
RAD
Your Network's Edge®
Service
Assured
Solutions
2017 Catalog

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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, mass transportation systems, and government agencies.

We are at the forefront of pioneering technologies, such as:

- Flexible virtual CPE deployments
- Performance monitoring overlay for any network
- Timing synchronization over packet
- Hardware miniaturization
- TDM over packet

For mobile, business and wholesale service providers, we provide an economical migration path to virtualization. In addition, our **Service Assured Access** solutions are designed to deliver a competitive edge: better QoE to reduce churn, service agility to minimize time to revenue, complete visibility of network and service performance for greater operational efficiency, and timing synchronization for LTE/LTE-A deployments.

For power utilities, mass transportation companies and government agencies, our **Service Assured Networking** solutions include best-of-breed tools for cyber-secure critical infrastructure communications, mobility, and seamless migration to modern packet switched networks and applications.

With 35 years of innovation, a significant worldwide presence in over 150 countries and an installed base of more than 15 million units, RAD has a proven track record of delivering value and addressing our customers' needs.

RAD is a member of the $1.25 billion RAD Group of companies, a world leader in telecommunications solutions.

vCPE at the Customer Edge

for Business Services

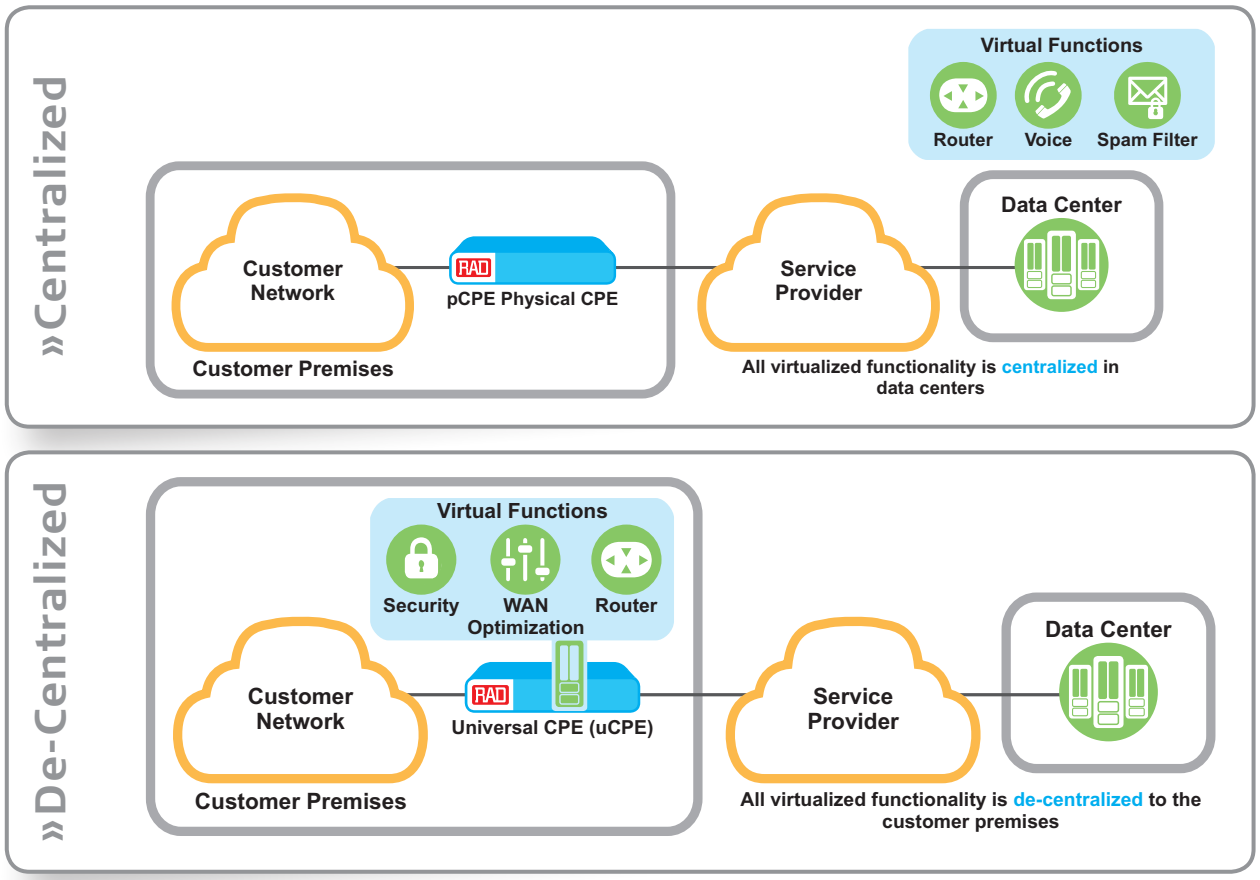
Virtualization by RAD

RAD, the industry pioneer of network edge virtualization, provides flexible vCPE platforms for the customer edge to fit diverse deployment scenarios. RAD offers a complete solution that includes L2/L3 NIDs featuring a virtualization engine, physical CPE (pCPE) devices, enhanced white box (Whitebox+) offerings, a powerful operating system (vCPE-OS) pre-integrated into RAD devices and available for third-party white box platforms, pluggable devices to accelerate server performance, and management and orchestration for the network edge.

This solution is complemented by RAD's D-NFV Alliance, an ecosystem of network orchestrator and VNF vendors, as well as international system integrators specializing in new pre-certified NFV/vCPE applications.

vCPE Deployment Modes

Different uses for different markets and service needs:



RAD's vCPE Building Blocks

Hybrid	Software	Hardware
Whitebox+ ETX-2i hybrid platform with embedded physical network functions (PNFs)	**White Box** ETX-2v pure compute platform	**Pluggable PNFs** MiNID, MiRIC, MiTOP, MiCLK
• Pay-as-you-grow flexibility allows operators to spin-up virtual managed services, from security to routing, SD-WAN to IT services, and much more		• Pluggable PNFs to enhance white box: MEF 2.0 NID, PM responder/generator, PDH/SDH/SONET uplink, TDM user interface, 1588 PTP GM
• Powerful, carrier-class operating system allows service providers to control all devices and functions; integrated networking functions and flexible access management on RAD or third-party vCPEs		• Compatible with third-party white box devices
• Single HW platform to optimize inventory		
• RADview domain orchestration to deploy and chain VNFs		
• Cost-optimized white box vCPE for business services with optional license-based PNFs: routing, NID, tunneling, performance monitoring		
• Whitebox+ delivers wire-speed networking performance while preserving CPU resources for instantiation of additional VNFs		
• Preserve established network operations procedures; avoid extra boxes		

vCPE Best Sellers:

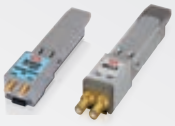
vCPE Platforms, Operating System

ETX-2i, ETX-2v, vCPE-OS

Operating System, Management and Orchestration

RADview, vCPE-OS

Pluggable PNFs

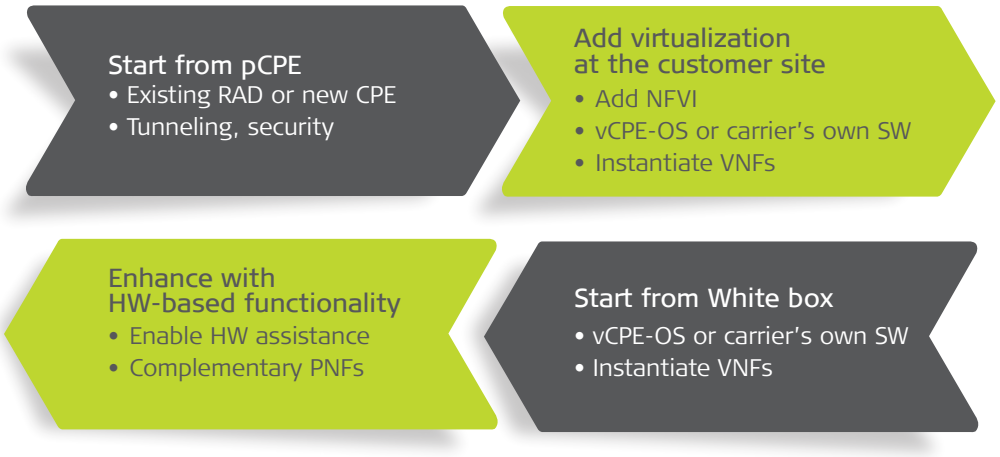


MiNID, MiCLK, MiRIC, MiTOP

Phased vCPE Deployment

Different starting points to the same destination

RAD's innovative approach enables service providers to start with a white box uCPE that can host VNFs, and then later activate licensed-based PNFs (e.g., a NID or hardware-based router functionality). Alternatively, a customer can be started off with a L2/L3 NID, with a modular x86 server added later for VNF hosting and full uCPE functionality:



D-NFV Alliance

RAD's Distributed NFV (D-NFV) Alliance is an ecosystem of application developers and virtual function vendors addressing the enterprise market, as well as orchestrator vendors offering network-wide managed end-to-end solutions, from the cloud to the customer premises. Once tested and approved by RAD, these applications are made available to service providers around the globe via RAD's vCPE platforms, to enhance their service offering for enterprise and SMB customers. D-NFV Alliance applications include:

Security

- Firewall
- Web filtering
- Intrusion Prevention System
- Anti-virus
- Encryption

Networking

- WAN optimization
- Router
- Application awareness
- WiFi controller

Unified Communications

- IP-PBX
- VoIP GW
- Fax
- Video
- SBC

Testing Tools

- Traffic analyzers
- Troubleshooting applications
- Network monitoring

General Applications

- Enterprise IT
- Business intelligence
- CRM
- Lawful interception

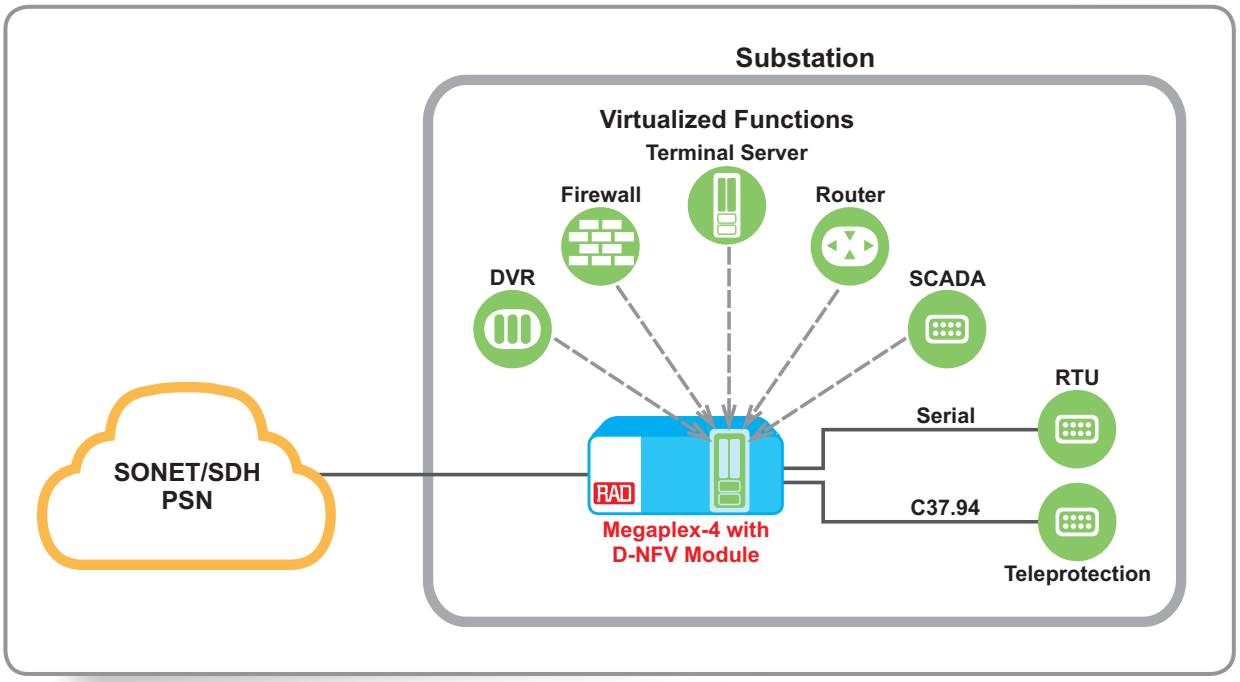
Performance Monitoring

- TWAMP
- Application performance
- Packet collection
- Accounting
- Policy enforcement

Versatile Add-On Functions

for Critical Infrastructure

Virtualization by RAD



- 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

Multiservice Access Node with D-NFV

Megaplex-4

D-NFV Orchestrator

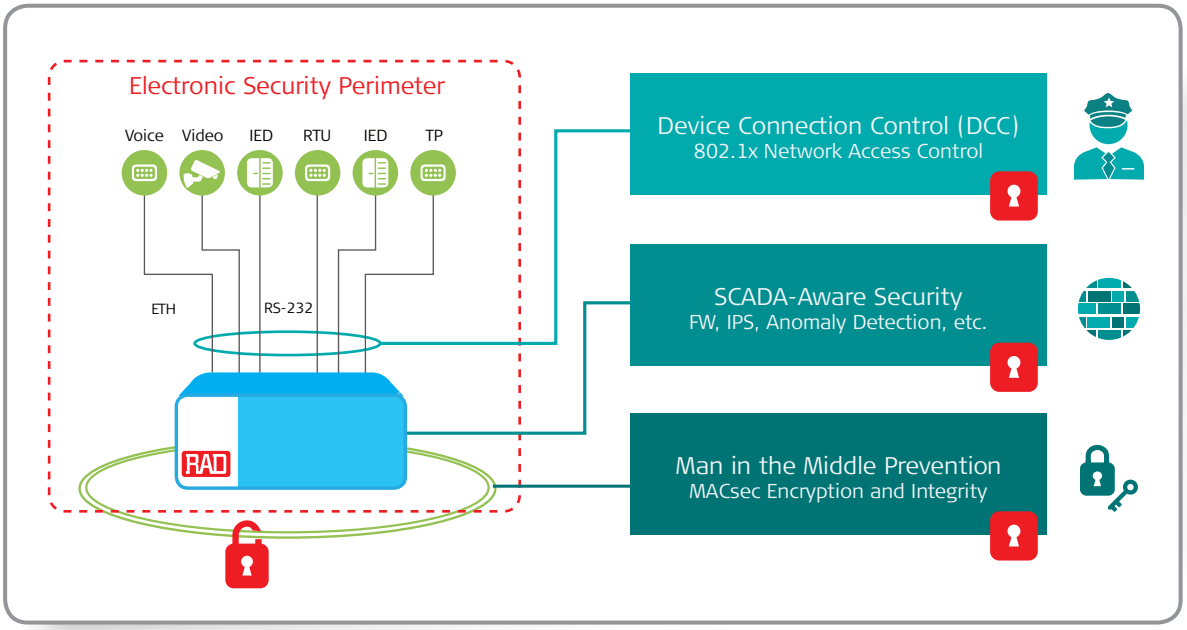
RADview

Cyber Security
for Critical Infrastructure

Cyber Shield by RAD

As critical infrastructure networks become smarter, automated and more connected, they are also more susceptible than ever to cyber threats. Communication networks of power grids, water systems, public transportation, and oil rigs are subjected to hundreds, sometimes thousands of cyber attacks per day. RAD's secure-by-design Service Assured Networking solutions ensure that your operational network remains reliable and protected at all times.

