www.pseudowire.com

Railway Communications

RAD offers a wide range of communications solutions for the railway industry, including voice and data transmission, video surveillance and connectivity for train information displays, signaling and alarms.

www.railwaycommunications.com

Satellite Optimization

This Web site features a portfolio of field-proven satellite communications optimization products that provide efficient voice and multiservice access for a wide range of satellite applications on land and at sea.

www.radsatellite.com

Wireless Access

RAD supports a wide range of wireless solutions for voice, data and LAN traffic in point-to-point and point-to-multipoint applications, integrating multiple technologies and services.

www.rad-wireless.com

*RAD maintains a number of local and regional Web sites in various languages. For further details see **www.rad.com**

RAD Group

Founded in 1981, the RAD Group consists of 13 independent companies, that develop, manufacture and market product solutions for diverse segments of the networking and telecommunications industry.

Member firms operate autonomously, without a holding company, but are guided by the RAD Group's founders under a common strategic umbrella. This decentralized business philosophy maximizes the advantages inherent in smaller business units, such as flexibility, entrepreneurial spirit and management focus. Five RAD Group companies currently trade on the NASDAQ Stock Market in the U.S., while the others are privately held by the Group's founders and assorted venture capital firms.

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