Service Assured Solutions

2014 Catalog

RAD

RAD Company Profile

Established more than 30 years ago, RAD is an award-winning manufacturer of Service Assured Solutions for service providers, power utilities, transportation networks, and the government sector. Its leading-edge technology, strict adherence to quality standards and environmentally friendly operations, together with a corporate culture that encourages innovation and values long-term commitment to its customers, channels, suppliers, and employees, combine to make RAD an ideal partner.

Fast Facts

- Established in 1981, privately held RAD is the anchor of the RAD Group of companies, with revenues exceeding $1 billion
- RAD maintains over 25 offices on six continents, supporting 300 sales channels serving 165 countries
- RAD has a global installed base of more than 12 million units deployed
- RAD has a distinguished record of leadership in industry bodies such as the International Telecommunications Union (ITU), IEEE, Metro Ethernet Forum (MEF), Broadband Forum, the Internet Engineering Task Force (IETF), NFV ISG and CELTIC, a EUREKA cluster that is the only European research and development program dedicated to end-to-end telecommunications solutions
- RAD's MiNID was voted the 2013 Best Telecom Product of the year at the Ethernet 40th birthday party by a panel of judges that included Bob Metcalfe, the inventor of the Ethernet protocol

Leading Customers

RAD is a preferred Service Assured Access solution provider for more than 150 service providers around the world, from Tier 1 fixed/mobile incumbents, to city carriers, ISPs, and rural service telcos. Customers include industry global leaders such as **AT&T, Bell Canada, Bharti Airtel, CenturyLink, China Mobile, China Telecom, Deutsche Telekom/T-Mobile, Embratel, France Telecom/Orange, Hutchison, KDDI, KPN, MegaFon, MTS, SingTel, SoftBank, Sunrise, Telefónica, A1 Telekom Austria, TeliaSonera, Telstra, TELUS, Verizon,** and **Vodafone.**

For power utilities, RAD Service Assured Networking solutions play a vital role in supporting and protecting critical infrastructure for generation, transmission, and distribution operators, including **Beijing Power, CELPE, EDF, Eletronorte, E.ON, Enel, Hydro-Québec, Israel Electric Corporation, Meralco, Tata Power,** and **Terna Italia.**

Transportation networks that rely on RAD Service Assured Networking solutions include those of **CFR (Căile Ferate Române, the Romanian state railway), JBV (Jernbaneverket, the Norwegian Rail Administration), MTA New York City Transit, RFI (Rete Ferroviaria Italiana, the Italian railway),** and **Transport for London.**

RAD also provides Service Assured Networking solutions for the government sector, including national, regional and municipal authorities; police, public safety and first responders; homeland security and defense.

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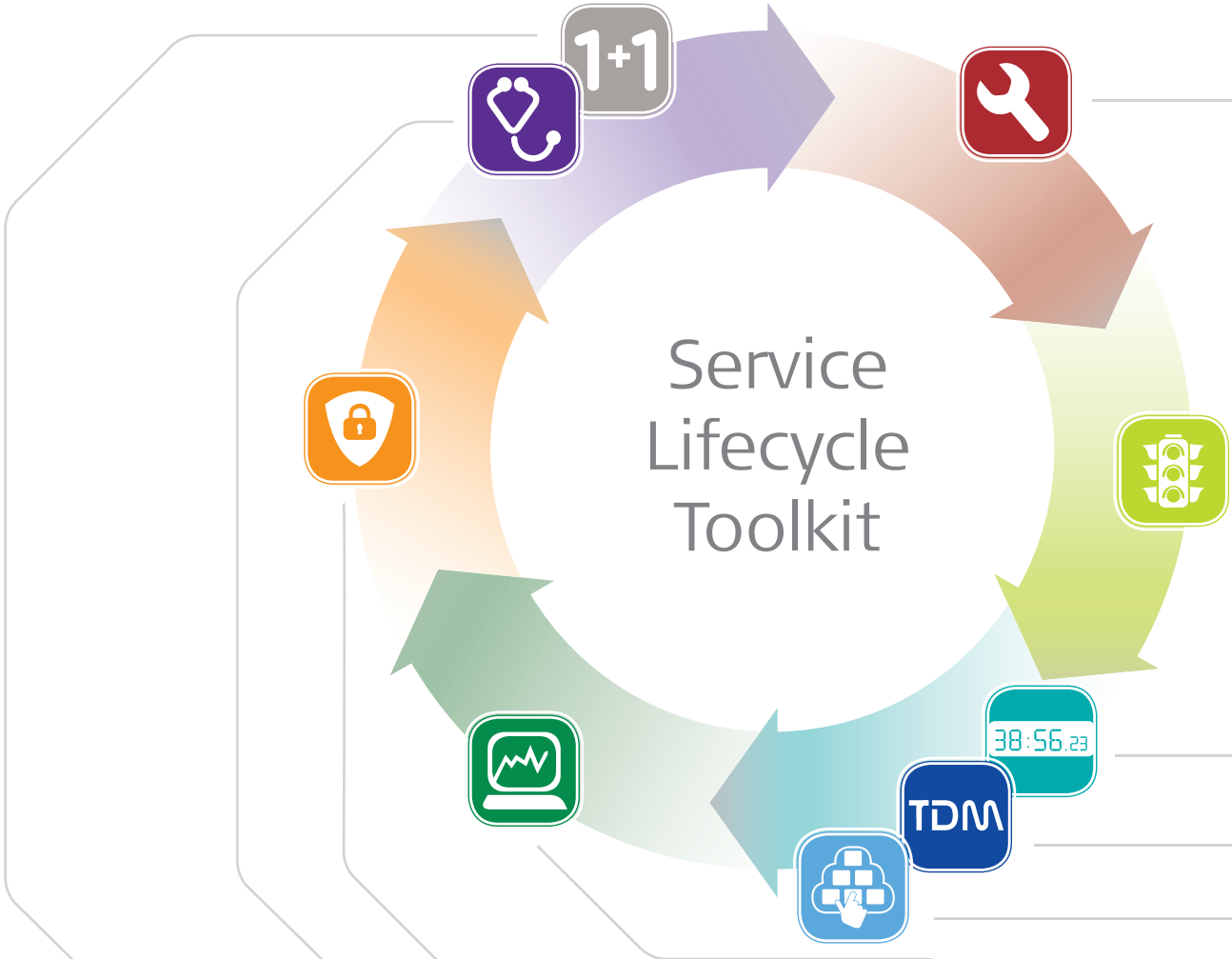
Service Assured Solutions Throughout the Service Lifecycle



Resiliency

- Link aggregation group (LAG) using IEEE 802.3-2005 LACP (link aggregation control protocol)
- Ethernet Ring Protection Switching (G.8032 ERPS)
- EVC protection (G.8031)
- Traffic Duplication

Fault Management

- Automated fault detection & isolation
- Fast detection (3.3 ms) of LOC
- EVC alarm propagation (AIS & RDI)
- HW-based fault management, OAM (CC, LB, LT)
- Wire-speed loopback testing (L2/L3)

Security

- 802.1X
- SNMPv3
- IPSec
- SCADA Firewall

Ongoing Performance Monitoring

- L2/L3 preformance monitoring
- Scalable long-term KPI collection engine
- One-way delay measurements
- PM dashboard (SLA policies, correlation, violation alerts)
- End-customer PM portal & SLA reports
- Provide OSS visibility to L2/L3 performance data, allowing real time network optimization

Service Assured Solutions comprise the following attributes:

- Advanced H-QoS
- Distributed NFV
- Ethernet & legacy services
- Performance monitoring
- Reliability & protection
- Same service look & feel over any access
- Service visibility, end-to-end
- SLA reporting
- Synchronization over packet
- Traffic Duplication

Service Turn-Up

- Automatic installation
- Zero-touch configuration
- Auto-inventory discovery
- One-touch service validation
- On-demand remote modification

Traffic Management

- Classification
- CIR & EIR traffic policing per flow (CoS)
- Hierarchical scheduling, shaping
- Congestion avoidance mechanism

Timing

- Synchronous Ethernet
- Built-in GPS
- IEEE 1588v2 TC & slave for frequency & phase
- Distributed IEEE 1588v2 Grandmaster
- Hybrid Sync-E & 1588 TOD

TDM

- CESoPSN
- SAToP
- CESoETH (MEF-8)
- UDP/IP encapsulation
- PDH and SDH/SONET

Distributed NFV

- Rapid deployment/upgrade of network functionality at the customer premises
- Relocate functionality to CPE for more effective performance, enhanced security, and reduced expenses
- Combine Layer 2/3 demarcation with standard virtual machine (VM) platform

Service Management System

- Point-and-click provisioning
- Security access profiles, network partitioning
- GUI: Network clouds, links, nodes, end-to-end services, status indication
- Multi-platform Java for Windows, UNIX
- Northbound TMF MTOSI interface to NMS/OSS

Ethernet Performance Monitoring Portal

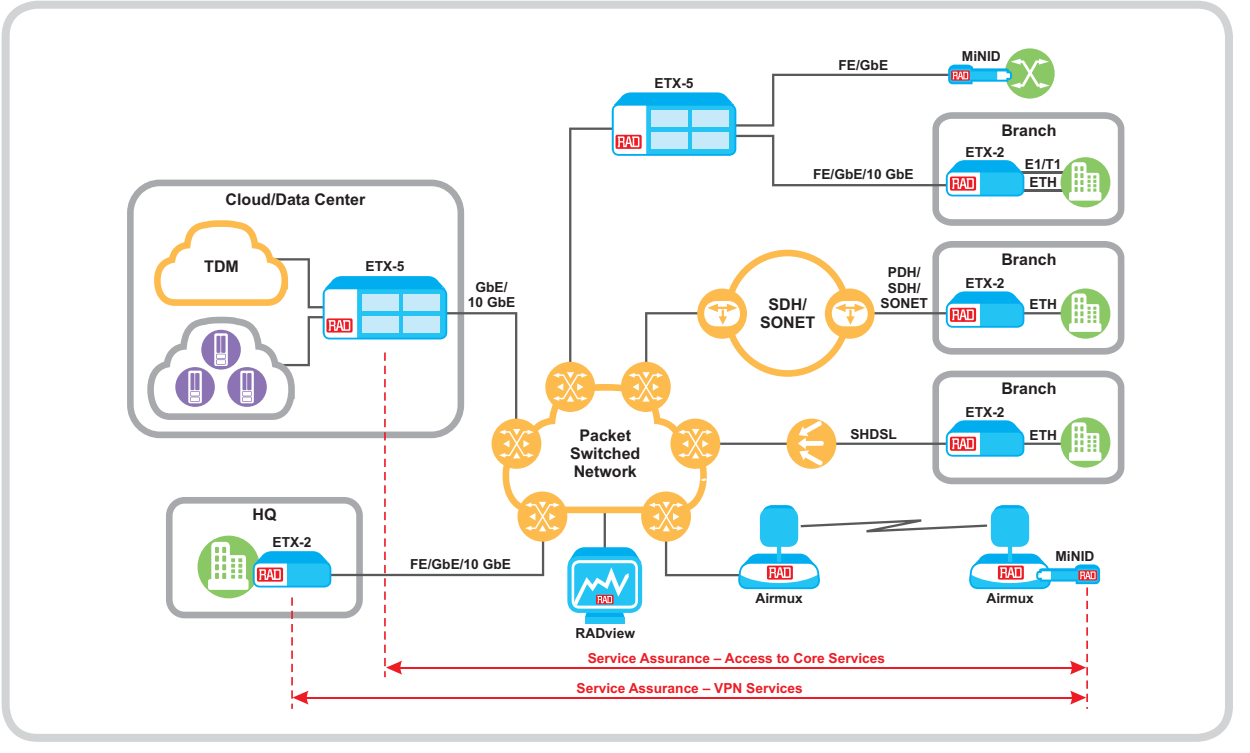
- Collects, stores and presents KPIs from RAD devices
- Actual performance metrics based on ITU-T Y.1731:
  - Frame delay (latency)
  - Frame delay variation (jitter)
  - Packet delivery ratio
  - Availability
- Threshold policy management
- Performance dashboard with aggregated and drill-down views
- Instant and scheduled report generation
- Immediate detection of service degradation

Service Assured Solutions for Service Providers

Service providers today are looking for vendor partners who can help them increase their revenues, reduce their total cost of ownership and expedite delivery of new value-added services. RAD offers a wide range of Service Assured Access solutions. Based on flexible deployment modes, these solutions make it easier to plan, deploy, provision, and maintain existing and new services for retail business service providers, international service providers, wholesale service providers, mobile backhaul operators, and cloud service providers.

RAD's Service Assured Access solutions are based on a comprehensive and standard set of MEF 2.0 certified Carrier Ethernet tools for performance assurance in packet switched networks and for legacy migration. RAD's Service Assured Access toolkit also includes enhancements for facilitating a smooth, secure and cost-effective transition to the new NFV and SDN environment.

Carrier Ethernet Business Services



Solution Highlights

- Reduce TCO and increase your potential revenue stream from premium business services
- MEF CE 2.0-certified products with circuit validation tests (RFC-2544/Y.1564), hardware OAM, fault management, and multi-CoS traffic management
- Flexible access media support: Fiber, SHDSL, PDH/SDH/SONET
- Improved service visibility and SLA reporting with RADview Performance Monitoring (PM) portal
- EVC aggregation from multiple remote locations to enterprise headquarters, data centers and cloud access POP
- Continued support for legacy TDM services using TDM pseudowires
- Wide range of flexible deployment scenarios, including instant Carrier Ethernet upgrades to legacy switches, routers and microwave radios using the MiNID Ethernet demarcation SFP sleeve

Products Included in this Solution:

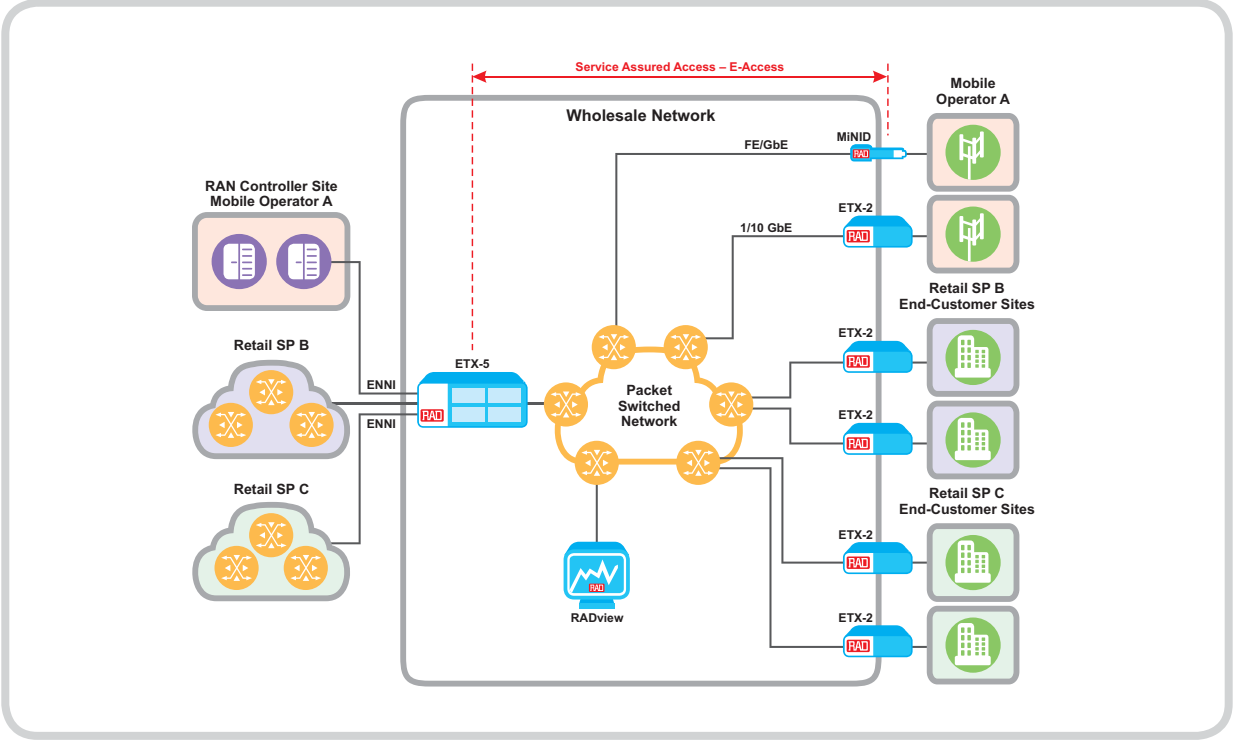
ETX-2
Carrier Ethernet Demarcation and Aggregation

ETX-5
Ethernet Service Aggregation Platform

MiNID
Ethernet Demarcation SFP Sleeve

RADview
Carrier-Class Network Management System

Carrier Ethernet Wholesale Services



Solution Highlights

- Easy, cost-effective delivery of wholesale Carrier Ethernet transport services to multiple service providers
- Seamless hand-off between provider domains
- End-to-end visibility and SLA monitoring into network, and service performance across multiple 3rd-party networks
- Deliver backhaul services to mobile and business service providers over the same transport network
- MEF-certified Carrier Ethernet 2.0 E-Access support with single-CoS and/or multiple-CoS EVC/OVC
- 1-GbE and 10-GbE E-NNI interfaces with optional redundancy
- High capacity aggregation device with small form factor saves rack space at the POP

Products Included in this Solution:

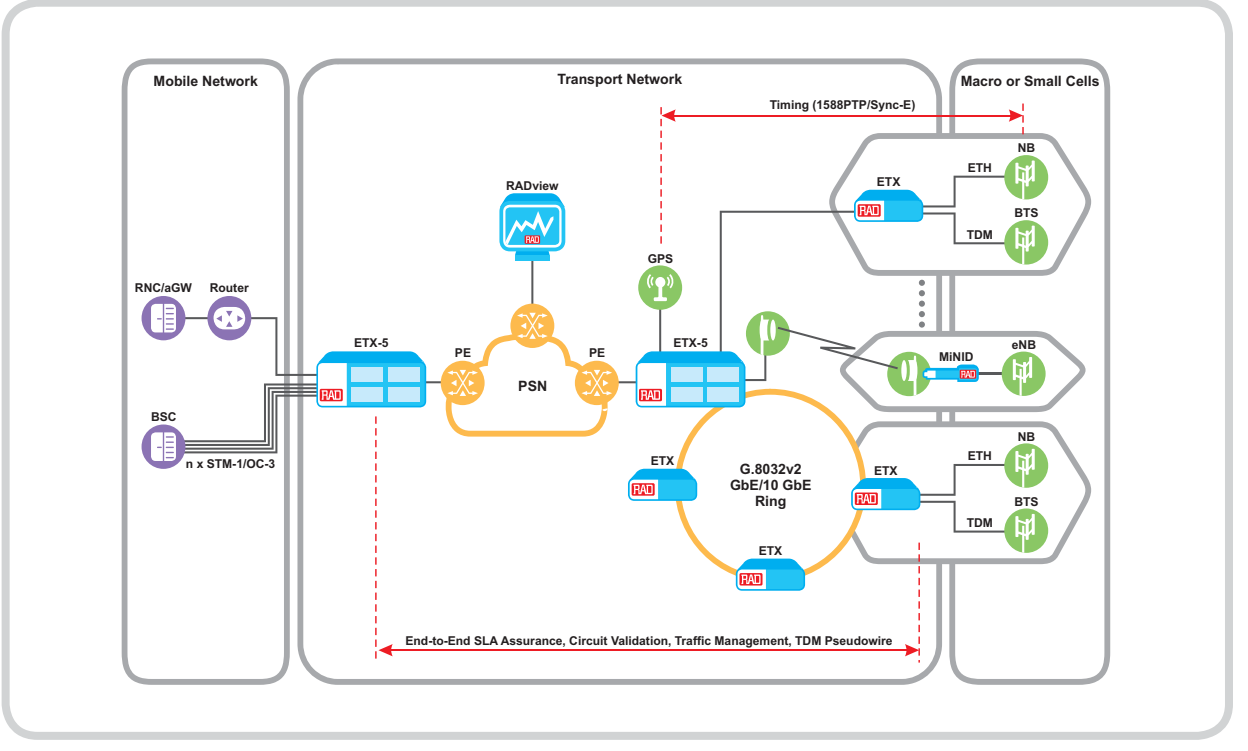
ETX-2
Carrier Ethernet Demarcation and Aggregation

ETX-5
Ethernet Service Aggregation Platform

MiNID
Ethernet Demarcation SFP Sleeve

RADview
Carrier-Class Network Management System

Mobile Backhaul with Timing Distribution



Solution Highlights

- Easy, cost-effective control of mobile backhaul SLAs involving colocated eNodeBs and BTSs, as well as small cells
- MEF Carrier Ethernet 2.0-certified mobile demarcation and aggregation portfolio enables multi-CoS delivery of 2G/3G/4G traffic over the same RAN with service management, performance monitoring and OAM-based diagnostics
- Integrated Carrier Ethernet with TDM pseudowire supports 2G traffic in the same device
- Ensure service visibility and control for small cells, while meeting space and power supply restrictions
- Highly accurate phase (Time Of Day) and frequency synchronization using standard IEEE 1588v2 and/or Sync-E technologies
- Unique MiNID Ethernet demarcation SFP sleeve helps normalize mobile backhaul transport network with diverse access architectures

Products Included in this Solution:

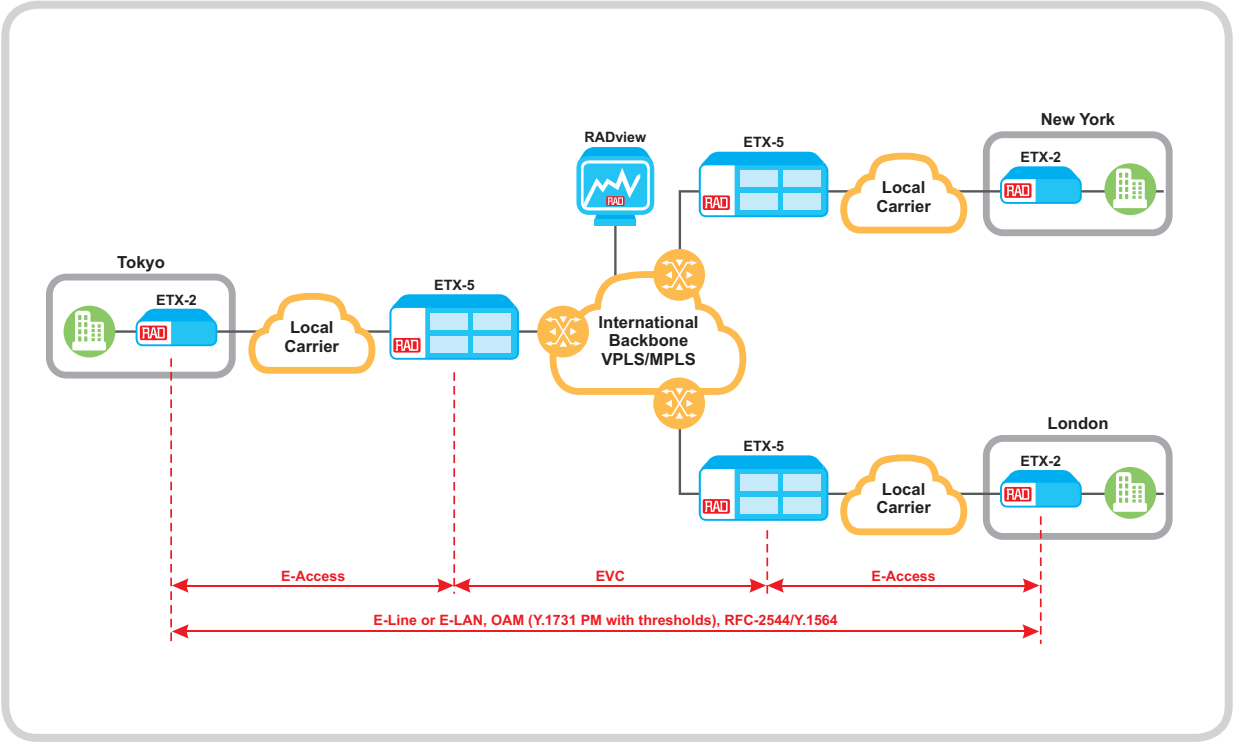
ETX-2
Carrier Ethernet Demarcation and Aggregation

ETX-5
Ethernet Service Aggregation Platform

MiNID
Ethernet Demarcation SFP Sleeve

RADview
Carrier-Class Network Management System

Carrier Ethernet International Services



Solution Highlights

- Service assurance across different network segments and end-to-end by deploying RAD devices at customer premises and interconnection points
- Multi-CoS Carrier Ethernet services with the same "look and feel" over fiber/copper/TDM/wireless access
- Fast time-to-market and service rollouts for higher revenues, using standardized E-NNI attributes
- Lower TCO with an extensive service management and monitoring toolset, as well as automatic provisioning and troubleshooting
- Improved service visibility and SLA reporting with RADview Performance Monitoring (PM) portal
- Instant Carrier Ethernet upgrades to 3rd-party equipment, such as legacy switches, routers and microwave radios using the MiNID Ethernet demarcation SFP sleeve

Products Included in this Solution:

