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 strategy, unified. This decentralized approach maximizes the advantage 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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RAD Company Profile

RAD is a global Telecom Access solutions and products vendor. Our customers are top-tier service providers, power utilities, transportation companies, and governments.

We are at the forefront of pioneering technologies, such as:
• Distributed NFV
• Hardware miniaturization
• Timing synchronization over packet switched networks
For **mobile, business and wholesale service providers**, we offer Service Assured Access solutions designed to improve the way they compete: better QoE to reduce churn, service agility to minimize time to revenue, and complete visibility of network performance for greater operational efficiency. In addition, we provide an economical migration path to virtualization and application awareness.

For **power utilities, transportation companies and governments**, our Service Assured Networking solutions include best-of-breed tools for high security and mission-critical communications, mobility, and seamless migration to modern packet switched networks and applications.

With over 30 years of operation, a significant worldwide presence in over 150 countries, and an installed base of more than 13 million units, RAD is both experienced and very committed to make every project a success. RAD is a member of the $1.2 billion RAD Group of companies, a world leader in telecommunications solutions.
D-NFV at the Customer Edge

RAD’s new generation of L2/L3 NIDs and multiservice platforms are now enhanced with a powerful x86 platform for hosting virtual network functions and applications. It is controlled by the service provider and resides at the customer edge, allowing the service provider to offer new software-based services to end customers in an agile manner.

Phased NFV Deployment

**Phase 1**
*Customer Edge NFV (Center-Less NFV)*

- **Initial deployment**
  Center-less D-NFV solutions with minimum upfront investment and risk, while benefiting from fast service introduction

**Phase 2**
*Full-Blown NFV (NFV Everywhere)*

- **Full-scale deployment**
  NFVs at the edge, network nodes and data center, as justified, benefit from a shared IT resource pool
Profitability from Day 1

RAD’s D-NFV (Distributed Network Functions Virtualization) solution for service providers delivers new revenue opportunities and a multitude of benefits:

- **Service Agility**: fast service introduction, try-and-buy options, new service opportunities with better user experience, lower churn
- **Low Cost**: no upfront investment in data center redesign, no dedicated appliance per new applications, lower operational costs with a single device – less power, space, support
- **Low Complexity**: unified management, point-and-click, improved reliability with higher MTBF
- **Future Ready**: buy a powerful NID/NTU today, add D-NFV tomorrow
- **D-NFV Alliance**: applications ecosystem

- High performance and functional flexibility with an innovative architecture combining hardware and software components
- Advanced L2/L3 NID/NTU functionality adds critical SLA assurance capabilities, otherwise not available in a standalone server
- Optimized price/performance ratio with modular virtualization infrastructure enables capacity adjustments to various access rates and applications
- Designed for carrier-approved NFV management tools (OpenStack, KVM hypervisor, etc.); open to integration into third-party orchestration systems
- SDN-ready

RAD’s D-NFV Alliance

RAD’s Distributed NFV (D-NFV) Alliance is an ecosystem of application developers and virtual function vendors addressing the enterprise market. Once tested and approved, these applications are made available to service providers around the globe via RAD’s D-NFV platform, to enhance their service offering for enterprise and SMB customers.
D-NFV for Mission-Critical Communications

- Reduces the number of physical network devices for better reliability and simpler operation, with software-based functions running on an x86 D-NFV module integrated within RAD’s Megaplex-4
- Integrates higher-level applications (routing, firewall, encryption, SCADA, and more) with communications platform in a single device
- Future-ready and flexible solution to meet new applications’ needs
- Terminal server allows transmission of any serial protocol over IP
- Supports tailor-made as well as third-party applications, tested and certified by RAD
- Smaller footprint
RAD offers service providers a wide range of Service Assured Access solutions designed to improve the way they compete: better quality of experience (QoE) to reduce churn, service agility to minimize time to revenue and complete visibility of network performance for greater operational efficiency - all of which translate to increased revenues and lower TCO.

RAD provides business, mobile and wholesale service providers the most comprehensive service lifecycle toolkit to easily plan, deploy, provision, and maintain existing and new, value-added services.

Our Service Assured Access solutions fit any access and are available in various deployment modes, including emerging vCPE implementation. In addition to enabling MEF Carrier Ethernet 2.0, IP and synchronization services, they are enhanced with new capabilities to facilitate a smooth, secure and cost-effective transition to NFV, SDN and application awareness.
Carrier Ethernet and IP VPNs

Solution Highlights
- Easily plan, deploy, provision, and maintain SLA-based services with the same “look and feel” over fiber/copper/TDM/wireless access
- Built-in Carrier Ethernet demarcation switch with integrated L3 router functionality
- MEF CE 2.0-certified with a feature-rich toolkit: RFC-2544/Y.1564 testing, multi-CoS traffic management, fault management, Y.1731/TWAMP performance monitoring
- Enhanced service provisioning, visibility and reporting using RADview Service Manager and Performance Monitoring portal
- Built-in Distributed NFV for service agility and premium offerings at the customer edge
- Instant upgrades to existing equipment with MiNID service assurance booster

Products Included in this Solution:
- ETX-2: IP and Carrier Ethernet Demarcation
- ETX-5: Ethernet Service Aggregation Platform
- MiNID: Miniature Programmable Network Interface Device
- RADview: Carrier-Class Network Management System
VPN for International Service Providers

Solution Highlights
- Service assurance across different network segments and end-to-end by deploying RAD devices at the customer edge 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
- Built-in Distributed NFV for service agility and premium offerings at the customer edge

Products Included in this Solution:

- **ETX-2**
  IP and Carrier Ethernet Demarcation

- **ETX-5**
  Ethernet Service Aggregation Platform

- **MiNID**
  Miniature Programmable Network Interface Device

- **RADview**
  Carrier-Class Network Management System
TDM Services over Packet Networks

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-2
IP and Carrier Ethernet Demarcation

ETX-5
Ethernet Service Aggregation Platform

IPmux
TDM Pseudowire Access Gateways

RADview
Carrier-Class Network Management System
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 Carrier Ethernet.
- Deliver legacy applications alongside new offerings using the same access link to reduce costs and increase efficiency.
- Agile, seamless introduction of Ethernet/IP services over existing SDH/SONET.
- Optional offload of Ethernet traffic to PSN, while TDM traffic is kept over SDH/SONET core.
- TDM pseudowire ensures service continuity for legacy applications and equipment.
- Avoid costly maintenance of obsolete TDM network equipment.
- Service Assured Access solution enables Metro Ethernet Forum's Carrier Ethernet 2.0 services.
- Next-generation services with D-NFV.