3-Tier Electronic Security Perimeter (ESP) Protection



Multiservice Access Node with D-NFV

Megaplex-4

Ruggedized SCADA-Aware Gateway/Switches and Routers

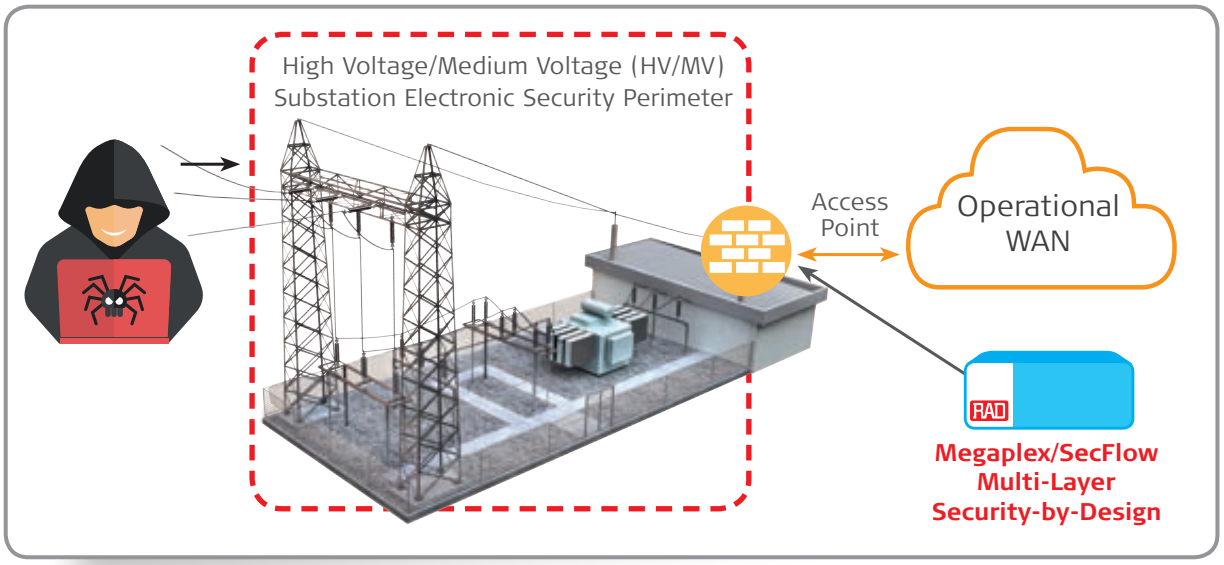
SecFlow®

Scan for cyber security video

Boosting NERC-CIP Compliance

RAD's SAN solutions are in line with recent North American Electric Reliability Corporation Critical Infrastructure Protection (NERC-CIP) directives to boost your cyber security and compliance levels:

- Encryption and integrity for all communications outside ESP
- Application (SCADA) aware firewall
- Record/monitor all device connections in substations



- Cyber Shield solution protects from attacks on SCADA and management traffic
- Strategically located to securely manage all electronic access to the substation's ESP, and to protect the cyber assets within it from external and internal attacks:
  - Device connection control (DCC) using IEEE 802.1x Network Access Control to ensure authenticated and authorized internal substation connections
  - SCADA-aware security layer, including firewall, intrusion prevention, anomaly detection, and more
  - IEEE 802.1AE (MACsec) and IPsec encryption and data integrity verification to prevent source-spoofing, session hijacking, man-in-the-middle and Distributed Denial of Service (DDoS) attacks
- Boost compliance level with NERC-CIP requirements for bulk electric systems (BES) protection
- Layered security approach addresses all vulnerability points including integrity, confidentiality (encryption), authentication, authorization, and auditing
- Access control, user authentication and privilege-level associations for local and remote access using Secure Shell (SSH), TACACS or RADIUS

RAD Solutions

Service Assured Access Solutions for Service Providers

RAD offers communications service providers, who are facing exponential growth in bandwidth requirements and increasing competition from web giants and OTT providers, a wide range of Service Assured Access (SAA) solutions. RAD's SAA solutions are designed to improve the way CSPs compete, with better service agility and lower TCO. They harness RAD's state-of-the-art innovation, including flexible vCPE for business services, performance monitoring for any network, and cost-effective timing synchronization for mobile networks.

RAD provides the most comprehensive service life-cycle toolkit to easily plan, provision and orchestrate MEF-certified Carrier Ethernet 2.0 and IP services over any access. In addition, we facilitate a smooth, low-risk transition to NFV/SDN-based programmable networks.

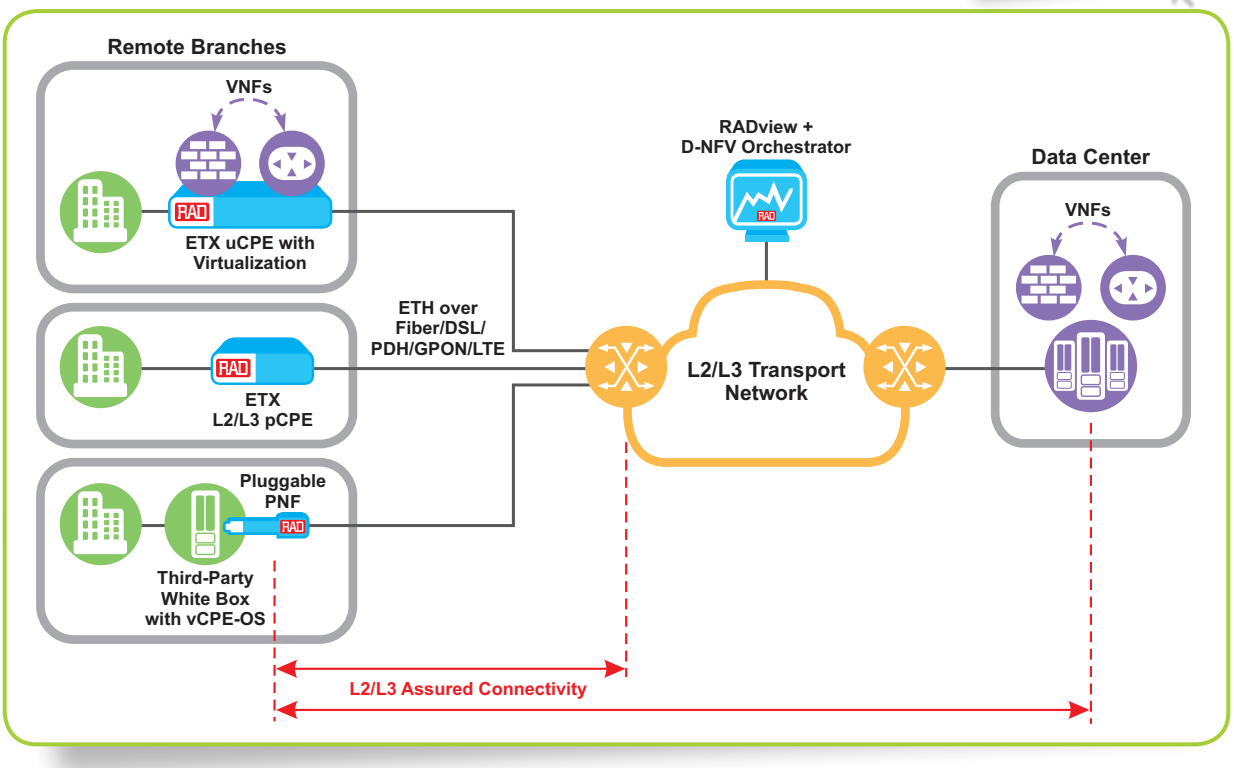
Service providers around the world rely on RAD's Service Assured Access solutions to automate their services, boost quality of experience (QoE) and maximize revenues. Key SAA solutions include:

- vCPE functionality for faster service rollouts and easier operations, including edge domain orchestration and alliance of VNF and orchestration vendors
- Powerful performance monitoring add-on for any network
- World's first distributed Grandmaster in an SFP for LTE/LTE-A and small-cell timing synchronization
- SLA-assured service life-cycle management
- TDM and PSN services and migration

Scan for vCPE market report

vCPE

Virtualization by RAD
See Pages 4-6



Your Benefits:

- Fits any vCPE implementation mode: centralized, de-centralized, or a mixture of both, allowing flexible virtualization of business CPE functionalities across access, aggregation and core domains
- Cost-optimized white box vCPE for business services with optional license-based physical network functions (PNFs): routing, NID, tunneling, performance monitoring
- Integrated and optimized compute resources enable remote deployment of network functions and value-added services; VNF download and service-chain configuration are performed with a powerful and intuitive edge orchestrator
- CPU hardware offload, together with forwarding plane acceleration, allows consistent and predictable wire-speed performance with built-in service assurance, freeing up CPU resources for additional services
- Pluggable Physical Network Functions (PPNF) allows assured seamless connectivity over Ethernet fiber/copper, WiFi, xDSL/PDH/GPON, as well as LTE (uplink/backup)
- RAD operating system (vCPE-OS) runs on RAD or third-party white box platforms

Products Included in this Solution:

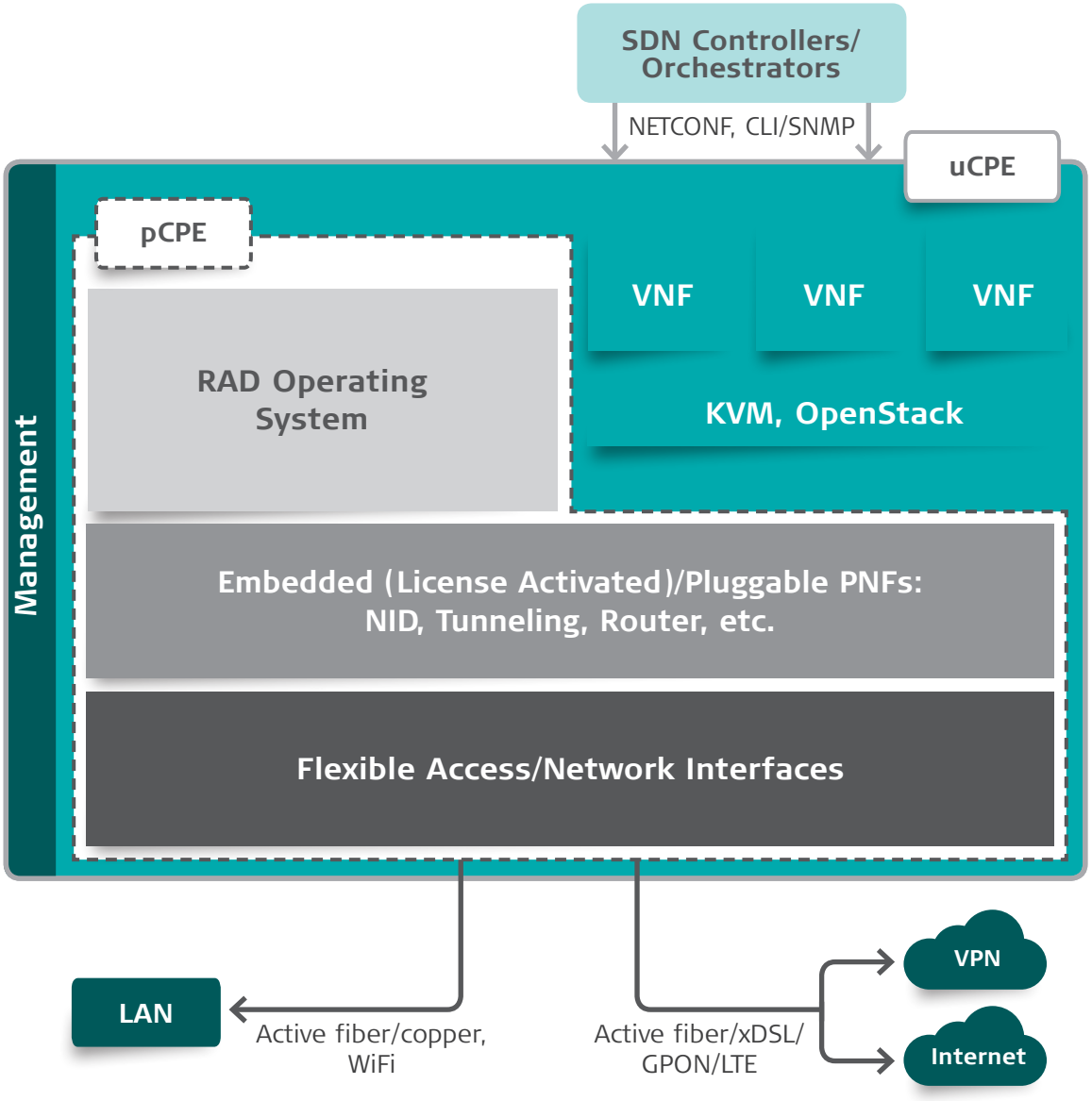
ETX-2i, ETX-2v, vCPE-OS
vCPE Platform, Operating System

MiNID
Miniature Programmable Network Interface Device

RADview, vCPE-OS
Operating System, Management and Orchestration

Scan for vCPE video presentation

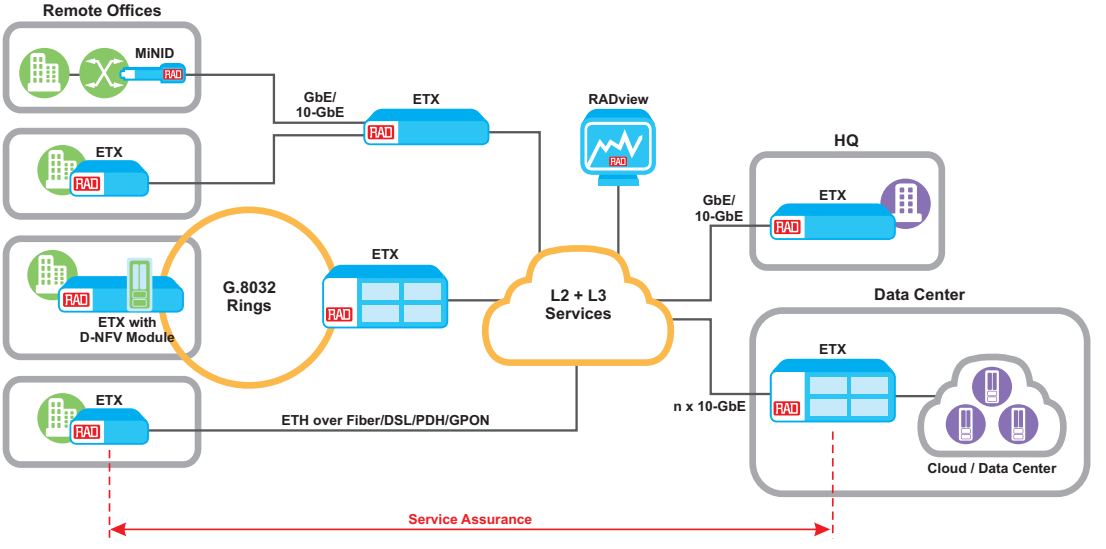
vCPE system architecture



- Open NFV/SDN architecture facilitates integration with network-wide orchestrators and SDN controllers
- Powerful, carrier-class operating system (vCPE-OS), pre-integrated on RAD vCPE platforms and also available for third-party white box devices

Carrier Ethernet and IP VPNs

Virtualization by RAD
See Pages 4-6



Your Benefits:

- Easily plan, deploy, provision, and maintain SLA-based business and cloud access services with the same "look and feel" over any access: fiber/copper/TDM/wireless
- 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
- Instant upgrades to existing equipment with MiNID service assurance booster
- Enhanced service provisioning, visibility and reporting using RADview Service Manager and RADview Performance Monitoring portal
- vCPE (Distributed NFV) functionality for service agility and premium offerings at the customer edge

Products Included in this Solution:

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

ETX-5
Ethernet Service Aggregation Platform

MiNID
Miniature Programmable Network Interface Device

RADview
Network Management and Orchestration

Performance Monitoring for Business VPNs

Virtualization by RAD
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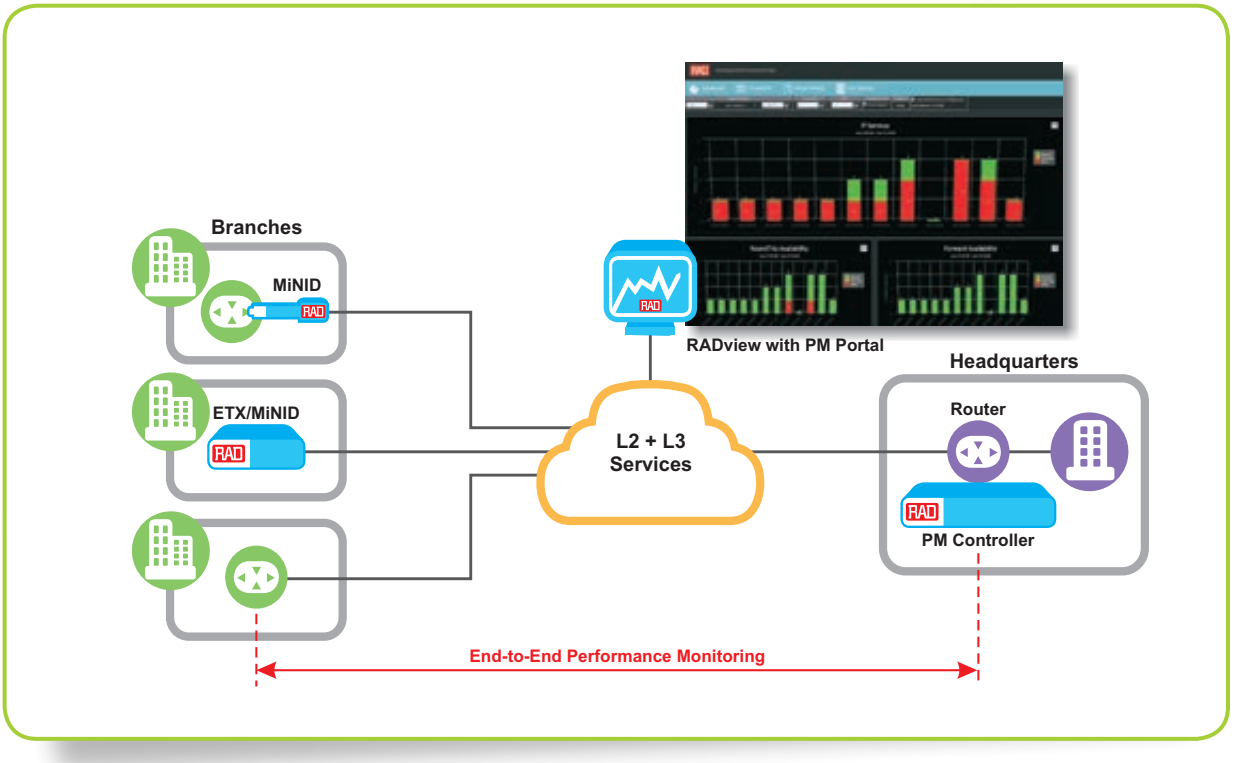