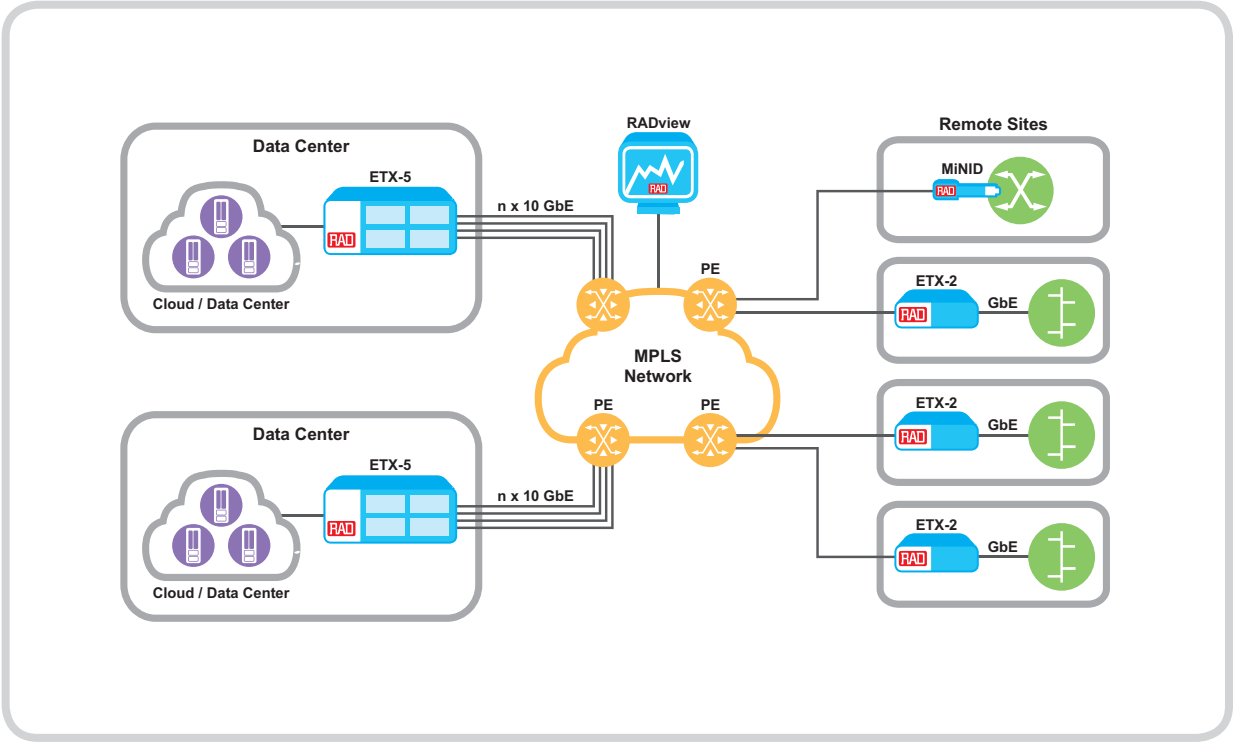
ETX-2
Carrier Ethernet Demarcation and Aggregation

ETX-5
Ethernet Service Aggregation Platform

MiNID
Ethernet Demarcation SFP Sleeve

RADview
Carrier-Class Network Management System

Carrier Ethernet Cloud Connectivity



Solution Highlights

- Guarantee service performance over private cloud VPNs
- Facilitate interconnection between data centers and customer premises
- Ensure better QoE per application with multi-CoS support
- Increase revenues by offering premium cloud access services with SLA monitoring
- Achieve OpEx reduction with continuous monitoring of the access quality per CoS
- Aggregate SLA-based cloud services using a central cloud access demarcation device, with advanced traffic management tools and high scale performance monitoring

Products Included in this Solution:

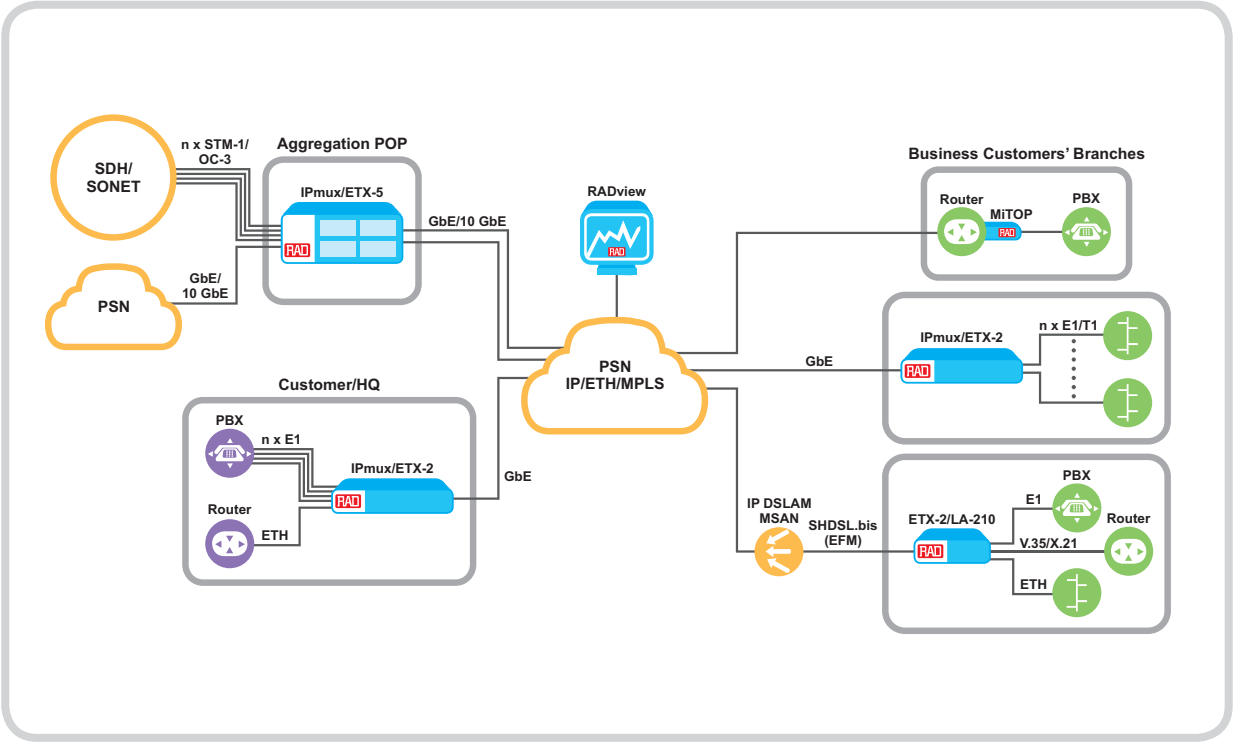
ETX-2
Carrier Ethernet Demarcation and Aggregation

ETX-5
Ethernet Service Aggregation Platform

MiNID
Ethernet Demarcation SFP Sleeve

RADview
Carrier-Class Network Management System

TDM Services over Packet



Solution Highlights

- Maintain legacy TDM services over new packet network to keep revenue flow and customer loyalty
- Enable alternative providers to add leased lines to their service portfolio to attract new customers
- Support heterogenic First Mile footprint requiring CPE support for DSL/EFM, active Ethernet, GPON connections, and flexibility in PWE termination options: Customer site-to-customer site; customer site-to-POP/network; POP-to-POP
- Allow a single transport network for IP/Ethernet and TDM services to simplify operations and lower TCO

Products Included in this Solution:

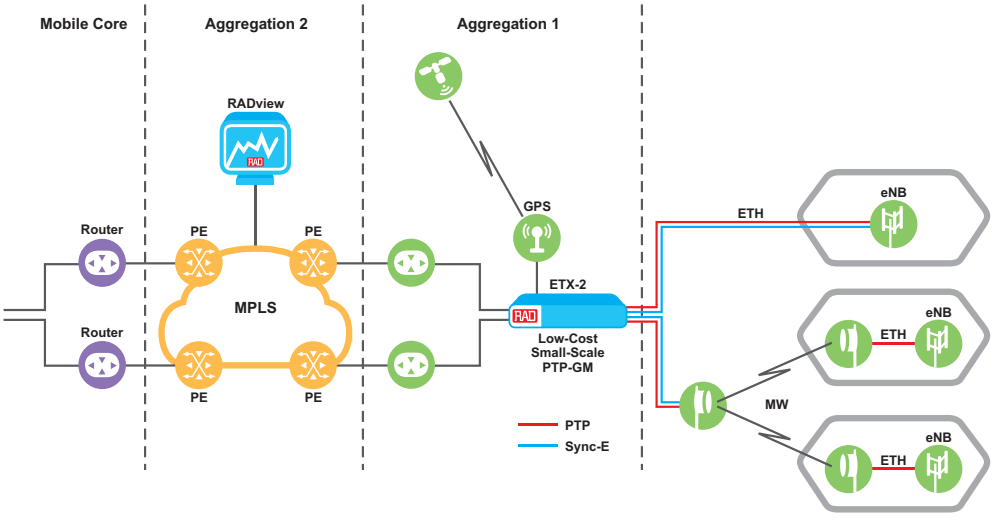
ETX-5
Ethernet Service Aggregation Platform

IPmux-2L, IPmux-4L, IPmux-4LGE, IPmux-16L
TDM Pseudowire Access Gateways

MiTOP-E1/T1, MiTOP-E3/T3
Smart SFP-Format TDM Pseudowire Gateways

RADview
Carrier-Class Network Management System

Distributed Grandmaster for LTE/LTE-A Networks



Solution Highlights

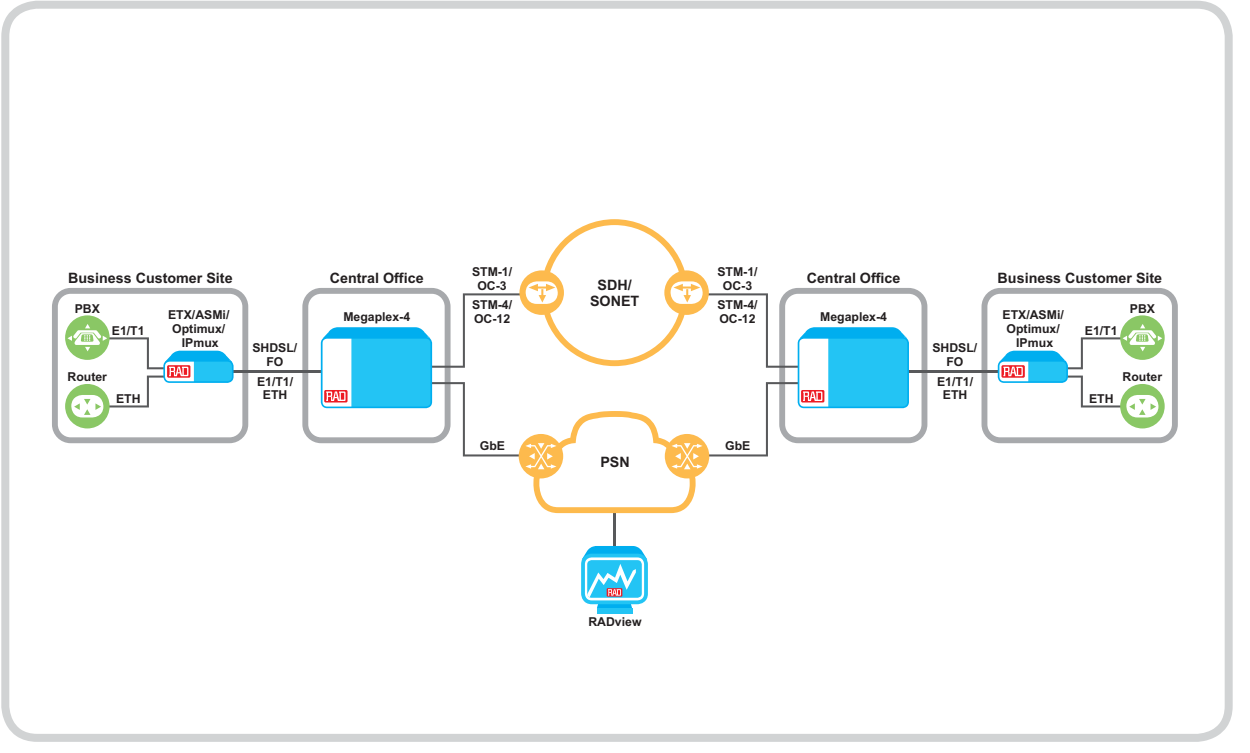
- Maintain TOD and synchronization accuracy for LTE and LTE Advanced at a lower cost by deploying RAD's Distributed Grandmaster solution at the last aggregation point in the network
- Better service coverage for small-cells, in-building and underground installations
- Reduce cost by eliminating the need for investing in hop-by-hop BC/TC support in the core/aggregation network
- Lower cost per base station compared to a "GPS on every tower" scenario
- Based on G.8275.1 PTP time telecom profile
- Lower TCO and reduce POP rental costs by combining 1588 Grandmaster functionalities with mobile demarcation and aggregation in a single, small form-factor device

Products Included in this Solution:

ETX-2
Carrier Ethernet Demarcation and Aggregation

RADview
Carrier-Class Network Management System

Hybrid TDM and Ethernet Access



Solution Highlights

- Dual TDM and Carrier Ethernet processing engines allow the same CPEs and aggregation equipment to be used throughout the migration process over DSL, fiber, E1/T1, wireless, or active Ethernet
- Deliver legacy applications alongside new offerings using the same access link to reduce costs and increase efficiency
- Quick, seamless introduction of Ethernet/IP services over existing SDH/SONET
- Optional offload of Ethernet bandwidth to PSN, while TDM traffic is kept over SDH/SONET core
- TDM pseudowire ensures service continuity for legacy applications and equipment
- Eliminate costly maintenance of obsolete 3rd-party TDM equipment
- Service Assured Access solution enables Metro Ethernet Forum's Carrier Ethernet services

Products Included in this Solution:

ASMi-52, ASMi-52L
SHDSL Modems

ETX-1
Ethernet Demarcation Switch

Megaplex-4
Next Generation Multiservice Access Nodes

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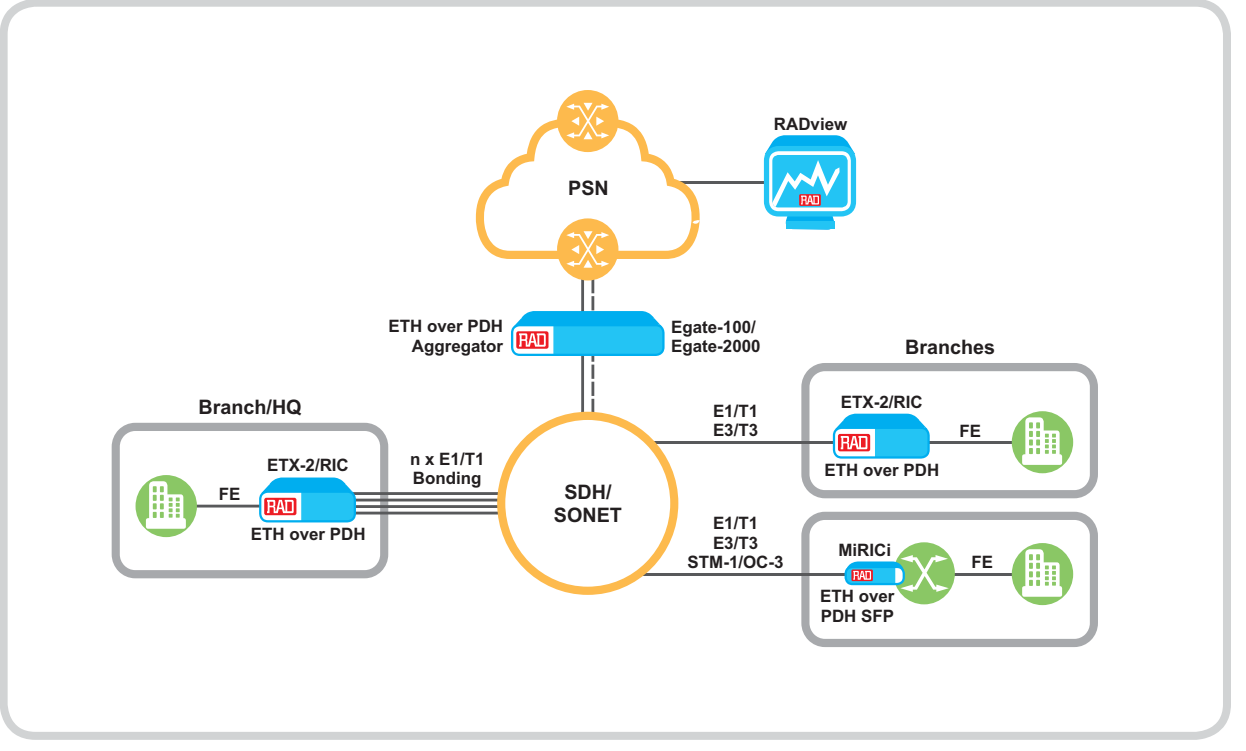
Carrier-Class Network Management System

Ethernet over PDH/SDH/SONET



Solution Highlights

- Enable carrier-grade MEF-certified (EVPL, EPL) service delivery with advanced monitoring and SLA assurance over available PDH microwave, SDH/SONET access rings or leased SDH/SONET wholesale service
- Allow better service reach and faster TTM when PSN metro coverage is limited, or fiber trenching is not feasible
- Meet diverse customer needs with scalable high access rates via bonding

Products Included in this Solution:

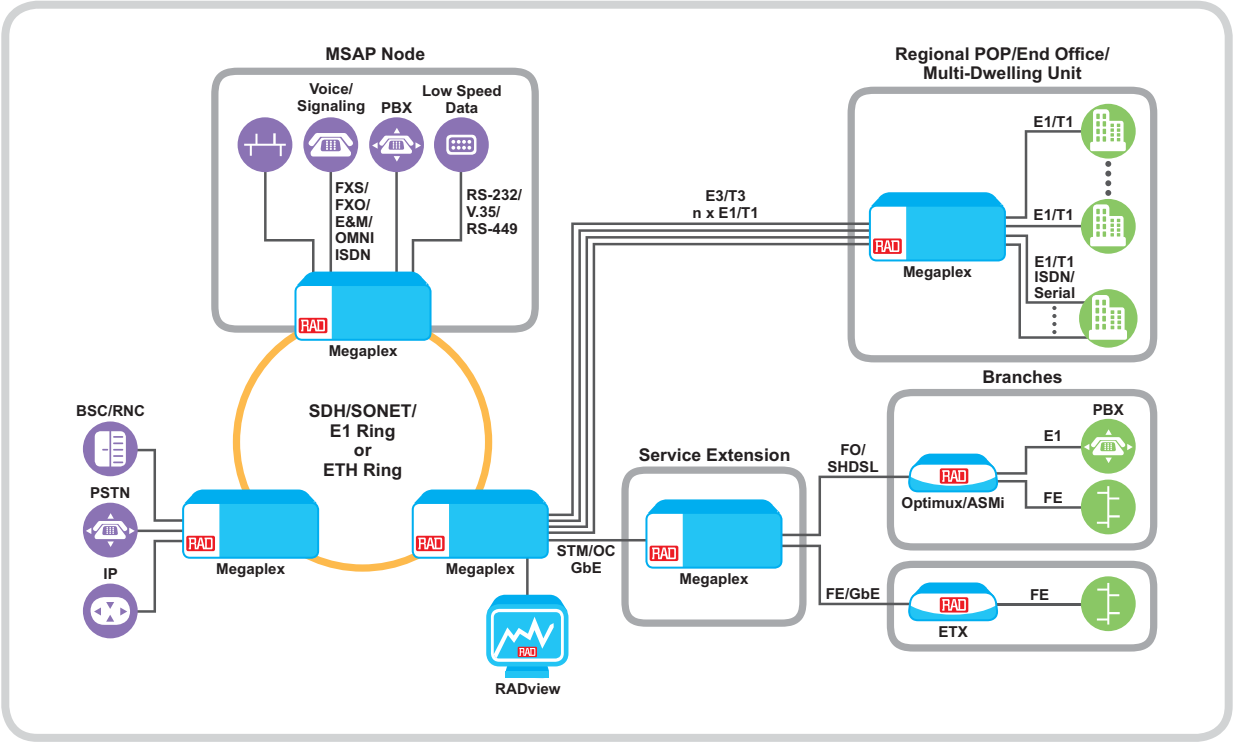
Egate-2000
Gigabit Ethernet Aggregator over PDH, SDH/SONET Access

ETX-2
Carrier Ethernet Demarcation and Aggregation

MiRICi-E1/T1, MiRICi-E3/T3
Smart SFP Ethernet to E1/T1 or E3/T3 Remote Bridges

RADview
Carrier-Class Network Management System

Obsolete DACS/Mux Replacement



Solution Highlights

- Replacement solutions for obsolete digital cross-connect (DACS) platforms, channel banks, multiplexers, bandwidth managers, and DTU equipment
- Dual TDM and Carrier Ethernet processing engines and future-proof design enable a smooth migration to next-generation networks and services
- Variety of replacement options depending on capacity requirements and switching capabilities
- High density and small form factor improve network efficiency and reduce OpEx related to power consumption and rack space at the POP
- SHDSL modems, optical multiplexers and CPEs for tail-end service extension, as well as other access gateways to support large network nodes, feeder networks, and extension of backbone networks

Products Included in this Solution:

ASMi-52, ASMi-52L
SHDSL Modems

ETX-2
Carrier Ethernet Demarcation and Aggregation

Megaplex-4
Next Generation Multiservice Access Nodes

RADview
Carrier-Class Network Management System

Service Assured Access

Based on a standard set of Carrier Ethernet tools that can be implemented in a variety of deployment mode scenarios over any access infrastructure, RAD's Service Assured Access allows retail business Ethernet service providers, wholesale providers, mobile backhaul providers, and cloud connectivity providers to offer a resilient, always-on service with predictable QoS/QoE.

Increase revenues:

- Improve customer stickiness
- Reduce churn
- SLA transparency
- Fast service turn-up
- SLA/premium service introduction
- Upselling opportunities

Reduce TCO:

- Automated operations
- Reduce truck rolls
- Minimize technician dispatches
- Reduce trouble-ticket handling
- Enhanced network resource utilization

RAD

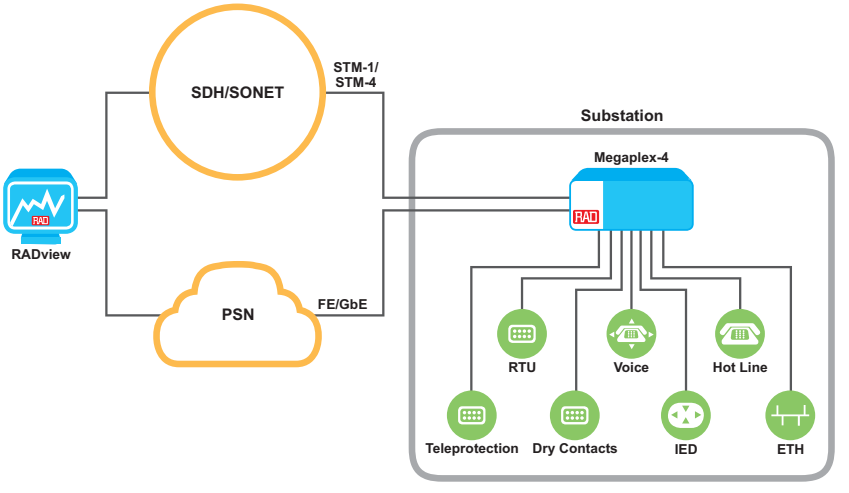
Service Assured Solutions for Power Utilities

For more than 30 years, RAD has worked closely with its worldwide energy utility customers to provide field-proven communications solutions that address the automation, Teleprotection and core operational network needs of their transmission and distribution (T&D) grids.

Today, power utilities are being challenged to migrate their TDM/SDH/SONET communications networks to Ethernet/IP-based ones. Smart Grid communications, equipment obsolescence and evolving security requirements are just a few of the drivers behind this transition.

RAD's Service Assured Networking for power utility communications networks enables power utilities to choose the most flexible and cost-effective path toward the future: Phased migration of some or all parts of their network or swift migration of the entire network (with the possible exception of certain mission-critical applications like Teleprotection). Whatever the choice, RAD's Service Assured Networking offers reliable, secure, managed, and performance-guaranteed solutions for automation, protection, security and ICT networking.