Products Included in this Solution:

- ASMi
  SHDSL Modems
- ETX-2
  IP and Carrier Ethernet Demarcation
- Megaplex-4
  Next-Generation Multiservice Access Nodes
- RADview
  Carrier-Class Network Management System
Cloud Connectivity

Solution Highlights

- Offer compelling and competitive cloud services that meet enterprise customers’ traffic volumes and QoE (quality of experience) expectations
- Increase revenues by offering premium cloud connectivity services with SLA monitoring
- Improve QoE per application with multi-CoS support, L2 and L3 performance measurement, visibility and fault management
- Lower OpEx with per-CoS ongoing quality monitoring of the access link
- Aggregate SLA-based cloud services using a central cloud access demarcation device, with advanced traffic management tools and high scale performance monitoring
- Built-in Distributed NFV for service agility and premium offerings at the customer edge

Products Included in this Solution:

ETX-2
IP and Carrier Ethernet Demarcation

ETX-5
Ethernet Service Aggregation Platform

MiNID
Miniature Programmable Network Interface Device

RADview
Carrier-Class Network Management System
Wholesale Networking

Solution Highlights

- Provide wholesale Carrier Ethernet transport services to multiple service providers with complete visibility and controlled service hand-off between multiple networks.
- Support mobile and business service providers over the same transport network.
- Provide SLA-based backhaul all the way to the end-customer site, cell site or POP.
- MEF-certified Carrier Ethernet 2.0 E-Access support with single-CoS and/or multiple-CoS EVC/OVC for standards-based carrier-to-carrier connectivity.
- Seamless connection between networks with 1-GbE and 10-GbE E-NNI interfaces with optional redundancy.
- Instant upgrades to legacy switches, routers and third-party equipment with the MiNID service assurance booster.

Products Included in this Solution:

- **ETX-2** IP and Carrier Ethernet Demarcation
- **ETX-5** Ethernet Service Aggregation Platform
- **MiNID** Miniature Programmable Network Interface Device
- **RADview** Carrier-Class Network Management System
Mobile Backhaul

Solution Highlights
- Control mobile backhaul SLAs for macro and small cells
- MEF Carrier Ethernet 2.0-certified and multi-CoS traffic delivery with service management and OAM-based diagnostics
- Performance monitoring for L2-based and L3-based backhaul
- Integrated Carrier Ethernet with TDM pseudowire in the same device
- Ensure service visibility and control for small cells, while meeting space and power consumption restrictions
- Timing distribution including an integrated GPS; highly accurate phase (Time of Day) and frequency synchronization using standard IEEE 1588v2 and/or Sync-E technologies
- Miniature MiNID NID helps normalize mobile backhaul transport network with diverse access architectures
- Add-on functionalities with D-NFV

Products Included in this Solution:

ETX-2
IP and Carrier Ethernet Demarcation

ETX-5
Ethernet Service Aggregation Platform

MiNID
Miniature Programmable Network Interface Device

RADview
Carrier-Class Network Management System
Performance Monitoring for Mobile Networks

Solution Highlights
- Performance monitoring for L2-based and L3-based backhaul services
- Add-on functionalities with D-NFV
- Ensure service visibility and control for small cells and macro cells while meeting space and power consumption restrictions
- Verify backhaul performance with service activation tests (Y.1564)

Products Included in this Solution:

**ETX-2**
IP and Carrier Ethernet Demarcation

**MiNID**
Miniature Programmable Network Interface Device

**RADview**
Carrier-Class Network Management System
RAD provides Service Assured Networking solutions that address all the communication needs of the power utilities, oil and gas, transportation, and government sectors. These solutions include best-of-breed tools for high security and reliability, mobility, and seamless migration to modern packet-switched communication networks and applications.

Our Service Assured Networking solutions for utilities address numerous applications, such as SCADA communications, cyber security, substation and distribution automation, protection communications, core network, and virtualization. In addition, they enable reliable and efficient communications for railways, motorways, and air & maritime traffic control. RAD also helps government, public safety and homeland security ICT managers realize fast and secure communications for TETRA, real-time applications and video surveillance, with end-to-end service assurance.
Power Substation Multiservice Operational Network

Solution Highlights

- Powerful cross-generation TDM and carrier-grade Ethernet capabilities, including TDM DS0 cross connect and SDH/SONET, Gigabit Carrier Ethernet with OAM and assured QoS, TDM pseudowire, and Ethernet over NG-PDH/SDH/SONET
- Carrier Ethernet increases security (802.1X, MACsec)
- Easily configurable connectivity of all serial automation and Teleprotection devices to either SDH/SONET network or to a packed network
- Supports analog and digital data and voice devices, as well as Ethernet IEDs, with versatile rates from RS-232 up to STM-4/OC-12 or GbE
- Guaranteed smooth migration to PSNs based on the hybrid design and optional TDM traffic duplication over both SDH/SONET and Ethernet networks for reduced latency, better resiliency and gradual migration to PSN
- Future-ready with virtualization capabilities, for adding new applications (security, router, SCADA) to the communications features using RAD’s innovative x86 D-NFV module.

Products Included in this Solution:

- **ETX-5**
  Ethernet Service Aggregation Platform

- **Megaplex-4**
  Next-Generation Multiservice Access Nodes

- **RADview**
  Carrier-Class Network Management System
Distance and Differential Protection Communications

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 (Zero) msec hardware protection
- Sub-2 msec end-to-end delay over PSN
- Tested interoperability with most Teleprotection contact relays from leading vendors (such as Alstom, ABB, Siemens, SEL, Schneider)
- Distance protection complies with IEC 60834

Products Included in this Solution:

- Megaplex-4
- RADview

Megaplex-4
Next-Generation Multiservice Access Nodes

RADview
Carrier-Class Network Management System
Secure IEC 61850-3 Substation Network

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 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 IP SCADA to both old and new RTUs by converting IEC-101 and IEC-104, or Modbus serial and IP, DNP3 and others
- Enable secure, dedicated networks over fiber and/or radio links using IPSec encryption and distributed security SCADA firewall suite

Products Included in this Solution:
- **SecFlow-2**
  Ruggedized SCADA-Aware Ethernet Switch/Router
- **SecFlow-4**
  Modular Ruggedized SCADA-Aware Ethernet Switch/Router
- **RADview**
  Carrier-Class Network Management System
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 communications over fiber optics, radio links, 2G/3G/LTE cellular links and leased lines from a 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
- SecFlow-1: Ruggedized SCADA-Aware Gateway
- RADview: Carrier-Class Network Management System
Utilities

Oil & Gas Utilities Communications

1. Communications Network for Refineries, Pumping and Compression Stations and Along Pipelines

Solution Highlights

- A comprehensive communications solution for automation and IT applications in oil and gas fields and along pipelines
- Complies with environmental standards for outdoor installations in harsh conditions
- Supports any available media and connectivity option, including fiber, radio, 2G/3G cellular links, or leased lines from a local telco
- Distributed SCADA security suite with integrated firewall and encryption
- Point-to-point and point-to-multipoint radio system supports up to 250 Mbps over sub-6 GHz bands, with dedicated bandwidth allocation per site and service reach of up to 120 km

Products Included in this Solution:

- Airmux-5000: Point-to-Multipoint Ethernet Radio
- SecFlow-2: Ruggedized SCADA-Aware Ethernet Switch/Router
- RADview: Carrier-Class Network Management System
Solution Highlights

- Support bi-directional broadband connectivity to deliver real-time video, internet access (WiFi), data, and VoIP to supply and service vessels
- Up to 100 Mbps total available throughput using base stations installed on offshore rigs and radio terminals on vessels
- 360° mobility coverage across a range of up to 10 km
- Seamless handover between base stations for non-stop communications
- Advanced QoS mechanisms, encryption and guaranteed bandwidth per vessel
- License-free, sub-6 GHz frequencies

Products Included in this Solution:

Airmux-5000
Point-to-Multipoint Ethernet Radio
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, and multiparty hotlines, as well as passenger information systems (PIS)
- Support legacy TDM and Ethernet traffic delivery over SDH/SONET and/or carrier-grade fiber optic rings
- Carrier-grade Ethernet ensures service performance and ongoing KPI monitoring
- Ethernet extension over fiber or copper to enable service reach to remote M2M and video devices
- Enable Layer 3-7 applications (routing, security, SCADA), in addition to communications platform, using x86 Distributed Network Functions Virtualization (D-NFV) module

Products Included in this Solution:

- **ASMi-54**
  SHDSL Modems

- **Megaplex-4**
  Next-Generation Multiservice Access Nodes

- **RADview**
  Carrier-Class Network Management System
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 250 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** IP and Carrier Ethernet Demarcation
- **RADview** Carrier-Class Network Management System
Transportation

Secure Automation and Operations Communications

Solution Highlights

- Build a secure network for SCADA, CCTV and signaling traffic, using a protected ring combining wireless and fiber optics
- Support a mixture of Ethernet, serial and discrete (dry contacts) devices with a distributed SCADA firewall for secure access
- Seamless connectivity for next-gen SCADA using serial to IP protocol conversion
- Secure mobile access from trains to control centers using distributed device authentication methods
- PoE (Power over Ethernet) for direct connectivity of IP CCTV cameras

Products Included in this Solution:

- **SecFlow-1**
  Ruggedized SCADA-Aware Gateway
- **SecFlow-2**
  Ruggedized SCADA-Aware Ethernet Switch/Router
- **RADview**
  Carrier-Class Network Management System
Highway Communications

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**
  - IP and Carrier Ethernet Demarcation

- **SecFlow-2**
  - Ruggedized SCADA-Aware Ethernet Switch/Router

- **RADview**
  - Carrier-Class Network Management System
Air Traffic Control and Maritime Communications

Solution Highlights

- Ensure uninterrupted communications between 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
- On-the-move communications for vehicles and vessels in airports and harbors

Products Included in this Solution:

Megaplex-4
Next-Generation Multiservice Access Nodes

RADview
Carrier-Class Network Management System
Smart City Communications

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 Broadband Wireless Radios
- Airmux-5000 Point-to-Multipoint Ethernet Radio
- SecFlow-2 Ruggedized SCADA-Aware Ethernet Switch/Router
- RADview Carrier-Class Network Management System
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, using the 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
Governments

2 Broadband Connectivity for Police Vehicles

Solution Highlights

- Support bi-directional broadband connectivity for real-time video surveillance feeds to and from police patrol cars
- Support connectivity of moving vehicles at up to 250 km/h
- Up to 100 Mbps total available throughput
- Guaranteed bandwidth per vehicle, using a point-to-multipoint, sub-6 GHz encrypted radio system with advanced QoS mechanism
- Seamless handover for real-time video streaming
- Reliable coverage over long distances in various terrains and topologies
- WiFi coverage extends outside the vehicle for video transmissions

Products Included in this Solution:

Airmux-5000
Point-to-Multipoint Ethernet Radio
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, 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.

**ACE-3220**
Multiservice Cell-Site Gateway

- 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 interface modules, each housing four SHDSL/SHDSL.bis ports (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

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.

**ACE-3400, ACE-3402**
Aggregation-Site Gateways

- 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)
**Airmux-400**

**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 250 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 250 Mbps aggregated (Airmux-400P), up to 200/400 Mbps aggregated (Airmux-400L), or up to 50 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

**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-3220. 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-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 63 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 63 remote subscriber units per sector with aggregated throughput of 5, 10, 20, 25, 50, and 100 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 – typically 4 to 10 msec in full sector load

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
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, V35 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

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
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.

### DXC Family
**Digital Cross Connects**

- Non-blocking cross connect of 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

### 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’s 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
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

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 and 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, WFO scheduling and shaping
- ITU-T G.8032 Ethernet Ring Protection Switching (ERPS)
- RADview management; CLI configuration
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 award-winning 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.

- MEF Carrier Ethernet 2.0-certified for E-Line, E-LAN, E-Tree, E-Access services, as well as L3 VPNs and TDM pseudowire over packet networks
- Distributed virtual network functions at the customer edge
- Enhanced traffic management per EVC/EVC-CoS
- Accurate and scalable Ethernet OAM with one-way and two-way measurements, performance monitoring, built-in RFC-2544/Y.1564 tester capabilities, TWAMP support, and L2/L3 diagnostic loopbacks
- ITU-T G.8032 Ethernet Ring Protection Switching; 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 Performance Monitoring Portal, RADview Service Manager and RADview D-NFV Orchestrator

See ordering options and unique features >>>

See Pages 4-5
ETX-2 Ordering Options and Unique Features:

ETX-2i: IP and Carrier Ethernet Demarcation Device with D-NFV

The ETX-2i is a next-generation hybrid L2 and L3 demarcation device for business and mobile applications. It is ideal for E-Line, E-LAN, E-Tree, and E-Access services, L3 VPNs, and value-added services using virtualization at the customer edge. The ETX-2i features an 8 Gbps forwarding engine for Carrier Ethernet and IP with high capacity service provisioning, performance monitoring, Network Functions Virtualization (NFV), and application awareness capabilities. With future-proof design and architecture, it supports dynamic forwarding to fit software defined networks (SDN).

- Up to eight GbE combo ports
- Integrated 8 Gbps switch/router
- Flexible classification, H-QoS traffic management and scheduling
- Modular network interfaces: FE/GbE (combo), E1/T1, T3, VDSL2, or SHDSL
- Flexible synchronization offering Sync-E, IEEE 1588v2 slave, BC and TC for frequency and phase synchronization in mobile networks
- Pluggable x86 D-NFV server module for hosting virtual functions
- SDN-ready with configurable forwarding

ETX-203AM: Universal Carrier Ethernet Demarcation Device

Available as a modular demarcation device, the ETX-203AM enables operators to deliver Carrier Ethernet services and IP VPNs over any network connection. This reduces carrier TCO and simplifies purchasing, homologation, training, service production, and management integration.

- Four FE/Gigabit Ethernet user ports
- Modular network interfaces: FE/GbE (combo), E1/T1, T3, VDSL, or SHDSL
- Optional 1 Gbps wire-speed router module for L3 VPN demarcation
- NEBS-compliant and environmentally hardened enclosure options

ETX-203AX: Carrier Ethernet Demarcation Device

ETX-203AX delivers SLA-based Ethernet business services 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 options
- NEBS-compliant option in a metal enclosure
The ETX-205A provides advanced Carrier Ethernet and L3 demarcation, as well as Network Functions Virtualization (NFV) capabilities, and offers combo interfaces and power supply redundancy. As a demarcation device for mobile backhaul, the ETX-205A incorporates Distributed Grandmaster™ functionalities, and is installed at cellular tower and controller sites to guarantee differentiated SLAs for LTE/LTE-A mobile operators, while cutting down provider costs by minimizing equipment needed for timing and demarcation.