Your Benefits:

- Performance monitoring for L2, L3 VPNs to assure service level agreement (SLA) for businesses
- PM Controller functionality supports Y.1731, TWAMP, ICMP Echo ("ping"), and UDP Echo opposite RAD devices or third-party responders
- RADview PM supports SLA reporting with drill-down capabilities per PM session
- Optional service assurance upgrade with MiNID:
  - Easy plug-and-play installation in existing installed base
  - Unique form factor reduces space and power consumption requirements
  - L2 (Y.1731) and L3 (TWAMP) test generation and response
  - Service activation testing
  - Analysis of micro-bursts affecting QoE
- Deep end-to-end visibility and performance monitoring across heterogeneous networks and equipment types, independent of installed-base capabilities

Products Included in this Solution:

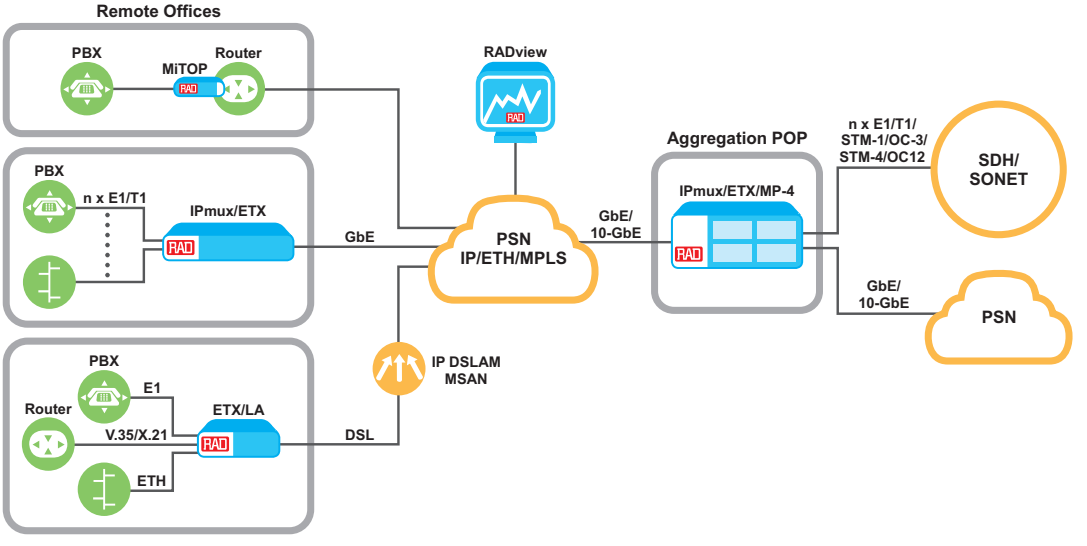
ETX-2/ETX-2i
IP and Carrier Ethernet Demarcation with D-NFV

MiNID
Miniature Programmable Network Interface Device

PM Controller
Performance Monitoring Generator

RADview
Network Management and Orchestration

TDM Services over Packet Networks



Your Benefits:

- 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, 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
Network Management and Orchestration

Hybrid TDM and Ethernet Access

Virtualization by RAD
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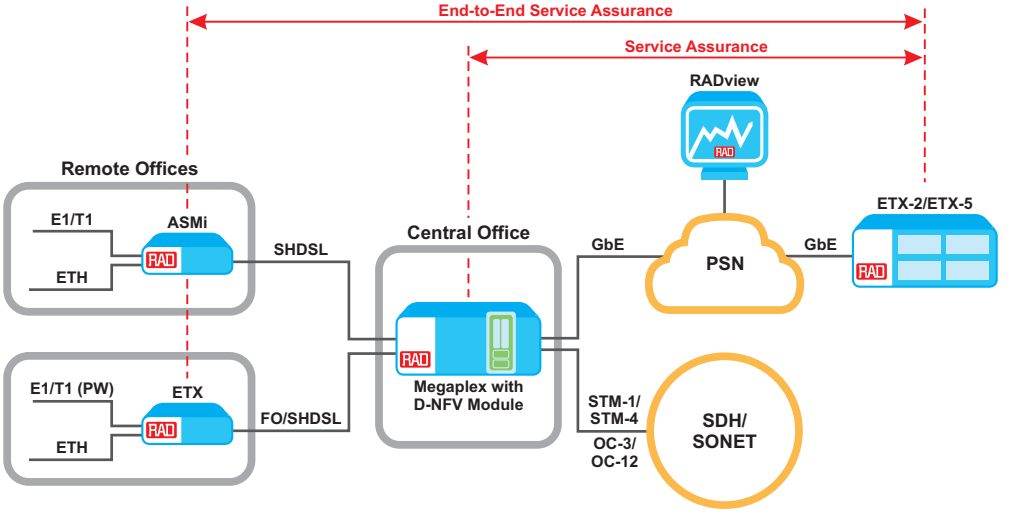

Your Benefits:

- 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 Node

RADview
Network Management and Orchestration

Mobile Backhaul

Virtualization by RAD
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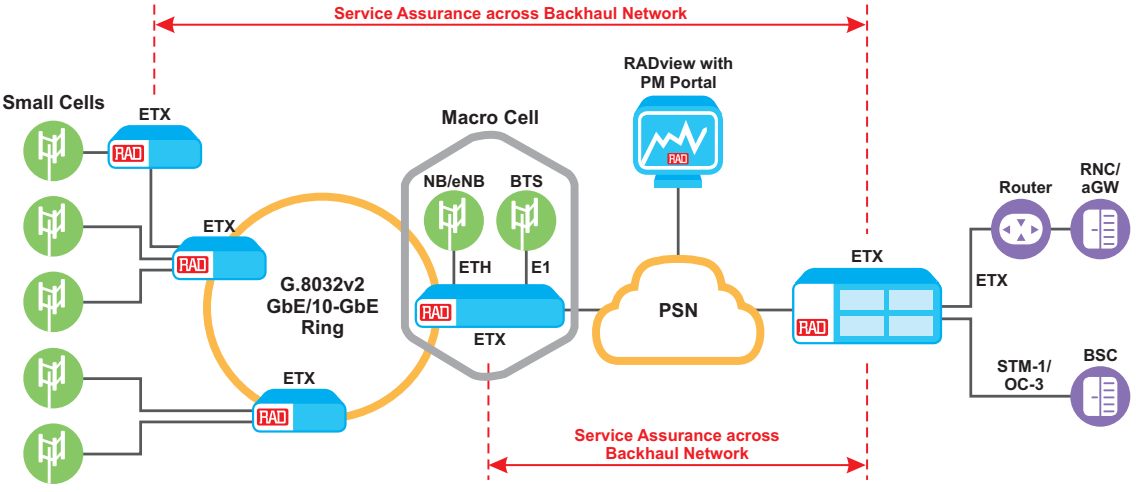

Your Benefits:

- Highly efficient small-cell aggregation:
  - Flexible topologies (hub and spoke, ring)
  - Small form factor to meet space and power supply restrictions
  - Timing synchronization
- Ensure service visibility and control service level objectives (SLOs) in small-cell backhaul
- Multi-CoS Carrier Ethernet/ IP backhaul 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 for 2G/3G
- Fiber, SHDSL/VDSL, GPON, PDH support

Products Included in this Solution:

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

ETX-5
Ethernet Service Aggregation Platform

RADview
Network Management and Orchestration

Performance Monitoring for Mobile Networks

Virtualization by RAD
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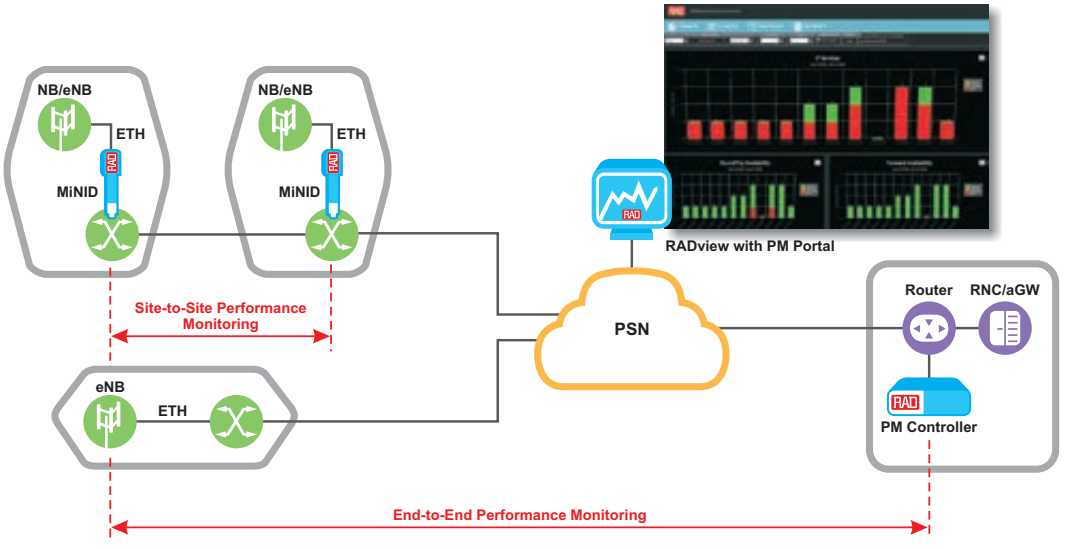


Your Benefits:

- Monitoring and troubleshooting backhaul performance, including LTE X2, S1 traffic path
- Service activation tests (RFC-2544/Y.1564) and continuous performance monitoring
- PM Controller functionality (appliance/VNF) supports Y.1731, TWAMP, ICMP Echo ("ping"), and UDP Echo opposite RAD devices or third-party responders
- High precision one-way measurements opposite any TWAMP responder
- RADview Performance Monitoring portal for SLA reporting
- Enhanced service assurance with MiNID:
  - Easy plug-and-play installation in existing backhaul networks
  - L2/L3 test generation and response capabilities
  - Remote packet capture for deep traffic analysis

Products Included in this Solution:

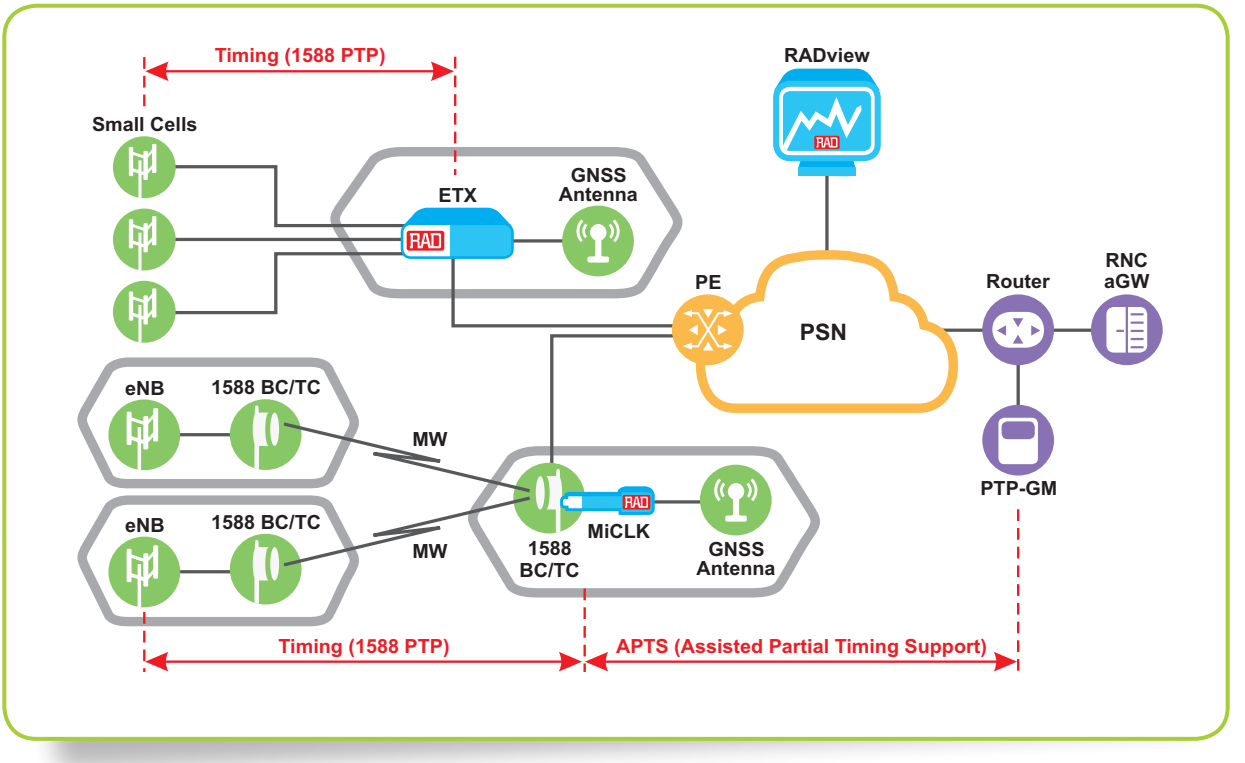
MiNID
Miniature Programmable Network Interface Device

PM Controller
Performance Monitoring Generator

RADview
Network Management and Orchestration

Scan for customer video

Timing Synchronization for Mobile Networks



Your Benefits:

- Addressing stringent timing requirements (frequency/phase) for LTE/LTE-A macro and small cells with a fully featured PTP Grandmaster:
  - ETX-2 in a local POP/hub
  - MiCLK unique SFP plugged into an aggregation switch
- Cost efficiency by bringing PTP Grandmaster closer to the cell site
- Built-in GNSS receiver (GPS/Glonass/BeiDou)
- Full network coverage, even in underground and indoor installations
- No need to install GNSS antenna on every cell site; avoid spoofing and jamming
- Fits existing installed base – no need for CapEx investments in retrofitting network with 1588 BC/TC support across the entire path
- Robust GNSS backup – time holdover for 72 hours, using Sync-E or 1588 frequency references from the network (Assisted Partial Timing Support)

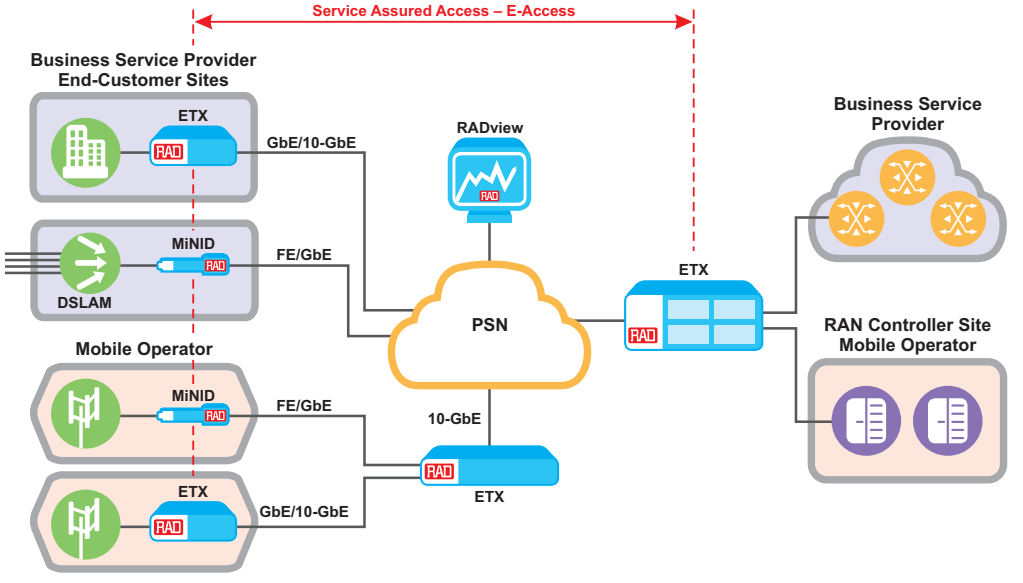
Products Included in this Solution:

ETX-2
IP and Carrier Ethernet Demarcation

MiCLK
1588 Grandmaster on an SFP

RADview
Network Management and Orchestration

Wholesale Networking



Your Benefits:

- Provide wholesale Carrier Ethernet transport services to multiple service providers with complete visibility and controlled service hand-off between multiple networks
- Demarcation for business, mobile and DLSAM backhaul 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 for legacy switches, routers and third-party equipment with the MiNID service assurance booster

Products Included in this Solution:

