ribbon

Accelerating Network Transformation

Time to Turn the Lights Out on SONET

Operators now have an urgent need to retire their SONET networks and migrate their legacy SONET services onto a modern packet network. Fortunately, this is a good time to undertake this migration. We have well established, field proven, processes to make this migration seamless and risk-free and we have the technology to support SONET services on the packet network in a manner, which is at least equivalent to, if not better than the legacy SONET network.

Whilst some might see this migration as a burden, the advanced packet network deployed to support these legacy services provides the multi-access IP edge network required for operators to take full advantage of the opportunities opened up by 5G, Gigabit FTTP and the digitized cloud economy.

Platform Evolution – SONET to Packet

1st Generation SONET

2nd Generation SONET

SONET Services Over Packet Network

~ 1,000x space reduction
- 7.2 Gb/s of switching in a half rack (1993)
- 300 Gb/s of switching in 1RU. (today)

~ 100x power/bit reduction
- ~ 100W / Gb/s (1993)
- ~ 1W / Gb/s (today)
- ~ Similar reductions for cooling

Rip out SONET instead of buying more power

SONET has been an extremely successful technology, with millions of nodes deployed and billions of dollars made from the incredibly diverse set of applications it has supported. It was the obvious transport technology of choice in the mid-90s when the telecoms world was built around nx64kb and the traffic was voice or circuit switched connectivity. But at the beginning of the millennium we started to see the introduction of mainstream data services and we saw the start of 2nd Generation SONET where data services were mapped onto the TDM network using Ethernet over SONET. With IP and Ethernet becoming ubiquitous for all new services and applications, the service mix was swinging from circuit switched towards packet. So SONET evolved again and we saw the new techniques added to better support these new IP based services on the TDM transport network. However, it makes more sense and is more efficient to use a network architected and optimized to carry this IP traffic. Therefore, we saw the introduction and growth of Carrier Ethernet and MPLS networks to provide transport network optimized for these IP services.

Why migrate TDM services to IP Transport?

The truth is for many years there was no need to do this.

In most cases, network operators built a new packet network to support these new IP and Ethernet services. The SONET network continued to support the circuit switched services, as it remained highly reliable and continued to meet all of the customer expectations.

What has changed?

We see a number of factors that have now changed; this is forcing Service Providers to migrate their SONET services away from their legacy SONET networks.

- **Increasing Risk of Outages**
  - **End of life and support for legacy SONET technology** – the equipment has been in the network for a very long time, in many cases 20 years plus, this equipment is now reaching a period where increased failure rates are to be expected
  - **Difficulty in sourcing "spares"** – vendors and component suppliers have shutdown, or are in the process of shutting down their SONET products, this makes it extremely difficult to source spares for equipment when it fails

- **SONET Networks are Increasingly Expensive with no Incremental Revenue**
  - **High Cost of Maintenance** – as the failure rates increase, operators need to spend more money, time and energy on maintaining the network. So what used to be a very cheap network to run is now becoming an increasingly costly and an increasing resource drain
  - **Loss of skills** – many of the staff with strong SONET skills have, or are close to retiring.
  - **Need for improved efficiency** - IP transport technologies are far more efficient at transporting IP traffic
  - **End of TDM based services** – Most Service Providers have now stopped selling "new" SONET based services to their customers

- **Need to Support Increasingly Complex IP Based Services**
  - **Need next generation transport platform** - we are moving to a new digitized world with 5G, fiber to the premise, digitized services, cloud, IoT/IIoT enabling Smart everything, etc. Operators need a platform which allows them to easily move all their clients along this journey
  - **New devices are IP based** – all new services, applications and devices are IP based. As network capabilities are renewed and modernized there is a need for a converged IP transport network
  - **Regulation** – There is a regulatory need to improve carbon footprint, new platforms offer huge environmental savings. For example what could be supported on an OC-48 ADM rack in the past can now be supported on a single blade 1RU (or less), power and cooling requirements have likewise reduced. All this means that switching to a modern IP transport system can help a business in its move to meet carbon reduction targets.