“Hybrid” Multiservice Substation Connectivity and Migration



Solution Highlights

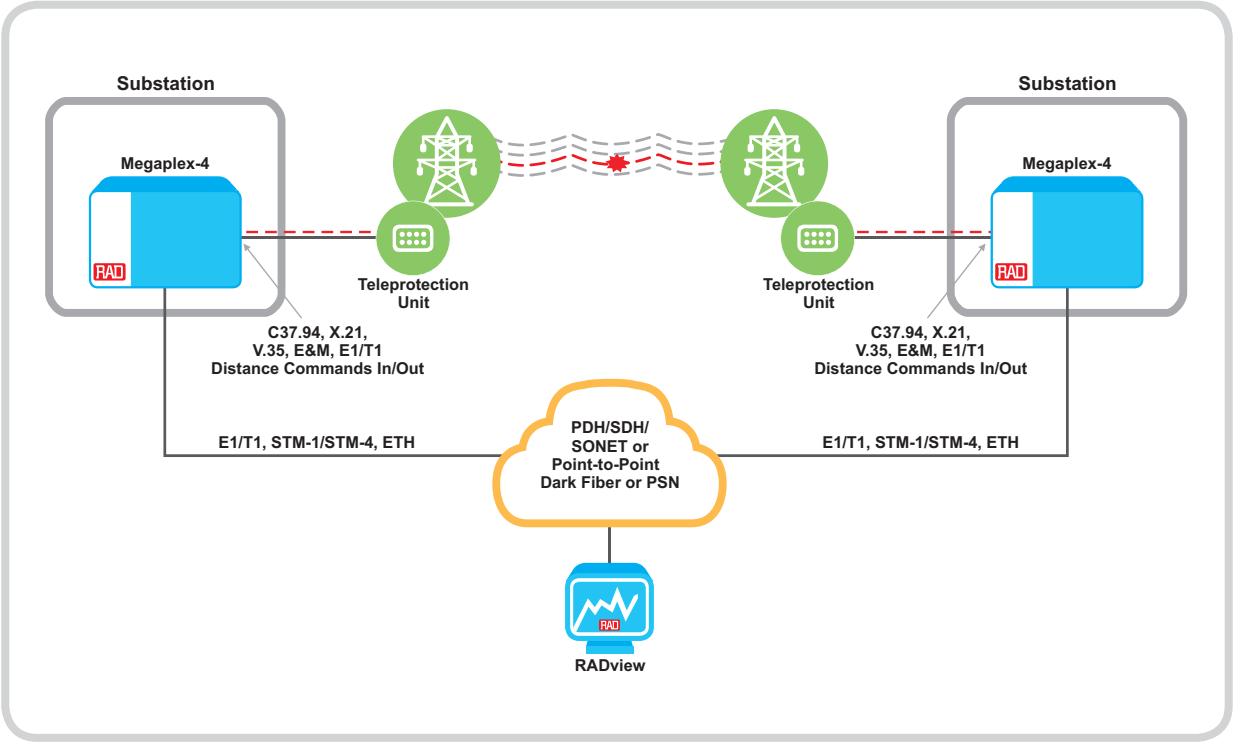
- Powerful cross-generation TDM and carrier-grade Ethernet capabilities, including TDM DS0 cross-connect and SDH/SONET, Gigabit Carrier Ethernet and OAM, TDM pseudowire over Ethernet/IP, and Ethernet over NG-PDH/SDH/SONET
- Easily configurable connectivity of all serial automation and Teleprotection devices to either the existing SDH/SONET network, new SDH/SONET rings or to a new PSN
- Dedicated Teleprotection interfaces for differential C37.94 and distance relays
- Supports analog and digital voice and Ethernet IED, or IT devices with versatile rates from RS-232 up to STM-4/OC-12 or GbE
- Guaranteed smooth migration to PSNs by ongoing support for legacy devices; optional Traffic Duplication over both SDH/SONET and Ethernet networks for reduced latency, better resiliency and gradual migration to PSN

Products Included in this Solution:

Megaplex-4
Next Generation Multiservice Access Nodes

RADview
Carrier-Class Network Management System

Distance and Differential Teleprotection



Solution Highlights

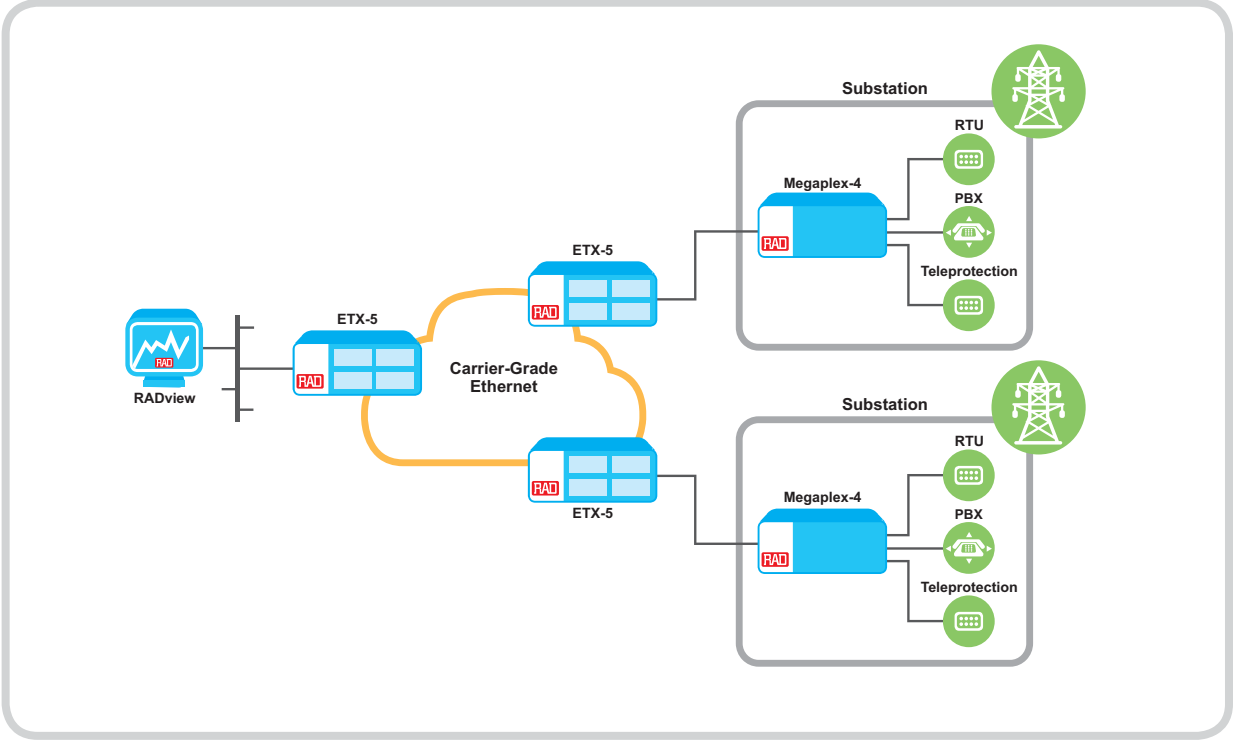
- Single product supports both distance trip command relays and differential Teleprotection delivery over TDM or IP network
- Wide range of Teleprotection interfaces — Serial, G.703 Co-directional, E&M, C37.94 — to extend differential Teleprotection relay over TDM and Ethernet networks
- Reduce CapEx and OpEx by using a single-box solution for all substation communications services, including voice, data, automation and Teleprotection signals
- Redundancy hierarchy from the Teleprotection interface up to the communication link ensures 0 msec (Zero) hardware protection and sub-10 msec end-to-end delay over PSN
- Tested interoperability with most Teleprotection contact relays from leading vendors (Alstom, ABB, Siemens, SEL, Schneider)

Products Included in this Solution:

Megaplex-4
Next Generation Multiservice Access Nodes

RADview
Carrier-Class Network Management System

Operational Core Network Using Carrier-Grade Ethernet



Solution Highlights

- Carrier-grade Ethernet is ideal for replacing SDH/SONET for operational applications and to enable Service Assured Networking
- Simplified architecture and management
- Increased security (802.1X, MACsec)
- Lower latency
- Assured QoS using Carrier Ethernet tools
- Ongoing performance monitoring

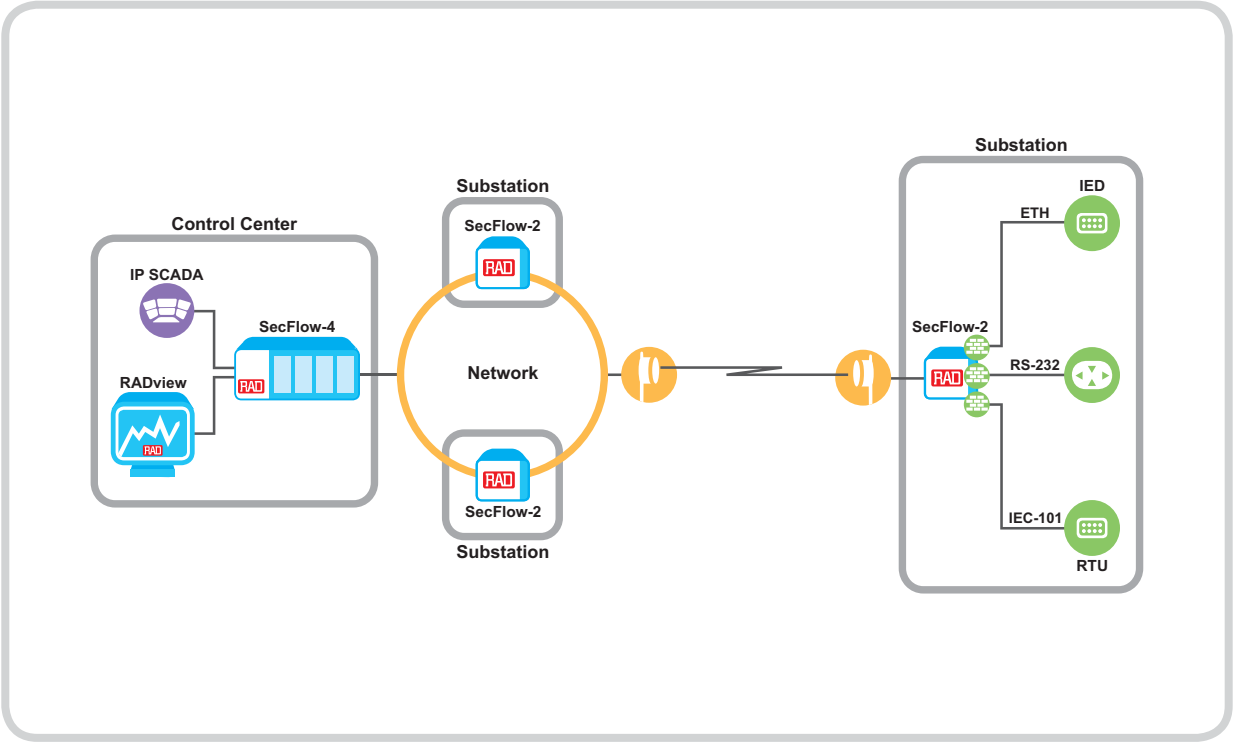
Products Included in this Solution:

ETX-5
Ethernet Service Aggregation Platform

Megaplex-4
Next Generation Multiservice Access Nodes

RADview
Carrier-Class Network Management System

IEC 61850-3 Secure Substation Communications



Solution Highlights

- Support Ethernet-based IEC 61850 substation communications for mission-critical automation traffic within the substation and between SCADA control centers
- Enable co-existence of serial-based RTUs and new Ethernet IEDs with full redundancy over various topologies using fiber optic rings, 2G/3G cellular modems and external radio systems
- Comply with IEC 61850-3 and IEEE 1613 environmental standards
- Built-in router enables seamless communication of the IP SCADA to both old and new RTUs by converting IEC-101 to IEC-104, or Modbus serial to IP, DNP3 and others
- Enable secure, dedicated networks over fiber and/or radio links using IPSec encryption and a dedicated, distributed security SCADA firewall suite

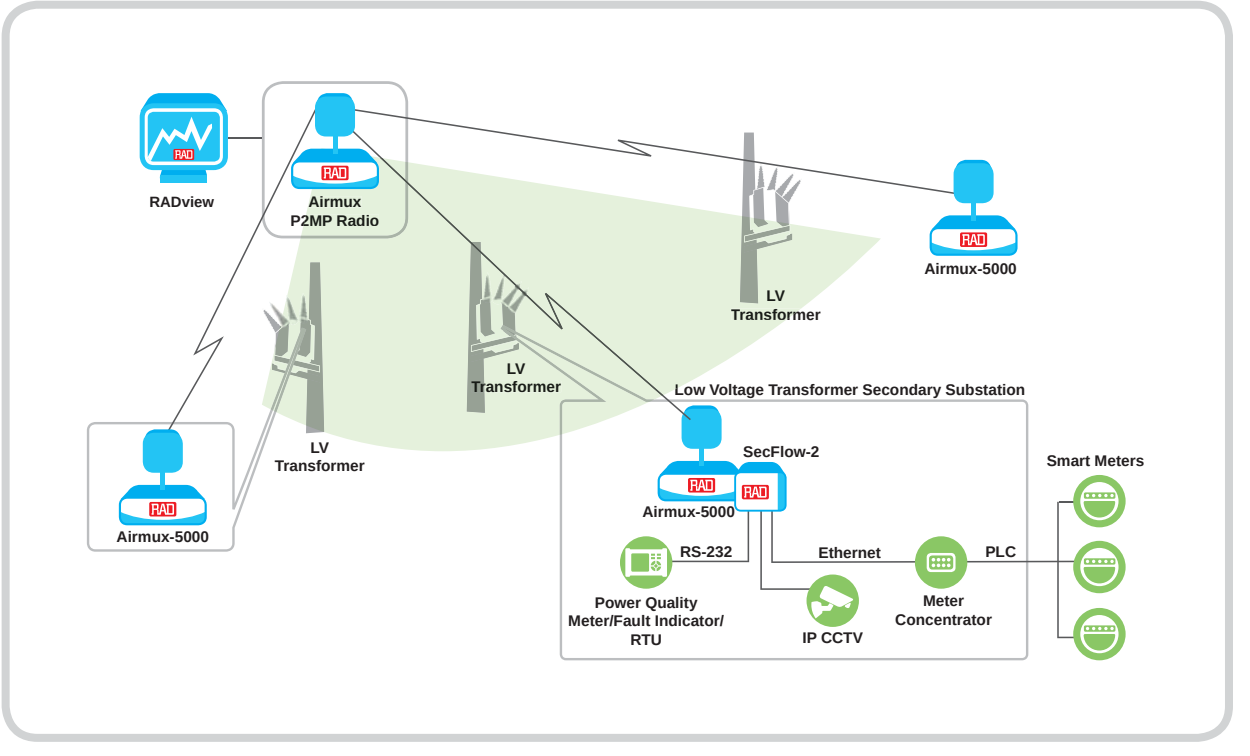
Products Included in this Solution:

RADview
Carrier-Class Network Management System

SecFlow-2
Ruggedized SCADA-Aware Ethernet Switch/Router

SecFlow-4
Modular Ruggedized SCADA-Aware Ethernet Switch/ Router

Distribution Automation and Smart Metering Backhaul



Solution Highlights

- A comprehensive solution addressing communications to secondary substations, metering and automation network integration and cyber security
- Comply with IEC 61850-3 and IEEE 1613 environmental standards for outdoor installations
- Seamless communication for IP SCADA over fiber optics, radio links, across 2G/3G cellular links, or copper circuits and leased lines from a local telecom service provider
- Integrated firewall with distributed SCADA security suite
- Point-to-multipoint radio connectivity supports high capacity mission-critical traffic over licensed and unlicensed sub-6 GHz bands, with dedicated bandwidth allocation and service level agreement (SLA) per subscriber

Products Included in this Solution:

Airmux-5000
Point-to-Multipoint Ethernet Radio

RADview
Carrier-Class Network Management System

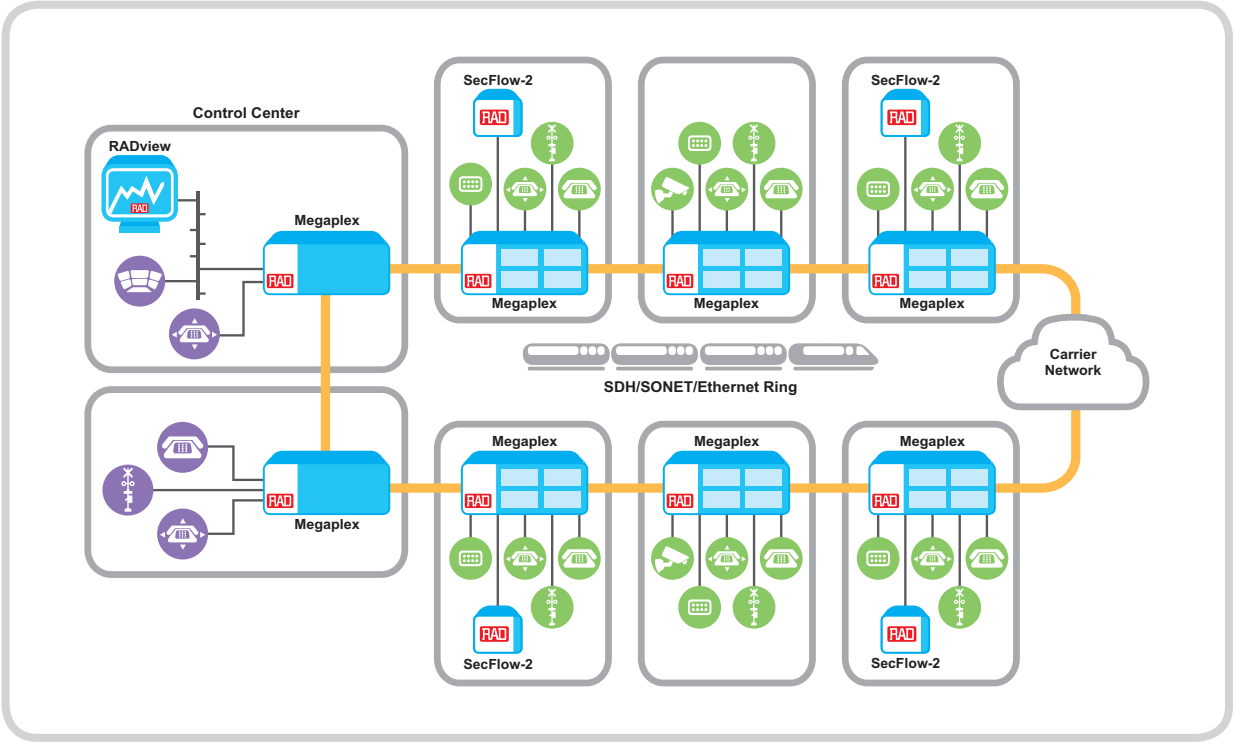
SecFlow-2
Ruggedized SCADA-Aware Ethernet Switch/Router

Service Assured Solutions for Transportation

RAD's Service Assured Networking solutions include reliable and efficient communications for a wide variety of applications for railways, motorways, and air & maritime traffic control. They range from Omnibus voice, track signaling and control, to train schedule display panels and ticketing terminals in stations, as well as mobile Internet access. RAD also provides unique mobility solutions for efficient communications between control centers and on-board installations, such as digital message boards and video cameras.

In addition, RAD is one of the few solutions vendors to ensure error-free and resilient communications for airline, airport and air traffic control operations, as well as for reliable and efficient ship-to-shore or harbor communications for navigation data, voice, Ethernet, GSM connectivity applications, video surveillance, and maritime traffic control operations.

Railway Station Connectivity



Solution Highlights

- Ensure protected connectivity between stations and control room using multidrop and ring topologies
- Support mission-critical railway applications, including automatic train supervision (ATS), centralized traffic control (CTC), SCADA, multi-party hotlines, and passenger information systems (PIS)
- Support legacy TDM and Ethernet traffic delivery over SDH/SONET and/or carrier-grade fiber optic rings
- Hybrid Ethernet and TDM with Traffic Duplication over both SDH/SONET and Ethernet networks for lower latency and better resiliency
- Seamless conversion of legacy SCADA to IP SCADA and security
- Carrier-grade Ethernet ensures service performance and ongoing KPI monitoring

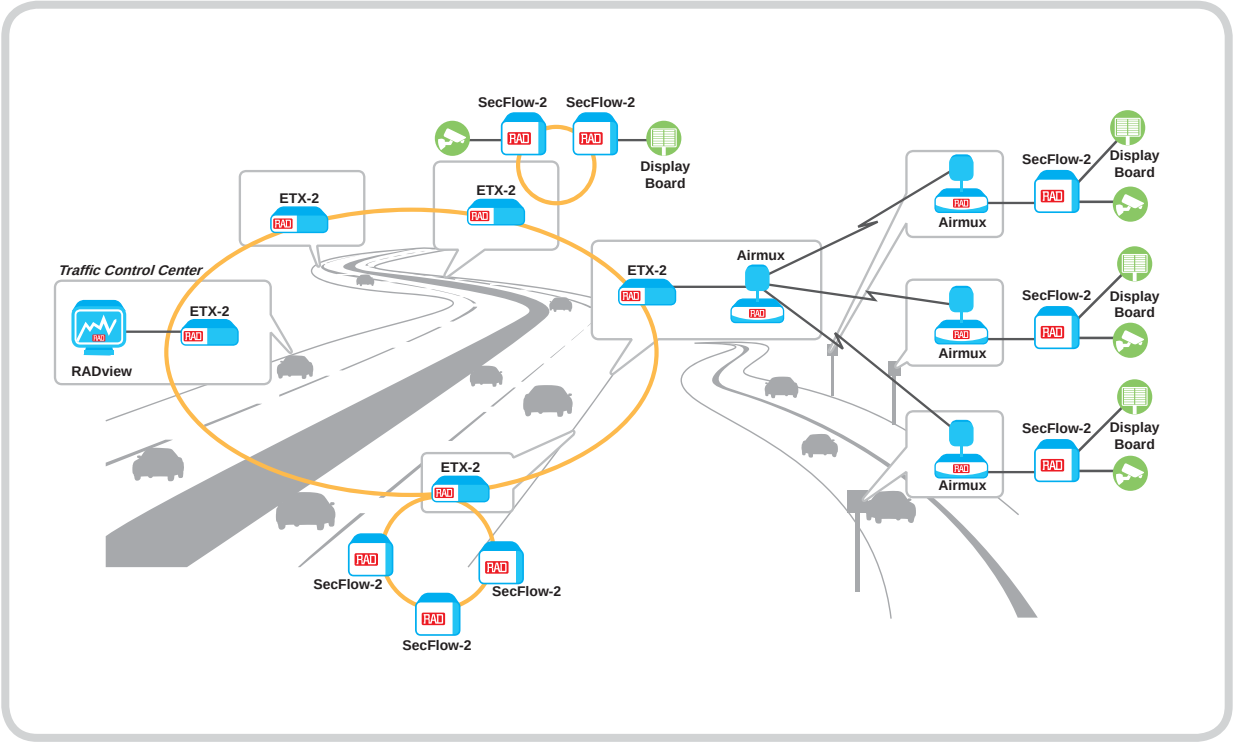
Products Included in this Solution:

Megaplex-4
Next Generation Multiservice Access Nodes

RADview
Carrier-Class Network Management System

SecFlow-2
Ruggedized SCADA-Aware Ethernet Switch/Router

Highway Security and Data Connectivity



Solution Highlights

- Backhaul high definition video feeds and roadside display board data from remote facilities over fiber, high speed sub-6 GHz radio links and 10-GbE rings
- Enable outdoor installations with industrial design and ruggedized enclosures
- 10-Gigabit carrier-grade Ethernet core rings with traffic management capabilities ensure reliable connectivity with appropriate quality of service for various applications

Products Included in this Solution:

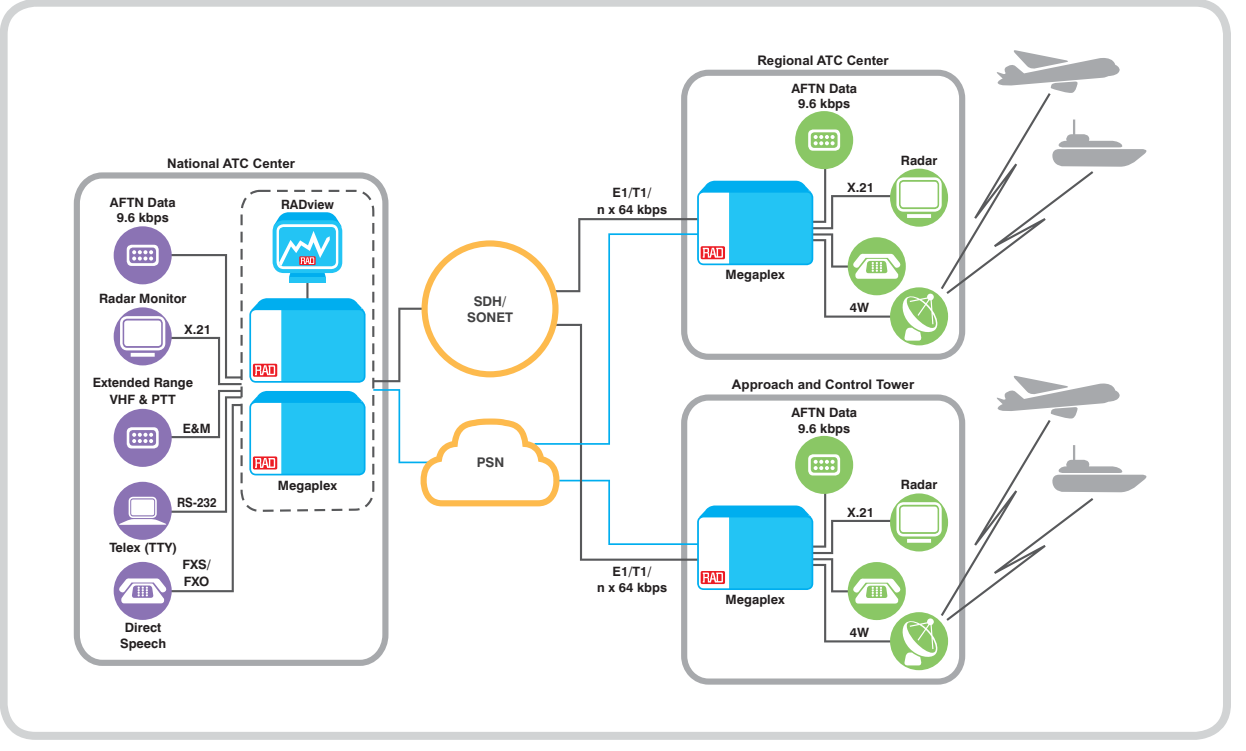
Airmux-5000
Point-to-Multipoint Ethernet Radio

ETX-2
Carrier Ethernet Demarcation and Aggregation

RADview
Carrier-Class Network Management System

SecFlow-2
Ruggedized SCADA-Aware Ethernet Switch/Router

Air Traffic Control and Maritime Communications



Solution Highlights

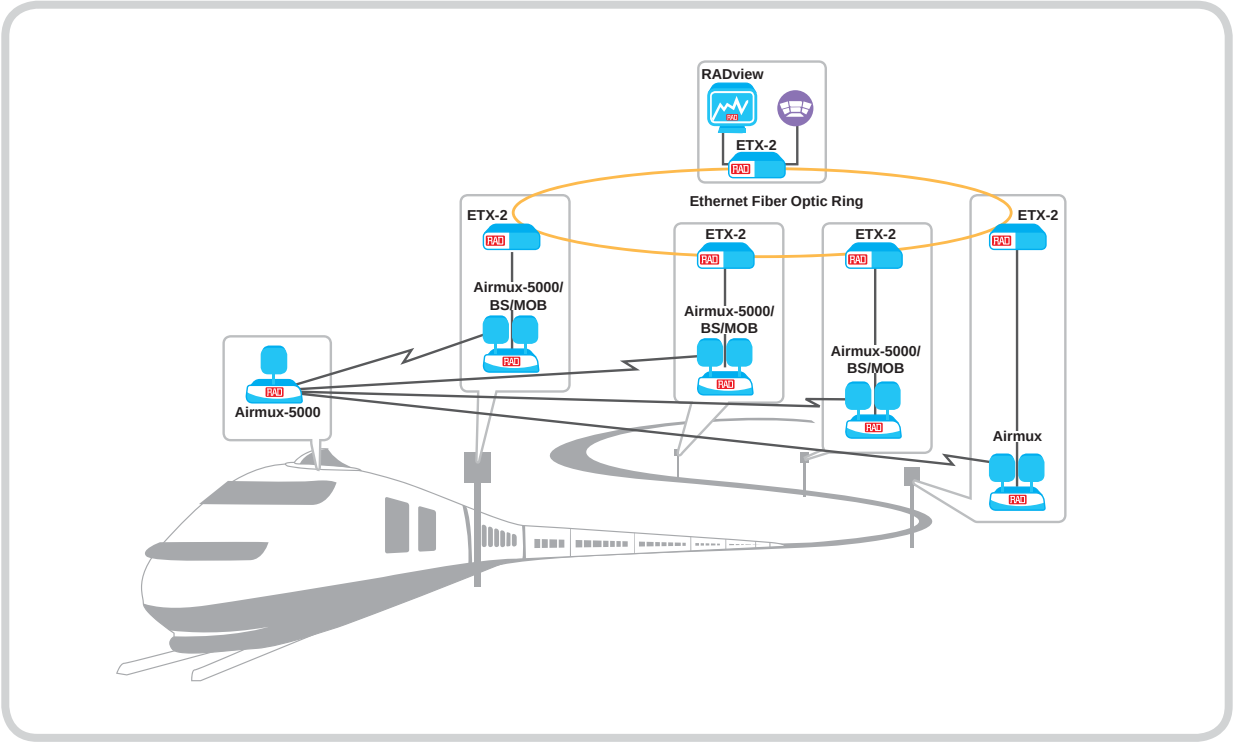
- Ensure uninterrupted air-ground communications between aircraft or vessels, control towers, and traffic control centers with RAD's multiservice connectivity solutions for air traffic control and maritime communications
- Deliver direct speech (DS), Telex (TTY), radar data (RD), extended range VHF (ER), 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 subrate leased line transmission and backup to reduce OpEx
- Ruggedized platforms withstand the rigors of field operations
- Support fail-safe operations with ISDN, VSAT and Ethernet backup

Products Included in this Solution:

Megaplex-4
Next Generation Multiservice Access Nodes

RADview
Carrier-Class Network Management System

Wireless Mobility



Solution Highlights

- Support bi-directional broadband connectivity for on-board video surveillance and Internet access in moving vehicles using easy-to-deploy base stations and Ethernet access switches
- Guarantee high capacity mobile video and data connectivity for ruggedized mobile units mounted on vehicles, trains and vessels at affordable total cost of ownership (TCO)
- Support connectivity on moving vehicles at up to 300 km/h
- Up to 100 Mbps total throughput
- Seamless handover for real-time video streaming
- Reliable coverage over long distances in various terrains and topologies
- Best reliability and performance in Metro and underground deployments

Products Included in this Solution:

Airmux-5000
Point-to-Multipoint Ethernet Radio

ETX-2
Carrier Ethernet Demarcation and Aggregation

RADview
Carrier-Class Network Management System

Service Assured Networking

RAD offers energy utility customers field-proven Service Assured Networking solutions over SDH/SONET and packet switched networks for the operational needs of their transmission and distribution (T&D) grids.