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

ETX-5
Ethernet Service Aggregation Platform

MiNID
Miniature Programmable Network Interface Device

RADview
Network Management and Orchestration

Service Assured Networking Solutions for Critical Infrastructure

Carrier Ethernet = The Next-Generation SDH/SONET

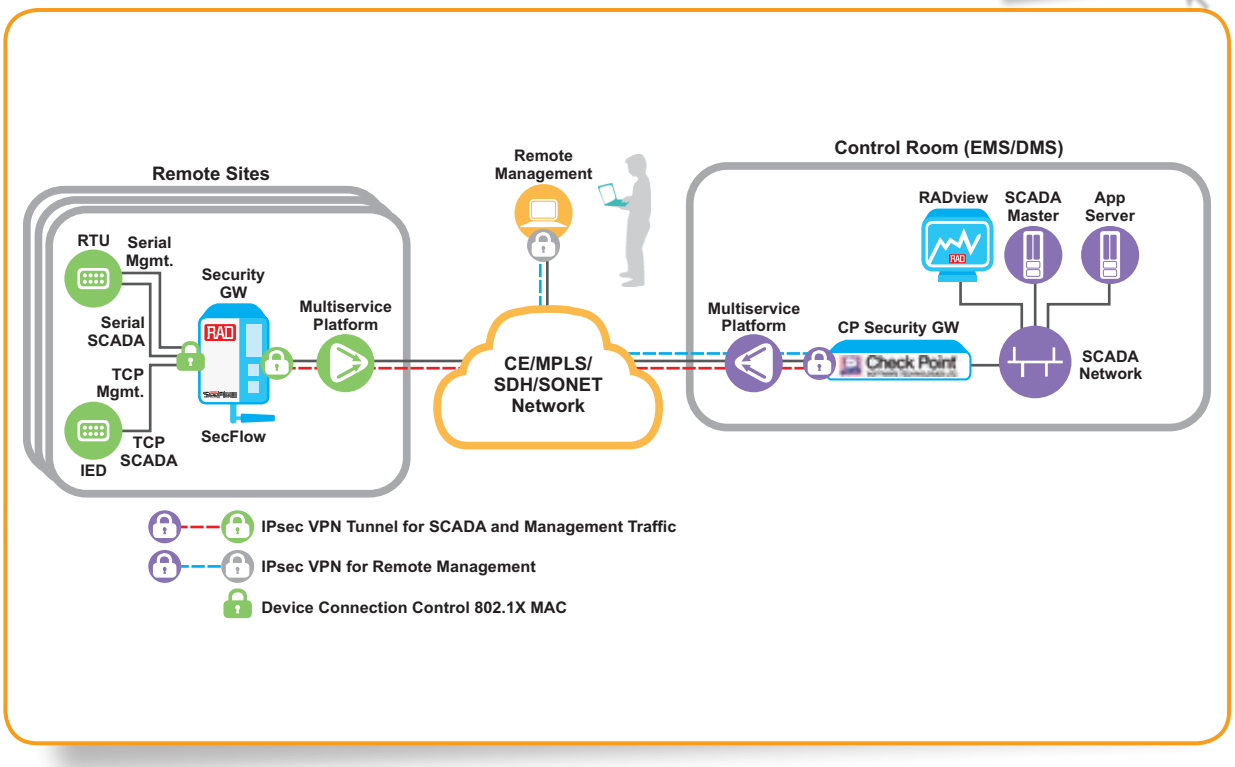
RAD provides Service Assured Networking solutions that ensure seamless migration to packet-switched communication networks and applications.
We address all the mission-critical communication needs of the utilities, transportation and government sectors.

Offering best-of-breed reliability tools, our Service Assured Networking solutions are used for SCADA and WAN communications, cyber security, and distribution automation, as well as Smart/Safe City deployments.

Scan for "Future of Power Grids" paper

Cyber Shield for Critical Infrastructure

Cyber Shield by RAD
See Pages 8-9



Your Benefits:

- RAD's SecFlow substation security gateway isolates industrial control systems (ICS)/automation devices from attack vectors on management and SCADA planes:
  - Cyber Shield for management traffic (NERC CIP Intermediate System)
  - Cyber Shield for SCADA traffic
- Upgrades existing operational technology (OT) networks with Intermediate System for secure remote and local access, SCADA-aware firewall, Intrusion Prevention System functionality, man-in-the-middle attack prevention, encryption, device connection control, event logger, and anomaly detection
- Fits any OT network architecture and ICS/SCADA device connectivity (serial or TCP)
- The most comprehensive and cost-effective solution on the market simplifies multi-box alternatives

Products Included in this Solution:

SecFlow-1
SCADA Secure Switch/Routers

Check Point Security Gateway

RADview
Network Management and Orchestration

Scan for Cyber Shield demo video

Power Utility Communications

Cyber Shield by RAD
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Virtualization by RAD
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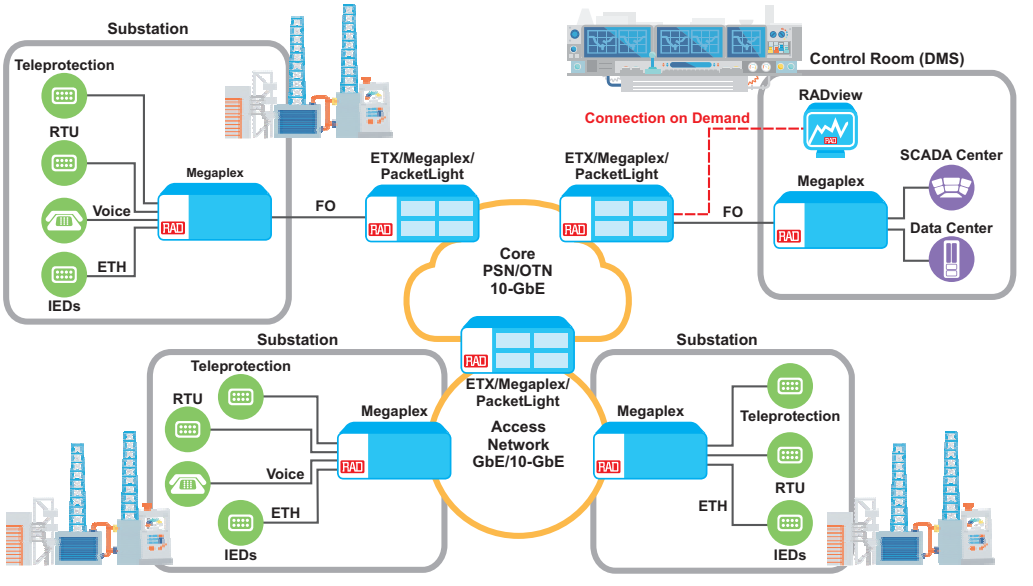
1 Multiservice Operational Network



Your Benefits:

- Powerful cross-generation TDM and Ethernet capabilities, including TDM DS0 cross connect and SDH/SONET, Gigabit Carrier Ethernet with OAM and assured QoS, TDM pseudowire, Ethernet over NG-PDH/SDH/SONET, and OTN/DWDM
- Complete cyber attack prevention suite, including encryption, authentication, authorization, and auditing
- Easily configurable connectivity of all serial automation and Teleprotection devices to either SDH/SONET network or to a packet 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 hybrid design for reduced latency and better resiliency
- Future-ready with virtualization capabilities for adding new applications (security, router, SCADA) using RAD's innovative x86 D-NFV module

Products Included in this Solution:

ETX-5
Ethernet Service Aggregation Platform

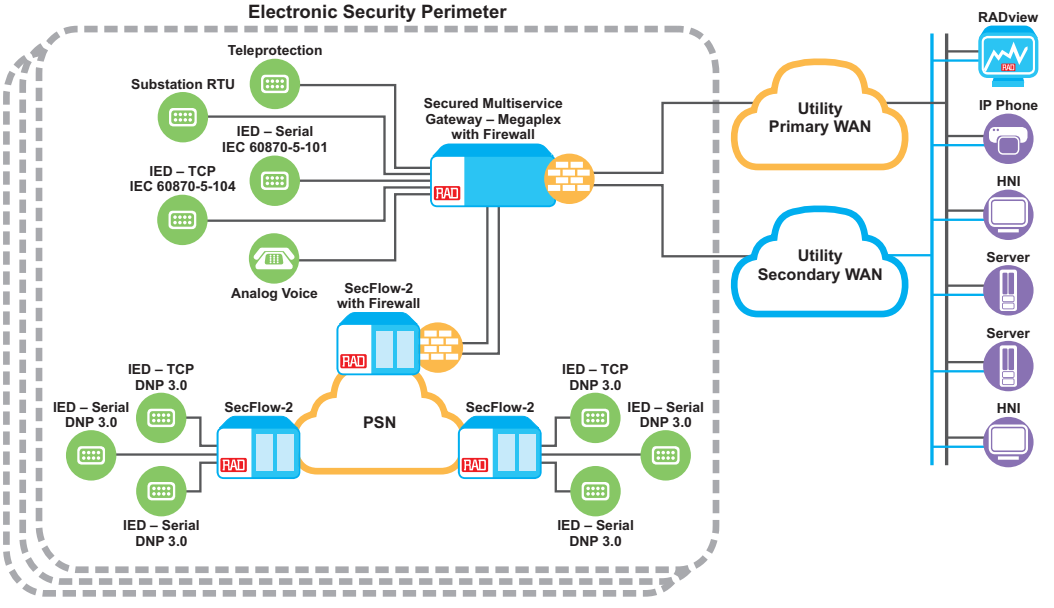
Megaplex-4
Next-Generation Multiservice Networking Node

RADview
Network Management and Orchestration

PacketLight
Complete Solutions for WDM/OTN and Dark Fiber Applications

Cyber Shield by RAD
See Pages 8-9

2 Ruggedized Substation LAN



Your Benefits:

- 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, 3G/4G 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, DNP 3.0 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:

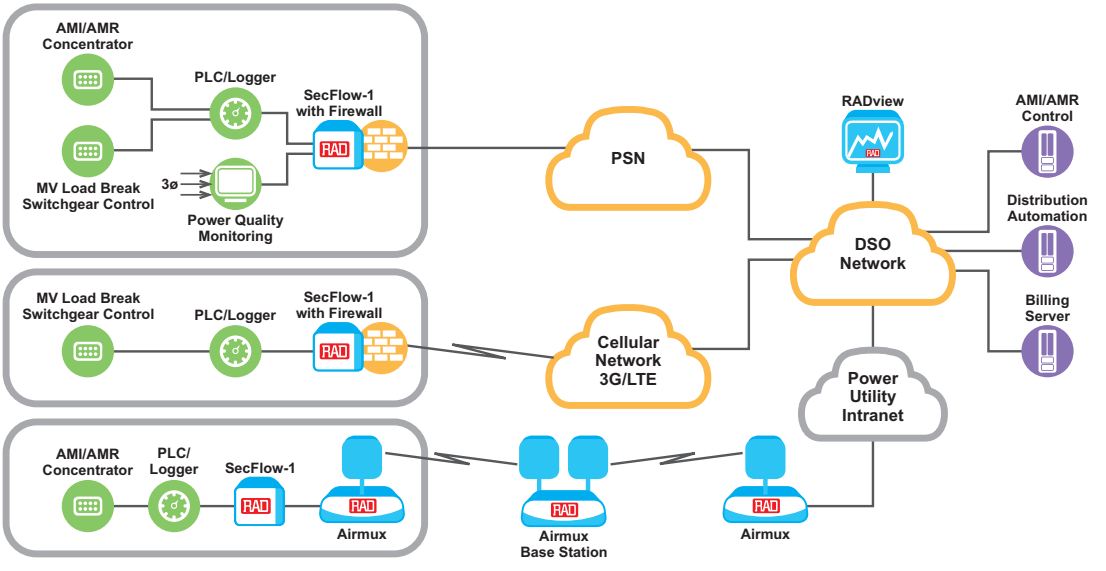
Megaplex-4
Next-Generation Multiservice Networking Node

RADview
Network Management and Orchestration

SecFlow-2
Ruggedized SCADA-Aware Ethernet Switch/ Router

Cyber Shield by RAD
See Pages 8-9

3 Distributed Automation and Smart Meter Backhaul



Your Benefits:

- 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 IPsec with SCADA-aware firewall and encryption
- 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
- Transparent delivery of SCADA protocols

Products Included in this Solution:

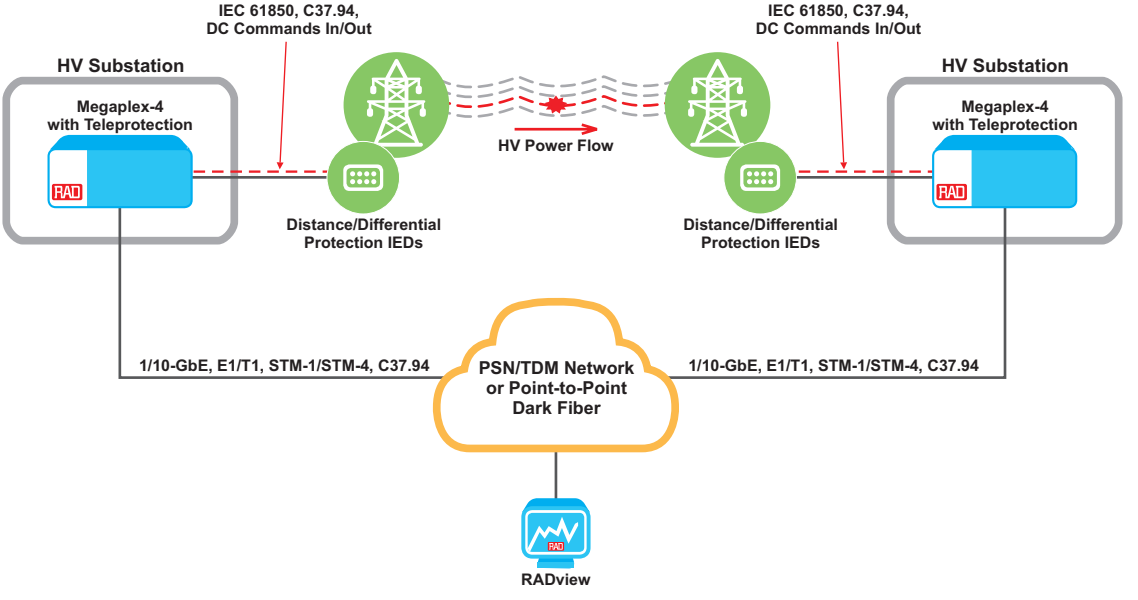
Airmux-5000
Point-to-Multipoint Broadband Wireless Access

RADview
Network Management and Orchestration

SecFlow-1
Ruggedized SCADA-Aware Gateway

Cyber Shield by RAD
See Pages 8-9

4 Distance and Differential Protection Communications



Your Benefits:

- 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 communication over any infrastructure
- Reduce CapEx and OpEx by using a single-box solution for all substation communication 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:

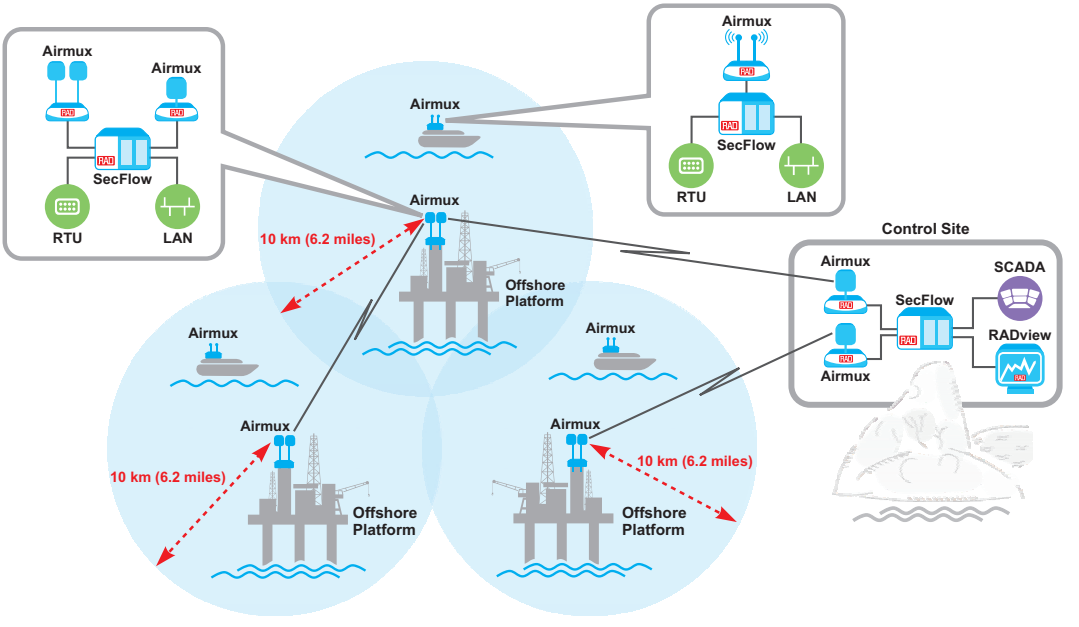
Megaplex-4
Next-Generation Multiservice Networking Node

RADview
Network Management and Orchestration

Oil & Gas Utility Communications

Cyber Shield by RAD
See Pages 8-9

1 Offshore Communications



Your Benefits:

- Support bi-directional broadband connectivity to deliver real-time video, internet access (WiFi), telemetry, data, and VoIP to supply and service vessels
- Up to 100 Mbps total available throughput per vessel
- 360° mobility coverage across a range of up to 10 km (6.2 miles)
- 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-400
Point-to-Point Broadband Wireless Access