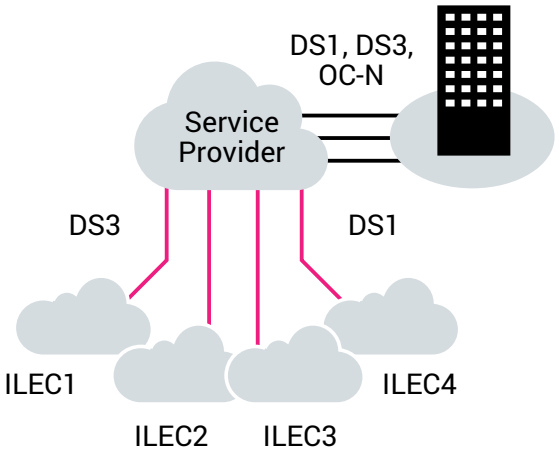
- **Migration to packet is now well proven and low-risk**
  - **Migration Technology** – with many migrations over the last 10 years, the circuit emulation (CES) technologies required to migrate SONET services on to the packet network are fully proven.
  - **Support for Deterministic Services** - The challenges involved with supporting deterministic services, including the need for low latency, high reliability and complete determinism have been solved with deterministic packet transport technologies such as MPLS-TP

The relative importance of each of these factors varies from business sector to business sector and operator to operator. However, what is clear is there is now an urgent need to move the legacy TDM services onto a modernized transport network.

Impact on Service Providers

Variety of TDM equipment

- ADMs
- Cross-connects
- D4 channel banks
- M13 muxes
- Big, little, medium



Dozens of applications

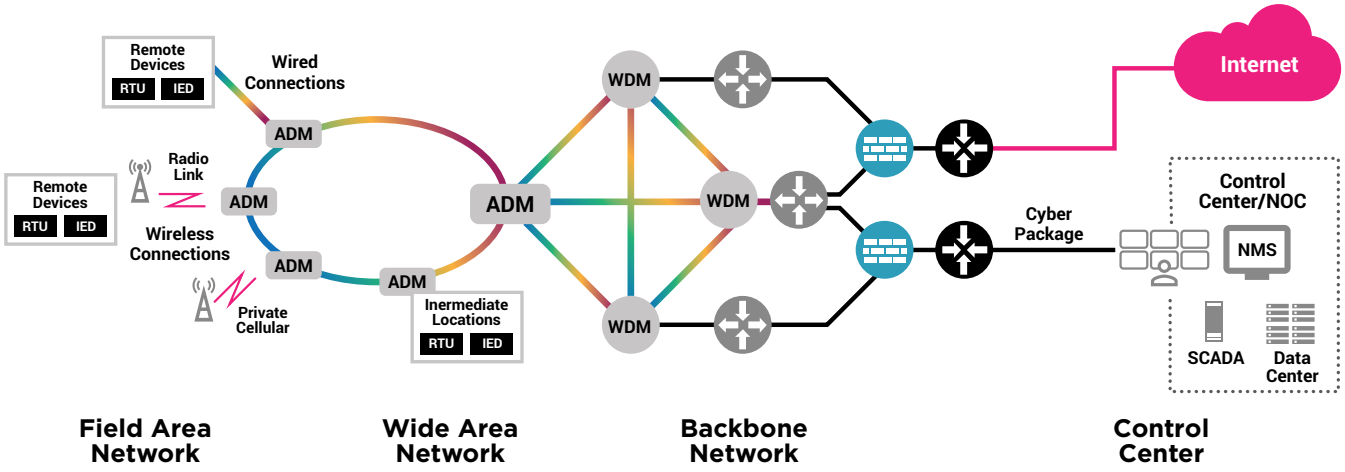
- Interoffice infrastructure
- Long distance networking
- Access
- Data
- Video
- Mobile backhaul
- Business services
- Residential “broadband”

Service providers already have established packet networks to support IP and Ethernet services. However, most of these Service Providers are also running a TDM network in parallel to the packet network. This legacy TDM network enables them to continue to support customers with high-value legacy SONET services such as private line services or support legacy infrastructure like voice trunking.