These include:

- Substation multiservice connectivity and migration with Traffic Duplication
- Distance and differential Teleprotection
- IEC 61850-3 secure substation communications
- Operational core network using carrier-grade Ethernet
- Distribution automation and smart metering backhaul
- Integrated security and firewall tools

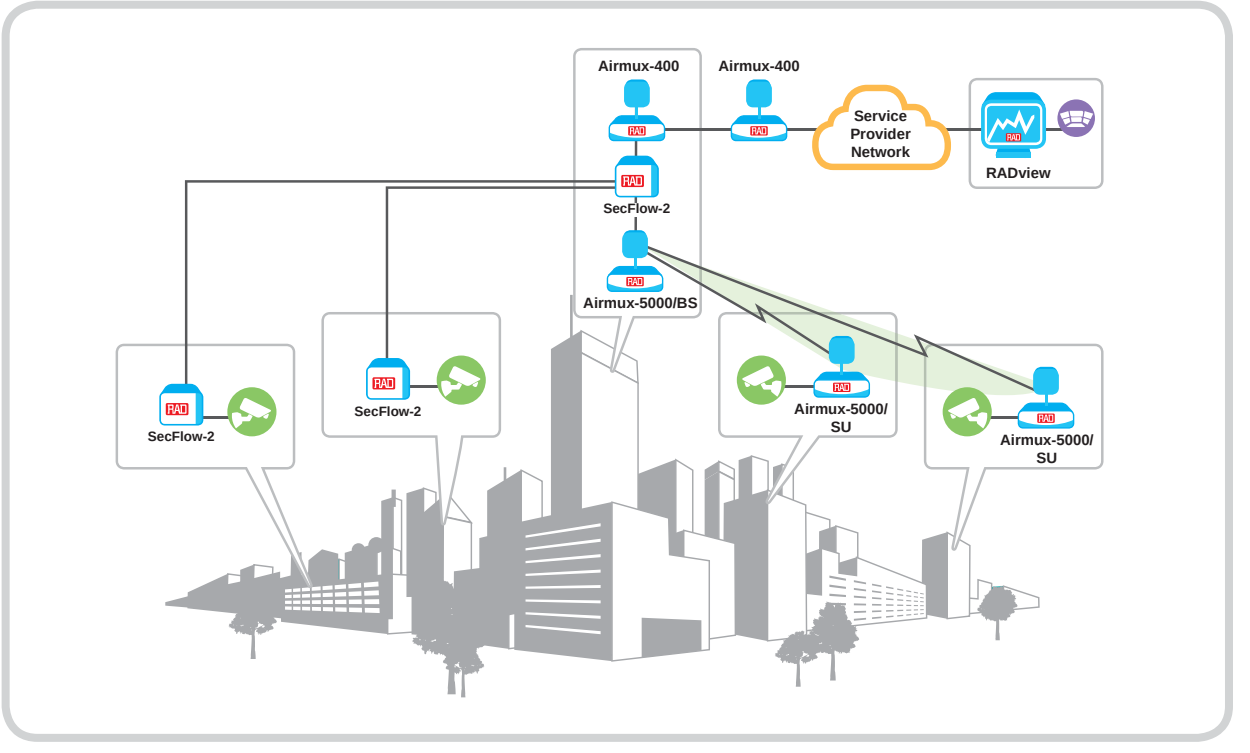
RAD

Service Assured Solutions for Government & Enterprise

RAD's Service Assured Networking solutions can help government, public safety and homeland security ICT managers realize fast and secure communications for TETRA, real-time applications and video surveillance, while supporting both legacy and packet switched services and networks with end-to-end service assurance.

For enterprise communications networks, RAD's Service Assured Networking solutions provide secure and evolutionary migration from legacy interfaces and networks to packet switched interfaces and networks.

Safe City and Security



Solution Highlights

- Provide coverage for Smart City and Safe City communications
- Connect security cameras and sensors in urban and rural areas over fiber optics and wireless radios
- Feature quality of service (QoS) capabilities to guarantee committed bandwidth for HD cameras
- Central management to provision and control the communications network
- Turnkey deployment solutions by RAD for Safe City and security projects, including consulting, communications, video surveillance and analytics systems, cameras, and sensors

Products Included in this Solution:

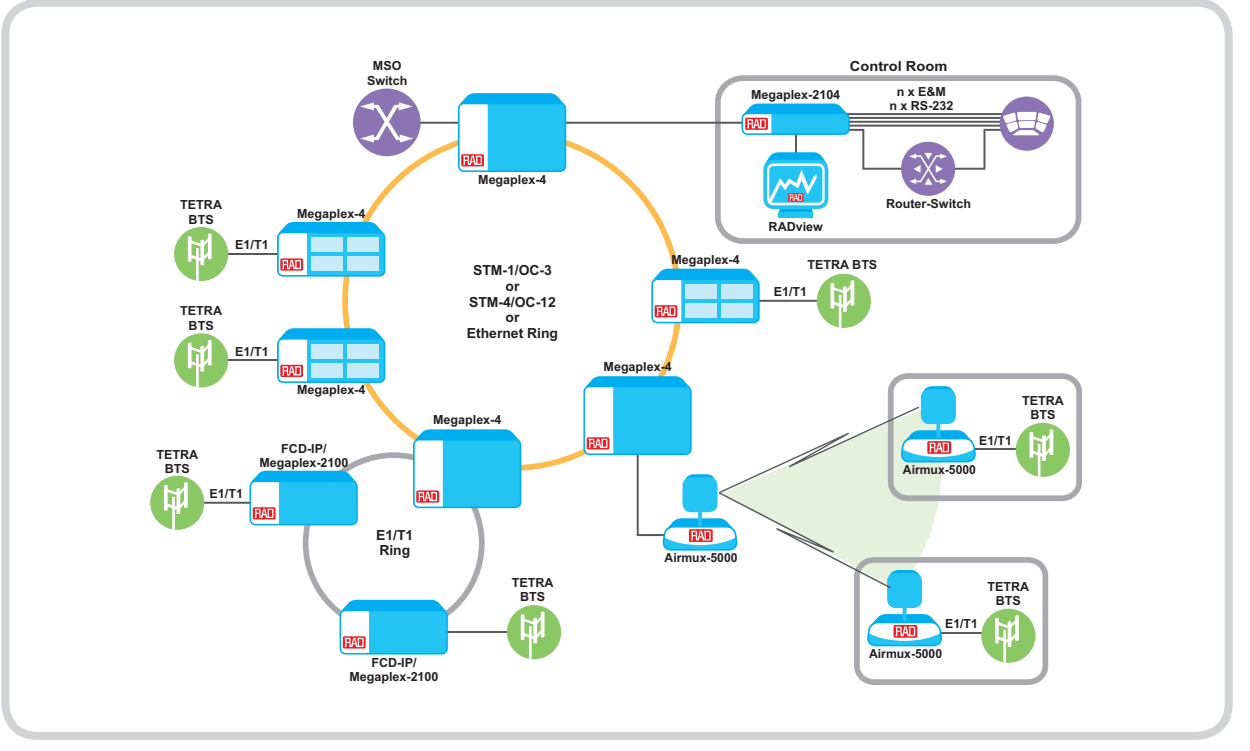
Airmux-400
Airmu-400L,
Airmux-400LC
Broadband Wireless Radios

Airmux-5000
Point-to-Multipoint Ethernet Radio

RADview
Carrier-Class Network Management System

SecFlow-2
Ruggedized SCADA-Aware Ethernet Switch/Router

TETRA and Two-Way Radio Backhaul



Solution Highlights

- Connect remote dispatcher and TETRA (terrestrial trunked radio) control rooms with MSO (main switching office) sites and TETRA switches over TDM and radio links
- Ring topologies to ensure service resiliency, high availability and fail-safe communications of TETRA V+D (voice and data), high speed TEDS (TETRA enhanced data services) and PMR (professional mobile radio) traffic
- Scalable capacity supports a bandwidth range from E1/T1 to STM-4/OC-12
- Simplify network monitoring and control with remote management
- Future-proof systems eliminate the need for deploying new equipment as the network is upgraded from TDM to IP
- Point-to-point and point-to-multipoint backhaul over sub-6 GHz radio with committed SLA and QoS capabilities

Products Included in this Solution:

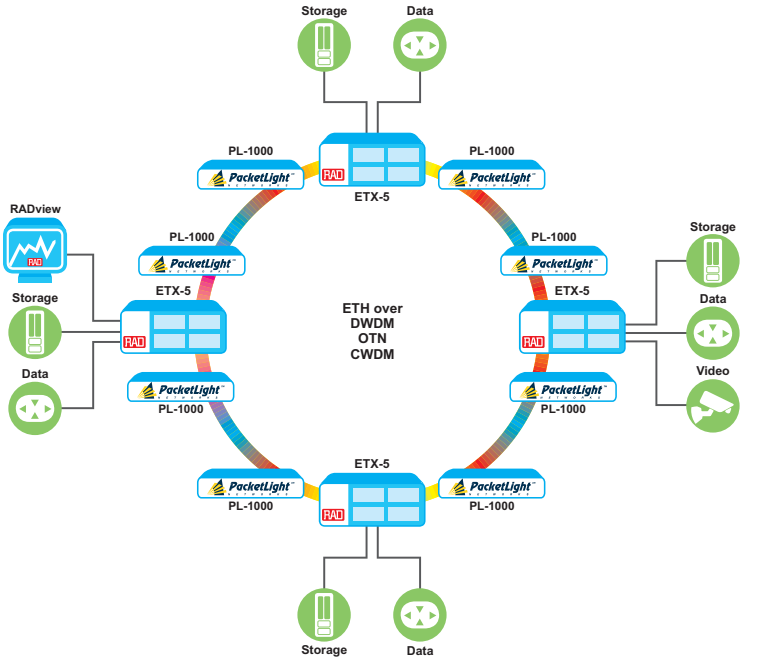
Airmux-5000
Point-to-Multipoint Ethernet Radio

FCD-IP
E1/T1 Access Unit with Integrated Router

Megaplex-4
Next Generation Multiservice Access Nodes

RADview
Carrier-Class Network Management System

DWDM/CWDM Transport



Solution Highlights

- End-to-end transport solution for data, storage, voice and video applications over DWDM/CWDM or OTN for enterprise and government institutes, such as insurance companies, financial institutions, universities, healthcare organizations, utilities, and service providers
- Supports business continuity and disaster recovery requirements
- Carrier-class, cost-effective devices enable simple configuration for transporting 2 Mbps up to 100 Gbps of traffic over up to 88 channels
- Features performance monitoring and transparent, low latency traffic delivery capabilities with low power consumption

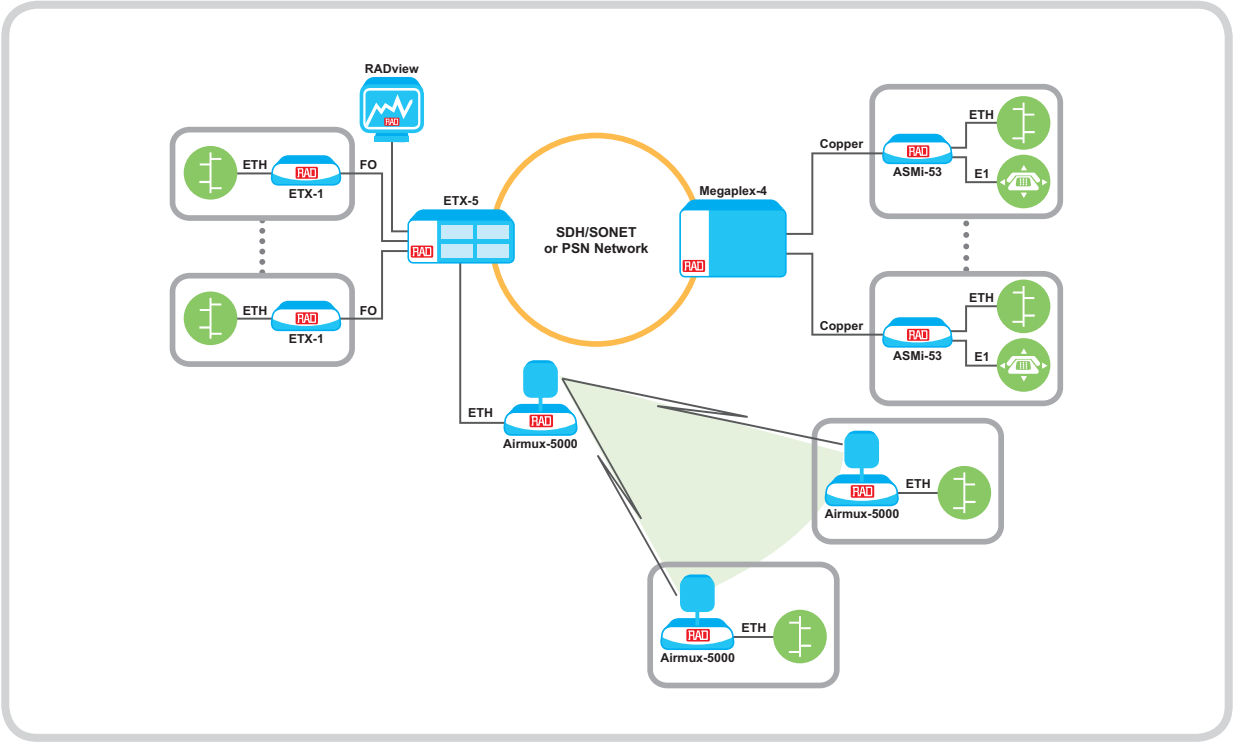
Products Included in this Solution:

ETX-5
Ethernet Service Aggregation Platform

PacketLight
Complete Solutions for WDM/OTN and Dark Fiber Applications

RADview
Carrier-Class Network Management System

Remote Government/Military Branch Connectivity over Fiber, Copper and Wireless



Solution Highlights

- Connect a privately owned government/military/public network to remote sites using diverse infrastructure
- Support multiple services, including Ethernet, TDM and low speed data with same device
- Utilize existing SDH/SONET network or build a state-of-the-art PSN-based backbone

Products Included in this Solution:

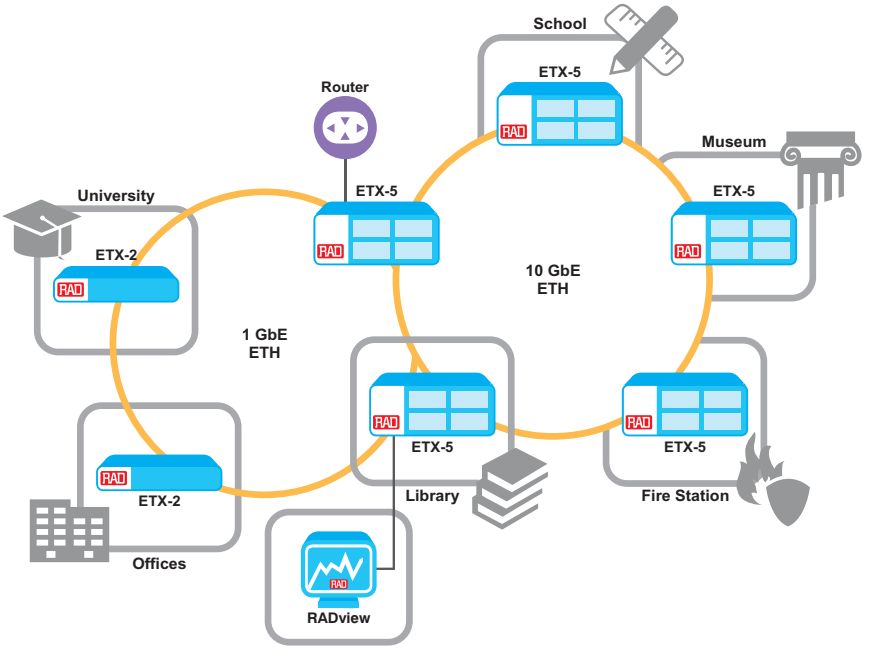
Airmux-5000
Point-to-Multipoint Ethernet Radio

ASMi-53
SHDSL.bis CPE Modem

ETX-1
Ethernet Demarcation Switch

RADview
Carrier-Class Network Management System

Private Carrier-Grade Ethernet Network for Campuses and Municipalities



Solution Highlights

- Fully redundant carrier-grade Ethernet core for managed and monitored connectivity for municipal institutes or campuses
- Fully compliant with MEF Carrier Ethernet 2.0 service offering of E-Line, E-LAN
- Enhanced capabilities include: Traffic management, performance monitoring, end-to-end management, legacy transport using TDM pseudowire, and service assurance OAM tools to simplify deployment and operations

Products Included in this Solution:

ETX-2
Carrier Ethernet Demarcation and Aggregation

ETX-5
Ethernet Service Aggregation Platform

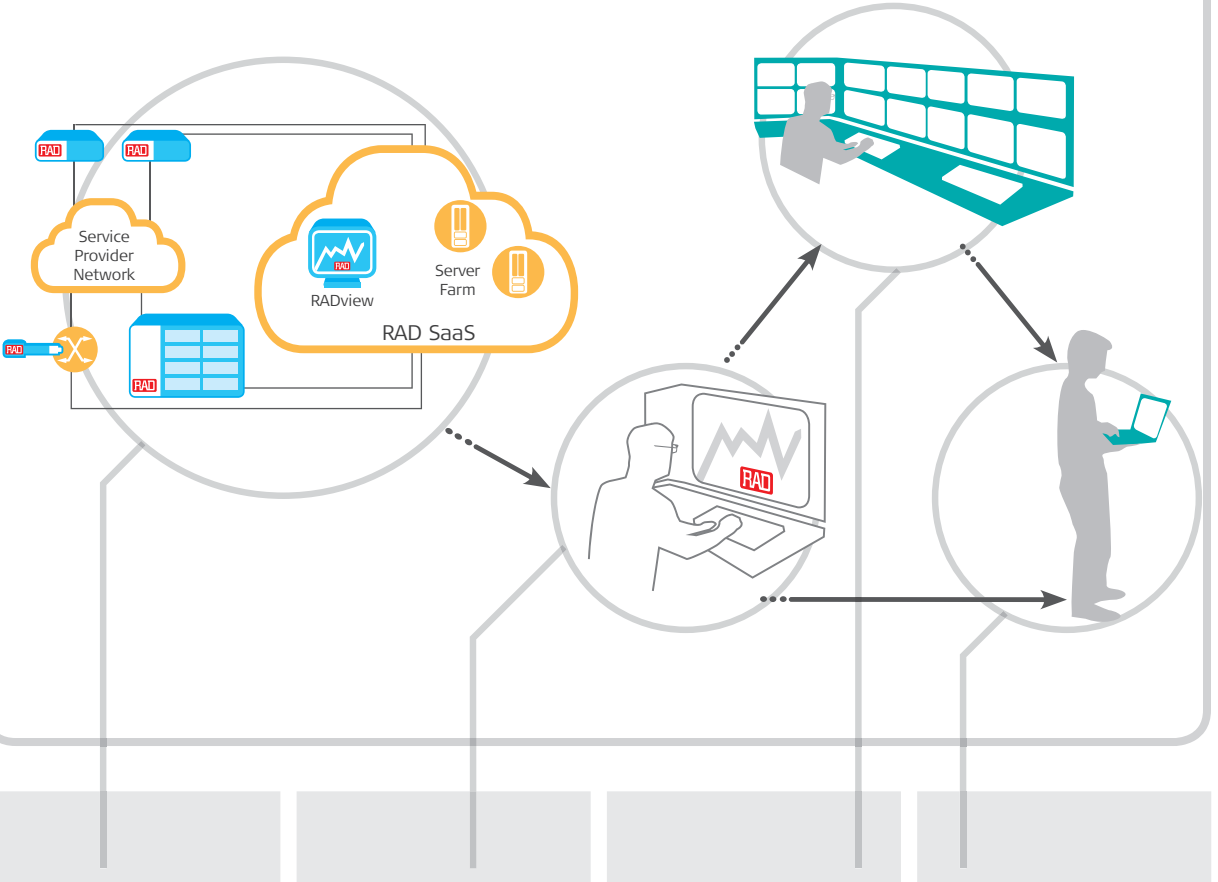
RADview
Carrier-Class Network Management System

RAD's Performance Monitoring as a Service Solution

RAD is now offering a SaaS solution that includes a powerful performance monitoring software tool, a team of experts for monitoring and analyzing the reported data and a cloud-based infrastructure for easy and fast access to the SLA parameters. RAD's PM as a Service allows operators to derive value with minimal effort, by understanding the source of any problem or by forecasting needs and bottlenecks.

PM as a Service (PMaaS): Outsource Your Service Assured Access Operations to RAD

How does it work?



Data Collection

- RADview Performance Monitoring collects KPI statistics from RAD ETXs or 3rd-party NIDs with MiNID
- Data is transmitted from service provider network to cloud over a secure VPN

Expert Analysis

- Monitor actual performance vs. SLA and anticipate service degradation
- Isolate malfunctioning segments using fault analysis tools
- Forecast future demand per end-customer

Reporting and Recommendations

- Deliver reports to SP via cloud-based PM portal
- Escalate QoS issues to SP operations
- Identify upselling opportunities

End-User Reporting (optional)

- Deliver reports to end-user via cloud-based PM portal (modified view)
- Provide analysis and recommendations

Products A-Z

ACE-3100
Cell-Site Gateway

RAD's ACE-3100 multiservice cell-site gateway simplifies provisioning and control of mobile broadband services while enabling simultaneous delivery of GSM, UMTS and HSPA traffic over the same transport network. It works opposite the ACE-340x and ACE-3600 aggregation-site gateways, as well as opposite third-party multiservice aggregation devices, to leverage available infrastructure to access ATM, SDH/SONET and high capacity, economical packet switched transport networks.

The ACE-3100 incorporates 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. Various QoS schemes support the delivery of ATM and TDM traffic over Layer 2 and Layer 3 networks, while powerful synchronization capabilities ensure highly accurate timing for 2G and 3G traffic over packet backhaul.

- **Multiservice support for ATM, TDM and Ethernet traffic delivery over packet networks**
- **Up to four E1/T1 ports**
- **Up to two ATM-155 ports**
- **Two Fast Ethernet ports (UTP/SFP)**
- **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**
- **SNMP management**

ACE-3220
Multiservice Cell-Site Gateway

RAD's ACE-3220 multiservice cell-site gateway is specifically designed to simplify provisioning and control of mobile broadband services while enabling simultaneous delivery of 2G-4G traffic over the same transport network. It grooms GSM, UMTS, HSPA and LTE traffic over a unified PSN (packet switched network) flow using diverse backhaul technologies, including ATM, ADSL2+, SHDSL.bis, and Gigabit Ethernet, as well as TDM and Ethernet microwave. Supporting operators and mobile transport providers in their migration to all-IP radio access networks (RAN), the ACE-3220 incorporates advanced pseudowire emulation (PWE) capabilities.