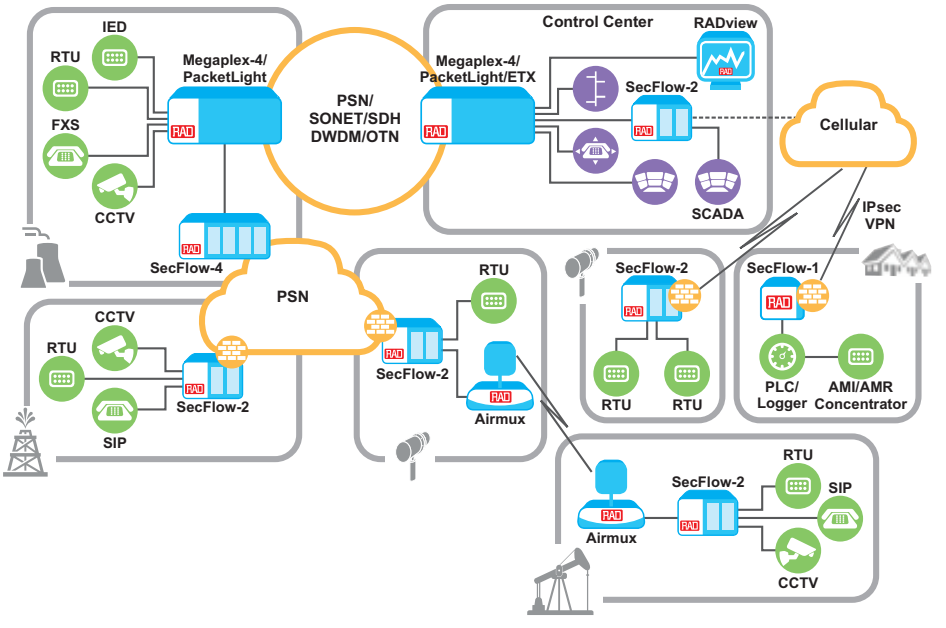
Airmux-Mobility
Mobile Wireless Access

RADview
Network Management and Orchestration

SecFlow-2
Ruggedized SCADA-Aware Ethernet Switch/Router

Cyber Shield by RAD
See Pages 8-9

2 Multiservice Operational Network for Oil & Gas Utilities



Your Benefits:

- Cyber-secure SCADA connectivity for compressor stations, storage tanks, LACT and flow meters, cathodic protection, etc.
- Multiservice aggregation for any transport network, including SDH/SONET, PSN and OTN/DWDM
- Complies with environmental standards for outdoor installation 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 (74.5 miles)
- Supports all communication needs, including SCADA protocols, voice and new packet services (CCTV, VoIP, etc.)

Products Included in this Solution:

Megaplex-4
Next-Generation Multiservice Networking Node

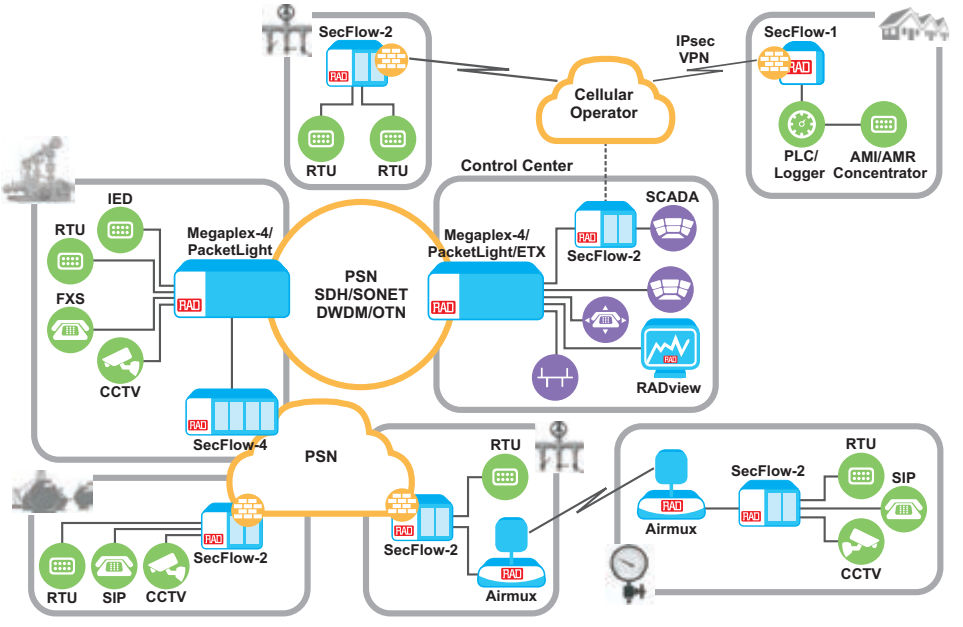
PacketLight
Complete Solutions for WDM/OTN and Dark Fiber Applications

RADview
Network Management and Orchestration

SecFlow-2
Ruggedized SCADA-Aware Ethernet Switch/Router

Water Utility Communications

Cyber Shield by RAD
See Pages 8-9



Your Benefits:

- Cyber-secure SCADA connectivity for water monitoring and automation devices, sensors, pumps, surface and groundwater availability tracking devices, etc.
- Multiservice aggregation for any transport network, including SDH/SONET, PSN and OTN/DWDM
- Complies with environmental standards for outdoor installation in harsh conditions
- Supports any available media and connectivity option, including fiber, radio, 3G/4G 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 750 Mbps over sub-6 GHz bands, with dedicated bandwidth allocation per site and service reach of up to 120 km (74.5 miles)
- Supports all communication needs, including SCADA protocols, voice and new packet services (CCTV, VoIP, etc.)

Products Included in this Solution:

Airmux-5000
Point-to-Multipoint Broadband Wireless Access

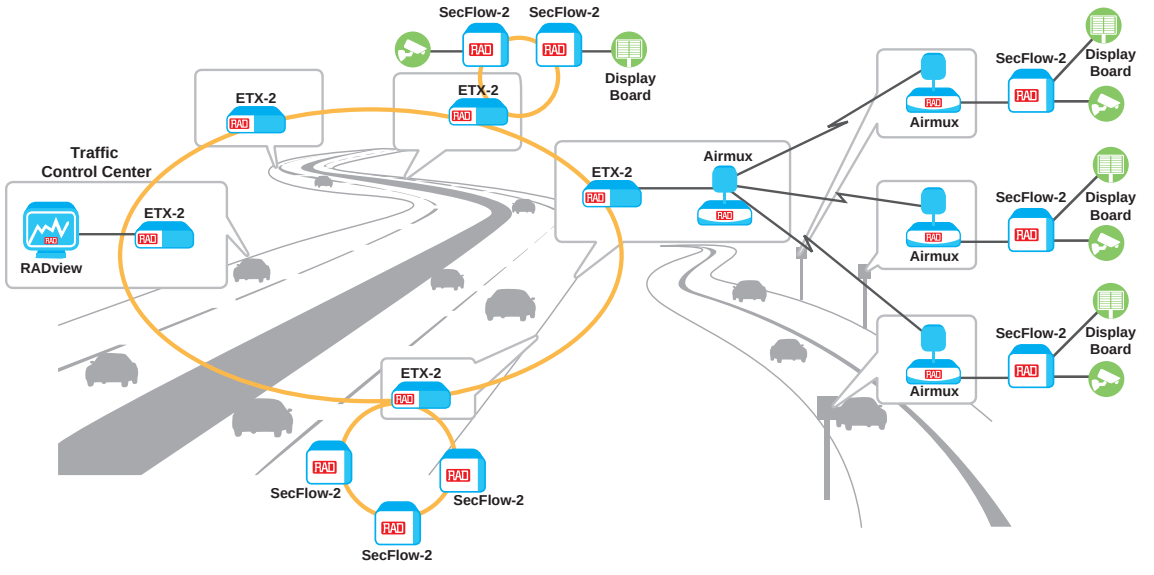
Megaplex-4
Next-Generation Multiservice Networking Node

RADview
Network Management and Orchestration

SecFlow-2
Ruggedized SCADA-Aware Ethernet Switch/Router

Highway Communications

Cyber Shield by RAD
See Pages 8-9



Your Benefits:

- Backhaul high-definition video feeds and roadside display board data from remote facilities over fiber, high throughput sub-6 GHz radio links and 10-GbE rings
- Enable outdoor installations with industrial design and ruggedized enclosures
- 10-GbE 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-Mobility
Mobile Wireless Access

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

RADview
Network Management and Orchestration

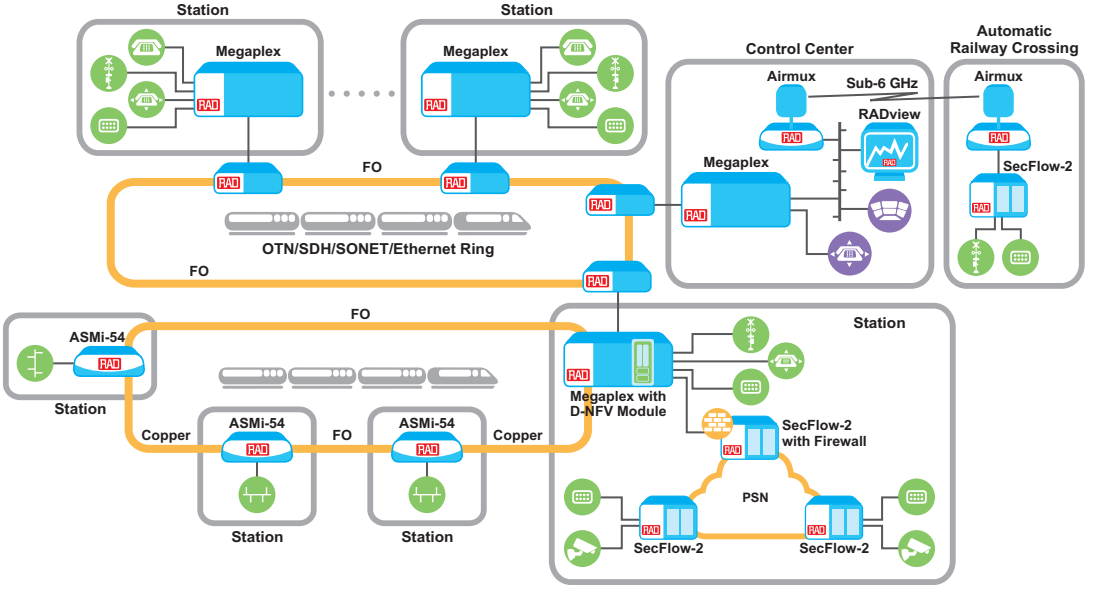
SecFlow-2
Ruggedized SCADA-Aware Ethernet Switch/Router

Train and Metro Communications

Cyber Shield by RAD
See Pages 8-9

Virtualization by RAD
See Page 7

1 Multiservice Operational Network for Trains and Metros



Your Benefits:

- 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/PSN/DWDM/OTN 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.bis Modems

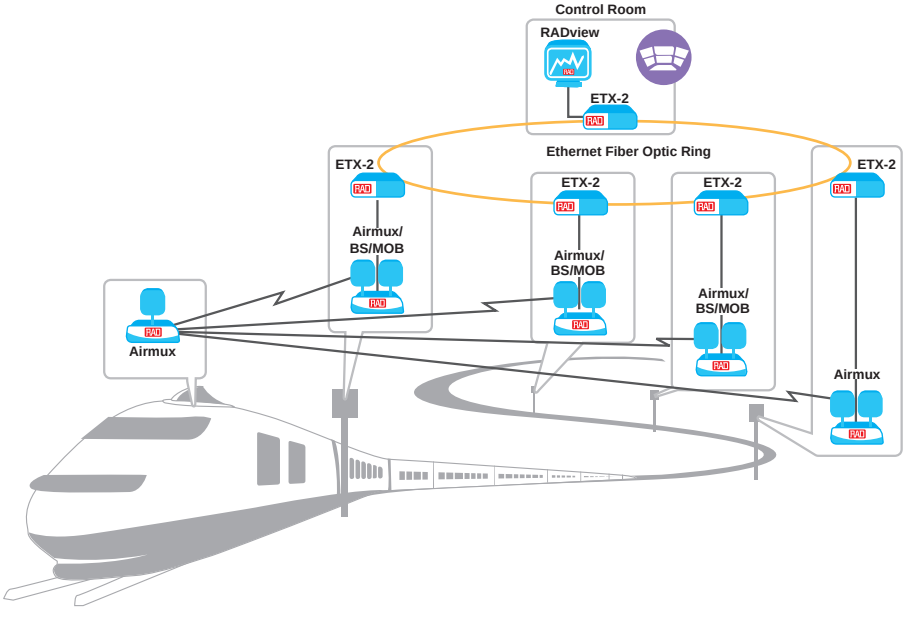
Megaplex-4
Next-Generation Multiservice Networking Node

PacketLight
Complete Solutions for WDM/OTN and Dark Fiber Applications

RADview
Network Management and Orchestration

Cyber Shield by RAD
See Pages 8-9

2 Wireless Broadband Mobility for Trains and Metros



Your Benefits:

- Support bi-directional broadband connectivity for on-board video surveillance, infotainment and WiFi in moving vehicles using easy-to-deploy base stations and Ethernet access switches
- Guarantee high capacity mobile video and data connectivity for ruggedized mobile units mounted on vehicles, trains and vessels at affordable total cost of ownership (TCO)
- Support connectivity on moving vehicles at up to 300 km/h (186.4 mph)
- 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-Mobility
Mobile Wireless Access

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

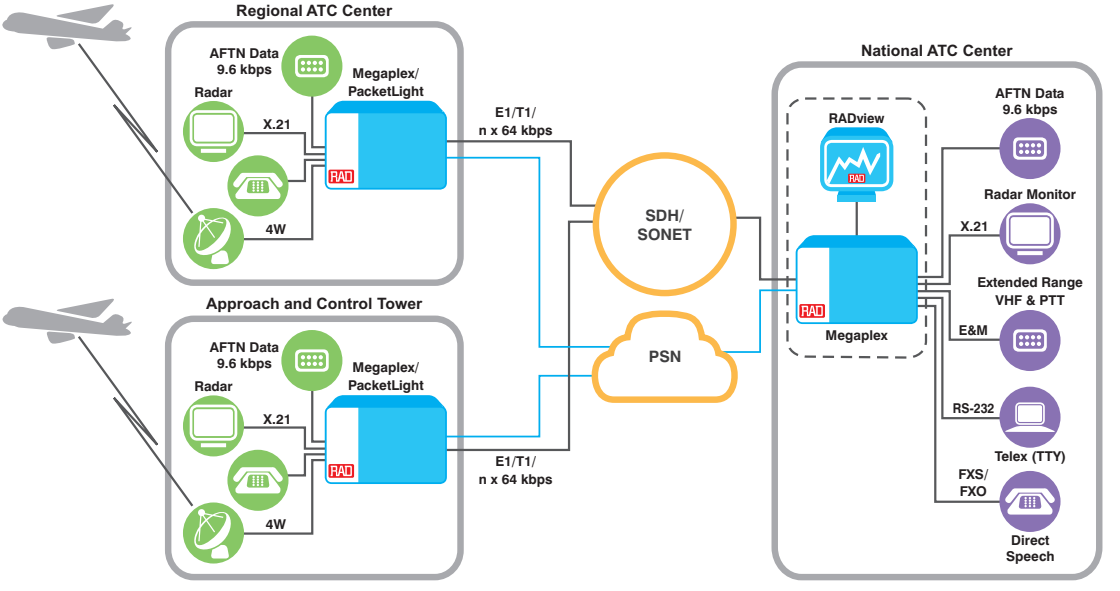
RADview
Network Management and Orchestration

Air-Traffic Control Communications

Cyber Shield by RAD
See Pages 8-9

Virtualization by RAD
See Page 7

1 Multiservice Operational Network for Air-Traffic Control



Your Benefits:

- Ensure reliable, uninterrupted communications between different traffic control centers with RAD's multiservice connectivity solutions over any transport network, including SDH/ SONET/PSN/OTN/DWDM
- 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
- Distributed SCADA security suite with integrated firewall and encryption
- Optimized for subrate leased line transmission and backup to reduce OpEx
- Ruggedized platforms withstand the rigors of field operations
- Support fail-safe operations with ISDN, VSAT and Ethernet backup

Products Included in this Solution:

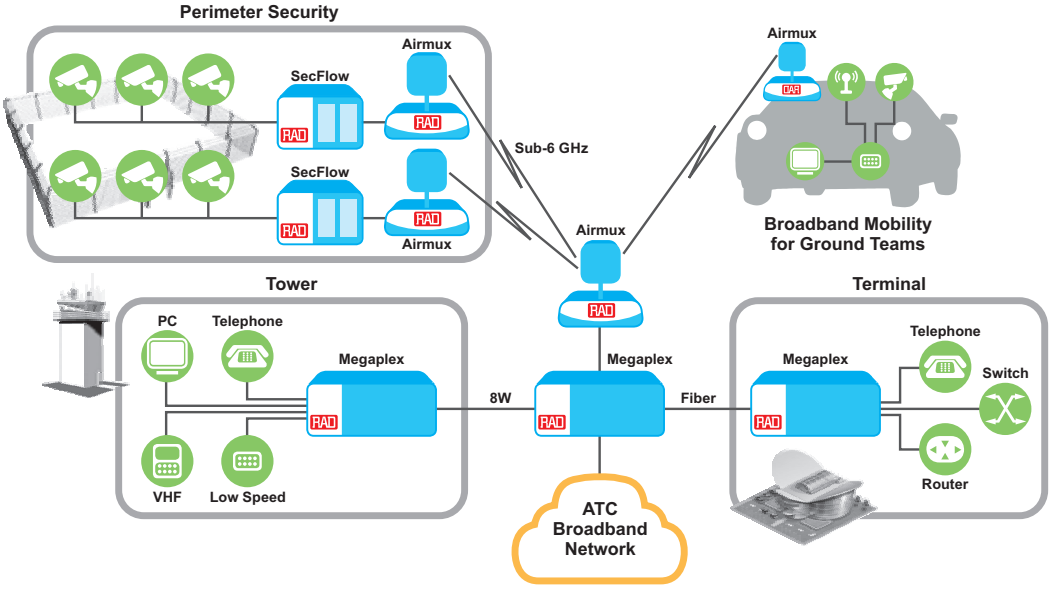
Megaplex-4
Next-Generation Multiservice Networking Node

PacketLight
Complete Solutions for WDM/OTN and Dark Fiber Applications

RADview
Network Management and Orchestration

Cyber Shield by RAD
See Pages 8-9

2 Airport Communications



Your Benefits:

- Ensure uninterrupted communications between control towers and traffic control centers with RAD's multiservice connectivity solutions for air-traffic control 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
- Ruggedized platforms withstand the rigors of field operations for outdoor CCTV cameras and other security applications
- On-the-move communications for vehicles and vessels in airports and harbors
- Transport traffic over copper, fiber, microwave, or satellite links
- Distributed SCADA security suite with integrated firewall and encryption

Products Included in this Solution:

Airmux-Mobility
Mobile Wireless Access

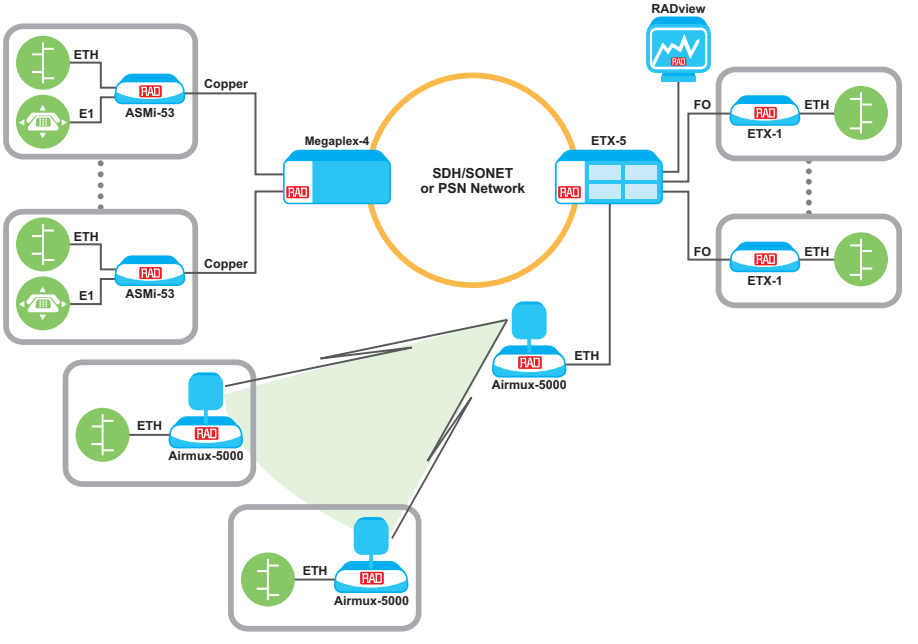
Megaplex-4
Next-Generation Multiservice Networking Node

SecFlow-2
Ruggedized SCADA-Aware Ethernet Switch/Router

Police and Military Communications

Cyber Shield by RAD
See Pages 8-9

1 Multiservice Operational Network for Police and Military



Your Benefits:

- 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 Broadband Wireless Access

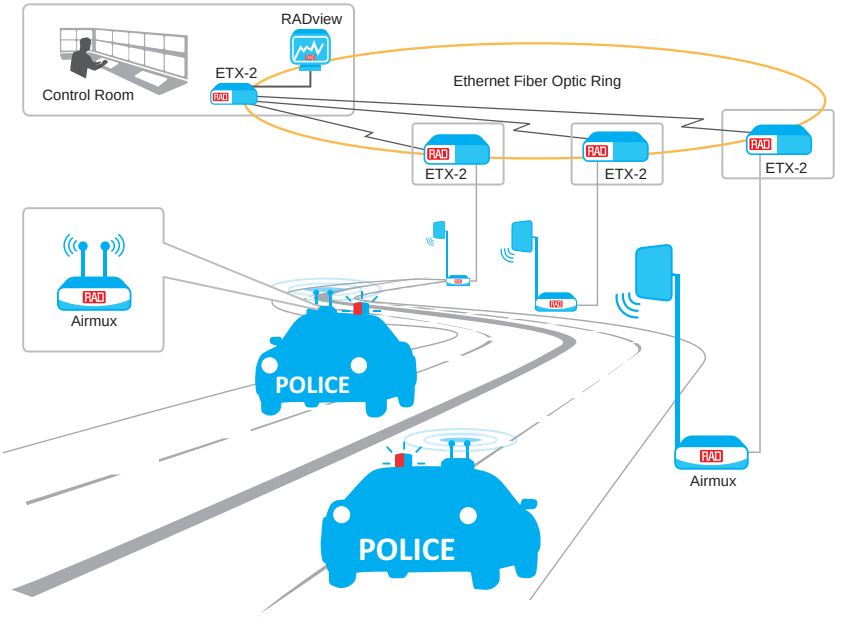
ASMi-53
SHDSL.bis CPE Modem

ETX-1
Ethernet Demarcation Switch

RADview
Network Management and Orchestration

Cyber Shield by RAD
See Pages 8-9

2 Broadband Mobility for Police and Military



Your Benefits:

- 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 (186.4 mph)
- Up to 100 Mbps total available throughput per vehicle
- 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:

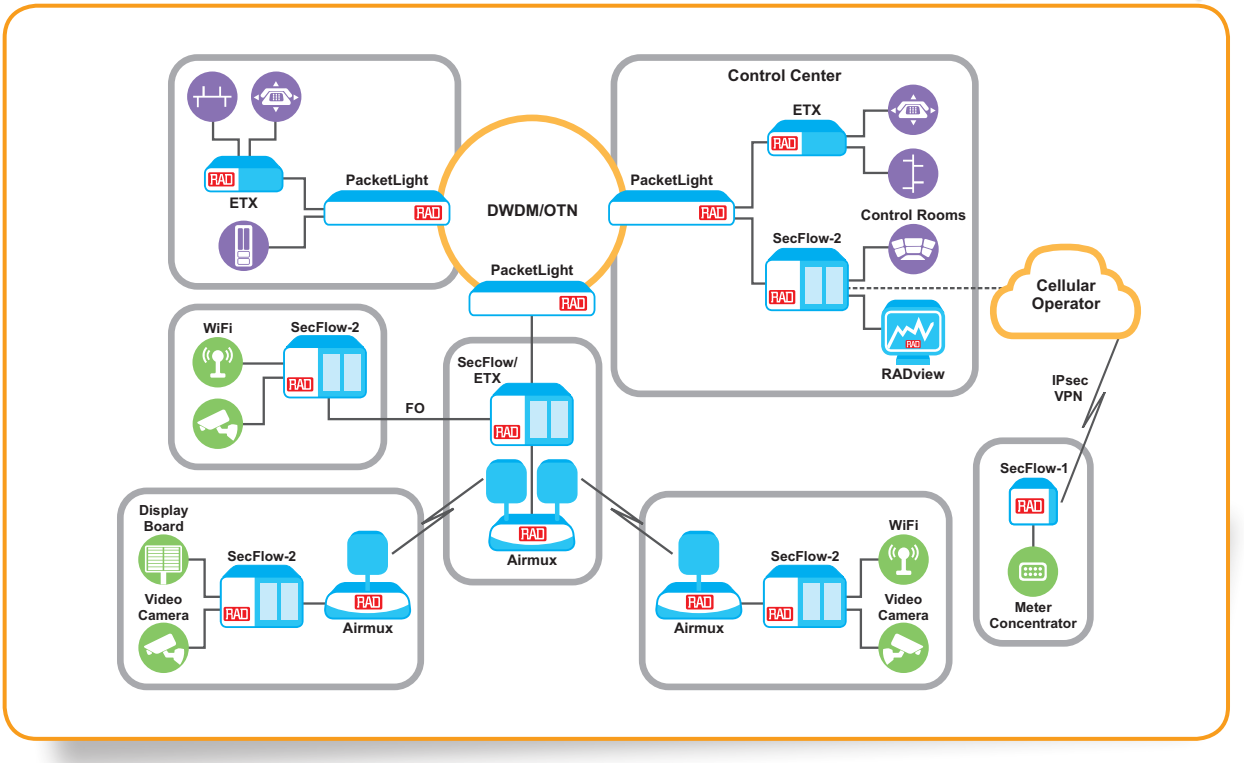
Airmux-Mobility
Mobile Wireless Access

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

RADview
Network Management and Orchestration

Smart City Communications

Cyber Shield by RAD
See Pages 8-9



Your Benefits:

- Provide coverage for Smart City communications
- Connect security cameras, WiFi access points, display boards, meter concentrators, and other sensors in urban and rural areas over fiber optics and wireless radios
- Central management to provision and control the communications network
- Long-distance fiber optic private network backbone with OTN/ DWDM multi-tunneling at rates of up to 100G
- 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-5000
Point-to-Multipoint Broadband Wireless Access

PacketLight
Complete Solutions for WDM/OTN and Dark Fiber Applications

RADview
Network Management and Orchestration

SecFlow-2
Ruggedized SCADA-Aware Ethernet Switch/Router

RAD Products A-Z

• A

ACE-3402
Aggregation-Site Gateway

RAD's ACE-3402 aggregation-site gateway is a carrier-class multiservice aggregator, 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, this device ensures 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-3402 incorporates 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-3402 is a 2U-high device and fits into 19-inch racks for easy installation in limited spaces.

- **Channelized STM-1/OC-3 with up to 63 x VC-12 channels for SDH or 84 x 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-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 gateway is a small, modular unit with total front access design. It supports service operators in their migration to all-IP RAN and enables optimized provisioning of mobile broadband and rich-media services.

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

Airmux-400

Point-to-Point Broadband Wireless Access

Best Seller

RAD's Airmux-400 series of point-to-point broadband wireless radios delivers 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 750 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, 40 MHz, or 80 MHz channel bandwidth**
- **Up to 16 E1/T1 ports; up to two Gigabit Ethernet interfaces**
- **Net throughput (aggregated):**
  - **Airmux-400H: up to 750 Mbps**
  - **Airmux-400Hi: up to 750 Mbps**
  - **Airmux-400P: up to 250 Mbps**
  - **Airmux-400L: up to 200 Mbps**
  - **Airmux-400LC: up to 50 Mbps**
  - **Airmux-400SP: up to 25 Mbps**
- **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**

Airmux-5000

Point-to-Multipoint Broadband Wireless Access

Best Seller

RAD's Airmux-5000 point-to-multipoint broadband wireless radios are 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 750 Mbps aggregated sector capacity and a range of up to 40 km (25 miles), a single Airmux-5000 base station supports up to 64 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 6.4 GHz in a single device**
- **Up to 750 Mbps aggregated throughput per sector**
- **Up to 64 remote subscriber units per sector with aggregated throughput of 5, 10, 20, 25, 50, and 100 Mbps**
- **Supports fixed and nomadic applications**
- **Airmux-5000i with beamforming antenna**
- **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**

• A

Airmux-Mobility

Mobile Wireless Access

Best Seller

RAD's Airmux-Mobility family of point-to-multipoint radios ensures continuous service to subscribers in motion with bi-directional, uninterrupted broadband connectivity on the move for offshore installations and vessels, safe city vehicles, as well as on-board communications for trains and metro.

Scan for Airmux-Mobility video

• Airmux-5000MOB

Airmux-5000MOB is ideal for oil rigs, maritime vessels and police/patrol vehicles. It supports real-time video surveillance transmissions and internet access, as well as data and VoIP feeds.

- **Coverage range of 11 km (6.8 miles)**
- **Integrated WiFi access point (802.11b/g/n) for video transmissions**
- **Built-in GPS for vehicle tracking**
- **Direct DC power from the vehicle (10 to 36 VDC), power consumption <25W**
- **Up to 750 Mbps total available throughput from the base station**
- **Up to 100 Mbps total available throughput for vehicle/vessel subscriber units**
- **SNMPv3**
- **AES 128**
- **IP67 rating for severe outdoor conditions**

• Airmux-5000RT

RAD's Airmux-5000RT delivers the highest throughput for on-board communications with guaranteed bandwidth to each railway vehicle, even on subways and monorail lines. It offers bi-directional and asymmetrical train-to-track bandwidth with per-train quality of service (QoS) guarantees. This allows always-on communications between trains and control and operations centers for critical services such as information displays, panic buttons, PTT (push-to-talk), telemetry, ticketing machines, and video streaming. Offering multi-band support in a single box, the Airmux-5000RT offers customization capabilities to address special frequencies, architectures, and more. It is fully compliant with railway environmental standards, which are prerequisite for all equipment installed on railways and metros.

- **High capacity sector base station – up to 750 Mbps aggregated throughput with guaranteed bandwidth per train**
- **Extended coverage for each base station**
  - **Up to 1 km (0.6 miles) underground**
  - **Up to 5 km (3 miles) above ground**
- **High speed – up to 300 km/h (190 mph)**
- **Configurable asymmetric uplink/downlink traffic**
- **Supports up to 3x3 MIMO/Diversity**
- **Seamless handover below 50 msec**
- **Over the air QoS, enabling prioritization of multiple services**
- **Low and fixed latency and jitter**
- **IP67 rating for severe outdoor conditions**
- **Supports railway standards: EN 50155, EN 61373, EN 50121**
- **Air link performance monitoring (ALPM) for system and air interface analysis and reporting**

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**

ASMi-53
SHDSL.bis CPE Modem

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

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

- **E1, V.35 and Fast Ethernet extension over multiple SHDSL.bis lines**
- **Standards-compliant SHDSL (ITU-T G.991.2 and ETSI 101524)**
- **Up to 11.4 Mbps over 4-wire**
- **EFM (Ethernet in the First Mile) bonding per IEEE 802.3-2005; M-Pair bonding for HDLC per G.991.2**
- **TC-PAM 16 or TC-PAM 32 line coding**
- **Ethernet bridging**
- **VLAN prioritization and Ethernet QoS support**
- **SHDSL EOC management channel (inband)**
- **Functions as CPE opposite central devices (LRS-102/Megaplex-4)**
- **Optional remote power feed from DSL line**

• A/D

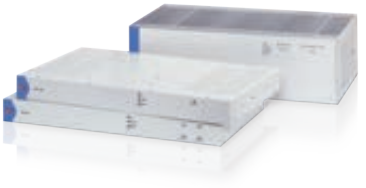
ASMi-54 Family
SHDSL.bis Modems

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

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

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

DXC Family
Digital Cross Connects



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

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

- **Non-blocking cross connect 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, E1 and T1**
- **Optional common logic and power supply redundancy**
- **Optional link and/or hardware protection**
- **Integrated fiber optic modem**
- **Built-in E1/T1 converter, including A-law/μ-law and signaling conversion for PCM timeslots**

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**

Egate-2000

Gigabit Ethernet Aggregator over PDH, SDH/SONET Access

RAD's Egate-2000 is a carrier-grade, high capacity Ethernet over SDH/SONET aggregation device that provides MEF-compliant Ethernet services over channelized STM-16/OC-48 connections. It is typically deployed in a central location to aggregate traffic from remote devices, such as RAD's RICi Ethernet over TDM smart NTUs. Together, they form a complete Carrier Ethernet over TDM access solution from the service provider central site to the customer premises.

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

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

• E

ETX-1

Ethernet Demarcation Switch

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, WFQ scheduling and shaping**
- **ITU-T G.8032 Ethernet Ring Protection Switching (ERPS)**
- **RADview management; CLI configuration**
- **Wide-range power supply**

ETX-102, ETX-202

Basic Ethernet Demarcation Devices

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

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

ETX-1300

Gigabit Ethernet Aggregation Switch

The ETX-1300 is a high density, multi-port 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**

• E

ETX-2i

IP and Carrier Ethernet Demarcation with D-NFV

Best Seller

CE 2.0 MEF CERTIFIED

Part of RAD's Service Assured Access solutions, the ETX-2i line of next-generation NID/NTUs offers advanced demarcation for SLA-based, L2 and L3 business services, wholesale services and mobile backhaul. The ETX-2i is MEF Carrier Ethernet 2.0-certified and offers a complete service life-cycle toolset.