• Integrated 1 Gbps 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
• Built-in x86 D-NFV server module for hosting virtual functions
• 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 E-Access 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 20 x 1-GbE ports in various combinations

ETX Distributed NFV Applications

The ETX-2 features an x86-based D-NFV module for hosting virtual functions (VFs) and applications. The D-NFV module runs on DNFV-OS, which includes standard KVM hypervisor and OpenStack compute node to support RAD VFs and third-party applications. RADview D-NFV Orchestrator enables easy VF download. Supported applications include:

- **Router**
  - Virtual router for hosted public clouds and branch CPE deployments
- **Cryptography**
  - Standard AES 256-bit cipher encryption/decryption of L2-L4 traffic
- **Firewall**
  - Unified threat management for provider-managed SMB services
- **Session Border Controller (SBC)**
  - Manages VoIP signaling and media flows
- **Packet Analyzer**
  - Troubleshooting-on-demand from the customer edge using a packet sniffer VF
- **WAN Optimization**
  - Eliminates content duplication, handles compression and optimizes latency

Contact your local RAD distributor for additional/new application information.
ETX-5
Ethernet Service Aggregation Platform

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 is Carrier Ethernet 2.0-certified 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.

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.
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

ETX-204A
Carrier Ethernet/Mobile Demarcation Device

The ETX-204A is an advanced demarcation device for SLA-based Ethernet business services and mobile backhaul. It ensures carrier-grade performance and Five Nines (99.999%) reliability, and allows remote end-to-end service control. The ETX-204A handles up to 5 Gbps of Ethernet user traffic at wire-speed with advanced traffic management and differentiated, per-flow quality of service (QoS) capabilities.

As a mobile demarcation device (MDD), the ETX-204A combines a cell-site gateway or a small hub device with Ethernet demarcation functionalities and is installed at cellular tower and controller sites to help backhaul and transport providers, as well as fixed-mobile carriers, guarantee differentiated SLAs for 3G, HSPA and LTE mobile operators. As an all-in-one device, it cuts down provider costs by minimizing equipment needed for timing and demarcation.

- MEF-9/14 certified for EPL, EVPL services
- Multi-rate FE/Gbe UTP/SFP combo ports with auto-detection
- Enhanced traffic management with multiple shapers and H-QoS per EVC
- Ethernet OAM, performance monitoring and built-in RFC-2544 tester capabilities; L2/L3 diagnostic loopbacks
- TWAMP support for performance monitoring over L3 networks
- ITU-T G.8031 Ethernet Linear Protection Switching
- Sync-E, 1588v2 support
- RADview management; CLI configuration
The FCD-155 and FCD-155E transport 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, or used as an add/drop multiplexer on the SDH/SONET ring (FCD-155E), these devices improve 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 and FCD-155E are widely deployed by carriers and service providers to leverage their optical bandwidth for revenue-generating Ethernet services, while enterprises, utilities and campuses use them to provide LAN services over existing fiber optic infrastructure.

**FCD-155**

STM-1/OC-3 Terminal Multiplexer

- Standard next-generation STM-1/OC-3 terminal or ADM (FCD-155E) utilizing GFP, VCAT, LCAS
- Grooms Ethernet and E1/T1/E3/T3 traffic over STM-1/OC-3 fiber or copper links (FCD-155)
- Multiservice functionality in the same box:
  - Two or six 10/100BaseT ports or a single GbE port
  - Up to eight E1/T1 ports or one E3/DS3 port (FCD-155); up to 21 E1/28 T1 ports, one E3/DS3 port, or 21 E1/28 T1 ports and one E3/T3 (FCD-155E)
- SFP-based uplinks and Gigabit Ethernet interface
- Optional dual power supply configuration (FCD-155E)
- Advanced management option including DCC and IP tunneling
- Available with standard protection on the main link
- Compact size

**FCD-155E**

Ethernet over SDH/SONET ADM

- Standard next-generation STM-1/OC-3 terminal or ADM (FCD-155E) utilizing GFP, VCAT, LCAS
- Grooms Ethernet and E1/T1/E3/T3 traffic over STM-1/OC-3 fiber or copper links (FCD-155)
- Multiservice functionality in the same box:
  - Two or six 10/100BaseT ports or a single GbE port
  - Up to eight E1/T1 ports or one E3/DS3 port (FCD-155); up to 21 E1/28 T1 ports, one E3/DS3 port, or 21 E1/28 T1 ports and one E3/T3 (FCD-155E)
- SFP-based uplinks and Gigabit Ethernet interface
- Optional dual power supply configuration (FCD-155E)
- 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

- 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

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 requiring voice and data connectivity and Internet access via low rate TDM lines.
**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

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**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
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.

**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.
**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

**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
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.

**LA-210**

**EFM DSL Network Termination Unit**

- 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

**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

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 TDM and Ethernet CPEs that are connected over various access links.

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 various services up to STM-4/OC-12 and 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
- Ethernet security features including 802.1x and MACsec
- 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 cards for subscriber and main link connections
- Pluggable x86 D-NFV server module for hosting virtual functions and applications

The Megaplex-4 offers an x86 D-NFV module for hosting virtual functions (VFs) and applications. The D-NFV module runs on DNFV-OS, which includes standard KVM hypervisor and OpenStack compute node to support RAD VFs and third-party applications. RADview D-NFV Orchestrator enables easy VF download. Supported applications include:

- **Router**
  Virtual router for hosted public clouds and branch CPE deployments
- **Cryptography**
  Standard AES 256-bit cipher encryption/decryption of L2-L4 traffic
- **Firewall**
  Unified threat management for provider-managed SMB services
- **Packet Analyzer**
  Troubleshooting-on-demand from the customer edge using a packet sniffer VF
- **WAN Optimization**
  Eliminates content duplication, handles compression and optimizes latency

Contact your local RAD distributor for additional/new application information.
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

Introducing the New RADadvantage Partners Program

RADadvantage Partners Program

For details see p.78-79
MiNID
Miniature Programmable Network Interface Device

MiNID is a field-programmable miniature L2/L3 network interface device (NID), available as an SFP sleeve and in a standalone enclosure. Part of RAD’s Distributed Network Functions Virtualization (D-NFV) portfolio, it enriches the Service Assured Access offering with software-defined functionalities for enhanced demarcation, remote monitoring, fault isolation, and more.

The MiNID provides instant upgrade for legacy switches and routers to help service providers, mobile operators and wholesale carriers introduce new services quickly and with better quality of experience (QoE) while increasing operational efficiency and lowering costs. Remotely managed via CLI, web interface and SNMP, it features zero-touch provisioning for fast and simple installation and does not require dedicated training.

MiNID Sleeve

The MiNID SFP sleeve is easily pluggable into SFP ports of switches and routers and eliminates the need for standalone demarcation devices. It seamlessly hosts standard FE and GbE SFP modules, and delivers substantial OpEx savings by eliminating additional power, space and cabling expenses.

- Plug-and-play installation
- Compatible with standard fiber and copper SFPs in a variety of ranges
- Fits small cells, macro cells, switches, routers, DSLAMs, and more

MiNID Standalone

The MiNID is also available in a miniature standalone enclosure, with a variety of user and network port options for maximum interface flexibility. Optional bypass-relay functionality ensures fail-safe operation and Power over Ethernet (PoE) support eliminates the need for an additional power supply.