- **Eight or 16 built-in E1/T1 ports (UNI/IMA/CES); optional STM-1/OC-3 ATM port**
- **Four UTP/SFP Fast Ethernet ports; Gigabit Ethernet SFP/UTP combo port**
- **Up to two additional modular interfaces, including:**
  - Two ADSL2/2+ interfaces (Annex A, B)
  - Four SHDSL/SHDSL.bis interfaces (Annex A, B, F, G)
- **Flexible bonding options: SHDSL.bis, IMA and M-Pair support**
- **Multi-standard Ethernet, TDM and ATM pseudowire encapsulation over PSNs**
- **Ethernet-to-Ethernet and Ethernet-to-ATM bridging capabilities to transport Ethernet traffic from the IP Node B**
- **PPPoE support for HSPA applications**
- **Remote management with RADview**

• A

ACE-3400, ACE-3402
Aggregation-Site Gateways

RAD's ACE-3400 and ACE-3402 aggregation-site gateways are carrier-class multiservice aggregators, specifically designed to optimize cellular backhaul by multiplexing various ATM or TDM services into a single IMA, STM-1/OC-3 or Gigabit Ethernet network interface. Typically located at hub sites or BSC/RNC sites, these devices ensure the most economical allocation of backhaul resources in delivering 2G, 3G and next-generation services over ATM and SDH/SONET transport networks. Moreover, the ACE-3400 and ACE-3402 incorporate advanced pseudowire emulation capabilities, supporting operators in their migration to cost-effective packet transport by enabling the use of wholesale DSL services and Ethernet, IP or MPLS backbones for the provisioning of delay-tolerant, as well as real-time services.

The ACE-3400 is a 3U device, while the ACE-3402 is 2U high. Both devices fit into 19-inch racks for easy installation in limited spaces.

- **32 or 63 x ATM UNI/IMA/CES, E1/T1 (ACE-3400)**
- **Channelized STM-1/OC-3 with up to 63 x VC-12 channels for SDH or 84 VT 1.5 channels with UNI/IMA/CES**
- **1+1 Gigabit Ethernet uplink**
- **Up to 512 pseudowire connections with CESoPSN, SAToP and ATMoPSN support**
- **ATM and pseudowire OAM, QoS**
- **End-to-end fault propagation between legacy and packet switched networks**
- **+/-16 ppb frequency accuracy; high precision clock distribution**
- **RADview management system compliant with any third-party NMS/OSS; Fast Ethernet management interface (ACE-3402)**

ACE-3600
RNC-Site Gateway

RAD's ACE-3600 RNC-site gateway is a multiservice, multi-generation aggregation device for cost-effective delivery of UMTS, HSDPA and next-generation 3GPP traffic over Ethernet, IP and MPLS backbones. Converging multiple STM-1/OC-3 links over Gigabit Ethernet, the ACE-3600 uses pseudowire encapsulation to transport real-time ATM traffic over packet technology, with accurate PSN synchronization and distribution schemes.

Typically located at RNC sites, the ACE-3600 RNC-site gateway is a small, modular unit with total front access design, working opposite cell-site gateways such as RAD's ACE-3100. Together, these solutions support service operators in their migration to all-IP RAN and enable optimized provisioning of mobile broadband and rich-media services.

- **Four STM-1/OC-3c ATM ports with full redundancy**
- **One Gigabit Ethernet port with full redundancy**
- **Up to 1024 pseudowire connections over a packet switched network**
- **ATM and pseudowire OAM, QoS**
- **Full ATM switching, including traffic scheduling and shaping**
- **VLAN tagging per 802.1Q with 802.1p scheduling for QoS over L2 networks**
- **APS per G.841 for full system protection**
- **RADview management system compatible with any third-party NMS/OSS**

Airmux-400, Airmux-400L, Airmux-400LC

Broadband Wireless Radios

RAD's Airmux-400 series of carrier-class broadband wireless radios deliver native Ethernet and TDM services over a single wireless link in various sub-6 GHz frequencies. With a flexible combination of Ethernet and up to 16 E1/T1 interfaces, the high capacity Airmux-400 radio systems provide aggregated throughput of up to 200 Mbps and a range of up to 120 km (75 miles).

The Airmux-400 incorporates advanced features, such as MIMO and OFDM for optimal performance and unmatched robustness in all environments, making it ideal for:

- Cellular, WiMAX and ISP backhaul
- Broadband access
- Private networks

- **Multi-band operations over 2.3 to 2.5 GHz, 2.7 GHz, 3.5 GHz, and 4.8 to 6 GHz in a single device**
- **5 MHz, 10 MHz, 20 MHz, or 40 MHz channel bandwidth**
- **Up to 16 E1/T1 ports; up to two Gigabit Ethernet interfaces**
- **Net throughput: Up to 200 Mbps aggregated (Airmux-400), up to 50 Mbps aggregated (Airmux-400L), or up to 10/25 Mbps aggregated (Airmux-400LC)**
- **OFDM, MIMO and antenna diversity capabilities**
- **Extended range – up to 120 km (75 miles)**
- **Hub-site synchronization (HSS) supports simultaneous transmission from up to 16 colocated Airmux-400 and Airmux-5000 units**
- **Ring protection link (RPL) for Ethernet resiliency**
- **Spectral power measurement and RF survey tool – "Spectrum View" – for quick and easy installation**

AXCESS+

Airmux-5000

Point-to-Multipoint Ethernet Radio

RAD's Airmux-5000 carrier-class point-to-multipoint Ethernet radio system is the ideal wireless solution for business users demanding high capacity throughput with dedicated traffic bandwidth allocation and service level agreement (SLA) per subscriber. Featuring up to 250 Mbps aggregated sector capacity and shared base station architecture, a single Airmux-5000 base station supports up to 32 remote subscriber units (SUs) with multi-band operation, making it ideal for:

- **Service providers and ISPs**, offering IP backhaul and 4G/broadband access for remote, rural and underserved communities
- **Private networks**, requiring high capacity inter-branch connectivity for university campuses, healthcare organizations, government institutions, large enterprises and public establishments
- **Security and surveillance applications**, requiring aggregation and backhaul of traffic from multiple colocated HD cameras

- **Multi-band operation over 2.5 to 2.7 GHz, 3.3 to 3.8 GHz and 4.8 to 6 GHz in a single device**
- **Up to 250 Mbps aggregated throughput per sector**
- **Up to 32 remote subscriber units per sector with aggregated throughput of 5, 10, 20, 25 and 50 Mbps**
- **Supports fixed, nomadic and mobility applications**
- **5 MHz, 10 MHz, 20 MHz, or 40 MHz channel bandwidth**
- **OFDM, MIMO and antenna diversity capabilities**
- **Range up to 40 km (25 miles)**
- **Intra- and inter-site TDD synchronization using hub-site synchronization (HSS) and GPS**
- **Low constant latency – 4 to 10 msec typical under full sector load**

AXCESS+

• A

ASMi-52, ASMi-52L
SHDSL Modems

The ASMi-52 SHDSL multiplexer and ASMi-52L SHDSL modem transmit E1, Ethernet or serial data streams on an SHDSL link at various data rates of up to 4.6 Mbps. Incorporating TC-PAM technology for extending the transmission range, the SHDSL modems enable carriers to cost-effectively reach more users with copper lines at higher data rates over longer distances in the First Mile. The devices address the data transmission and Ethernet extension needs of enterprise users. Typical users include municipalities, utilities, corporate connectivity, and cellular backhaul providers.

- **ASMi-52: Two user ports supporting combinations of E1, V.35/X.21/RS-530, and 10/100BaseT**
- **ASMi-52L: Single user port of E1, V.35/X.21/RS-530 or 10/100BaseT, or four Fast Ethernet ports with an integrated switch**
- **Data rates between 2.3 Mbps and 4.6 Mbps**
- **Complies with ITU-T G.991.2 and ETSI 101524 standards for SHDSL**
- **Operates opposite RAD's LRS-102, DXC, and Megaplex modules as well as third-party equipment**
- **Managed by SNMP, Telnet or ASCII terminal**
- **Available as a 1U half-19" plastic or metal enclosure, or as an EN 50121-4 compliant rail mount**

ACCESS+

ASMi-53
SHDSL.bis CPE Modem

The ASMi-53 SHDSL.bis CPE modem is a cost-effective device for extending V.35, E1 and mid-band Ethernet services over multi-pair bonded copper links. Ensuring reliable performance over poor quality or noisy lines, the ASMi-53 SHDSL.bis CPE modem operates in full duplex mode over 2-wire or 4-wire lines, achieving variable data rates of up to 11.4 Mbps.

The ASMi-53 is ideal for carriers, service providers and mobile operators, as well as for enterprises, utilities and transportation companies looking for economical delivery of voice and broadband data traffic in point-to-point or hub-and-spoke communications.

- **E1, V.35 and Fast Ethernet extension over multiple SHDSL.bis lines**
- **Standards-compliant SHDSL (ITU-T G.991.2 and ETSI 101524)**
- **Up to 11.4 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**
- **VLAN prioritization and Ethernet QoS support**
- **SHDSL EOC management channel (inband)**
- **Functions as CPE opposite central devices (LRS-102/Megaplex-4)**
- **Optional remote power feed from DSL line**

ACCESS+

ASMi-54 Family
SHDSL.bis Modems

The ASMi-54 line includes the multi-port ASMi-54 advanced SHDSL.bis modem, the cost-effective ASMi-54L SHDSL.bis modem and the ASMi-54LRT managed SHDSL.bis modem with integrated router, as well as a card module (ASMi-54C) for the Megaplex-4 chassis. The devices support point-to-point and hub-and-spoke connectivity, while the ASMi-54 also supports drop-and-insert (daisy chain) and ring topologies over copper and fiber.

The managed SHDSL.bis modems extend E1 and mid-band Ethernet services over multi-pair bonded copper links. Ensuring reliable performance over poor quality or noisy lines, the devices employ next-generation SHDSL technology and EFM bonding to achieve variable data rates of up to 22.8 Mbps. The ASMi-54 family is ideal for service providers, mobile operators, enterprises, utilities, and transportation companies. The devices feature a compact, half 19-inch enclosure, with optional rail-mountable metal enclosure for deployment in extreme temperature environments.

- **Up to four Fast Ethernet ports with an integrated switch or router (ASMi-54LRT); optional one (ASMi-54L, ASMi-54LRT) or four (ASMi-54) E1 interfaces**
- **ITU-T G.991.2, ETSI 101524; TC-PAM 16 or TC-PAM 32**
- **ASMi-54, ASMi-54LRT: Up to 22.8 Mbps over 8-wire (4 pairs)**
- **ASMi-54L: Up to 11.4 Mbps over 4-wire (2 pairs), 5.7 Mbps over 2-wire (1 pair), or up to 30 Mbps over 4-wire using RAD's high performance SHDSL technology**
- **EFM bonding per IEEE 802.3-2005; M-Pair bonding for HDLC**
- **VLAN prioritization, rate limitation per port and Ethernet QoS support; Ethernet OAM per IEEE 802.3-2005 (formerly 802.3ah)**
- **Static NAT/NAPT routing; Solid Firewall™ protection for LAN and DMZ with ingress rate limitation; IPSec VPN support (ASMi-54LRT)**
- **Managed via SNMP, Telnet and ASCII terminal**

DXC Family
Digital Cross Connects

RAD's DXC-8R, DXC-10A and DXC-30 provide digital access and cross-connect functionality for multiple services, supporting a wide range of applications for carriers, cellular operators, ISPs, utilities, transportation, campus networks, and enterprises. The point-to-multipoint devices can broadcast any traffic combination from a single input to numerous destinations and provide non-blocking cross-connect for up to 120 lines.

The DXC family modular digital cross-connect units support E1/T1 conversion, inverse multiplexing, signaling monitoring, grooming of fractional traffic, and transmission of T1 circuits over E1 lines.

- **Non-blocking cross connect up to 960 timeslots**
- **Traffic grooming**
- **Compact 1U or 3U-high enclosures**
- **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**

• E

Egate-100

Gigabit Ethernet over TDM Aggregation Gateway

RAD's Egate-100 Gigabit Ethernet over TDM gateway transports Gigabit Ethernet traffic over channelized STM-1/OC-3 or over three DS3 lines. It leverages widely available PDH/SDH/SONET networks to deliver carrier-class Ethernet Private Line (EPL) services at granular rates, from a fractional E1/T1 to bonded n x E1/T1 channels. The Egate-100 supports NG-PDH encapsulation and bonding standards, such as generic framing procedure (GFP), virtual concatenation (VCAT) and link capacity adjustment scheme (LCAS).

The Egate-100 Gigabit Ethernet over TDM gateway is typically deployed in a central location to aggregate Ethernet user traffic received from a large number of remote units, such as RAD's RICi Ethernet demarcation devices, providing a complete access solution from the service provider central site to the customer premises.

- **Supports MLPPP, as well as GFP (G.8040, G.7041/Y.1303), VCAT (G.7043) and LCAS (G.7042) standards**
- **MEF-certified for EPL services per MEF-9 specifications**
- **Ethernet OAM per IEEE 802.3-2005 (formerly 802.3ah)**
- **Four priority queues per VLAN priority (802.1p), DSCP and IP Precedence; 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**

CARRIER ETHERNET MEF Certified Compliant

EtherAccess

Egate-2000

Gigabit Ethernet Aggregator over PDH, SDH/SONET Access

RAD's Egate-2000 is a carrier-grade, high capacity Ethernet over SDH/SONET aggregation device that provides MEF-compliant Ethernet services over channelized STM-16/OC-48 connections. It is typically deployed in a central location to aggregate traffic from remote devices, such as RAD's RICi Ethernet over TDM smart NTUs. Together, they form a complete Carrier Ethernet over TDM 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 existing PDH/SDH/SONET infrastructure to deliver carrier-class Ethernet services to sites where native Ethernet is not available.

- **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 ring protection switching**
- **Full system redundancy; CE and NEBS-compliant**

EtherAccess

EtherHaul-1200

Millimeter-Wave E-Band Radio

The EtherHaul-1200 is a high capacity, millimeter-wave, all-outdoor Gigabit Ethernet radio that dramatically lowers the cost of wireless and Ethernet backhaul. Operating in the uncongested and inexpensively licensed 71–76 GHz and 81–86 GHz E-band spectrum, the EtherHaul-1200 features a capacity of up to 1 Gbps with carrier-grade networking capabilities, as well as with enhanced adaptive bandwidth, coding and modulation for maximum spectral efficiency. Uniquely based on an all-silicon design, the highly economical system requires fewer components and offers greater reliability. Low power consumption and small size, and quick and easy installation that requires minimal site preparation, further reduce TCO (total cost of ownership), and make it ideal for mobile operators, business service providers and enterprises.

- **Operates in the 71–76 GHz and 81–86 GHz E-band spectrum; 250/500 MHz channel bandwidth**
- **Supports TDD/FDD, OFDM air interface**
- **Symmetric and asymmetric aggregated capacity of 1000 Mbps (TDD) or 2000 Mbps (FDD)**
- **Maximum link distance of 4,500m (14,765 ft)**
- **Full Carrier Ethernet support, including Ethernet OAM, performance monitoring, and Ethernet ring protection switching**
- **Advanced QoS classification, prioritization, shaping, and policing, supporting eight classes of service with SP, WFQ scheduling**
- **G.8262, G.8264 Synchronous Ethernet; IEEE 1588v2 transparent clock (TC)**
- **AES 128, AES 256 encryption**
- **1-ft or 2-ft antenna**

ETX-1

Ethernet Demarcation Switch

Hot Product

ETX-1 is an entry level Ethernet demarcation switch for service providers offering Ethernet connectivity services for business applications. Combining switch functionality with basic Ethernet demarcation capabilities, the ETX-1 enables quick, cost-effective service deployment to meet enterprise demand for Ethernet Private Line connectivity and LAN-to-LAN interworking.

The ETX-1 is deployed in hub-and-spoke or ring topologies and features Ethernet QoS, OAM and diagnostics to lower OpEx associated with service provisioning and monitoring. In addition, built-in switch functionalities allow local service provisioning within the organization, without the need to traverse the operator's network.

- **Six Gigabit Ethernet user/network ports**
- **MEF-9 and MEF-14 certified for EPL services**
- **Ethernet bridging and switching per 802.1D, 802.1Q, 802.1Q-in-Q**
- **Full Ethernet OAM and performance monitoring suite**
- **Six QoS priority queues with SP, WFQ scheduling and shaping**
- **ITU-T G.8032 Ethernet Ring Protection Switching (ERPS)**
- **RADview management; CLI configuration**

CARRIER ETHERNET MEF Certified Compliant

EtherAccess

• E

ETX-2

Carrier Ethernet Demarcation

Hot Product

The ETX-2 offers advanced L2 and L3 demarcation for SLA-based Ethernet business services, wholesale services and mobile backhaul. It is available in various ordering options allowing customers true cost/performance optimization by deploying the best device for their needs with the right form factor and capacity, interfaces, functionalities, and type of enclosure.

Part of RAD's Service Assured Access solution, the ETX-2 is designed to lower service provider TCO and increase revenues with an extensive service lifecycle toolkit that can be implemented in a variety of deployment modes over any access infrastructure.

- **E-Line, E-LAN, E-Tree, L3 VPN and TDM pseudowire services over packet networks**
- **Service uniformity over multiple access technologies, including FE, GE, 10GE, SHDSL, and TDM**
- **Multiple FE, GE, 10GE, and E1/T1 user interfaces**
- **Enhanced traffic management with multiple shapers and H-QoS per EVC/EVC.CoS**
- **Hardware-based Ethernet OAM, performance monitoring and built-in RFC-2544/Y.1564 tester capabilities; L2/L3 diagnostic loopbacks**
- **ITU-T G.8032 Ethernet Ring Protection; G.8031 Ethernet Linear Protection Switching; Link Aggregation (LAG) per 802.3ad; dual homing (1:1) redundancy**
- **Timing over Packet synchronization with Sync-E and IEEE-1588v2**
- **RADview management with CLI configuration; supported by RADview Ethernet Performance Monitoring Portal and RADview Service Manager**
- **MEF Carrier Ethernet 2.0-compliant and certified**

CE 2.0 MEF CERTIFIED

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ETX-2 Ordering Options and Unique Features:

- **ETX-203AX : Carrier Ethernet Demarcation Device**

Delivers SLA-based Ethernet business services, such as Ethernet Private Line (EPL), Ethernet Virtual Private Line (EVPL) and bridged E-LAN to the customer premises over native Ethernet access. It handles up to 5 Gbps of user traffic at wire-speed and is ideal for carriers, service providers, and wholesale operators requiring advanced Ethernet functionality at customer premises and multi-tenant units (MTUs).

- **Six FE/GbE ports (two network, four user); flexible selection of SFP and copper interfaces**
- **Wide range AC/DC power supply**

- **ETX-203AM: Universal Carrier Ethernet Demarcation Device**

Available as a modular demarcation device, enabling operators to deliver Carrier Ethernet services over Gigabit Ethernet, TDM or SHDSL network connections, using a single device. This reduces carrier TCO and simplifies purchasing, homologation, training, service production, and management integration. As a feature-rich demarcation point for SLA-based Ethernet business services, it supports Ethernet Private Line (EPL) and Ethernet Virtual Private Line (EVPL) over the same physical link with IP VPN, VoIP, and dedicated Internet access, all with differentiated quality of service and end-to-end monitoring.

- **Four FE/Gigabit Ethernet user ports; FE/GbE (combo), E1/T1, T3, or SHDSL modular network ports**
- **Optional environmentally hardened enclosure**

- **ETX-205A: Advanced Carrier Ethernet/Mobile Demarcation Device**

Provides advanced Carrier Ethernet demarcation capabilities housed in a small form factor, and offers combo interfaces and power supply redundancy. As a mobile demarcation device (MDD), the ETX-2 combines a cell-site gateway or a small hub device with Ethernet demarcation, as well as Distributed Grandmaster™ functionalities. It is installed at cellular tower and controller sites to guarantee differentiated SLAs for 3GPP and LTE/LTE-A mobile operators, while cutting down provider costs by minimizing equipment needed for timing and demarcation.

- **Integrated 1G static router for L2 and L3 VPN service demarcation with superior traffic management and monitoring capabilities**
- **Flexible synchronization offering Sync-E, IEEE 1588v2 slave, BC and TC for frequency and phase synchronization in mobile networks**
- **Distributed GM architecture integrating built-in GPS receiver with IEEE 1588v2 Grandmaster functionality for cost-optimized LTE deployments**
- **E1/T1 pseudowire services per MEF-8, UDP/IP, MPLS static labeling in SAToP and CESoP modes, and with CAS**
- **Optional environmentally hardened enclosure**

- **ETX-220A: 10G Carrier Ethernet Demarcation/Aggregation Device**

Optimized for high speed access applications, the ETX-220A combines intelligent demarcation and aggregation capabilities to deliver SLA-based Carrier Ethernet services for enterprise and carrier-to-carrier applications. As a demarcation solution, the ETX-220A is used for managing the service hand-off at an enterprise headquarters handling a large volume of traffic, at carrier inter-connects, or between provider networks. Alternatively, it can also be used as an aggregation solution at the concentration point, where a single unit can support numerous services and concurrent OAM sessions.

- **Up to 4 x 10-GbE ports and up to up to 20 x 1-GbE ports in various combinations**

• E

ETX-5

Ethernet Service Aggregation Platform

Hot Product

The ETX-5 reduces TCO (total cost of ownership) in delivering aggregated Ethernet and TDM pseudowire traffic from the access network to the PE (provider edge) over native 10-GbE links. Featuring the highest capacity-to-size ratio in the market and extremely low power consumption, it frees up expensive PE capacity, lowers price per link and saves on rack space and associated costs. The ETX-5 conforms to emerging Carrier Ethernet 2.0 specifications and includes an extensive toolset to deliver and manage SLA-based services.

The ETX-5 also features a comprehensive Timing over Packet synchronization toolset, including 1588 Grandmaster capabilities, eliminating the need for costly dedicated devices. Together with RAD's ETX demarcation devices, it offers a Carrier Ethernet access ecosystem from a single source and enables the convergence of business, wholesale and mobile network infrastructure.

- **Fully redundant, modular system designed for high availability**
- **Ethernet OAM termination and grooming; ITU-T Y.1564 generator/responder**
- **Extensive Sync-E, 1588v2 support, including 1588 Grandmaster**
- **Up to 16 x 10-GbE network/user ports; up to 80 x 1-GbE ports; up to 16 channelized STM-1/OC3 user/network ports**
- **Carrier Ethernet MEF-certified for MEF CE 2.0: E-Line, E-LAN, E-Tree services; MEF-8; MEF-22: mobile backhaul; MEF-26: E-NNI**
- **Ethernet Ring Protection Switching: ITU-T G.8032v2**
- **Extensive TDM pseudowire support: CESoPSN, SAToP, CESoETH (MEF-8), UDP/IP encapsulation**
- **AC or DC power feed; extremely low power consumption; NEBS-compliant**
- **Supported by RADview Service Manager and RADview Performance Monitoring portal**

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EtherAccess

ETX-26

Managed Ethernet Switch

ETX-26 is a managed Ethernet access switch featuring non-blocking architecture, small form factor and low power consumption. It is ideal for Ethernet Private Line connectivity and LAN-to-LAN interworking in campus deployments and for small to medium enterprises. In addition, the ETX-26 features proprietary power over Ethernet capabilities, to be used in conjunction with RAD's Airmux-400 broadband wireless radios as a single indoor device for Ethernet connectivity and ODU power feeding.

- **Three Gigabit Ethernet 1000BaseFX SFP ports**
- **Six Fast Ethernet 10/100BaseT UTP ports**
- **Ethernet bridging and switching per 802.1D, 802.1Q, 802.1Q-in-Q**
- **Four QoS priority queues with SP, WFQ scheduling**
- **ITU-T G.8032 Ethernet Ring Protection Switching (ERPS)**
- **Two proprietary power over Ethernet ports for Airmux applications**
- **Wide range of AC/DC power supplies**
- **SNTP, Net Inventory and Dying Gasp support for management, configuration and diagnostics**
- **Extended temperature range**

ETX-102, ETX-201, ETX-202

Basic Ethernet Demarcation Devices

The ETX-102, ETX-201 and ETX-202 deliver up to 1 Gigabit of user throughput over the fiber Local Loop, from the customer premises to the network's edge. This allows service providers to extend their reach using low-cost Ethernet as the access technology. The devices perform service demarcation for MEF-defined Ethernet Private Line (EPL) services. Alternatively, 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.

The ETX-102, ETX-201 and ETX-202 incorporate advanced Ethernet OAM features and QoS (quality of service) capabilities such as rate limitation and traffic prioritization per port and per service, to enable remote service provisioning and end-to-end SLA control.

- **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 management**

ETX-1300

Gigabit Ethernet Aggregation Switch

The ETX-1300 is a high density, multiport Gigabit Ethernet aggregation switch delivering Fast Ethernet traffic over Gigabit Ethernet packet switched networks. Working opposite CPEs, such as the ETX-1 and ETX-2, it functions as an Ethernet access aggregator with Ethernet bridging and switching capabilities, including VLAN-aware, VLAN-unaware, and VLAN stacking modes, as well as per-port and per-flow Ethernet QoS.

To ensure service and link resiliency, the ETX-1300 features Link Aggregation and ring protection support. Its carrier-grade design includes dual power supplies, alarm relay and an external clock. The ETX-1300 is ideal for lowering fiber aggregation costs by saving on expensive ports required in the PE. It can also be used as a managed basement aggregation switch in multi-tenant units (MTUs).