For the reasons given above Service Providers now have an urgent need to migrate these services onto the packet network. This packet network must support the full range of services they currently support on the SONET network and the network must offer equivalent, or better, performance than the existing SONET network. The migration itself should be “invisible” to the end users, with no service disruption.

Once migrated, the new network must have the flexibility to allow the customers to easily migrate their services from legacy SONET services to new packet services as and when they upgrade their applications. The new network must also give the service provider the ability to offer differentiated services and provide the agility to dynamically react to changing conditions.

Impact on Critical infrastructures used by Utilities and Transportation systems



Strategic Industries such as utilities (Oil, Gas, Water, Energy/Power etc) and companies running transportation networks (Road, Rail, Air, Ports, etc) need a communications network to allow them run their networks. These networks are, by definition, often mission critical and sometimes even life-critical and so the operations technology (OT) required to run these networks must be highly reliable, highly predictable and for some applications like tele-protection be low latency and low jitter.

SONET, with its highly deterministic performance, extensive OAM capabilites and high reliabilty is a perfect fit for these OT networks and in many cases these strategic industries built their own SONET networks to allow them to have complete control over their mission critical OT.

But the world is changing rapidly, and strategic industries now find themselves needing to modernize their SONET network and move onto a packet based network for their OT. All the drivers given for Service Providers apply for strategic industries, but they also face some additional challenges unique to their business:

- **Regulation** – regulation is placing increasing pressure on these industries across the complete range of their operations, from reduced wastage/spillage, reducing outages, and improving safety through to improved customer satifaction and carbon footprint reduction. Modern IP based devices, sensors and systems such as the Advanced Metering Infrastructre are required to meet these regulations
- **Move to Smart** – driven by regualtion and the need to improve businesses operations, most of these strategic industries are on the journey to becoimg “smart”. To enable this move, a vast number of sensors is being placed in the network generating data needs to be collected and feed into centralized systems. All of these sensors and the wireless systems used to connect to them are IP based
- **Legacy control networks must be maintained** – legacy control systems like SCADA and legacy IEDs and RTUs will continue to play a major role in these industries for many years to come.
- **Security** – strategic industries find themselves an extremely attractive target for cyber criminals and legacy devices were not built with security in mind. There is a very urgent need to improve the security of the OT network
- **IT/OT convergence** – improves the business processes by providing the IT network with realtime information about network.

- **UTelco** – a number of these strategic industries are becoming Utelcos and are using their unique geographical footprint and relasionship with the end customer to offer Telecoms services to enterprises and business customers. As 5G rolls out, there is the potential for these Utelcos to offer Mobile Network Operators the connectivity and capacity they require to connect base stations and the physical infrastructre in which to house Edge data centres for MEC.

As with Service Providers, the new packet network must support the full range of services supported by the SONET network today and the network must offer equivalent, or better, performance. In addition, to meet the OT network need for predictability and low latency, the new packet network must provide deterministic IP transport; traditional best effort IP transport is not acceptable for this type of network. The packet network must also increase network security, with some form of security added to protect the legacy SCADA network, IEDs and RTUs that will be in the network for many years to come. Ideally, operating the new network should be similar to the old network, reducing the risks of outages and mistakes caused by misconfigurations.

The migration itself must be proven risk-free; after all it is totally unacceptable to have an outage in the OT network due to the migration process.

Once migrated, the new network may stay in place for the next 10-15 years, so the platform must be flexible enough to adapt and evolve as needs evolve. This network may also have to be agile enough to allow the strategic industry to start operating as a Utelco.

Impact on Government and Defense

For many years, government networks and defense networks were built in a siloed approach using SONET technologies. This is hugely inefficient, prevents use of common features, toolsets, and services and stops these agencies gaining the benefits that be achieved from an integrate network. They now realize an integrated network bringing together the knowledge from multiple systems brings them huge advantages. As an example, we now see many defense forces focusing on the multi-domain battlefield where knowledge is shared from all elements of the battlefield, in doing this they are able to react faster than the opposition.

It makes sense to move to a modern packet transport network when consolidating these disparate SONET networks. The needs of these agencies are very similar to the needs of strategic industries discussed above i.e high-availability, deterministic IP transport, risk-free proven migration. However, the need for security is even more stringent and there is a need to be able to isolate parts of the network from the rest of the network.