- Two ports with flexible user or network functionalities
- Combo ports automatically select between fiber and copper/RJ-45
- Internal bypass relay for copper interfaces offers service continuity in the event of power failure
- Bypass PoE enables powering both the MiNID and the end device

MiNID Programmable Network Functions and Applications

The MiNID features a fully programmable, FPGA-based firmware for maximum flexibility. It enables easy download of demarcation and networking applications using the RADview D-NFV Orchestrator. Supported applications include:

Demarc
Service demarcation, PM and diagnostics for MEF Carrier Ethernet 2.0 and IP services with SLA assurance

AppAware
Application-aware demarcation with service monitoring providing up to L7 visibility and policy enforcement to improve quality of experience

Tunnel
Service demarcation with tunneling of L2 services over L3 networks

Contact your local RAD distributor for additional/new application information.
MiRiCi-155
Smart SFP Gigabit Ethernet over STM-1/OC-3 Converter

RAD’s 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

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

Optimux-45, Optimux-45L
Multiplexers for 21 E1/28 T1 over Fiber or T3

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)

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
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)

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
Optimux-1551, Optimux-1553
Fiber Multiplexers for 63 E1/84 T1 or 3 E3/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 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’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 includes 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
- Layer-1 encryption for GbE, 10G Eth, 4G FC and 8G FC
- 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)
RADview is a modular network management suite for RAD’s Service Assured Access and Service Assured Networking solutions. It enables configuration, provisioning, monitoring, and management of networks and services, and includes the following management tools:

- Network element manager
- End-to-end service manager for Carrier Ethernet services
- Performance monitoring portal for ongoing monitoring of Ethernet and IP services
- Service center for managing TDM services
- D-NFV orchestrator for virtual machines and application services at the customer edge
- Network planner for resource optimization and capacity planning

RADview is fully compliant with the ITU-T Telecommunications Management Network (TMN) standards, and features advanced fault, configuration, administration, performance, security (FCAPS) capabilities. Using an SNMP southbound interface, it also includes third-party device monitoring capabilities. RADview’s northbound interface enables integration into a third-party umbrella system (OSS).

- Monitors device health, optimizes network operations and minimizes mean time to repair (MTTR)
- Client/server architecture with multi-user support and seamless handover of user privileges
- Zero-touch and auto-discovery capabilities
- Wide range of northbound application programming interfaces (APIs)
- Interoperable with third-party NMS and leading OSS/umbrella systems
- Multi-platform java-based solution supporting Windows, Linux and UNIX
- IBM Tivoli’s Netcool®/OMNibus™ plug-in
- High availability and disaster recovery solutions

The RADview Performance Monitoring module enables ongoing monitoring of Ethernet and IP service performance by collecting KPI (key performance indicators) data from RAD devices. Part of RAD’s Service Assured solutions, it allows service providers and network operators to easily monitor and manage actual network and service performance over time and compare it to service requirements and SLA (service level agreement) guarantees.

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, analyzes 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
- TWAMP-based L3 performance monitoring for IP services
- SLA threshold policy management
- Performance dashboard with aggregated and drill-down views
- Statistics reporting; scheduled report generation
The 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 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

The 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 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.

- "Point-and-click" end-to-end service provisioning and OAM settings
- 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
- Standard northbound interfaces to third-party OSS systems
- GUI designed for management of very large networks

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The RADview Network Planner enables modeling and design of network topologies and services for deployments involving the ETX demarcation devices. Part of RAD’s Service Assured solutions, it allows service providers and network operators to tailor network and service architecture to their performance and capacity needs while ensuring resource optimization. The RADview Network Planner is an offline tool, which does not require installation of physical devices. It features a Web client with state-of-the-art user interface (UI) that provides intuitive visualization of network routes and traffic flows.

- Offline tool simplifies pre-deployment stages and minimizes inefficiencies
- Service planning reflects network scale limitations and route restrictions
- Topology architecture, including rings and sub-rings
- Resource optimization and capacity planning

The RADview D-NFV Orchestrator uses the OpenStack framework to manage the physical and virtual resources required for effectively running Distributed NFV and for delivering service agility at the customer edge. It creates, configures and manages virtual machines on the x86 D-NFV module residing within RAD’s customer-edge devices. In addition, it manages the repository of RAD-certified VF (virtual function) applications and is used to download the applications to the device.

Featuring a Web client with state-of-the-art user interface (UI), the D-NFV Orchestrator enables fast and easy service creation of value-added applications and provides status and utilization reports of the x86 D-NFV modules.

- Configuration and monitoring using OpenStack control node
- Manages application repository with data on vendor, usage and system requirements for each VF
- Downloading and provisioning multiple VFs by the D-NFV module
- x86 inventory management and utilization reporting
- DNFV-OS deployment; ongoing OS and application software updates
- Web client with intuitive UI
RIC-155GE
Gigabit Ethernet over STM-1/OC-3 NTU

RIC-155L
Managed Gigabit Ethernet to STM-1/OC-3 Converter

RIC-LC
Ethernet Converter for Multiple PDH Circuits

The RIC-155GE and RIC-155L deliver Gigabit Ethernet traffic over STM-1/OC-3 or channelized OC-3 links at 155 Mbps access rates. Enabling quality of service (QoS) management for multiple traffic types, as well as monitoring and diagnostics, the RIC-155GE and RIC-155L are ideal for extending Ethernet connectivity over TDM backbones. Other typical applications include IP DSLAM and WiMAX base station backhaul, inter-POP connectivity or high bandwidth private line services.

RIC-155GE
- GbE user port (RIC-155GE) or two UTP and SFP GbE user ports (RIC-155L)
- STM-1/OC-3c network ports
- VLAN-aware and VLAN-unaware bridging; VLAN stacking (RIC-155GE)
- G.7041/Y1303 GFP (RIC-155L) or HDLC (RIC-155GE) encapsulation
- Four QoS levels based on Strict Priority scheduling
- Remote and local, inband and out-of-band management, secure Telnet and Web applications, SNMPv3 and RADIUS

RIC-155L
- TDM to Ethernet fault propagation and loop detection mechanism (RIC-155GE)
- Ethernet jumbo frames supported (RIC-155L)
- Optional dual power supply (RIC-155GE)

RIC-LC
- Up to 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

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 RIC-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.
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
**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**

**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 IP66 (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

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/LTE cellular modems
- Integrated application-aware firewall for SCADA protocols
- L2/L3 VPN agent with IPSec

SecFlow-2

Ruggedized SCADA-Aware Ethernet Switch/Router

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 dual 2G/3G cellular modems
- Integrated application-aware firewall for SCADA protocols
- L2/L3 VPN agent with IPSec
SecFlow-4
Modular Ruggedized SCADA-Aware Ethernet Switch/Router

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

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

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
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

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
Peace of Mind, Where and When You Need It

RAD’s Service Assured Access (SAA) and Service Assured Networking (SAN) solutions are all about enabling service providers and network operators to deliver the best possible service experience and seamlessly migrate to next-generation networks – all while increasing operational efficiency and reducing TCO.

Complementing these offerings are RADcare Global Services, a great resource developed specifically to help our customers receive the full benefits of our solutions with real-time service guidance, planning and preventive maintenance.

RADcare Global Services provide expert consulting and troubleshooting assistance, online tools, regular training programs, and various equipment coverage options – all designed to enable seamless installations and faster service rollouts. Moreover, our RADcare programs help service providers to meet their SLAs and avoid penalties while private network operators can rely on full support for their mission-critical applications.