- **32 SFP/UTP Fast Ethernet user interfaces**
- **Four Gigabit Ethernet combo ports supporting Link Aggregation per IEEE 802.3ad**
- **Ethernet Ring Protection Switching per ITU G.8032**
- **Quality of service with queue mapping per port, P-bit, DSCP, or ToS**
- **Ethernet OAM per IEEE 802.3-2005 (formerly 802.3ah)**
- **Centralized SNMP-based remote management with RADView**

• F

FCD-155

STM-1/OC-3 Terminal Multiplexer

The FCD-155 transports Ethernet traffic over SDH or SONET networks, enabling carriers and service providers to provide LAN connectivity and Internet access while continuing to support E1, T1, E3, or T3 traffic. Installed at the customer site, the FCD-155 improves bandwidth efficiency by supporting Ethernet over SDH/SONET encapsulation and framing to enable IP channel bandwidth configuration in increments up to 100 Mbps wire-speed.

The FCD-155 is widely deployed by carriers and service providers to leverage their optical bandwidth for revenue-generating Ethernet services, while enterprises, utilities and campuses use the FCD-155 to provide LAN services over existing fiber optic infrastructures.

- **Standard next-generation STM-1/OC-3 terminal utilizing GFP, VCAT, LCAS**
- **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 interface**
- **Advanced management option including DCC and IP tunneling**
- **Available with standard protection on the main link**
- **Compact size**

AXCESS+

FCD-155E

Ethernet over SDH/SONET ADM

The FCD-155E transports next-generation Ethernet and TDM traffic over STM-1/OC-3 fiber or copper links. It also supports E1, T1, E3, and T3 services. The traffic is mapped into the SDH/SONET frame and can be terminated at any point on the network. Used as an add/drop multiplexer on the SDH/SONET ring (or as a terminal multiplexer at the remote site), the FCD-155E improves bandwidth efficiency by supporting Ethernet over SDH/SONET encapsulation and framing to enable IP channel bandwidth configuration in increments up to 100 Mbps wire-speed.

Carriers and service providers deploy the product to leverage optical bandwidth for revenue-generating Ethernet services, while enterprises, utilities and campuses use the FCD-155E to provide LAN services over existing fiber optic infrastructures.

- **Standard next-generation STM-1/OC-3 ADM utilizing GFP, VCAT, LCAS**
- **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
  - Eight or 21 E1/28 T1 ports, one E3/DS3 port or 21 E1/28 T1 ports, one E3/T3
- **Optional dual power supply configuration**
- **SFP-based STM-1/OC-3 uplinks and Gigabit Ethernet interface (SFP and UTP)**
- **Advanced management option including DCC and IP tunneling**
- **Available with standard protection on the main link**
- **Compact size**

FCD-IP

E1/T1 Access Unit with Integrated Router

RAD's FCD-IP access unit with integrated router is an E1/T1 or fractional E1/T1 access device that enables service providers to bundle data, voice and IP access services over a single E1 or T1 access line. It supports WAN services such as E1 or T1, Frame Relay with auto-learn and ISDN BRI for data backup. An integrated router supports IP routing and transparent bridging.

The FCD-IP is an ideal solution for small to medium size companies needing to integrate their voice and data traffic and access the Internet via low rate TDM lines.

- **One or two independent Ethernet ports or an integrated four-port switch (10/100BaseT)**
- **Data interfaces: V.35, RS-530, V.36/RS-449, V.24, X.21**
- **Three optional sub-E1/T1 ports or four analog ports (FXS, FXO, E&M) for PBX/phone connectivity**
- **IP/IPX routing and transparent bridging; OSPF support**
- **Supports Frame Relay (RFC 1490) and PPP protocols**
- **Self-healing ring and drop-and-insert capabilities**
- **Fail-safe sub-E1/T1 ensures uninterrupted service**
- **Dial backup over ISDN/PSTN**

IPmux-1E

TDM Pseudowire Access Gateway

RAD's IPmux-1E TDM pseudowire gateway is customer located equipment (CLE), extending TDM-based services over dark fiber, IP, Ethernet, and MPLS networks. Using TDM pseudowire technology, it delivers ISDN BRI, echo cancelled E1/T1 or FXS/FXO/E&M services over packet transport, in addition to enabling transparent LAN bridging. The IPmux-1E supports carriers in their migration to next-generation networks, by allowing them to continue generating revenues from their ongoing legacy services over PSNs. The ease of installation and support for legacy and next-generation Ethernet and IP-based services make it ideal for small and medium-sized enterprises (SMEs).

- **Transmits TDM-based services over Ethernet, IP or MPLS networks**
- **Analog, ISDN BRI or E1/T1 user ports with echo cancellation**
- **Transparent LAN bridging over packet switched networks**
- **Fiber and copper Fast Ethernet uplink interfaces**
- **QoS support**

IPmux-2L, IPmux-4L, IPmux-4LGE, IPmux-16L

TDM Pseudowire Access Gateways

The IPmux-2L, IPmux-4L, IPmux-4LGE, and IPmux-16L are cost-effective TDM pseudowire access gateways, extending TDM, HDLC and LAN traffic over dark fiber, IP, MPLS, or Ethernet. The devices provide an ideal solution for circuit emulation and legacy leased line services, as well as for PBX backhaul, PSTN access, TDM trunking over packet transport, and cellular backhaul. Incorporating a multi-standard pseudowire ASIC, they enable transparent delivery of legacy user traffic over next-generation transport with minimal processing delay.

IPmux-2L, IPmux-4L, IPmux-4LGE and IPmux-16L support point-to-point and hub-and-spoke network topologies, offering a complete migration solution when combined with other TDM pseudowire CPEs (such as IPmux-24 and IPmux-216) and aggregation gateways supporting TDM pseudowire (such as ETX-5, IPmux-155L, and Megaplex-4).

- **Up to two (IPmux-2L), four (IPmux-4L, IPmux-4LGE), eight or 16 (IPmux-16L) E1 user ports**
- **Optional n x 64 serial user data port (IPmux-2L)**
- **Three UTP/SFP Fast Ethernet user/network ports (IPmux-4L)**
- **Four UTP Fast Ethernet ports (IPmux-4LGE, IPmux-16L)**
- **One or three UTP/SFP Gigabit Ethernet network/user ports (IPmux-4LGE, IPmux-16L)**
- **Multi-standard TDM pseudowire ASIC: TDMoIP, CESoPSN, SAToP, CESoETH, HDLCoPSN**
- **QoS support with four priority queues**
- **Ethernet Ring Protection Switching (ERPS) per ITU-T G.8032 supporting up to 16 nodes per ring (IPmux-4LGE, IPmux-16L)**
- **Pseudowire OAM**
- **High precision clock recovery for 2G/3G cellular traffic over PSN; optional Sync-E support (IPmux-2L)**
- **Centralized SNMP-based remote management with RADView**

ACCESS+

IPmux-24, IPmux-216

TDM Pseudowire Access Gateways

The IPmux-24 and IPmux-216 extend TDM, HDLC and Ethernet services over packet transport using standard pseudowire encapsulation over Fast Ethernet or Gigabit Ethernet access. 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 while maintaining the mobile network's stringent synchronization requirements.

- **Up to four (IPmux-24), eight or 16 (IPmux-216) E1 or T1 TDM user ports**
- **Three SFP-based fiber or copper Fast Ethernet or Gigabit Ethernet interfaces**
- **Multi-standard hardware-based TDM pseudowire: 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 (CFM)**
- **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**

ACCESS+

IPmux-155L

Hub-Site Pseudowire Access Gateway

The IPmux-155L is a cost-effective access aggregator, delivering TDM pseudowire and Fast Ethernet user traffic over Gigabit Ethernet packet switched networks. Working opposite CPEs, such as the IPmux-24, IPmux-2L, IPmux-4L, MiTOP-E1, and IPmux-4LGE, it functions as a pseudowire termination unit and sends TDM pseudowire bundles from remote units to SDH/PDH backbones while Ethernet traffic is directed to packet networks. Featuring multi-standard pseudowire capabilities and a wire-speed, non-blocking Ethernet switch, the IPmux-155L hub-site pseudowire access gateway allows enterprises to replace expensive leased lines with cost-effective packet transport and offers an ideal solution for economical PSTN access and PBX backhaul, including standards-based ring topology.

- **Multi-standard hardware-based TDM pseudowire: TDMoIP, CESoPSN, SAToP, CESoETH, HDLCoPSN**
- **Transports a fully populated channelized STM-1 stream or up to 32 E1 channels over PSN**
- **1+1 redundant STM-1 ports**
- **Aggregates 32 Fast Ethernet UTP/SFP connections into four Gigabit Ethernet links**
- **ITU-T G.8032 Ethernet Ring Protection Switching (ERPS)**
- **Secure management: SNMPv3, SSH/SSL and RADIUS**
- **Centralized SNMP-based remote management with RADView**
- **Compact 1U (STM-1 version) or 2U (32 E1 version), 19-inch enclosure**

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, ISDN, and other services. In addition, TDM traffic can be transparently delivered over IP or Ethernet-based networks using pseudowire technology. Especially suited for the satellite environment, the Kilomux-2100 subrate multiservice multiplexer contains an elastic buffer to deal with the long delay introduced by the wireless path. Supporting SCADA and legacy analog voice interfaces, the Kilomux devices are also ideal for utility companies and air traffic control applications.

The low overhead proprietary multiplexing, 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.

- **Uplink data rates from 9.6 kbps to 1,536 kbps**
- **High quality, low bit rate analog voice/fax from 4.8 kbps to 14.4 kbps**
- **Digitally encoded toll-quality PCM/ADPCM analog voice/fax from 16 kbps to 64 kbps**
- **Low/high speed async/sync serial data interfaces**
- **Chassis capacity:**
  - **Kilomux-2100 with 12 I/O slots**
  - **Kilomux-2104 with four I/O slots**
- **Optional redundant power supply and uplink interface**
- **Drop-and-insert capability**
- **Ethernet bridge module for LAN connectivity**
- **Flexible timing options**

• L

LA-110
Integrated Access Device

RAD's LA-110 delivers multiple services such as voice, Ethernet and Internet access over low-cost xDSL and ATM transport. Leveraging existing deployments of wholesale SHDSL services, it offers cost and coverage benefits for SMEs (small and medium enterprises) and is ideal for leased line, cellular backhaul, Frame Relay, and corporate IT applications. By extending end-to-end management up to the customer premises, the LA-110 enables service differentiation and QoS guarantees. Furthermore, the LA-110 integrated access device allows a bandwidth capacity increase up to 9.2 Mbps, with IMA bonding over four SHDSL pairs.

- **Network ports: SHDSL or E1**
- **Up to 9.2 Mbps, 8 km (5 miles) with IMA bonding over four 2-wire SHDSL circuits**
- **Built-in 10/100BaseT user interface**
- **Optional user ports:**
  - E1/T1 TDM/ATM
  - ISDN BRI/PRI
  - Serial Frame Relay/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**

LA-210
EFM DSL Network Termination Unit

The LA-210 enables service providers to deliver mid-band Ethernet and high speed Ethernet where fiber is not present, by offering Ethernet access rates of up to 22 Mbps over bonded SHDSL.bis copper lines based on standard EFM (Ethernet in the First Mile) technology. Installed at the customer premises, it delivers Ethernet services, such as inter-office LAN connectivity, Internet access and virtual private networks (VPNs), as well as legacy TDM service, using pseudowire emulation. The LA-210 features Carrier Ethernet attributes, including Ethernet OAM for proactive SLA monitoring, quality of service (QoS) per Ethernet flow and advanced traffic management capabilities – all starting at the service hand-off points. The LA-210 is certified by the Metro Ethernet Forum to deliver Ethernet Private Line (EPL) and Ethernet Virtual Private Line (EVPL) services per MEF-9 and MEF-14 specifications.

- **Mid-band Ethernet access up to 22 Mbps using EFM bonding**
- **Up to four pairs of EFM bonded SHDSL.bis uplink lines**
- **Up to four Fast Ethernet user ports**
- **Pseudowire support for E1, V.35 or X.21 traffic**
- **MEF-9 and MEF-14 EPL and EVPL certified**
- **Advanced QoS mechanism per EVC/EVC.CoS**
- **Ethernet link and service OAM with performance monitoring for end-to-end SLA control**
- **Multi-standard pseudowire support for legacy services over PSN**

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LRS-102

Fiber and Copper Mux Rack

The LRS-102 is a cost-effective, modular central rack solution for RAD's Optimux fiber multiplexer or ASMi-54 SHDSL.bis products, extending E1/T1s, data and Ethernet traffic up to 120 km (75 miles) over fiber optic links, and TDM and Ethernet over SHDSL.bis with rates up to 22.8 Mbps over copper. A higher port density chassis occupying one-third of the space of the equivalent number of standalone units, the LRS-102 central solution saves on colocation costs and avoids multiple IP addresses in the network, resulting in a lower price per port. Typical LRS-102 applications include campus service sharing, Ethernet, data and voice range extension, cellular backhaul extension, video conferencing, and surveillance camera connectivity.

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

Megaplex-4

Next-Generation Multiservice Access Nodes

Hot Product

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EtherAccess

RAD's Megaplex-4 is a carrier-class, high capacity multiservice access concentrator for delivering legacy and next-generation services over PDH/SDH/SONET, or over packet switched transport 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 it an ideal core/edge solution for carriers and service providers. The device 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. Megaplex-4 can be used as a central aggregation unit for AXCESS+ and EtherAccess CPEs. The Megaplex-4 is available with a cable management solution to reduce storage space and handling, and eliminate cable waste.

- **Modular 4U or 2U 19-inch units housing multiple I/O modules**
- **Hybrid Ethernet and TDM architecture, supporting TDM, PSTN, ISDN, data, and Ethernet services up to STM-4/OC-12, and Ethernet up to multi-GbE**
- **Carrier-class reliability with hardware, service and system redundancy**
- **Seamless migration to next-generation communications with service provisioning and end-to-end path management**
- **MEF Carrier Ethernet 2.0-certified with traffic management, performance monitoring and Ethernet OAM**
- **Non-blocking cross connect for a high volume of DS0 channels**
- **Built-in support for distance and differential Teleprotection for power utility applications**
- **Omnibus for teleconferencing**
- **Integral xDSL modems and Optimux for subscriber and main link connections**

• M

Megaplex-2100, Megaplex-2104

Multiservice Access Multiplexers

The Megaplex-2100 and Megaplex-2104 are designed to groom, aggregate and transport multiple broadband and narrowband data and voice services over copper, DSL, fiber, wireless, or satellite circuits – all in a single-box solution. They are especially suitable for use as economical, compact remote multiservice nodes for utilities and transportation. In addition, the Megaplex-2100 and Megaplex-2104 are ideal for small to mid-size business entities, providing mixed data and voice services for both business and residential customers. They 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.

- **Multiple E1/T1 links, IP main link with TDMoIP support**
- **Delivers PSTN, ISDN and data services via:**
  - **Multiple analog and compressed voice channels (FXS, FXO, E&M)**
  - **Low speed data (V.24/RS-232, n x 64 kbps, G.703)**
- **RFER – Resilient Fast Ethernet Ring or E1/T1 ring protection**
- **Multiple alternative routing schemes in the event of trunk failure**
- **IEEE C37.94 interface for Teleprotection**
- **Omnibus for teleconferencing**
- **Integral xDSL modems for subscriber and main link connections**

AXCESS+

MiNID

Ethernet Demarcation SFP Sleeve

Hot Product

MiNID is a fully functional two-port network interface device (NID), housed in a smart SFP sleeve enclosure. Easily pluggable into SFP ports of switches and routers, it offers Carrier Ethernet demarcation and SLA assurance functionalities for remote service monitoring and fault isolation. Part of RAD's Service Assured Access solution, the MiNID handles up to 1 Gbps of Ethernet user traffic with per-port and per-flow OAM capabilities, as well as with performance monitoring counters, while providing remote end-to-end service control.

MiNID eliminates the need for standalone demarcation devices, while allowing service providers, mobile operators and wholesale carriers to receive real-time network/service performance reports with per-CoS SLA definition. Extremely easy to install and maintain, it does not require dedicated training and delivers substantial OpEx savings by lowering power consumption, space and installation costs.

- **Provides instant upgrade for legacy switches and routers to enable MEF Carrier Ethernet 2.0 services with SLA assurance**
- **Seamlessly hosts standard FE and GbE SFP modules**
- **Zero-touch provisioning for fast and simple installation**
- **Ethernet OAM, performance monitoring and RFC-2544 capabilities; L2/L3 diagnostic loopbacks**
- **Managed as a standalone device via CLI and Web interfaces, or integrated into host equipment's management**

EtherAccess

MiRICi-155

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

RAD's smart SFP MiRICi-155 connects Gigabit Ethernet LANs over wireline or wireless STM-1 or OC-3 links. The miniature Ethernet over STM-1/OC-3 converter provides TDM connectivity to any Ethernet device with an SFP (small form-factor pluggable) compatible, GbE port. Hot-swappable and software-configurable, the intelligent SFP converter is a fully managed device supporting standard GFP encapsulation. It delivers a complete Ethernet over SDH/SONET solution in a finger-sized SFP enclosure and enables a quick rollout of new Ethernet services over legacy TDM infrastructure. The MiRICi-155 is part of RAD's "System on an SFP" product line.

- **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 I²C**
- **Supports full duplex flow control**
- **Fault propagation from WAN to LAN link**

EtherAccess

MiRICi-E1/T1, MiRICi-E3/T3

Smart SFP Ethernet to E1/T1 or E3/T3 Remote Bridges

RAD's MiRICi-E1/T1 and MiRICi-E3/T3 connect Fast Ethernet or Gigabit Ethernet LANs over framed or unframed E1 or T1 circuits, or over framed T3 links. The smart SFP miniature remote bridges provide TDM connectivity to any Ethernet device with an SFP (small form-factor pluggable) compatible, Fast Ethernet or GbE port. Hot-swappable and software-configurable, the intelligent SFPs are fully managed devices supporting standard GFP encapsulation, as well as HDLC and cHDLC. They deliver a complete Ethernet over PDH solution in finger-sized SFP enclosures and enable a quick rollout of new Ethernet services over legacy TDM infrastructure. The MiRICi-E1/T1 and MiRICi-E3/T3 are part of RAD's "System on an SFP" product line, providing 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.

- **Supports framed and unframed E1/T1, E3/T3 link**
- **Supports standard GFP, HDLC-like, and cHDLC encapsulation**
- **Hot-insertion SFP-format plug, MSA-compliant**
- **User-configurable**
- **Enhanced management of control, status and monitoring**
- **Out-of-band management through I²C**
- **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)**

EtherAccess

• M/O

MiTOP-E1/T1, MiTOP-E3/T3

Smart SFP-Format TDM Pseudowire Gateways

RAD's MiTOP-E1/T1 and MiTOP-E3/T3 transport framed or unframed E1/T1 or E3/T3 traffic, respectively, over Ethernet, IP and MPLS networks. Featuring multi-standard pseudowire support and Synchronous Ethernet (Sync-E) in a finger-sized enclosure, the smart SFP devices provide an ideal solution for service providers, utility companies and enterprises wishing to ensure highly accurate timing synchronization for their legacy services while migrating to packet switched transport.

Part of RAD's "System on an SFP" portfolio, the MiTOP-E1/T1 and MiTOP-E3/T3 are designed for quick and simple insertion into any Fast Ethernet or Gigabit Ethernet port with an MSA-compatible socket.

- **Transmits TDM-based services over Ethernet, IP or MPLS networks**
- **Standard pseudowire encapsulation: CESoPSN, SAToP**
- **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)**

AXCESS+

EtherAccess

Optimux-45, Optimux-45L

Multiplexers for 21E1/28T1 over Fiber or T3

Optimux-45 and Optimux-45L are managed multiplexers transporting multiple E1 and T1 links, as well as a combination of E1 and T1 (according to ITU G.747), over a standard T3 or fiber link. They provide flexible solutions to meet the specific requirements of a broad range of applications and topologies, including campus ring, drop-and-insert for cellular backhaul, point-to-point over wireless links, and point-to-point over SDH/SONET. In addition, the Optimux-45 can serve as a cost-effective alternative to high speed ADMs or large DACs.

- **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**
- **Self-healing ring capabilities**
- **Range up to 110 km (68 miles)**
- **Optional redundant power supply and uplink interface**
- **Full management support for fault, configuration, performance, and security via RADview – RAD's network management system**

AXCESS+

Optimux-106, Optimux-108, Optimux-108L

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

The Optimux-106 and Optimux-108 fiber multiplexers deliver TDM and Fast Ethernet or serial data traffic over a fiber optic link, providing a simple, low-cost solution for point-to-point and point-to-multipoint connectivity up to 120 km (75 miles).

The Optimux-108L is an entry-level, power-saving E1 and Ethernet fiber optic multiplexer, enabling a 40% reduction in OpEx related to power consumption of network elements. Typical users include transportation and utility companies, universities and governments, Internet service providers (ISPs), and carriers extending data and voice from SDH/SONET networks or backhauling cellular traffic.

- **Up to four E1 or T1 ports and a Fast Ethernet user interface; optional V.35 user port (Optimux-106, Optimux-108)**
- **Full 100 Mbps Ethernet data rate (user)**
- **Simple plug-and-play installation**
- **Range extension up to 120 km (75 miles)**
- **Redundant uplink interfaces and power supplies (Optimux-106, Optimux-108)**
- **Card versions for the LRS-102 modem rack and for the Megaplex-4**
- **Management via ASCII terminal, Web server, Telnet or RADview**
- **Temperature-hardened enclosures**
- **Dedicated 10/100BaseT Ethernet management port or dual in-line package (DIP) switches for full or basic management capabilities (Optimux-108L)**

ACCESS+

Optimux-1025, Optimux-1032

Fiber Multiplexers for 16 E1/T1 and Gigabit Ethernet

The Optimux-1032 and Optimux-1025 provide a cost-effective solution for transparently delivering Gigabit Ethernet traffic as well as multiple E1 or T1 links, over a fiber optic link for distances up to 120 km (75 miles). The single-box solutions for fiber TDM and Ethernet connectivity offer CapEx and OpEx savings with "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.

- **Up to 16 E1 or T1 ports; up to three Gigabit Ethernet user ports**
- **Total fiber uplink capacity of 1,000 Mbps**
- **Simple plug-and-play installation**
- **Range extension up to 120 km (75 miles)**
- **Redundant hot-swappable uplink interfaces and power supplies**
- **Management via RADview, CLI, ASCII terminal, SNMPv3**
- **RADIUS, SSH**
- **Temperature-hardened enclosures**

ACCESS+

• O/P

Optimux-1551, Optimux-1553

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

The Optimux-1551 and Optimux-1553 are plug-and-play SDH/SONET terminal multiplexers, delivering multiple PDH tributary channels over a single STM-1/OC-3 (155 Mbps) link.

They combine the high capacity associated with SDH/SONET add/drop multiplexers (ADMs) with the simplicity and low cost of a terminal multiplexer to significantly reduce OpEx and CapEx. Extending point-to-point services over coax or fiber up to 80 kilometers (50 miles) to remote locations, the Optimux devices allow service providers to increase their customer reach, while avoiding the cost and complexity associated with deploying high-end ADMs. Furthermore, the Optimux-1551 and Optimux-1553 eliminate the need for deploying PDH multiplexers at customer sites, by consolidating traffic at the edge of the SDH/SONET network. This enables service providers to save the cost of fiber deployment and multiple ports on the ADM.

- **Up to 63 E1 or 84 T1 tributary channels (Optimux-1551) or three E3 or T3 user interfaces (Optimux-1553)**
- **Channelized STM-1/OC-3 main link with standard fiber optic (single mode, multimode and WDM) or coaxial interface**
- **1+1 unidirectional 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 and private networks**
- **Full management support for fault, configuration, performance, and security via RADview**
- **Range up to 80 km (50 miles)**

PacketLight

Complete Solutions for WDM/OTN and Dark Fiber Applications

PacketLight's product suite offers the flexibility to build a cost-effective, highly efficient optical network infrastructure for CWDM/DWDM, OTN and dark fiber connectivity, while addressing challenges faced by service providers and organizations.

PacketLight solutions are ideal 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 institutions.

The wide range of PacketLight xWDM and dark fiber solutions include multi-rate sub-10G CWDM/DWDM platforms, 10G CWDM/DWDM and 100G solutions with built-in OTN options, muxponders, amplification and booster solutions, WSS-based ROADMs, 10 x 1-GbE muxponders, and passive multiplexing solutions.

- **Multi-rate transponders, 2 Mbps to 100 Gbps**
- **Muxponder for high wavelength utilization; scales to 44/88 wavelengths**
- **Amplification over long distances**
- **Performance monitoring**
- **Supports single or dual fiber**
- **Low latency connectivity**
- **Hot-swappable PSU and fan**
- **Integrated management**
- **Compact 1U integrated devices**
- **Simple to install, maintain and configure**
- **Cost-effective CPE device**
- **Integrated OTN layer (with FEC)**

RADcare Global Services

Peace of Mind, Where and When You Need It

To ensure the best service for our customers and help them receive the full benefits of our products, RAD is offering a variety of service packages. These are designed to enable seamless installations and faster service rollouts. All of RAD's vital services are backed by a highly dedicated and professional team of regional support associates at internationally located Technical Assistance Centers, together with project management staff and international training professionals.

RADcare Technical Support

RAD and its Partners have coordinated resources in order to better support our customers worldwide. RADcare service packages offer four levels of tiered service plans (BasicPlus, Extended, Premium and Next Business Day), backed by trained staff in four regional support centers and covering such issues as hardware and software warranties, phone support, Next Business Day (NBD) spare parts shipment, and on-site spares inventory.

- **24 x 7 technical support**
- **Priority handling and escalation procedures**
- **Access to eSupport system for software update and software upgrade**
- **Strict SLA commitments on response, service restore and resolution times**
- **On-site spares**

RADcare Project Management

RAD's professional Project Management staff ensures that your project will have a timely and smooth implementation from the planning stage through completion. A single point of contact coordinates all project activities within RAD and employs advanced risk management techniques to identify and avoid potential conflicts before they become problems.