The ETX-2i also serves as a Universal CPE (uCPE), Whitebox+, which enhances a pluggable x86 server module with Physical Network Functions (PNFs) to enable superior performance for vCPE applications. It is supported by RADview management and orchestration.

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

Virtualization by RAD

Available as a modular demarcation device, the ETX-2i enables operators to deliver the most advanced Carrier Ethernet services, IP VPNs and vCPE functionalities over any network connection. In addition, the ETX-2i combines advanced timing functionalities for LTE/LTE-A.

- **Up to eight GbE combo ports**
- **Integrated wire-speed switch/router**
- **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**
- **Hot-pluggable x86 D-NFV server module for hosting virtual functions**
- **NEBS-compliant and environmentally hardened enclosure options**

• ETX-2i-B: IP and Carrier Ethernet Demarcation Device with D-NFV for SMBs

Virtualization by RAD

ETX-2i-B is a demarcation device optimized for remote branches and SMBs over native Ethernet access. It is ideal for carriers, service providers, and wholesale operators requiring advanced Ethernet L2/L3 functionality at customer premises and multi-tenant units (MTUs).

- **1U device with up to six GbE ports**
- **2U device with up to 10 GbE ports, ideal for cost-effective small-cell aggregation**
- **Integrated 6-Gbps switch/router**
- **Pluggable x86 D-NFV server module for hosting virtual functions (1U device)**

• ETX-2i-10G: 10G Carrier Ethernet Demarcation/Aggregation Device

The ETX-2i-10G combines intelligent, high bandwidth demarcation and aggregation capabilities for enterprise headquarters and mobile backhaul operators. As an aggregation solution at the concentration point, a single unit can support numerous services and concurrent OAM sessions.

- **19", 24-port unit with up to four 10-GbE ports and up to eight 1-GbE ports in various combinations**
- **Flexible synchronization offering Sync-E, IEEE 1588v2 slave, BC and TC for frequency and phase synchronization in mobile networks**
- **ITU-T G.8032 Ethernet Ring Protection Switching**
- **NEBS-compliant and environmentally hardened enclosure options**

ETX-2v

Open vCPE Platform

Best Seller

Virtualization by RAD

Scan for Whitebox+ presentation

The ETX-2v is a new portfolio addressing all vCPE deployment needs. It is installed at the customer premises (either at headquarters or in remote branch sites) to support a wide range of business customers and user scenarios, from small offices to large sites, using a variety of bandwidth and processing power options. It also features flexible operation of virtualized network functions (VNFs), from offices running several VNFs locally or integrating all the virtual functions at the data center. In addition to the superior networking mechanisms, ETX-2v features a variety of pluggable modules for all access media, while a RAD-developed operating system, vCPE-OS, optimizes data plane efficiency and integration to third-party orchestrators and SDN controllers.

- **Powerful x86 processor, hosting certified third-party VNFs (firewall, encryption, etc.)**
- **White box (pure compute platform) uCPE option**
- **Zero-touch and call-home provisioning**
- **Advanced routing capabilities, secure tunneling/VPN**
- **Comprehensive vCPE-OS operating system, including a management and security suite, compatible with third-party white box platforms**
- **Orchestration to deploy and chain VNFs, SDN support**
- **Supported infrastructure includes Ethernet, Wi-Fi, LTE, DSL, GPON and TDM**

ETX-2i/ETX-2v vCPE Applications

Virtualization by RAD

See Pages 4-6

The ETX-2i and ETX-2v feature an x86-based D-NFV module for hosting virtual functions (VFs) and applications. The D-NFV module runs on vCPE-OS, which includes standard KVM hypervisor and OpenStack compute node to support 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

PMC
Central generation of always-on performance monitoring over Layer 3 networks

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.

• E

ETX-2

Carrier Ethernet Demarcation

Best Seller

CE 2.0 MEF CERTIFIED

The ETX-2 line of Carrier Ethernet NID/NTUs offers demarcation for SLA-based business services, wholesale services and mobile backhaul. The ETX-2 is MEF Carrier Ethernet 2.0-certified for E-Line, E-LAN, E-Tree, and E-Access services, as well as delivering TDM pseudowire over packet networks. Supporting high capacity service provisioning per EVC/EVC.CoS, flexible classification and H-QoS traffic management, it also preforms accurate and scalable service testing and performance monitoring. The ETX-2 is supported by RADview management and enables a variety of protection mechanisms. It also offers NEBS-compliant and environmentally hardened enclosure options.

• ETX-203AX: Carrier Ethernet Demarcation Device

ETX-203AX 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; flexible selection of SFP and copper interfaces**
- **Wide-range AC/DC power supply**

• ETX-203AM: Universal Carrier Ethernet Demarcation Device

Available as a modular demarcation device, the ETX-203AM enables operators to deliver Carrier Ethernet services and L2 VPNs over any network connection.

- **Four FE/Gigabit Ethernet user ports**
- **Modular network interfaces: FE/GbE (combo), E1/T1, T3, VDSL, or SHDSL**

• ETX-205A: Carrier Ethernet Demarcation/Mobile Demarcation Device

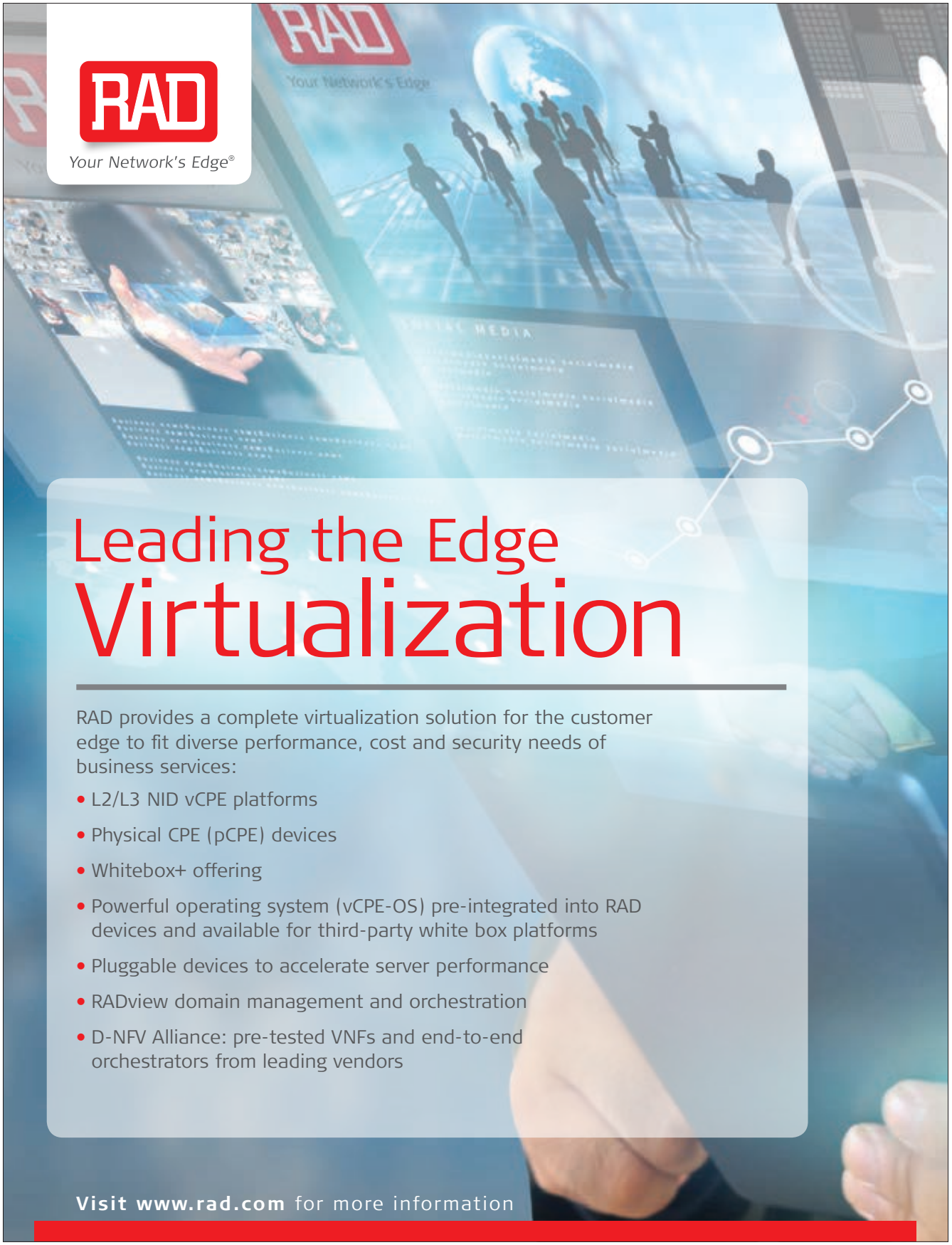
The ETX-205A provides advanced Carrier Ethernet demarcation and offers combo interfaces and power supply redundancy. For LTE/LTE-A mobile backhaul, the ETX-205A is installed at cellular tower and controller sites to guarantee differentiated SLAs.

- **L2 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 Grandmaster 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**

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

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.

- **Up to four x 10-GbE ports and up to 20 x 1-GbE ports in various combinations**
- **Flexible synchronization offering Sync-E, IEEE 1588v2 slave, BC and TC for frequency and phase synchronization in mobile networks**


RAD
Your Network's Edge®
Leading the Edge
Virtualization
RAD provides a complete virtualization solution for the customer edge to fit diverse performance, cost and security needs of business services:
• L2/L3 NID vCPE platforms
• Physical CPE (pCPE) devices
• Whitebox+ offering
• Powerful operating system (vCPE-OS) pre-integrated into RAD devices and available for third-party white box platforms
• Pluggable devices to accelerate server performance
• RADview domain management and orchestration
• D-NFV Alliance: pre-tested VNFs and end-to-end orchestrators from leading vendors
Visit www.rad.com for more information

• E

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 and MEF-14 certified for EPL, EVPL services**
- **Multi-rate FE/GbE UTP/SFP combo ports with auto-detection**
- **Enhanced traffic management with multiple shapers and H-QoS per EVC**
- **Ethernet OAM, performance monitoring and built-in RFC-2544 tester capabilities; L2/L3 diagnostic loopbacks**
- **TWAMP support for performance monitoring over L3 networks**
- **ITU-T G.8031 Ethernet Linear Protection Switching**
- **Sync-E, 1588v2 support**
- **RADview management; CLI configuration**

ETX-5

Ethernet Service Aggregation Platform

The ETX-5 is a leading CE 2.0 access aggregation switch, successfully deployed worldwide in many large networks. It delivers aggregated Ethernet and TDM pseudowire traffic from the access network to the PE (provider edge) over 10-GbE links. Part of RAD's Service Assured solutions for service providers and critical infrastructure, the ETX-5 is ideal first-level aggregation at the POP, E-NNI inter-carrier demarcation and as a pseudowire gateway for seamless migration to packet networks.

For an enhanced user experience, the ETX-5 is supported by the new RADview management and orchestration system, featuring an intuitive UI/UX to simplify configuration and enable zero-touch service provisioning end-to-end. The ETX-5 is Carrier Ethernet 2.0-certified and includes an extensive toolset to deliver and manage SLA-based services.

- **Carrier Ethernet MEF-certified for MEF CE 2.0: E-Line, E-LAN, E-Tree services, E-Access; MEF-8; MEF-22: mobile backhaul; MEF-26: E-NNI**
- **Ethernet Ring Protection Switching: ITU-T G.8032v2; supports 40-GbE ring over LAG, virtual rings**
- **Extensive TDM pseudowire support: CESoPSN, SAToP, CESoETH (MEF-8), UDP/IP encapsulation**
- **Ethernet OAM termination and grooming; ITU-T Y.1564 generator/responder**
- **16 x 10-GbE network/user ports; 80 x 1-GbE ports; 16 channelized STM-1/OC-3 user/network ports; four channelized STM-4/OC-12 user/network ports with redundancy**
- **Fully redundant, modular system designed for high availability**
- **Supported by RADview Service Manager and RADview Performance Monitoring portal**
- **AC or DC power feed redundancy; NEBS-compliant industrial-grade enclosure withstands extended temperature range**

FCD-155

STM-1/OC-3 Terminal Multiplexer

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-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**
  - **Up to eight E1/T1 ports (FCD-155); up to 21 x E1/28 x T1 ports, one E3/DS3 port, or 21 x E1/28 x T1 ports and one E3/T3 port (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

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.

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

IPmux-1E

TDM Pseudowire Access Gateway

Best Seller

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

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

IPmux-155L

Hub-Site Pseudowire Access Gateway

Best Seller

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

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

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

Best Seller

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**

IPmux-24, IPmux-216

Best Seller

TDM Pseudowire Access Gateways

The IPmux-24 and IPmux-216 extend TDM, HDLC and Ethernet services over packet transport using standard pseudowire encapsulation over Fast Ethernet or Gigabit Ethernet access. The devices' compact design, ease of installation, and advanced traffic management capabilities enable carriers to extend their services from legacy backbones over greenfield packet networks, without affecting customer experience or replacing existing end-user equipment. They also allow service providers to add traditional leased line services to their Layer 2 portfolio and permit enterprises to reduce their IT expenses on PSTN connectivity and branch-to-branch communications. In addition, they support cellular operators in migrating their services to economical packet switched backhaul while maintaining the mobile network's stringent synchronization requirements.

- **Up to four (IPmux-24), eight or 16 (IPmux-216) E1 or T1 TDM user ports**
- **Three SFP-based fiber or copper Fast Ethernet or Gigabit Ethernet interfaces**
- **Multi-standard hardware-based TDM pseudowire: TDMoIP, CESoPSN, SAToP, HDLCoPSN, CESoETH**
- **ITU-T G.8032 Ethernet Ring Protection Switching (ERPS) for sub-50 ms restoration; Ethernet link and TDM pseudowire redundancy**
- **Ethernet OAM: IEEE 802.3-2005 (formerly 802.3ah), 802.1ag/ ITU-T Y.1731 (CFM)**
- **High precision clock recovery for 2G/3G cellular traffic over PSN**
- **QoS per 802.1p, ToS/DSCP, EXP**
- **MEF-9, MEF-14 certified for EPL, EVPL services**

CARRIER ETHERNET MEF Certified Compliant

• K/L

Kilomux-2100, Kilomux-2104

Subrate Multiservice Multiplexers

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

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

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

LA-210

EFM DSL Network Termination Unit

Best Seller

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.

CE 2.0 MEF CERTIFIED

- **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 CE 2.0-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-2100, Megaplex-2104

Multiservice Access Multiplexers

The Megaplex-2100 and Megaplex-2104 are designed to groom, aggregate and transport multiple broadband and narrowband data and voice services over copper, 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**

• M

Megaplex-4

Next-Generation Multiservice Access Node

Best Seller

Cyber Shield by RAD
See Pages 8-9

CE 2.0 MEF CERTIFIED

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 10G 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**
- **Three-tier built-in cyber security, 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**
- **Supports fanless operation**
- **Integral xDSL modems and Optimux cards for subscriber and main link connections**
- **Pluggable x86 D-NFV server module for hosting virtual functions and applications**
- **Interoperability with old TDM equipment (Nokia, Newbridge)**

Megaplex-4 Virtualization Applications

Virtualization by RAD
See Pages 4-7

The Megaplex-4 offers an x86 D-NFV module for hosting virtual functions (VFs) and applications. The virtualization 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.

MiCLK

1588 Grandmaster on an SFP with Built-in GNSS

Best Seller

RAD's MiCLK® is the world's first Grandmaster on an SFP, allowing easy upgrades for existing base stations and backhaul equipment to support IEEE 1588 for LTE/LTE-A. Easily plugged into service routers to simultaneously distribute frequency and time, the patented MiCLK eliminates the need to install GPS/GNSS antennas at every cell site while providing highly accurate timing distribution with full network coverage – even in underground and in-building installations. It is also ideal for 4G small-cell deployments.

The field-proven MiCLK allows service providers to avoid spoofing and jamming risks, and dramatically reduces installation and engineering costs by eliminating the need for additional space or power requirements.

- **Fully-featured standard IEEE 1588 Grandmaster including phase/Time of Day (ToD) to meet stringent LTE Advanced requirements**
- **Built-in GNSS receiver**
- **Robust GNSS backup – time holdover when GNSS reception is lost, using Sync-E or 1588 frequency reference from the network (Assisted Partial Timing Support) to deliver continuous and accurate synchronization to the base station**
- **Miniature pluggable device fits in any standard SFP port**
- **Scalable solution supports over 64 slaves**
- **Part of RAD's vCPE offering**

Virtualization by RAD
See Pages 4-6

• M

MiNID

Miniature Programmable Network Interface Device

Best Seller

PATENTED

CE 2.0 MEF CERTIFIED

MiNID® is a field-programmable miniature L2/L3 network interface device (NID), available in a variety of form factors. Part of RAD's vCPE and white box solution portfolio, it enriches the Service Assured Access offering with software-defined functionalities for enhanced demarcation, remote monitoring, fault isolation, as well as remote packet capture and micro-burst measurement capabilities.