These vital services are available from authorized RAD Partners and backed by a highly dedicated and professional team of regional technical assistance centers, together with project management staff and international training professionals.
RADcare Global Services

**Partner Benefits**

- Strict service level agreements (SLAs): receive response, restore service and resolve issues within a known and guaranteed time frame.
- Move to the head of the queue with priority handling by RAD support centers and round-the-clock access to RAD's experts.
- Free access to eSupport, including regular software updates and patches, online/remote configuration assistance and RAD's FAQ knowledge base.

**Customer Benefits**

- Ensure optimal quality of experience for your customers by maintaining a high quality network.
- Meet your SLAs and avoid penalties by minimizing service outages and enabling fast recovery.
- Plan ahead to limit your spending on support and eliminate hardware repair costs related to old equipment.
- Shorten time to market (TTM): rely on RADcare to support your operations so you can turn up new services faster.
RADcare Professional Services encompass all relevant aspects of the pre-installation design and rollout stages to get the new network up and running as quickly and as seamlessly as possible while providing additional vital benefits:

- Peace of mind – critical projects receive full support to ensure fast and smooth deployments and enable seamless installations and faster service rollouts, resulting in satisfied customers
- Take advantage of RAD’s experience and thorough understanding of its products and your application environment
- Allow your technician to learn first-hand how to ensure optimal operation of the network and service

RADcare Professional Services include the following valuable elements:

- Planning
- Staging
- Site Survey
- Equipment Installation
- Acceptance Testing and Commissioning
- Resident Engineer

RADcare Project Assured Service

Complex solutions installed in mission-critical environments typically involve precise planning, testing, launching, and ongoing support – and therefore require hands-on assistance by RAD’s solution specialists in the early stages of the project lifecycle.

Enjoy full Project Assured led by certified RAD engineers who are committed to your project’s success from start to finish. RAD offers different Project Assured packages which include:

- High level design (HLD): thorough review of the physical topology, required hardware and software, and network management
- Low level design (LLD): a definitive reference for system and network implementation, including detailed configuration instructions for devices, network management system and interfaces
- Configuration and testing performed by RAD experts to ensure ideal turn-up
- Full documentation of your system’s installation requirements for easier maintenance and future changes
- Commissioning design and execution so that the entire network can be certified before sign-off
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.

- A single point of contact (Project Manager) within RAD supervises all logistical, technical and commercial aspects of the implementation of all network solutions under your contract
- Periodic status meetings to identify and avoid potential conflicts and issues before they become a problem
- Detailed test procedures and documentation, regular progress reports and management of all aspects of your specific configuration

RADcare 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.

- Technical seminars, web-based training and project-based training: a variety of on-site and remote interactive training options to ensure your engineers master your RAD equipment
- Taught by RAD’s expert engineers, course materials include a carefully balanced mix of lecture, demonstration and hands-on experience
- Topics include theory, configuration and troubleshooting, and can be designed around your choice of products and applications
- RAD Authorized Technical Trainer (ATT): certification of skilled engineers as RAD-approved trainers, entitling them to deliver courses on RAD equipment
A
ADSL (Asymmetric DSL): A DSL technology with greater downstream rate than upstream
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
Application Awareness (AAw): The capacity of a network element to optimize handling of traffic based on knowledge of application type
APS (Automatic Protection Switching): See Protection Switching
Availability: A measure of the percentage of time that a service is usable
Available Bandwidth Measurement (ABM): A mechanism to measure the data rate available to a flow, not only the data rate already being utilized

B
Backhaul: The network segment between the source and the core, e.g., a mobile backhaul network extends from the cellular base station to the network core
Bandwidth Profile: An Ethernet service characteristic that specifies the committed and excess bandwidths and burst sizes that may be consumed by a service
Best-Effort: A service class in which delivery and traffic parameters are not guaranteed
Broadband Forum (BBF): An international organization promoting broadband wireline communications

C
Carrier Ethernet: Carrier Ethernet is a standardized, carrier-class service and network defined by five attributes that distinguish Carrier Ethernet from familiar LAN-based Ethernet, namely standardized services, scalability, reliability, quality of service and service management
CCM (Continuity Check Message): An OAM mechanism used (e.g., by Y.1731) to detect continuity failures
CE: Carrier Ethernet, Customer Edge, Customer Equipment
CEN: Carrier Ethernet Network [used interchangeably with Metro Ethernet Network, MEN]
CESoETH: Circuit Emulation Services over Ethernet, a pseudowire mechanism for transporting TDM over Ethernet
CE-VLAN CoS (Customer Edge VLAN CoS): The PCP field in a 802.1Q tagged or priority tagged Ethernet frame that indicates the class of service
CE-VLAN CoS Preservation: An EVC attribute indicating that the CE-VLAN CoS of an egress frame must remain identical to that of the corresponding ingress 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 as defined in IEEE 802.1ag (identical to the fault management sections of ITU-T Y.1731)
CIGRE (Conseil International des Grands Réseaux Electriques): An international organization promoting collaboration to improve electric power systems
Circuit Emulation Service (CES): A service that transports TDM-based traffic over a packet network
Class of Service (CoS): A parameter representing the particular level of performance to be provided, indicated by the PCP field in Ethernet, the DSCP field in IPv4, or the Traffic Class field in IPv6 and MPLS
Color-Aware: When determining the bandwidth profile compliance level (green, yellow, or red) of a frame, the property of taking into account a previously determined bandwidth profile compliance level
Color-Blind: When determining the bandwidth profile compliance level (green, yellow, or red) of a frame, the property of not taking into account any previously determined bandwidth profile compliance
Color ID (Color Identifier): The (green/yellow/red) value indicating bandwidth profile compliance level of a frame
Committed Burst Size (CBS): A bandwidth profile parameter indicating the size (in bytes) available for a burst of frames to remain compliant (colored “green”)
Committed Information Rate (CIR): A bandwidth profile parameter indicating the average rate (in bits per second) for compliance (colored “green”)
Control House: In power utilities, 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 indicates whether unused green bucket tokens can be used in the yellow bucket (for more information on token bucket model and algorithm, see MEF 10.3 and MEF 41)
CPE (Customer Premises Equipment): Equipment located at the customer premises, typically owned and controlled by the service provider

For the complete glossary see www.rad.com
**Cross Connect**: A network device that demultiplexes, switches and remultiplexes synchronous signals (low-order cross connects may switch individual voice channels or E1/T1 signals, while high-order cross connects may switch high speed optical signals)

**CSP**: Communication Service Provider

**C-Tag**: Customer (subscriber) VLAN Tag

**C-Tag Frames**: Ethernet frames with a single customer VLAN tag

**Customer Edge (CE)**: Customer network equipment connected to the service provider network

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

**DA (Destination Address)**: A header field identifying a packet’s destination

**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 a unicast, multicast, or broadcast DA

**DEI (Discard/Drop Eligibility Indicator)**: A header bit indicating that a frame may be dropped

**Differential Protection**: In electric utilities, 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**: In electric utilities, 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)**: An OAM mechanism used (e.g., by Y.1731) to perform two-way delay measurement

**DNP3 (Distributed Network Protocol)**: A set of communications protocols used between substation RTUs or IEDs and master stations for the electric utility industry

**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**: A MEP that sends frames towards the network and away from the bridge relay entity