- **Single point of contact**
- **Project coordination**
- **Periodic meetings and progress reports**
- **Project-specific documentation**

RADcare Professional Services

RAD offers a variety of professional services, encompassing all relevant aspects of the pre-installation design and rollout stages.

RADcare Professional Services include:

- **High and low level project/ network design**
- **Priority handling and escalation procedures**
- **On-site services: Acceptance testing, site engineering, site survey, commissioning, and on-site training**

RADcare Professional Training Center

RAD's training programs are designed to keep your team up to date with the latest RAD solutions. RAD training ensures that your engineers gain the maximum benefit from the RAD solution you have implemented.

- **Regional pre-sales and technical seminars**
- **Training-on-demand**
- **Telecom technology courses**
- **Partner sales training**
- **RAD certification**

• R

RADview

Carrier-Class Network Management System

RADview is a modular network management suite for Service Assured Access, featuring a network element manager, a service manager for managing end-to-end Carrier Ethernet services, an Ethernet performance monitoring portal for ongoing monitoring of Ethernet service performance, and a service center for managing TDM services.

RADview is a multi-platform system for configuration, provisioning, monitoring, and management of networks and services. Fully compliant with the ITU-T Telecommunications Management Network (TMN) standards, the RADview management suite features advanced fault, configuration, administration, performance, security (FCAPS) capabilities. RADview uses an SNMP southbound interface, and also features third-party device monitoring capabilities. Its northbound interface enables integration into a third-party umbrella system (OSS).

- Monitors device health, optimizes network operations and minimizes mean time to repair (MTTR)
- Fully compliant with TMN standards; advanced FCAPS functionality
- Client/server architecture with multi-user support and seamless handover of user privileges
- 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
- Automated change management

RADview – Performance Monitoring

Ethernet Performance Monitoring Portal

Hot Product

RADview — Performance Monitoring module enables real-time and ongoing monitoring of Ethernet service performance by collecting KPI (key performance indicators) data from RAD devices. Part of RAD's Service Assured Access solution, it allows service providers to easily monitor and manage actual network and service performance over time and compare it to SLA (service level agreement) guarantees – a critical component of premium MEF-based carrier services to business, wholesale and mobile customers.

The RADview Performance Monitoring module enables immediate detection of service degradation, so that remedial actions are taken to quickly restore guaranteed performance levels. The system retrieves data lost due to connection failures and exports standard CSV ASCII files to OSS or third-party management systems.

- **Collects, stores and presents KPIs from RAD devices**
- **In-service bandwidth utilization measurements**
- **Actual performance metrics based on ITU-T Y.1731:**
  - **Frame delay (latency)**
  - **Frame delay variation (jitter)**
  - **Packet delivery ratio**
  - **Availability**
- **Threshold policy management**
- **Performance dashboard with aggregated and drill-down views**
- **Current and interval-based statistics reporting; scheduled report generation**
- **Immediate detection of service degradation**

RADview – Service Manager

Service Management for Ethernet Services

Hot Product

RADview – Service Manager module is part of the RADview management suite and provides end-to-end management of MEF-based Carrier Ethernet services for Service Assured Access. An intuitive GUI, "point-and-click" functionality and easy-to-follow wizards facilitate provisioning, monitoring, diagnostics and SLA assurance, so that carriers, service providers and utility network operators can add new service offerings, as well as minimize overall operating costs, reduce provisioning times and maximize the efficiency of the entire network.

- **Unified rich client application for all EMS/NMS/SM functionalities**
- **"Point-and-click" end-to-end service provisioning**
- **Automatic correlation of network faults with impacted services and customers**
- **Security management supporting user access profiles and allowing network partitioning**
- **Graphic representation of network clouds, links, nodes, end-to-end services, and network status indication**
- **Multi-platform Java-based solution supporting Windows and UNIX**
- **Standard TMF MTOSI northbound interface to third-party NMS/OSS systems**
- **GUI designed for management of very large networks**

RADview – Service Center

Path Management System for TDM

Hot Product

RADview – Service Center path management system enables end-to-end management of RAD's TDM access products, while easy-to-follow wizards facilitate provisioning and monitoring over SDH/SONET and PDH networks. Supported capabilities include automatic path routing, automatic re-routing of protected paths, physical and logical representation of the network links, and more. The system allows network operators to add new service offerings while minimizing overall operating costs, reducing provisioning times and maximizing the efficiency of the entire network.

- **"Point-and-click" provisioning from a central workstation for networks of RAD Axcess+ products**
- **Automatic periodic self-healing of faulty services**
- **Service security management, supporting user network access profiles and allowing network partitioning**
- **Service availability report**
- **Dynamic filter displays service and network link-related alarms**
- **Physical and logical graphic representation of network clouds, links, nodes, end-to-end services, and network status indication**
- **CORBA-based client-server architecture and northbound CORBA interface to umbrella systems (OSS)**
- **Windows-based client and UNIX (Solaris)-based server**

• R

RIC-155GE

Gigabit Ethernet over STM-1/OC-3 NTU

The RIC-155GE bridges Gigabit Ethernet traffic over STM-1/OC-3 access or channelized OC-3 circuits, providing carriers and service providers with a migration path for connecting future-ready IP devices with GbE interfaces into existing SDH/SONET networks at 155 Mbps access rates. 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.

- **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**

RIC-155L

Managed Gigabit Ethernet to STM-1/OC-3 Converter

RAD's RIC-155L is a managed Ethernet converter for bridging Fast Ethernet or Gigabit Ethernet and STM-1/OC-3 connections. Enabling quality of service (QoS) management for multiple traffic types, as well as monitoring and diagnostics, the RIC-155L is ideal for extending Ethernet connectivity over TDM backbones in point-to-point applications, and for cost-effective backhaul of IP DSLAM and WiMAX base station traffic over SDH/SONET access networks.

- **Two GbE user ports (UTP and SFP)**
- **A single STM-1/OC-3 network port**
- **GFP (G.7041) encapsulation**
- **VLAN-aware and VLAN-unaware bridging**
- **Four QoS levels based on Strict Priority scheduling**
- **Remote and local, inband and out-of-band management**
- **TDM to Ethernet fault propagation**
- **Ethernet jumbo frames supported**

RIC-LC

Ethernet Converter for Multiple PDH Circuits

RAD's RIC-LC is a Fast Ethernet over E1 converter that provides simple, efficient and cost-effective Ethernet connectivity over up to 16 bonded E1 links. As an Ethernet converter for multiple PDH circuits, the RIC-LC enables service providers to supply high capacity Ethernet services to remote locations over existing TDM infrastructure. Deployed in point-to-point or hub-and-spoke topologies, it operates opposite Ethernet over TDM demarcation devices and aggregators, such as RAD's RICi-16, Egate-100 and Egate-2000, as well as opposite third-party gateways that support Ethernet over NG-PDH encapsulation and bonding techniques.

The RIC-LC is an ideal solution for Ethernet Private Line and Ethernet Private LAN services, inter-office connectivity, and IP DSLAM, IP Node B and WiMAX base station backhaul over PDH access networks.

- **One, four, eight, or 16 E1 network interfaces**
- **Four Fast Ethernet UTP/SFP user ports**
- **GFP (G.8040), VCAT (G.7043), LCAS (G.7042)**
- **VLAN-aware and VLAN-unaware bridging; VLAN stacking**
- **Four QoS levels; SP and WFQ scheduling; CIR (committed information rate) support**
- **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**

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

Ethernet over Four or Eight E1 or T1 NTUs

RAD's RICi-4E1, RICi-4T1, RICi-8E1 and RICi-8T1 deliver mid-band and Fast Ethernet services over up to eight bonded E1 or T1 circuits. Employing various standard bonding technologies to create a scalable, virtual channel from individual E1 or T1 circuits, these devices improve overall network availability by reducing latency and optimizing line utilization and throughput. RAD's RICi NTUs support a large variety of applications, including transparent inter-LAN connectivity, direct Internet access and Ethernet Private Line, as well as IP DSLAM and WiMAX base station backhaul.

The devices are deployed in point-to-point or hub-and-spoke topologies, providing a cost-effective, high performance solution for mid-band and Fast Ethernet services over legacy PDH/SDH/SONET backbones.

- **Four or eight E1/T1 ports**
- **Up to four 10/100BaseT user ports**
- **Circuit bonding using MLPPP**
- **Metro Ethernet Forum certified for MEF-9 EPL services**
- **Four QoS levels according to VLAN priority (802.1p), DSCP, and per port priority schemes, per application requirements**
- **Ethernet OAM per 802.1ag and performance monitoring per ITU Y.1731 for end-to-end SLA control**
- **Secure Telnet and Web applications; SNMP and RADIUS**

CARRIER ETHERNET MEF Certified Compliant

EtherAccess

• R

RICi-16
Ethernet over Bonded PDH NTU

The RICi-16 connects Fast Ethernet LANs over multiple bonded PDH links, enabling service providers to extend high capacity Ethernet-based services to remote locations. It is also ideal for backhauling Ethernet traffic from IP Node Bs, IP DSLAMs and WiMAX base stations over copper-based or microwave PDH connections. Employing standard Ethernet over NG-PDH technology, the RICi-16 improves overall network availability by reducing latency and optimizing line utilization and throughput.

The RICi-16 is MEF-certified for Ethernet Private Line and Ethernet Virtual Private Line services. It is equipped with advanced Ethernet SLA capabilities for handling multi-priority traffic, ensuring latency, jitter and packet delivery performance on a per-flow basis. The RICi-16 features a "pay-as-you-grow" license model, allowing the addition of E1/T1 links according to evolving bandwidth requirements.

- **Up to 16 E1/T1 ports; two bonded clear channel T3 ports or a single channelized T3 port**
- **Up to four 10/100BaseT user ports**
- **Circuit bonding using standard GFP, VCAT and LCAS with multi-VCG support**
- **Metro Ethernet Forum certified (MEF-9, MEF-14) for EPL, EVPL services**
- **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**

CARRIER ETHERNET MEF Certified Compliant

EtherAccess

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 framed or unframed E1/T1 or E3/T3 circuits.

The devices are deployed in point-to-point or hub-and-spoke topologies, working opposite RAD's RICi-16, Egate-100, and Egate-2000 Ethernet over TDM gateways. This enables carriers and service providers to extend their customer reach and utilize legacy PDH infrastructure in delivering new Ethernet services. Typical applications include Ethernet access, backhauling network management traffic and connecting inter-office or enterprise LAN segments.

- **10/100BaseT user port**
- **Single E1, T1, E3, or T3 network port**
- **PDH to Ethernet fault propagation and TDM loop detection**
- **Interoperable with third-party devices:**
  - **RICi-E1/T1 supports standard GFP (ITU-T G8040) and HDLC**
  - **RICi-E3/T3 supports X.86 (LAPS)**
- **QoS priority queues**
- **Plug-and-play functionality using DHCP client**
- **Remote diagnostic tools on TDM and Ethernet ports**
- **Managed via SNMP, Web server or Telnet**

CARRIER ETHERNET MEF Certified Compliant

EtherAccess

ROC-19/19L
Outdoor Cabinet

ROC-19/19L is a self-contained outdoor cabinet for housing a single 19"-wide RAD unit and a cabling system for various telecom services. Constructed for outdoor use, the enclosure is powered from a DC power source and is ideal for service providers that require efficient environmental isolation for their equipment.

The ruggedized IP56 (ROC-19) and IP66 (ROC-19L) NEMA-4-rated construction includes a rain hood, offering full shielding and protection against dust, rain and ice. Efficient ventilation is assured by an intake fan with replaceable air filters (ROC-19) or passive convection (ROC-19L). Secure, efficient maintenance and access are offered by a 2-point (ROC-19L) or 3-point (ROC-19) door locking mechanism, as well as an integrated fiber cable splicer/guide system, intrusion detection and over-current protection.

- **Outdoor cabinet for one 19"-wide RAD unit, with integrated fiber splicer and guides**
- **IP56-66/NEMA-4-rated metal enclosure**
- **24 VDC- or 48 VDC-powered**
- **Effective grounding and over-current protection**
- **2- or 3-point door locking**
- **Intake fan with replaceable filters, or passive cooling**
- **Wall or pole mounting options**

SecFlow-1
Ruggedized SCADA-Aware Gateway

Hot Product

The compact SecFlow-1 is a ruggedized, multiservice SCADA-aware gateway for remote sites, connecting serial and Ethernet devices with built-in security mechanisms designed specifically for SCADA applications. It combines functionalities that typically require separate devices and provides an efficient distributed security layer protecting from insider attacks. Dual built-in cellular modems are used to provide network access to remote sites where fiber isn't available, or for main fiber link redundancy. These modems also allow users to utilize widely available public cellular networks for inter-site connectivity, while eliminating security threats with integrated L2/L3 VPN and IPsec.

The SecFlow-1 is ideal for utility companies and critical infrastructure organizations requiring distributed security, such as Smart Grid and intelligent transportation operators, water and gas utilities, as well as public safety and homeland security agencies.

- **Multi-functional, compact and ruggedized system**
- **Designed for harsh environments**
- **IEC-101, IEC-104, Modbus and DNP3 protocol support**
- **FE and GbE ports**
- **Serial interfaces with protocol gateway and tunneling**
- **Dual integrated 2G/3G cellular modems**
- **Integrated application-aware firewall for SCADA protocols**
- **L2/L3 VPN agent with IPsec**

• S

SecFlow-2

Ruggedized SCADA-Aware Ethernet Switch/Router

Hot Product

The compact SecFlow-2 is a ruggedized Ethernet switch/router with built-in security mechanisms designed specifically for SCADA applications. It combines functionalities that typically require separate devices and provides an efficient distributed security layer protecting from insider attacks. The device monitors SCADA commands using deep packet inspection to validate their fit with the application logic for specific functions. This compact switch/router further integrates multiservice functionalities, such as cellular and SHDSL modems, to provide network access to remote sites, as well as serial interface connectivity of legacy user devices.

The SecFlow-2 ruggedized SCADA-aware Ethernet switch/router is ideal for utility companies and critical infrastructure organizations requiring distributed security, such as Smart Grid and intelligent transportation operators, water and gas utilities, as well as public safety and homeland security agencies.

- **Multi-functional, compact and ruggedized system**
- **Designed for harsh environments**
- **Advanced Ethernet and IP feature-set**
- **Ethernet interfaces with optional PoE support**
- **Serial interfaces with protocol gateway and tunneling**
- **Integrated 2G/3G cellular and SHDSL modems**
- **Integrated application-aware firewall for SCADA protocols**
- **Integrated L2/L3 VPN agent**

SecFlow-4

Modular Ruggedized SCADA-Aware Ethernet Switch/Router

Hot Product

The SecFlow-4 is a high density, modular system with built-in security mechanisms designed specifically for SCADA applications. It combines functionalities that typically require separate devices and provides an efficient distributed security layer protecting from insider attacks. The device monitors SCADA commands using deep packet inspection to validate their fit with the application logic for specific functions. This ruggedized, modular switch/router provides a flexible platform with a combination of fiber and copper Ethernet ports, as well as serial interfaces for legacy devices.

The SecFlow-4 modular ruggedized SCADA-aware Ethernet switch/router is ideal for utility companies and critical infrastructure organizations requiring distributed security, such as Smart Grid and intelligent transportation operators, water and gas utilities, as well as public safety and homeland security agencies.

- **High density, modular and ruggedized system**
- **Designed for harsh environments**
- **Advanced Ethernet and IP feature-set**
- **Ethernet interfaces with optional PoE support**
- **Serial interfaces with protocol gateway and tunneling**
- **Integrated application-aware firewall for SCADA protocols**
- **Integrated L2/L3 VPN agent**

SFP-ER

Miniature Ethernet over Copper Range Extension Device

SFP-ER is an SFP Ethernet over copper extender that improves bandwidth capacity and service reach over existing copper lines. By enabling delivery of 100 Mbps beyond copper lines' distance limit of 100m (328 ft), it allows service providers and private network operators to deliver Ethernet connectivity without costly fiber installations from the POP, street cabinet, building basement, or campus communications to the customer premises or service end-points. Housed in a small form-factor pluggable (SFP) enclosure, the SFP-ER is designed for quick and simple insertion into any Fast Ethernet port with an MSA-compatible socket.

- **Point-to-point Ethernet connectivity with rates up to 100 Mbps**
- **Extends the distance limit for Ethernet connectivity over Cat5 or twisted pairs to up to 550m (1,804 ft)**
- **Full duplex transmission over 2-wire, 4-wire, or 8-wire copper lines**
- **Small form factor**
- **Pluggable into any Ethernet switch with MSA-compatible 100BaseFX ports or SGMII GE (for maximum data rates of 100 Mbps)**

SFP/XFP Transceivers

Small Form-Factor Pluggable Transceivers

RAD's SFP/XFP (small form-factor pluggable) transceivers are hot-swappable, input/output transceiver units converting optical and electrical media. Providing a wide range of detachable interfaces to multimode/single-mode optic fibers and UTP/coaxial electrical cables, RAD's miniature transceiver units enable significant savings in system maintenance and upgrade costs, as well as facilitate efficient design of host devices and flexible network planning.

It is strongly recommended to order RAD devices with original RAD SFPs/XFPs installed, to ensure that the entire assembled unit has undergone comprehensive functional quality tests. RAD cannot guarantee full compliance to product specifications for units using non-RAD SFPs/XFPs.

- **MSA (multi-source agreement) compliant**
- **Built-in DDM (digital diagnostic monitoring) function**
- **64 to 2016-byte frames, including VLAN-tagged frames**
- **LOS (loss of signal) fault propagation**
- **Flow control mechanism**

•S

SPH-16
SFP Patch Hub

The SPH-16 is a managed SFP patch hub that connects up to 16 Fast Ethernet (100 Mbps) and Gigabit Ethernet (1000 Mbps) copper sockets (RJ-45) to any standard SFP device. Compatible with any standard Ethernet switch featuring RJ-45 connectors, it can act as a multi-port media converter enabling carriers to maintain a unified service over fiber and copper infrastructure. The SPH-16 houses RAD's special "System on an SFP" devices, including the MiRICi-E1/T1 and MiRICi-E3/T3 miniature Ethernet over TDM remote bridges, as well as the MiTOP-E1/T1 and MiTOP-E3/T3 SFP-format TDM pseudowire gateways.

- **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**

S-RPT, S-RPT/4W
SHDSL/SHDSL.bis Repeaters

RAD's S-RPT and S-RPT/4W extend the transmission distance of SHDSL or SHDSL.bis modems operating on 2-wire or 4-wire lines, respectively. Employing TC-PAM 16/ TC-PAM 32 technology, these SHDSL repeaters can double the transmission distances. Typical applications include DSL links alongside highways, railways, pipelines, power lines, and waterways, as well as DSL transport to remote concentrators in rural or remote areas, and communication lines to military, construction or temporary field camps and sites.

Installed between two SHDSL modems, the S-RPT and S-RPT/4W regenerate the received modem signal faultlessly. Multiple repeaters can be used, without introducing jitter or wander problems.

- **Ethernet in the First Mile (EFM) bonding**
- **Based on the SHDSL standard for higher speeds and longer loop ranges**
- **Locally or remotely powered**
- **Available as a desktop unit or in IP67 casing for installation in communication ducts**
- **Fully manageable via EoC link**
- **High quality, high performance**

Glossary

For the complete glossary see www.rad.com

A

Access Ethernet Private Line: Access Ethernet Private Line (EPL) service uses a point-to-point OVC to associate one OVC end point at a UNI and one OVC end point at an ENNI. One UNI can support only a single instance of the Access EPL service.

Access Ethernet Virtual Private Line: Access Ethernet Virtual Private Line (EVPL) service uses a point-to-point OVC to associate one OVC end point at a UNI and one OVC end point at an ENNI. One UNI can support one or more Access EVPL instances.

Access Provider: An operator MEN that offers the Ethernet access service type

Alarm Indication Signal (AIS): A signal transmitted by an intermediate network element along a transport circuit to alert the receiving end of the circuit of a fault

All-to-One Bundling: A UNI attribute in which all CE-VLAN IDs are associated with a single EVC

Availability: A measure of the percentage of time that a service is useable

B

Bandwidth Profile: An Ethernet service characteristic that specifies the committed and excess bandwidth that may be consumed by a service at a reference point (e.g., a UNI)

Bandwidth Profile per CoS ID: A bandwidth profile applied on a per-class of service identifier basis

Bandwidth Profile per EVC: A bandwidth profile applied on a per-EVC basis

Best-Effort: A QoS class in which no specific traffic parameters and no delivery guarantees are provided

C

Carrier Ethernet: Carrier Ethernet is a ubiquitous, standardized, carrier-class service and network defined by five attributes that distinguish Carrier Ethernet from familiar LAN-based Ethernet. These are: Standardized services, scalability, reliability, quality of service and service management.

CCM (Continuity Check Message): CCM provides a means to detect connectivity failures in an MEG. CCM messages are transmitted periodically and do not require a response.

CE: Customer Edge, Customer Equipment

CEN: Carrier Ethernet Network (used interchangeably with Metro Ethernet Network, MEN)

CESoETH: Circuit Emulation Services over Ethernet

CE-VLAN CoS (Customer Edge VLAN CoS): The code point bits in the IEEE 802.1Q tag in a service frame that is either tagged or priority tagged

CE-VLAN CoS Preservation: An EVC attribute in which the CE-VLAN CoS of an egress service frame is identical in value to the CE-VLAN CoS of the corresponding ingress service frame

CE-VLAN ID/EVC Map: An association of CE-VLAN IDs with EVCs at a UNI

CE-VLAN ID Preservation: An EVC attribute in which the CE-VLAN ID of an egress service frame is identical in value to the CE-VLAN ID of the corresponding ingress service frame

CE-VLAN Tag (Customer Edge VLAN TAG): The IEEE 802.1Q Customer VLAN Tag in a tagged service frame

CFM: Connectivity Fault Management. See IEEE 802.1ag.

Circuit Emulation Service (CES): A service that transports TDM-based traffic over a packet-based network

Class of Service (CoS): A set of service frames that have a commitment from the service povider to receive a particular level of performance

Class of Service Identifier (CoS ID): An indicator for a particular CoS instance. The mechanism and/or values of the parameters in the mechanism to be used to identify the CoS name that applies to the frame

CLE: Customer Located Equipment

Color-Aware: A bandwidth profile property where a predetermined level of bandwidth profile compliance for each service or ENNI frame, indicated by the color identifier, is taken into account when determining the level of compliance for each service or ENNI frame

Color-Blind: A bandwidth profile property where a predetermined level of bandwidth profile compliance for each E1 frame, if present, is ignored when determining the level of compliance for each E1 frame

Color ID (Color Identifier): The mechanism and/or values of the parameters in the mechanism used to identify the color that applies to the frame at a given interface

Color Identifier for Service Frame: The mechanism and/or values of the parameters in the mechanism used to identify the color that applies to the frame at a given UNI. A particular color ID value may indicate color instance of green or yellow for a service frame. PCP and DSCP may indicate both CoS name and color. Information derivable from a) a set of one or more C-tag PCP values or b) a set of one or more DSCP values.

Color Mode (CM): CM is a bandwidth profile parameter. The Color Mode parameter indicates whether the color-aware or color-blind property is employed by the bandwidth profile. It takes a value of color-blind or color-aware only

Committed Burst Size (CBS): CBS is a bandwidth profile parameter. It limits the maximum number of bytes available for a burst of service or ENNI frames sent at the E1 speed to remain CIR conformant.

Committed Information Rate (CIR): CIR is a bandwidth profile parameter. It defines the long-term average rate in bits per second of service or ENNI frames up to which the network delivers service or ENNI frames and meets the performance objectives defined by the CoS service attribute.

Control House: A substation facility that contains control panels, batteries, battery chargers, supervisory control, power-line carrier, meters, and relays

Coupling Flag (CF): A bandwidth profile parameter that allows choice between two modes of operation of the Bandwidth profile algorithm. It takes a value of 0 or 1 only.

CPE (Customer Premises Equipment): A network element located at and owned by the end customer

Cross Connect: A network device that demultiplexes, switches and remultiplexes signals. Low-order cross connects may switch individual voice channels or E1/T1 lines, while high-order cross connects may switch high speed optical signals.

CSP: Communication Service Provider

C-Tag: Customer (Subscriber) VLAN Tag

C-Tag Frames: IEEE 802.1ad 1Q Ethernet Frames with one tag

Customer Edge (CE): Equipment on the subscriber side of the UNI

Customer Edge VLAN CoS: The priority code point bits in the IEEE 802.1Q customer VLAN tag in a service frame that is either tagged or priority tagged

Customer Edge VLAN ID: The IEEE 802.1Q Customer VLAN tag in a tagged service frame. The identifier derivable from the content of a service frame that allows the service frame to be associated with an EVC at the UNI

C-VLAN (Customer VLAN): A VLAN tag used by the end customer to distinguish internal services

D

DA: Destination Address

Data Service Frame: An Ethernet frame transmitted across the UNI toward the service provider or an Ethernet frame transmitted across the UNI toward the subscriber. A service frame can have unicast, multicast, or broadcast DA.

DEI: Discard/Drop Eligibility Indicator

Differential Protection: A mechanism that disconnects faulty line segments when differential current measurements on both ends of the protection zone are higher than a set point

Distance Protection: A mechanism that trips breakers when impedance measurements vary from those taken under normal conditions

Distributed Grandmaster: A technology developed by RAD for bringing the PTP distribution functionality closer to base stations, obviating the need for full 1588 network upgrades and/or the deployment of GPS receivers in every cell site

Distribution Substation: An electric substation located near end-users. Distribution substation transformers change the subtransmission voltage to lower levels for use by end-users.

Distribution Transformers: Reduce the voltage of the primary circuit to the voltage required by customers.

DM: Delay Measurement

DMM: Delay Measurement Message

DMR: Delay Measurement Response

DNP3 (Distributed Network Protocol): A set of communications protocols used between components in process automation systems. Its main use is in utilities such as electric and water companies.

Double-Tagged Frames: IEEE 802.1ad Ethernet frames with two tags. The outer tag is an S-tag, the inner tag is a C-tag.

