Operational Core Network
Using Carrier-Grade Ethernet

Typical users: Transmission & Distribution Power Utilities

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

**Service Assured Networking:** RAD offers secure, reliable, scalable, managed, and performance guaranteed solutions for automation, protection, security, and ICT networking that support multiple deployment scenarios over SDH/SONET and carrier-grade Ethernet networks. A vast array of capabilities include service provisioning, traffic management, timing synchronization, TDM pseudowire, ongoing performance monitoring, fault management, and various resiliency mechanisms.
Which Networking Technology Is the Best?

Why Carrier Ethernet Can Replace SDH/SONET

With the shift from SONET/SDH to packet in equipment interfaces and substation services, RAD is again at the forefront of assisting power utilities to rapidly adapt to the changing landscape of requirements. Today, RAD is applying its carrier-grade expertise in the field of Service Assured Networking and Carrier Ethernet to provide the most affordable, reliable and – most importantly – secure alternative to traditional SDH/SONET networks.

<table>
<thead>
<tr>
<th>Service Requirements</th>
<th>Carrier Ethernet</th>
<th>SDH/SONET</th>
<th>Carrier Ethernet Attributes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiservice</td>
<td>+</td>
<td>+</td>
<td>Pseudowire, traffic management, OAM, deployed worldwide</td>
</tr>
<tr>
<td>Synchronization and Timing</td>
<td>+</td>
<td>+ ( - )</td>
<td>SyncE, 1588v2, IEC C37.238, SDH only frequency</td>
</tr>
<tr>
<td>Critical Services</td>
<td>+</td>
<td>+</td>
<td>5-10 times lower latency than SDH/SONET</td>
</tr>
<tr>
<td>Resiliency</td>
<td>+</td>
<td>+</td>
<td>Sub 50ms: G.8032, G.8031, LAG, PWE redundancy, HSR, hardware redundancy</td>
</tr>
<tr>
<td>Deterministic Paths</td>
<td>+</td>
<td>+</td>
<td>E-line, E-LAN tunnel</td>
</tr>
<tr>
<td>Traffic Management</td>
<td>+</td>
<td>+</td>
<td>Hierarchical scheduling, end-to-end CIR for TDM</td>
</tr>
<tr>
<td>OAM</td>
<td>+</td>
<td>+</td>
<td>Y.1731, IEEE 802.1ag</td>
</tr>
<tr>
<td>End-to-End Management</td>
<td>+</td>
<td>+</td>
<td>End-to-end NMS and service management</td>
</tr>
<tr>
<td>Cyber Security</td>
<td>+</td>
<td>+</td>
<td>802.1X, MacSec, SNMPv3, app level: IPSec</td>
</tr>
</tbody>
</table>
 Carrier Ethernet Compared with MPLS and MPLS-TP

Which packet switched network technology is the best fit for power utilities communications networks? RAD has selected Carrier Ethernet as the most suitable technology to replace the trusted SDH/SONET network. The reasons why are outlined in the table below:

<table>
<thead>
<tr>
<th>Feature</th>
<th>Carrier Ethernet</th>
<th>IP/MPLS</th>
<th>MPLS-TP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simplicity</td>
<td>Simple – Similar in architecture to SDH/SONET</td>
<td>Complex – Requires an IP overlay and architecture</td>
<td>Complex – Requires an IP overlay and architecture</td>
</tr>
<tr>
<td>Resiliency</td>
<td>High Resiliency – Mesh and Ring</td>
<td>High Resiliency – Mesh and Ring</td>
<td>High Resiliency – Mesh and Ring</td>
</tr>
<tr>
<td>Security</td>
<td>Secure – Resistant to control plane attacks and has robust support for source authentication</td>
<td>Low Security – Many vulnerabilities exist. See RFC 5920 for complete list</td>
<td>Low Security – Vulnerable to data plane attack, snooping and scouting</td>
</tr>
<tr>
<td>Cost</td>
<td>Inexpensive</td>
<td>Higher cost per bit</td>
<td>Higher cost per bit</td>
</tr>
<tr>
<td>Circuit Set-up</td>
<td>Static – Requires NMS support for provisioning network services</td>
<td>Dynamic – Able to self-configure services on the fly</td>
<td>Static – Requires NMS support for provisioning network services</td>
</tr>
<tr>
<td>Field-proven</td>
<td>High – Many networks deployed and commonly supported by many vendors</td>
<td>High – Many networks deployed and commonly supported by many vendors</td>
<td>Unknown – Vendors only starting to support and deploy</td>
</tr>
</tbody>
</table>
Carrier-grade Ethernet is ideal for replacing SDH/SONET for operational applications, offering various advantages:

- Simplified architecture and management
- Increased security
- Lower latency
- Assured QoS using Carrier Ethernet tools
- Ongoing performance monitoring
- TDM support using Pseudowire
Hybrid Solution with Traffic Duplication

Traffic Duplication is a unique technology developed by RAD as part of its Service Assured Networking solution, to allow networks with mission critical applications to enhance reliability and performance. It can be used to minimize delay on critical utility applications (such as Teleprotection) by capitalizing on Carrier Ethernet’s reduced latency at higher speeds. Mission-critical traffic can be transported over a new Carrier Ethernet network that’s running in parallel to the existing SDH/SONET, preparing for full service migration later on. RAD’s Traffic Duplication yields proven gains on network resiliency by employing a redundant transport method. In addition, it does so with a minimal investment by using any existing PSN network. Finally, because of the physics of the packet network technology, this feature can be leveraged to actually provide shorter network delay and improve critical application performance such as Teleprotection. These technological and cost reduction benefits are available only with RAD’s Service Assured Networking solution.
Service Assured Networking Throughout the Service Lifecycle

Resiliency
- Link aggregation group (LAG) using IEEE 802.3-2005 LACP (link aggregation control protocol)
- Ethernet Ring Protection Switching (G.8032 ERPS)
- EVC protection (G.8031)
- Traffic Duplication
- IEC 61850-3 and IEEE 1613 compliant

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

Security
- 802.1X, MACsec
- SNMPv3
- SCADA Firewall
- IPSec

Ongoing Performance Monitoring
- Scalable long-term KPI collection engine
- One-way delay measurements
- PM dashboard (SLA policies, correlation, violation alerts)
- End-customer PM portal & SLA reports
- PM as a Service
Service Assured Networking comprises the following attributes:

- Advanced H-QoS
- Compliance with environmental standards
- Ethernet & legacy services
- Low latency
- Performance monitoring
- Reliability & protection
- Same service look & feel over any access
- Security for SCADA applications
- Service visibility, end-to-end
- Synchronization over packet
- TDM pseudowire
- Traffic Duplication

Service Management System

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

Ethernet Performance Monitoring Portal

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

Service Turn-Up

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

Traffic Management

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

Timing

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

TDM

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

Distributed NFV

- Rapid deployment/upgrade of network functionality
- Relocate functionality to CPE for more effective performance, reduced expenses
- Combine layer 2/3 demarcation with standard virtual machine (VM) platform

Service Assured Networking comprises the following attributes:
Additional RAD Service Assured Networking Solutions for Power Utilities

- Substation Communications
- Teleprotection Connectivity for Differential and Distance Relays
- Distribution Automation & Smart Metering Backhaul