**DPI (Deep Packet Inspection)**: A mechanism that classifies packets based on the entire packet (not solely on its headers), e.g., for the purposes of application awareness or intrusion detection

**DS0 (Digital Subscriber Level Zero)**: A synchronous signal at 64 kbps rate

**DS1 (Digital Signal Level 1)**: A TDM signal at E1 or T1 rate

**DS3 (Digital Signal Level 3)**: A TDM signal at E3 or T3 rate

**DSCP (Differentiated Services [DiffServ] Code Point)**: The field indicating CoS in an IPv4 packet

**DSL (Digital Subscriber Line)**: Any of a set of technologies for carrying broadband data over copper (telephone) lines

**DSO (Distribution System Operator)**: An electric 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; DSO can also be a power producer

**Dual-Ended (in OAM)**: A process whereby a MEP sends a measurement message to its peer MEP, which completes the measurement

**E**

**E1**: A 2.048 Mbps signal that supports 32 DS0s, at least 30 of which may be telephony grade voice channels

**E-Access**: Ethernet service type that uses 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**: The demarcation point at which a packet exits a network

**E-LAN**: An Ethernet service type with multipoint-to-multipoint topology, see EP-LAN and EVP-LAN

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

**Electric Substation**: Part of an electric grid which transforms voltage from high to low or low to high, or performs other switching, protection and control functions

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

**E-Line**: An Ethernet service type with point-to-point topology, see EPL and EVPL

**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 CENs 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.

EPL (Ethernet Private Line): A dedicated-bandwidth E-Line service.


EP-Tree (Ethernet Private Tree): A Carrier Ethernet service that provides a rooted-point-to-multipoint EVC.

Ethernet Access Provider: An operator providing an OVC-based Ethernet service between a UNI and an ENNI.

Ethernet Frame: An on-the-wire Ethernet data frame.

Ethernet LAN Service: See E-LAN.

Ethernet Line Service: See E-Line.

Ethernet over PDH (Plesiochronous Digital Hierarchy): A method for carrying Ethernet traffic over PDH (such as E1/T1 or E3/T3).

Ethernet over SDH/SONET: A method for carrying Ethernet traffic over SONET or SDH.

Ethernet Virtual Connection (EVC): An association of two or more UNIs that exchange Ethernet frames.

EtherType (Ethernet Type): A two-byte header field in an Ethernet frame indicating the payload’s protocol type.

E-Tree: An Ethernet service with point-to-multipoint topology.

EVC ID: The identifier for an EVC.


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

EVPL (Ethernet Virtual Private Line): A shared-bandwidth E-Line service.

EVPLAN (Ethernet Virtual Private LAN): A shared-bandwidth E-LAN service.

Excess Burst Size (EBS): A bandwidth profile parameter indicating the size (in bytes) available for a burst of frames to be colored “yellow.”

Excess Information Rate (EIR): A bandwidth profile parameter indicating the average rate (in bits per second) to be colored “yellow.”

F

FCS (Frame Check Sequence): A field enabling verification of correct reception of a frame, such as the last 4 bytes of an Ethernet frame.

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.

FEC (Forwarding Equivalence Class): An MPLS or IP flow.

Firewall: A network security element that admits or blocks packets according to a rule set.

First Mile: The segment of a communications path between the end-user and the edge of the service provider network.

Flow: A sequence of packets sharing a common source and destination, that are treated identically at all forwarding points (e.g., an EVC for L2, and a FEC for L3).

FLR: Frame Loss Ratio.

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

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-T standard defining Ethernet Linear Protection Switching.

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

GARP: Generic Attribute Registration Protocol.

GbE: Gigabit Ethernet.

GFPP (Generic Framing Procedure): ITU-T Recommendation G.7041 defining an efficient mapping of variable length messages (such as Ethernet frames) over a synchronous link (such as PDH or SDH).

GRE (Generic Routing Encapsulation): A protocol (defined in RFC 2784) that enables tunneling of other protocols over IP.

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.

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


IED (Intelligent Electronic Device): A microprocessor-based controller found in electric power systems to control electrical assets such as circuit breakers and transformers.

IEEE: Institute of Electrical and Electronics Engineers.

IEEE 1588: The IEEE precision time protocol (PTP) for timing 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.

IETF (Internet Engineering Task Force): An international organization that develops the internet’s architecture and protocols, the IETF produces RFCs.

IFDV: Inter-Frame Delay Variation.

Ingress: The demarcation point at which a packet enters a network.

IP (Internet Protocol): The Layer 3 protocol in the IETF suite of protocols, its two versions are IPv4 (RFC 791) and IPv6 (RFC 2460).


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 (International Telecommunication Union): The agency of the United Nations (UN) responsible for issues that concern information and communication technologies.

ITU-T (ITU Telecommunication Standardization Sector): The ITU sector responsible for telecommunications standardization.

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): An OAM diagnostic mechanism used (e.g., by Y.1731) to detect two-way continuity failures.

LBM: Loopback Message.

LBR: Loopback Reply.

LCAS (Link Capacity Adjustment Scheme): A method (defined in ITU-T G.7042) to dynamically increase or decrease the bandwidth of virtual concatenated containers in SDH.

LC (Lock): An OAM mechanism used (e.g., by Y.1731) to communicate the administrative locking of a MEP and consequential interruption of data traffic.

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): An OAM mechanism used (e.g., by Y.1731) to measure packet loss ratio.

LOF: Loss of Frame alignment.

LOS: Loss of Signal.

LSP (Label Switched Path): The sequence of LSRs from domain ingress to egress.

LSR (Label Switched Router): A router supporting MPLS.

LT (Link Trace): An OAM diagnostic mechanism used (e.g., by Y.1731) to trace a flow’s path.

M:

MA (Maintenance Association): A set of MEPs, each configured with the same MAID and MD level, established to verify the integrity of a single service instance (equivalent to a maintenance entity group, or MEG, defined in Y.1731).

MAC: Media Access Control.
**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 SDAM 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):** An international organization promoting Carrier Ethernet

**MEG (Maintenance Entity Group):** See MA

**MEN:** A Metro Ethernet Network comprising a single administrative domain (see CEN)

**MEP (Maintenance Association End Point):** A demarcation point at the edge of a maintenance domain that sends, receives and responds to OAM

**MIB (Management Information Base):** A hierarchical database used for managing network elements (see SNMP)

**Microwave:** Radio waves with frequencies between 300 MHz and 300 GHz; electric substations and cellular base stations commonly use microwave for backhaul

**MIP (Maintenance Domain Intermediate Point):** A demarcation point internal to a maintenance domain that responds to OAM sent from a MEP

**Modbus:** A serial communications protocol allowing for communication between many devices, commonly used in SCADA systems

**MPLS (Multiprotocol Label Switching):** A technology to forward packets based on locally defined labels rather than unique addresses, MPLS is used to forward IP and pseudowire packets

**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**

**NAT (Network Address Translation):** A network element that manipulates IP addresses of packets (e.g., enabling packets with nonroutable private addresses to flow into the global internet)

**NERC (North American Electric Reliability Corporation):** A nonprofit corporation formed by the electric utility industry to promote the reliability and adequacy of bulk power transmission in North America

**NERC-CIP (NERC Critical Infrastructure Protection):** A set of requirements designed to secure the assets required for operating North America’s bulk electric system