Down-MEP: An MEP in an IEEE 802.1 compliant bridge that sends frames away from the bridge relay entity

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

DSCP: Differentiated Services (Diff-Serv) Code Point

DSO (Distribution System Operator): A utility handling the distribution of energy for a part of a country or a region generally on a medium voltage (MV) electric line below 220 kV. DSOs interconnect to TSOs and small power producers. A DSO can also be a power producer.

Dual-Ended: A type of process where an MEP sends measurement information to a peer MEP that will perform the calculations

Dual Rate Bandwidth Profile: A bandwidth profile that specifies both CIR/CBS and EIR/EBS

E

E1: A 2.048 Mbps signal that supports thirty-two 64 kbps timeslots, at least 30 of which can transmit and receive data or digitized voice. The most common configurations for E1 lines are E1 PRI, and unchannelized E1.

E-Access: Ethernet service types that use an OVC with at least one UNI OVC end point and one ENNI OVC end point

EFM (Ethernet in the First Mile): A now disbanded task force that standardized 1) Ethernet DSL physical layers, 2) Ethernet inverse multiplexing (bonding), 3) new point-to-point Ethernet optical physical layers, 4) EPON, and 5) link layer OAM.

Egress Frame: A frame sent from the service provider network to the CE

E-LAN: An MEF Ethernet service type distinguished by its use of a multipoint-to-multipoint EVC

Electrical Grid: An integrated system of electricity distribution, usually covering a large area

Electric Utility: An organization responsible for the installation, operation, or maintenance of an electric supply system

E-Line: An MEF Ethernet service type distinguished by its use of a point-to-point EVC

EMS: Element Management System

End Point Map: A mapping of specified S-tag VLAN ID values to specified OVC end point Identifiers

End Point Map Bundling: When multiple S-VLAN ID values map to a single OVC end point in the end point map, and the OVC associating that OVC end point is not a rooted-multipoint OVC

E-NNI/ENNI (External Network-to-Network Interface): A reference point representing the boundary between two operator MENs that are operated as separate administrative domains

ENNI Frame: The first bit of the destination address to the last bit of the frame check sequence of the Ethernet frame transmitted across the ENNI

ENNI MTU: MTU of an ENNI frame at the ENNI

ENNI-N: ENNI network functional element

EPL: Ethernet Private Line

EP-LAN: Ethernet Private LAN

EP-Tree: Ethernet Private Tree

ETH-AIS: Ethernet Alarm Indication Signal

ETH-CC: Ethernet Continuity Check function

ETH-DM: Ethernet frame Delay Measurement function

Ethernet Access Provider: Operator of the MEN providing the OVC-based Ethernet service between a UNI and an ENNI

Ethernet Frame: A data frame on a wire from preamble to FCS

Ethernet LAN Service: An Ethernet service type distinguished by its use of a multipoint-to-multipoint EVC

Ethernet Line Service: An Ethernet service type distinguished by its use of a point-to-point EVC

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/SONET: Although SDH networks were originally engineered to transport voice traffic, many carriers are using their ubiquitous SDH/SONET infrastructure to deploy Ethernet services.

Ethernet Virtual Connection (EVC): An association of two or more UNIs that limit the exchange of frames to UNIs in the Ethernet Virtual Connection

EtherType: Ethernet Length/Type

ETH-LB: Ethernet Loopback function

ETH-LCK: Ethernet Lock signal function

ETH-LM: Ethernet Frame Loss Measurement function

ETH-LT: Ethernet Link Trace function

ETH-RDI: Ethernet Remote Defect Indication function

ETH-SLM: Ethernet Synthetic Loss Measurement function

ETH-Test: Ethernet Test function

E-Tree: An MEF Ethernet Tree (E-Tree) service type is any Ethernet service that is based on a rooted-multipoint Ethernet virtual connection (EVC)

EVC ID: The identifier for an EVC

EVC-MA: Ethernet Virtual Connection Maintenance Association

EVC Maximum Transmission Unit Size: The maximum size service frame allowed for an EVC

EVPL: Ethernet Virtual Private Line

EVP-LAN: Ethernet Virtual Private LAN

EVP-Tree: Ethernet Virtual Private Tree

Excess Burst Size (EBS): A bandwidth profile parameter. It limits the maximum number of bytes available for a burst of frames sent at E1 speed to remain EIR-conformant.

Excess Information Rate (EIR): A bandwidth profile parameter. It defines the long-term average rate in bits per second of frames up to which the network may deliver frames but without any performance objectives

F

FCS: Frame Check Sequence

FD: Frame Delay

FDR (Frame Delay Range): The difference between the observed percentile of delay at a target percentile and the observed minimum delay for the set of frames in time interval T

FDV: Frame Delay Variation

FDX: Full Duplex

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.

FLR: Frame Loss Ratio

FM: Fault Management

Frame Delay: The time required to transmit a service or ENNI frame from ingress E1 to egress E1

Frame Delay Range: The difference between the observed percentile of delay at a target percentile and the observed minimum delay for the set of frames in time interval T

Frame Delay Variation: The difference in delay of two service frames

G

G.8031: An ITU standard defining Ethernet Linear Protection Switching

G.8032: An ITU standard defining Ethernet Ring Protection Switching

GARP: Generic Attribute Registration Protocol

GbE: Gigabit 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.

GIWF (Generic Inter-Working Function): Provides functionality that allows CE devices with a non-Ethernet I/F to send traffic over an Ethernet UNI

GRE (Generic Routing Encapsulations): A protocol that encapsulates other protocols in order to route them over IP networks

Grooming: The process of aggregating channels in order to transmit the aggregate over a physical link

H

HDX: Half Duplex

High Voltage Circuit Switching: An operation in which a circuit breaker and disconnector de-energize a line (circuit breaker action) and thereby redirect the electricity flow

I

IA: Implementation Agreement

IEC (The International Electrotechnical Commission): An international non-profit, non-governmental standards organization that deals in power generation, transmission and distribution

IEC 60870-5-101 (IEC 101): An IEC standard for telecontrol, Teleprotection, and associated telecommunications, using serial transmission

IEC 60870-5-104 (IEC 104): An IEC standard for for telecontrol, Teleprotection, and associated telecommunications, using TCP/IP

IEC-61850: A IEC standard for electrical substation automation

IEEE: Institute of Electrical and Electronics Engineers

IEEE 1588: The IEEE precision time protocol (PTP) for frequency and Time Of Day distribution over packet switched networks

IEEE 802.1ag: IEEE standard for Ethernet connectivity fault management (CFM) OAM. 802.1ag may be used for testing liveliness of any Ethernet connection, whether a single link or end-to-end. See also Y.1731.

IEEE 802.3ah: See EFM (Ethernet in the First Mile).

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.

IETF: Internet Engineering Task Force

IFDV: Inter-Frame Delay Variation

Ingress: The direction from the CE into the service provider network

Ingress Frame: A Frame sent from an E1 into the service provider network

Intelligent Electronic Device (IED): Intelligent controllers of power system equipment, such as circuit breakers, transformers, and capacitor banks. IEDs receive data from sensors, and may issue commands (such as tripping circuit breakers) if they sense voltage, current, or frequency anomalies.

IP (Internet Protocol): IPv4 is for version 4 (RFC 791) and IPv6 is for version 6 (RFC 2460)

IPSec: Internet Protocol Security

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.

ITU-T: International Telecommunication Union – Telecommunication standardization sector

IWF: Inter-Working Function

L

L2: Layer 2

L2CP: Layer 2 Control Protocol

L2CP Tunneling: The process by which a frame containing a Layer 2 control protocol is transferred between external interfaces

LACP: Link Aggregation Control Protocol

LAG: Link Aggregation Group

LAN: Local Area Network

LB: Loopback. See Two-way OAM.

LBM: Loopback Message

LBR: Loopback Reply

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.

LCK (Lock): An OAM message transmitted by a MEP to indicate intentional administrative or diagnostic actions

Link OAM: OAM confined to a single communications link (e.g., Ethernet link OAM per clause 57 of IEEE 802.3)

Link Protection Mechanism: Any mechanism (e.g., LAG) used to protect traffic in the event of link failure across multiple communications links

LM: Loss Measurement

LMM: Loss Measurement Message

LMR: Loss Measurement Reply

LOF: Loss of Frame alignment

LOS: Loss of Signal

LTM: Link Trace Message

LTR: Link Trace Reply

M

MA: Maintenance Association

MAC: Media Access Control

Maintenance Association: IEEE 802.1ag defines Maintenance Association as a set of MEPs, each configured with the same MAID and MD level, established to verify the integrity of a single service instance. This term is equivalent to a maintenance entity group, or MEG, as defined by ITU-T Y.1731.

Maintenance Domain: The network or the part of the network for which faults in connectivity can be managed

Maintenance Domain Intermediate Point: Maintenance Domain Intermediate Point or equivalently MEG Intermediate Point defined by ITU-T Y.1731. A SOAM entity consisting of two MHFs

Maintenance Entity: A point-to-point relationship between two MEPs within a single MA. This term is equivalent to a Maintenance Entity, or ME, as defined by ITU-T Y.1731.

MD: Maintenance Domain

ME: Maintenance Entity

Mean Frame Delay: The arithmetic mean, or average of delays experienced by service or ENNI frames belonging to the same CoS frame set

Mean Time To Restore: The mean time from when a service is unavailable to the time it becomes available again

MEF: Metro Ethernet Forum

MEG: Maintenance Entity Group (equivalent to a MA)

MEN: A Metro Ethernet Network comprising a single administrative domain

MEP: Maintenance Association End Point

MFD: Mean Frame Delay

MIB: Management Information Base

Microwave: Radio waves with frequencies between 300 MHz and 300 GHz. Electric substations and cellular basestations commonly use microwave communications.

MIP: Maintenance Domain Intermediate Point

Modbus: A serial communications protocol allowing for communication between many (approximately 240) devices connected to the same network

MTTR: Mean Time To Restore

MTU (Maximum Transfer Unit): The size in bytes of the largest packet that can traverse a network or segment

Multicast Service Frame: A service frame that has a multicast destination MAC address

Multipoint-to-Multipoint EVC: An EVC with two or more UNIs

N

NERC (North American Electric Reliability Corporation): A nonprofit corporation based in Atlanta, Georgia. Formed by the electric utility industry to promote the reliability and adequacy of bulk power transmission in the electric utility systems of North America.

NERC-CIP: The NERC CIP (Critical Infrastructure Protection) plan is a set of requirements designed to secure the assets required for operating North America's bulk electric system.

NFV (Network Functions Virtualization): An emerging networking technology in which functionality conventionally carried out in dedicated network elements is performed in software hosted on computer hardware or virtual machines

NID (Network Interface Device): An element that forms the demarcation between two network domains. Typically a NID provides OAM and traffic condition functionalities.

NMS: Network Management System

NNI: Network to Network Interface

O

OAM: Operations, Administration and Maintenance

On-Demand: OAM actions that are initiated via manual intervention for a limited time to carry out diagnostics. On-Demand OAM can result in singular or periodic OAM actions during the diagnostic time interval.

One-Way OAM: An OAM exchange consisting of sending an OAM packet to a remote device for processing. One-way OAM may be used to measure packet loss and one-way delay (the latter when the two ends share a common clock).

Operator Virtual Connection: An association of OVC end points

OSS: Operations Support System

OVC: Operator Virtual Connection

P

P2P: Point-to-Point

PCP: Priority Code Point

Performance Monitoring: Performance Monitoring involves the collection of data concerning the performance of the network.

PM: Performance Monitoring

PM Session: The application of a given PM function between a given pair of MEPs and using a given CoS frame set over some (possibly indefinite) period of time

Point-to-Point EVC: An EVC with exactly 2 UNIs

Power Line Carrier: A device for producing radio-frequency power for transmission on power lines

Power Transformer: A device for raising or lowering voltage as needed to serve the transmission or distribution circuits

Proactive OAM: OAM actions that are carried on continuously to permit timely reporting of fault and/or performance status

PTP (Precision Time Protocol): See IEEE 1588.

PW (Pseudowire): A mechanism for tunneling a native service over an Ethernet, MPLA or IP network

Q

QoS: Quality of Service

Qualified Set of Service Frames: The set of frames that comply with specific criteria, such as the arrival time at the ingress UNI and bandwidth profile compliance, on which a performance attribute is based

R

RDI: Remote Defect Indication

Relay (in power utilities): A low-powered device used to activate a high-powered device. Relays are used to trigger circuit breakers and other switches in substations and transmission and distribution systems.

Responder MEP: In a single-ended session, the Responder MEP receives SOAM PM PDUs, from the controller MEP, and transmits a response to the controller MEP

RFC-2544: An IETF benchmark methodology defining a specific set of tests to measure and report the performance characteristics of network devices. RFC 2544 contains, among other tests, a method for measuring throughput.

RMP: Rooted Multipoint

Rooted-Multipoint EVC: A multipoint EVC in which each UNI is designated as either a root or a leaf. Ingress service frames at a root UNI can be delivered to one or more of any of the other UNIs in the EVC. Ingress service frames at a leaf UNI can only be delivered to one or more root UNIs in the EVC.

RSTP: Rapid Spanning Tree Protocol

RTU (Remote Terminal Unit): An industrial data collection device, typically located at a remote location, communicates data to a host system by using telemetry (such as radio, dial-up telephone, or leased lines).

S

Scheduled Downtime: A time interval agreed upon by both the subscriber and service provider during which a service may be disabled by the service provider

SDH (Synchronous Digital Hierarchy): The European standard for using optical media as the physical transport for high speed, long haul networks

SDN (Software Defined Networking): An emerging networking technology in which conventional control plane protocols are replaced by centralized software applications that configure simple SDN switches in the network

Service Assured Access: A collection of networking attributes throughout the service lifecycle designed to increase revenues and reduce total cost of ownership for service providers

Service Assured Networking: A collection of networking attributes throughout the service lifecycle designed to offer better service performance and reduced total cost of ownership

for power utilities communications

Service Frame: An Ethernet frame transmitted across the UNI toward the MEN or an Ethernet frame transmitted across the UNI toward the subscriber

Service Level Agreement: The contract between the subscriber or operator and service provider specifying the agreed to service level commitments and related business agreements

Service Level Specification: The technical specification of the service level being offered by either the service provider to the subscriber in the case of an EVC service or by an operator to a service provider in the case of an OVC

Service Multiplexing: A UNI service attribute in which the UNI can support more than one EVC instance

Service OAM: Service OAM is OAM used to monitor an individual service.

Service Provider: The organization responsible for the UNI to UNI Ethernet service(s)

SHDSL (Single-Pair High-Speed Digital Subscriber Line): A DSL transmission standardized in ITU-T G.991.2. The original SHDSL technology could 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 version (ex SHDSL.bis) uses more advanced line coding and multi-pair bonding technology to reach transmission rates up to 5.69 Mbps on one pair (2-wire) or a rate up to 22.8 Mbps over 8-wire.

Single-Ended (in OAM): A type of process where an MEP sends a measurement request and the peer MEP replies with the requested information so the originating MEP can calculate the measurement

Single Rate Service: A service that specifies either a CIR/CBS or EIR/EBS

SLA: Service Level Agreement

SLM: Synthetic Loss Measurement: See Y.1731.

Smart Grid: Bi-directional electric grids and communication networks that improve the reliability, security, and efficiency of the electric system for small-to-large-scale generation, transmission, distribution, storage, and consumption

SNMP: Simple Network Management Protocol

SNMP Agent: An SNMP entity containing one or more command responder and/or notification originator applications (along with their associated SNMP engine). Typically implemented in a network element

SNMP Manager: An SNMP entity containing one or more command generator and/or notification receiver applications (along with their associated SNMP engine). Typically implemented in an EMS or NMS

SOAM: Service Operations, Administration, and Maintenance

SOAM PDU: Service OAM frame, or Protocol Data Unit. Specifically, those PDUs defined in IEEE 802.1ag, ITU-T Y.1731 and related MEF specifications

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.

SP: Service Provider

S-Tag: Service (Provider) Tagged Frame

S-Tag Frames: IEEE 802.1ad Ethernet frames with one tag: S-Tag. The values of the S-VLAN IDs are in the range between 1 and 4094.

Step-Down Transmission Substation: Located at switching points in an electrical grid. They connect different parts of a grid and are a source for subtransmission lines.

Step-Up Transmission Substation: Receives electric power from a nearby generating facility and uses a large power transformer to increase the voltage for transmission to distant locations

STP (Spanning Tree Protocol): An Ethernet protocol for loop avoidance

Substation Automation Systems: All equipment that can be found in a substation control room, such as protection relays to protect the lines against fault or RTUs (remote terminal units) allowing substation measures to be sent to SCADA

Substations: A high-voltage electric system facility. It is used to switch generators, equipment, and circuits or lines in and out of a system.

Supervisory Control: Equipment that allows for remote control of a substation's functions from a system control center or other point of control

Supervisory Control and Data Acquisition (SCADA): A common industrial process control application that collects data from sensors on the shop floor or in remote locations and sends it to a control center

S-VLAN (Service VLAN): Also referred to as provider VLAN, a VLAN is used by the service provider to distinguish customers.

S-VLAN ID: The 12 bit VID field in the S-tag of an ENNI frame

Sync-E (Synchronous Ethernet): A mechanism defined in ITU-T standards G.8261, G.8262 and G.8264 to distribute highly accurate frequency over the Ethernet physical layer, using clock mechanisms similar to those used in SDH/SONET. As Sync-E operates on a single physical link, end-to-end frequency distribution requires all nodes along the entire clock distribution path to support Sync-E.

Synchrophasor: A device for precise real-time measurement of voltages and/or currents at points in an electric grid. The information is obtained from monitors called PMUs (phasor measurement units).

Synthetic Frame: An Ethernet OAM frame fashioned to share fate with service traffic

Synthetic Traffic: Traffic consisting of synthetic frames. Delay measurements typically use Synthetic Traffic to overcome the lack of standardized time-carrying fields in user traffic. Other OAM functions, such as frame loss, may also use synthetic frames

T

T1: A digital transmission with a capacity of 1.544 Mbps used in North America. A T1 may be channelized into 24 DS0s, each capable of carrying a single voice conversation or data stream. T1 may be carried on coaxial cable or two twisted pairs.

Tag: An optional field in a frame header

Teleprotection: Any of several protection schemes used in high-voltage transmission systems in order to enable the isolation of faults from the rest of the grid. Teleprotection systems consist of protection relays located remotely from each other, and a communications link between them.

TLV: Type, Length, Value

TOD: Time Of Day

Traffic Conditioning: A process responsible for classification, filtering, metering, marking, policing, shaping and, in general, conditioning the subscriber flow to ensure it is conformant before forwarding the traffic into or out of the network

Traffic Duplication: A unique technology developed by RAD to allow networks with mission critical applications to enhance reliability and performance. It can be used to minimize delay on critical utility applications (such as Teleprotection) by capitalizing on Carrier Ethernet's reduced latency at higher speeds.

TSO (Transmission System Operator): A utility handling the transport of energy for a country generally on electrical high voltage (HV) line above 220 kV (kiloVolts). A TSO is also responsible for the exchange of energy between countries.

Two-Way OAM: An OAM exchange consisting of sending an OAM packet to a remote device, which reflects it back to the originator. Two-way OAM may be used to measure round-trip delay.

U

UNI (User Network Interface): The physical demarcation point between the responsibility of the service provider and the responsibility of the subscriber

UNI-C: A compound functional element used to represent all of the functional elements required to connect an MEN subscriber to an MEN implementing a UNI-N

Unicast Service Frame: A service frame that has a unicast destination MAC address

UNI-MEG: UNI Maintenance Entity Group

UNI-N: A compound functional element used to represent all of the functional elements required to connect an MEN to an MEN subscriber implementing a UNI-C

Unscheduled Downtime: A time interval not agreed upon by both the subscriber and service provider during which the service provider determines that the service is not useable

UpMEP: An MEP in an IEEE 802.1 bridge that sends frames toward the bridge relay entity

User Network Interface: The physical demarcation point between the responsibility of the service provider and the responsibility of the subscriber

V

VCAT (Virtual Concatenation): An inverse multiplexing technique used to split SDH/SONET clients into logical channels, which may be transported independently

VID: VLAN Identifier

VLAN: Virtual LAN

VLAN ID: VLAN Identifier

Virtual NID (vNID): A "virtual NID" functionality is provided by the access provider (AP) to the E-access service purchased by the service provider (SP). vNID functionality allows the SP to monitor selected objects associated with the UNI in the AP's network, and allows the SP to set values for selected objects.

Virtual UNI (VUNI): The component consisting of a collection of service attributes in the VUNI provider's MEN

W

WAN: Wide Area Network

WTR: Wait to Restore

X

xSTP: Spanning Tree Protocol (multiple variations)

Y

Y.1564: An ITU recommendation specifying Ethernet service activation testing. Y.1564 may be used to assess the proper configuration of an Ethernet network before committing to deliver Ethernet-based services.

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.

SDN and NFV

By Yaakov (J) Stein, CTO

In the pages of this catalog we have presented a wide variety of different network elements, from relatively simple modems, through multiplexers and demarcation devices, through pseudowire gateways, to highly sophisticated aggregation switches and application specific multiplexers. Other vendors provide a yet more bewildering array of devices such as ROADMs, DSLAMs, BRAS, core/edge/application routers, eNodeBs, packet gateways, load balancers, NATs, security gateways, firewalls, intrusion detection/protection systems.

And new and ever more complex network elements are being invented all the time. In fact, the rate of introduction of new networking devices is escalating. This is because newer and more sophisticated value-added services are constantly being developed, each such service requiring communications bandwidth and specific networking attributes, often leading to deployment of dedicated network equipment. The rate at which such new services are being created is accelerating, their required time-to-market lead-time is decreasing, and their lifespan is shortening as they, in turn, are being replaced by yet newer services.

This situation may seem perfectly reasonable to RAD and other equipment vendors, who thus continue to develop and add to their catalogs new equipment types every year. On the other hand, our customers are finding it ever harder to acquire, shelve, power, and maintain this huge quantity and variety of devices.

In parallel with these business concerns are technology challenges. It has become increasingly difficult to experiment with new networking ideas. NEs and their protocols have becoming vastly more complex, and hence take longer to standardize and design. They are also becoming more expensive, consume more power, and are harder to manage.

Two complementary solutions have recently been proposed to ameliorate this situation: Network Functions Virtualization (NFV) and Software Defined Networks (SDNs). The precise definitions and delineations are still being debated, but the following is my elucidation of their principles.

The NFV approach replaces proprietary hardware network elements with software running on COTS (Commercial Off-The-Shelf) servers. NFV is a natural extension to the virtualization trend that has overtaken the IT (Information Technologies) world, wherein virtual machines (VMs) have replaced physical CPUs. Borrowing further from the cloud movement, virtualized network elements may be housed in datacenters, POPs or at the edge of the network in order to gain further economies of scale.

In essence, the NFV approach derives from the realization that most of the R&D effort behind designing network elements is actually software development of network functions. However, this software is designed to be embedded in very specific hardware platforms, rather than in general purpose platforms. This tight coupling results from the desire to maximize performance while minimizing cost, but comes at the expense of inflexibility of the resulting solution. In contrast, Virtual Network Functions (VNFs) can be placed on COTS platforms in datacenters, or distributed throughout the network (Distributed NFV).

NFV offers certain obvious advantages, including:

- Rapid deployment, relocation, upgrading, and turn-off of both networking and value-added services
- Standardization of functionality no matter where and on what device it is placed.
- More reasonable scaling of COTS server price and availability in comparison to dedicated communications hardware.
- The ability to flexibly locate network functionality wherever it is most effective or least expensive.
- The potential to combine multiple network functions on a single platform.

SDN and NFV (Cont.)

The SDN approach is to replace standardized networking protocols with centralized software applications that configure all NEs. SDN promises to reduce the complexity of distributed networking control protocols with the simplicity of programming an omniscient controller.

Basically SDN proponents are claiming that a centralized omniscient management system can administer networks more optimally than possible with control protocols exchanged locally between network elements each possessing only partial knowledge of the network topology and constraints.

The advantages of SDN include:

- Facilitation of experimentation with new networking concepts.
- Rapid development of software in comparison to protocol standardization and hardware development.
- Cost reduction due to simplification of network elements.
- Simplification of network maintenance due to centralized orchestration
- The ability to swiftly deploy, relocate and upgrade new features.

The most popular category of SDN utilizes flexibly programmable (but unintelligent) SDN switches, and employs a centralized SDN controller to configure their operation. SDN thus requires a (southbound) protocol to connect the SDN controller with SDN switches, the most popular of which is OpenFlow. However, in the most popular model of SDN, the SDN controller itself is not intelligent, rather the intelligence resides above the controller in a network operating system and network applications (switching, routing, load balancing, security, etc.). There is thus the need for (northbound) protocols to connect the SDN controller to the applications.

SDN and NFV are promising approaches, but there is still work to be done before they can be routinely deployed in operational networks. For example, the SDN community is only now addressing the software control of optical transport planes, and has yet to adequately address QoS and OAM. NFV can lead to significant reduction in turn-on times for new services, but service activation testing and performance monitoring are not yet integral building blocks of the NFV architecture.

For these reasons operational solutions based on SDN and NFV do not yet appear in this year's catalog, but will certainly play a prominent role in next year's.

RAD Group

RAD is the anchor of the RAD Group, an affiliation of ICT manufacturing companies often cited as one of the world's premier generators of hi-tech innovation. A unique business philosophy distinguishes the RAD Group, which has no holding company but is strategically guided by its founders. Each company in the RAD Group operates autonomously under a common strategic umbrella. This decentralized approach maximizes the advantages inherent in small business units, such as flexibility, entrepreneurial spirit and management focus. A new company is established when a market opportunity is identified – requiring a technology, marketing approach or corporate culture that does not exist in any of the other companies.

Four RAD Group companies are currently traded on the Nasdaq Stock Market in the US, while the others are privately held by the Group's founders and various venture capital firms.

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