MiNID also provides instant upgrades for legacy switches and routers, as well as for vCPE platforms and COTS servers 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 SFP

Virtualization by RAD

See Pages 4-6

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

- **Plug-and-play installation**
- **Fits small cells, macro cells, switches, routers, DSLAMs, COTS servers and more**
- **Variety of optical options**
- **LC connectors**
- **Extended temperature range**

• MiNID Sleeve

Virtualization by RAD

See Pages 4-6

The MiNID Sleeve is easily pluggable into SFP ports of switches and routers and seamlessly hosts standard FE and GbE SFP modules.

- **Compatible with standard fiber and copper SFPs in a variety of ranges**
- **Reduces inventory by reusing existing SFPs**

• 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 Standalone for Outdoor Installations

For outdoor installations, the MiNID Standalone is also available in a hardened enclosure.

- **No fans**
- **Wall and pole mount included**
- **Extended temperature range**
- **SFP interfaces**

MiRICi-155

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

Best Seller

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

- **Delivers Gigabit Ethernet traffic over a single STM-1/OC-3 link**
- **Supports standard GFP encapsulation**
- **Hot-insertion SFP-format plug, MSA-compliant**
- **User-configurable**
- **Enhanced management of control, status and monitoring**
- **Out-of-band management through I²C**
- **Supports full duplex flow control**
- **Fault propagation from WAN to LAN link**
- **Part of RAD's vCPE offering**

Virtualization by RAD
See Pages 4-6

MiRICi-E1/T1, MiRICi-E3/T3

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

Best Seller

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)**
- **Part of RAD's vCPE offering**

Virtualization by RAD
See Pages 4-6

• M/O

MiTOP-E1/T1, MiTOP-E3/T3

Smart SFP-Format TDM Pseudowire Gateways

Best Seller

Virtualization by RAD
See Pages 4-6

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)**
- **Part of RAD's vCPE offering**

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

Fiber Multiplexer for 63 E1/84 T1 over STM-1/OC-3

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

It combines 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 allows service providers to increase their customer reach, while avoiding the cost and complexity associated with deploying high-end ADMs. Furthermore, the Optimux-1551 eliminates 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**
- **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 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)**

• O/P

Optimux-45L

Multiplexer for 21 E1/28 T1 over Fiber or T3

Optimux-45L is a managed multiplexer 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. It provides 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.

- **Cross-connect capabilities for drop-and-insert and ring applications**
- **Multiplexes 21 x E1 or 28 x 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**

PacketLight

Complete Solutions for WDM/OTN and Dark Fiber Applications
Layer 1 - Encryption

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 44/96 wavelengths**
- **Layer-1 encryption for GbE, 10G Eth, 4G FC, 8G FC, and 16G FC**
- **Long distance solutions by amplification and DCM**
- **Performance monitoring**
- **Supports single or dual fiber**
- **Low latency connectivity**
- **Hot-swappable PSU (AC/DC) and fan**
- **Integrated management**
- **Compact 1U integrated devices**
- **Simple to install, maintain and configure**
- **Cost-effective CPE device**
- **Integrated OTN layer (with FEC)**

PM Controller

Performance Monitoring Generator

Best Seller

The PM Controller is a high capacity, central generator for always-on performance monitoring (PM), on-demand testing, diagnostics and troubleshooting of mobile backhaul networks, as well as for premium Carrier Ethernet and IP business services. It uses a wide variety of standard tools to provide deep visibility into network and service performance and to ensure optimal quality of experience in LTE/LTE-A networks, typically characterized by rapid small-cell deployment. Part of RAD's Service Assured Access offering, the PM Controller works opposite routers, switches, mobile base stations, or third-party responders, as well as opposite RAD's ETX and MiNID NIDs. As a non-disruptive add-on, the PM Controller is an ideal solution for existing heterogeneous networks. It enables top line PM and testing in a dynamic environment regardless of the capabilities of the underlying installed base.

- **PM Controller Standalone Appliance**

- **Four FE/GbE combo ports**
- **Monitors and troubleshoots backhaul performance**
- **Service activation tests (Y.1564) over L2/L3, opposite RAD devices or third-party responders**
- **Continuous connectivity and service performance monitoring sessions using TWAMP, ICMP and UDP Echo**
- **Connects to the RADview Performance Monitoring portal for SLA and quality of experience (VoLTE mean opinion score) reporting with aggregated and drill-down views per PM session**

- **PM Controller Virtual Network Function (VNF)**

RAD's PM Controller is also available as a VNF that can be downloaded to third-party servers and central-site appliances, as well as to the x86 server within RAD's vCPE devices, using the RADview D-NFV Orchestrator.

Virtualization by RAD
See Pages 4-6

PMC VNF

The PMC VNF provides central generation of always-on performance monitoring over Layer 3 networks.

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

• R

RADview

Network Management and Orchestration

Best Seller

Scan for RADview video

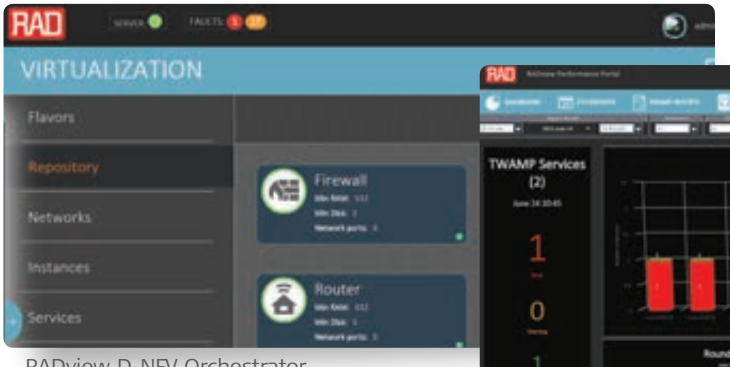
RADview is a modular network management suite for RAD's Service Assured Access and Service Assured Networking solutions. It enables configuration, provisioning, monitoring, and management of networks and services, and includes the following management tools:

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

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).

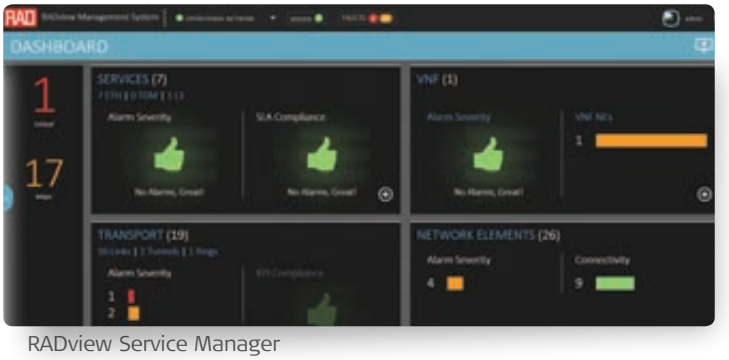
- **Monitors device health, optimizes network operations and minimizes mean time to repair (MTTR)**
- **Client/server architecture with multi-user support and seamless handover of user privileges**
- **Zero-touch and auto-discovery capabilities**
- **Wide range of northbound application programming interfaces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

Intuitive, HTML 5 UI/UX:



RADview D-NFV Orchestrator

RADview Performance Monitoring



RADview Service Manager

• RADview Performance Monitoring

The RADview Performance Monitoring module enables ongoing monitoring of Ethernet and IP service performance by collecting KPI (key performance indicator) 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**
- **Monthly and real-time SLA statistics reporting**

• RADview D-NFV Orchestrator

The RADview D-NFV Orchastrator uses the OpenStack framework to manage the physical and virtual resources required for effectively running vCPE services and for delivering service agility at the customer edge. It installs, 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 RADview D-NFV Orchastrator 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**

Virtualization by RAD
See Pages 4-7

• RADview Service Manager

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 planning, 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.

- **Offline resource optimization and capacity planning simplifies pre-deployment stages**
- **"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**

• RADview Service Center

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**
- **Windows-based client and Linux-based server**

RIC-155GE

Gigabit Ethernet over STM-1/ OC-3 NTU

RIC-155L

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

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.

- **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/Y.1303 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**
- **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

Ethernet Converter for Multiple PDH Circuits

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

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

- **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**

• R

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

Ethernet over Four or Eight E1 or T1 NTUs

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

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

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

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 G.8040) 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 IP56 (ROC-19) and IP66 (ROC-19L) NEMA-4-rated construction includes a rain hood, offering full shielding and protection against dust, rain and ice. Efficient ventilation is assured by an intake fan with replaceable air filters (ROC-19) or passive convection (ROC-19L). Secure, efficient maintenance and access are offered by a 2-point (ROC-19L) or 3-point (ROC-19) door locking mechanism, as well as an integrated fiber cable splicer/guide system, intrusion detection and over-current protection.

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

• S

SecFlow-1

Ruggedized SCADA-Aware Gateway

Best Seller

Cyber Shield by RAD
See Pages 8-9

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 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.

- **Multiservice support: Fast Ethernet/GbE, Serial RS-232/485**
- **Connectivity to remote and isolated sites using a dual SIM cellular modem for 2G/3G/HSPA+/HSDPA/LTE uplink supporting flexible connectivity methods such as encrypted L3 DMVPN, IPsec VPN, NAT**
- **Advanced Ethernet and IP feature-set**
- **Cyber security suite: IPsec encryption, ACL (L3-L4), SCADA-aware firewall**
- **Serial protocol handling with transparent tunneling/protocol conversion/terminal server feature-set for IEC-60870-5-101, IEC-60870-5-104, Modbus RTU to Modbus TCP and DNP3.0 RTU to TCP**
- **Complies with IEC-61850-3 and IEEE 1613**
- **Wide range of form factors and functionalities addressing various installation needs for small sites, substation process bus and station bus, data collection sites, and high density aggregation sites**

SecFlow-2

Ruggedized SCADA-Aware Ethernet Switch/Router

Best Seller

Cyber Shield by RAD
See Pages 8-9

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 can monitor 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 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 3G/HSPA+/LTE cellular modems**
- **Integrated application-aware firewall for SCADA protocols**
- **L2/L3 VPN agent with IPsec**

SecFlow-4

Modular Ruggedized SCADA-Aware Ethernet Switch/Router

Cyber Shield by RAD
See Pages 8-9

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 can monitor SCADA commands using deep packet inspection to validate their fit with the application logic for specific functions. This ruggedized, modular switch/router provides a flexible platform with a combination of fiber and copper Ethernet ports, as well as serial interfaces for legacy devices.

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

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

SFP/XFP/SFP+ Transceivers

Small Form-Factor Pluggable Transceivers

RAD's SFP/XFP/SFP+ 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 SFP/XFP/SFP+ transceivers 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 SFP/XFP/SFP+ pluggable transceivers.

Optical SFPs

- **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**

Smart SFPs

- **GPON OLT in an SFP**
- **VDSL SFP**

• S

SPH-16
SFP Patch Hub

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

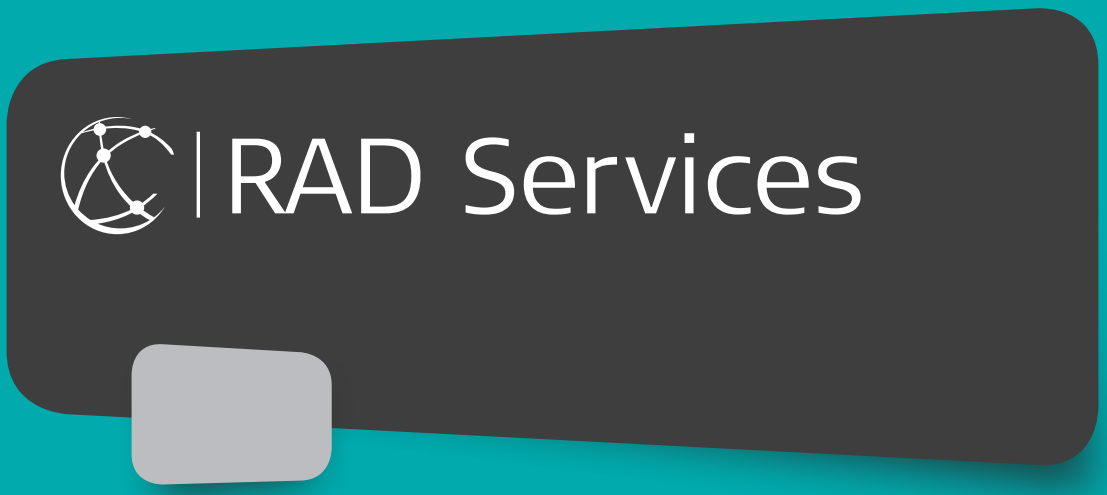
- **Converts standard Ethernet copper (RJ-45) ports to SFP sockets**
- **Fully transparent Layer 1 conversion at wire-speed**
- **Supports any standard SFP device, bypassing the vendor's specific SFP port protection**
- **Auto-discovery of Fast Ethernet and Gigabit Ethernet**
- **Optional dual power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

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

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

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

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


RAD Services

RADcare

Global Services

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

- Project Assured
- Guidance throughout design and rollout
- High- and low-level network design
- Support service migration and network upgrades
- On-site services

- Strict SLA commitments on response, service restore and resolution times
- 24 x 7 support, priority handling and escalation procedures
- RADcare Online portal for software updates and upgrades
- Optional multi-year blanket coverage

- Training-on-demand
- Regional sales, pre-sales and technical seminars
- RAD certification

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

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 RADcare Online, 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

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 life-cycle.

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 | 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 | 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

RADadvantage
Partners Program

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

Glossary

For the complete glossary see www.rad.com

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 useable

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

CE 2.0: MEF's designation for its second generation of CE service standards

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

CESoP, CESoPSN: Circuit Emulation Services over Packet, a pseudowire mechanism for transporting TDM over packet switched networks

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

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

CPE (Customer Premises Equipment): Equipment located at the customer premises, typically owned and controlled by the service provider

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

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

D

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

DHCP: Dynamic Host Configuration Protocol, a protocol that automatically provides a host with an IP address

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

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

E

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

E3: A 34.368 Mbps TDM signal

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 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

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

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-LAN (Ethernet Private LAN): A dedicated-bandwidth E-LAN 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: See Ethernet Virtual Connection

EVC.CoS: EVC and Class of Service

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

EVP-LAN (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

FE: Fast (100 Mbps) Ethernet

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 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

GbE: Gigabit Ethernet

GFP (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

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

I

I²C: Inter-Integrated Circuit, a serial bus used e.g., in SFPs

IA: Implementation Agreement

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

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

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

IEC 61850: An IEC standard for electrical substation automation

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)

IPsec (Internet Protocol Security): A protocol suite for securing IP communications

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 (e.g., Ethernet)

L2CP: Layer 2 Control Protocol

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

L3: Layer 3 (e.g., IP)

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

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

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 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, Message Authentication Code

MACsec: A protocol for securing Ethernet communications defined in 802.1AE

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

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

MEF-n: See CE 2.0

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 non-routable 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

NFV ISG (NFV Industry Specification Group): An ETSI (European Telecommunication Standards Institute) group working on developing requirements and architecture for NFV

NID (Network Interface Device): An element that forms the demarcation between two network domains. Typically an 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

OC-x: Optical Carrier signal

Orchestration: The automated deployment, configuration and management of computational elements, networks and/or services. In the context of NFV, orchestration is the highest level of the MANO (Management and Orchestration) system

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

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

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

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

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

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 for 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

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 life-cycle designed to increase revenues and reduce total cost of ownership for service providers

Service Assured Networking: A collection of networking attributes throughout the service life-cycle designed to offer better service performance and reduced total cost of ownership for power utilities communications

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 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 to up to 5.69 Mbps over single pair (2-wire) and up to 22.8 Mbps over 8-wire

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 for monitoring connectivity and performance defined in IEEE 802.1ag, ITU-T Y.1731

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

STM-n: Synchronous Transport Module signal

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

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 Traffic: Traffic synthesized for the purpose of OAM and not carrying user data

T

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

T3: A 44.736 Mbps TDM signal

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

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

U

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

UNI-C: A compound functional element implementing the customer facing functions of the UNI

UNI-N: A compound functional element implementing the network facing functions of the UNI

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

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

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

VLAN: Virtual LAN

VLAN ID (VID): VLAN Identifier

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

W

WAN: Wide Area Network

WDM: Wavelength Division Multiplexing

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

Y.1731: An ITU-T OAM standard for monitoring an Ethernet service

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

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 guided by its founders. Each company in the RAD Group operates autonomously under a common strategic umbrella. This decentralized approach maximizes the advantages inherent in small business units, such as flexibility, entrepreneurial spirit and management focus. A new company is established when a market opportunity is identified – requiring a technology, marketing approach or corporate culture that does not exist in any of the other companies. Four RAD Group companies are currently traded on the Nasdaq Stock Market in the US, while the others are privately held by the Group's founders and various venture capital firms.

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