**NETCONF:** An IETF network management protocol with mechanisms to install, manipulate, and delete configuration of network elements (see YANG)

**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

**NTP (Network Time Protocol):** The IETF protocol for timing distribution over IP networks

**O**

**OAM:** Operations, Administration and Maintenance

**On-Demand OAM:** OAM diagnostics actions that are manually initiated

**One-Way OAM:** An OAM exchange consisting of sending an OAM packet to a remote device for processing (e.g., one-way packet loss measurement, one-way delay measurement)

**Operator Virtual Connection (OVC):** An association of UNIs or ENNIs in a single operator’s CEN

**OSS (Operations Support System):** A system used by service providers to manage their networks, which supports functions such as network inventory, service provisioning, network configuration, and fault management

**P**

**P2P:** Point-to-Point

**PCP (Priority Code Point):** The field indicating CoS in a tagged Ethernet frame (colloquially called “P-bits”)

**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 two 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

Protection Switching: An automatic mechanism for network resilience in the event of failure of a network element or link

Pseudowire (PW): A technique for tunneling a service (such as TDM or Ethernet) over a packet switched network (such as Ethernet, MPLS, or IP)

PTP (Precision Time Protocol): See IEEE 1588

Q

QoE (Quality of Experience): A subjective measure of performance of an end-to-end communications path as perceived by a human end-user

QoS (Quality of Service): An objective measure of performance of a communications channel or network segment or path as indicated by parameters such as information loss rate and latency

R

RDI (Remote Defect Indication): An OAM messaging mechanism used (e.g., by Y.1731) to report a defect in the reverse direction

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

RFC (Request for Comments): Documents produced by the IETF

RFC 2544: An IETF benchmark methodology defining tests to measure performance characteristics (e.g., throughput) of packet forwarding devices

Rooted-Multipoint EVC: A multipoint EVC in which each UNI is designated as either a root or a leaf

RSTP (Rapid Spanning Tree Protocol): See STP

RTU (Remote Terminal Unit): A device that interfaces physical objects to a SCADA system

S

SA (Source Address): A header field identifier a packet's source

SAToP (Structure Agnostic TDM over Packet): A TDM pseudowire protocol (defined in RFC 4553) that is agnostic to the TDM structure (such as framing or channelization)

SCADA (Supervisory Control and Data Acquisition): An industrial computer system that monitors and controls a process, in electric utilities, SCADA monitors electric assets in substations

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 either towards the network or towards the subscriber

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

Service Level Specification: The technical specification of the service level

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)

SFP (Small Form-Factor Pluggable): A compact, hot-pluggable optical transceiver

SHDSL (Single-Pair High speed Digital Subscriber Line): A symmetric-rate DSL transmission standardized in ITU-T G.991.2, originally at rates of 192 kbps to 2.3 Mbps over a single pair (2-wire), or 384 kbps to 4.6 Mbps over 4-wire, but extended up to 5.69 Mbps over single pair (2-wire) and up to 22.8 Mbps over 8-wire

Single-Ended (in OAM): A process whereby a MEP sends a measurement request and its peer MEP replies with the requested information so the originating MEP can complete its measurement
SLM (Synthetic Loss Measurement): An OAM diagnostic mechanism used (e.g., by Y.1731) to estimate packet loss ratio using synthetic traffic

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): An IETF protocol for managing network elements (see MIB)

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

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

SOAM (Service Operations, Administration, and Maintenance): A set of mechanisms defined by MEF for monitoring connectivity and performance of CEN entities

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

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

Substation: See Electric Substation

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

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 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

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 synthesized for the purpose of OAM and not carrying user data

T

T1: A 1.544 Mbps signal that supports 24 DS0s, which may be telephony-grade voice channels

TC (Traffic Class): The field representing CoS in an IPv6 or MPLS network (in the latter case, previously called EXP)

TCO (Total Cost of Ownership): An estimate of the direct and indirect costs over the lifetime of the product or system

TCP (Transmission Control Protocol): The Layer 4 protocol (initially defined in RFC 2460) of the IETF suite of protocols

TDMoIP (TDM over IP): A TDM pseudowire protocol (defined in RFC 5087) that takes advantage of TDM structure (such as framing or channelization)

Teleprotection: In electric utilities, 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

Timing over Packet (ToP): Any method for distribution of timing (frequency, phase, or Time-of-Day) information over a packet network, such as 1588 or NTP

TLV (Type, Length, Value): An extensible method of encoding an information element

ToD (Time of Day): “Wall clock” time referenced to a primary time reference clock

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.

TWAMP (Two Way Active Measurement Protocol): A protocol, defined in RFC 5357, for actively measuring two-way metrics between IP network elements.

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.

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 a CEN subscriber to a CEN 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 a CEN to a CEN subscriber implementing a UNI-C.

Unscheduled Downtime: A time during which the service provider determines that the service is not useable which is not scheduled downtime.

Up-MEP: An MEP that sends frames towards 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.

vCPE (Virtual CPE): The virtualization and relocation of at least part of the functionality of a CPE.

VID: VLAN Identifier.

Virtual NID (vNID): A functionality is provided by the access provider (AP) to the E-Access service purchased by the service provider (SP), allowing the SP to read and set values of objects in the NID management information base.

Virtual UNI (VUNI): The component consisting of a collection of service attributes in the VUNI provider’s network.

VLAN: Virtual LAN.

VLAN ID: VLAN Identifier.

VNF (Virtual Network Function): A networking functionality implemented in software for placement on a standard processor.

W

WAN: Wide Area Network.

WTR (Wait to Restore): A state in a protection switching protocol entered once the failure has been cleared.

X

XML (eXtensible Markup Language): A method of storing data in a format that is both human-readable and machine-parsable.

Y

Y.1564: An ITU-T standard for Ethernet service activation testing.


YANG: An IETF standard data modeling language for modeling configuration of network elements (see NETCONF).

1

1DM: A Y.1731 message used for one-way delay measurement.
Welcome to the RADadvantage Partners Program

Commitment. Trust. Respect. Partnership. These are just some of the values that comprise the essence of RADadvantage, RAD’s channel partner program. Ultimately, the success of a partnership is measured by the benefits that are enjoyed by all parties: the vendor, its partners, and their respective end-users. That’s why RAD places immense value on its network of channel partners and aims to make selling RAD products and services both easy and lucrative.
Shared Interests and Commitments

RAD and its channel partners embrace a set of fundamental guiding principles, including:

- Work together to deliver the highest quality products, solutions and services that create loyal end-users
- Aim to maximize profitability for both parties
- Conduct business in an atmosphere of trust and mutual respect
- Resolve problems with candor and good judgment
- Cooperate to win new business and improve existing opportunities

RADadvantage Program Highlights

The RADadvantage Partners Program is designed to incrementally reward partners based on achievements in annual revenues, service level accreditation and commitment. Designated partnership levels are reviewed and adjusted annually.

RADadvantage partners enjoy benefits such as:

- Industry-leading margins
- Distribution of new, profitable sales opportunities
- Deal protection for registered projects
- Deeply discounted demo gear
- Support for joint marketing activities
- Official acknowledgment of reselling relationship
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 generations 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 strategy, umbrella. This decentralized approach maximizes the advantage 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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