Once deployed, these networks have to be highly agile as the services they support are evolving rapidly and they must be completely multiservice as more and more disparate systems are integrated. As an example, governments and municipalities are providing funding for infrastructures, which improve local economies and ways of life, and we see the integration of many systems to create smart cities.

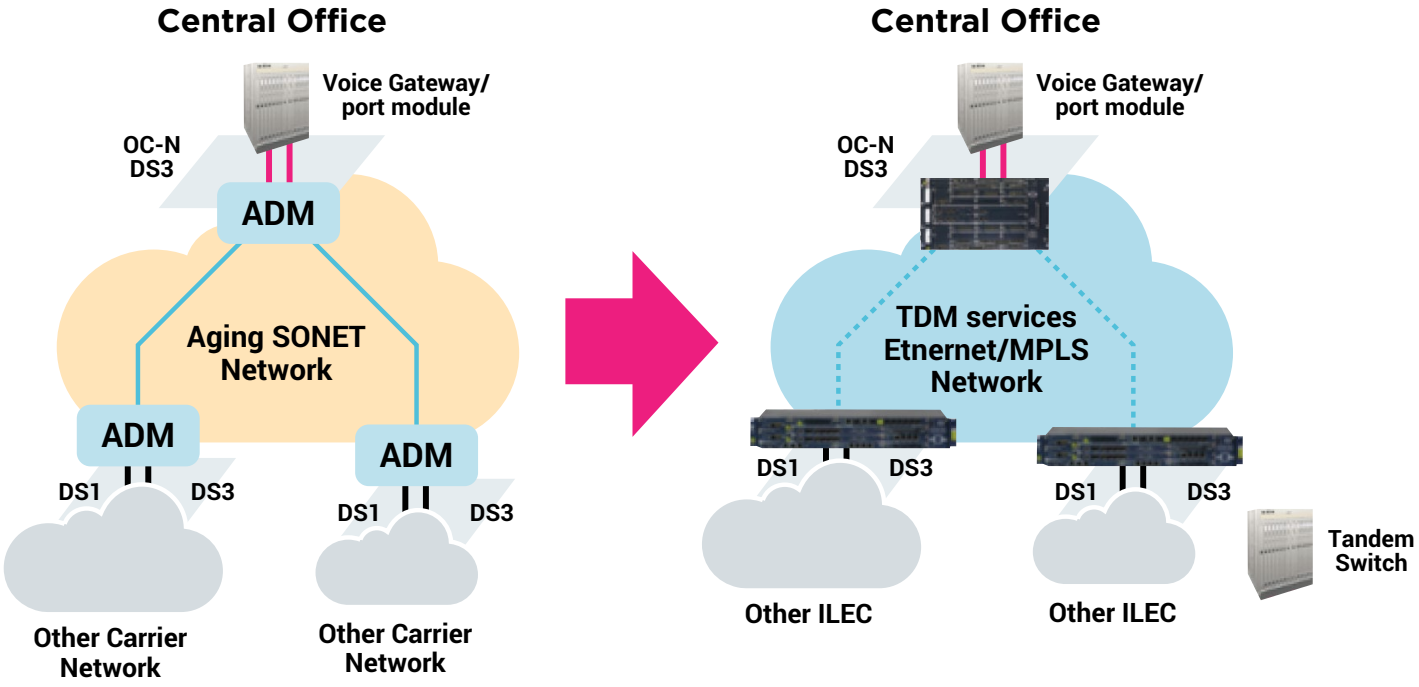
The Goal of Migration

The migration needs are common across all the market sectors. They all have a near-term need, albeit for a variety of different reasons, to migrate from SONET to an advanced packet network.

Also in common across all these market sectors is the need for this advanced packet network to be truly multiservice, not only supporting SONET over packet but also Ethernet, MPLS, Segment routing and network slicing. With these capabilities, the operators can be confident that they have the toolset to evolve as their markets and individual needs evolve.

Case Study Examples

Migrating Voice Trunks



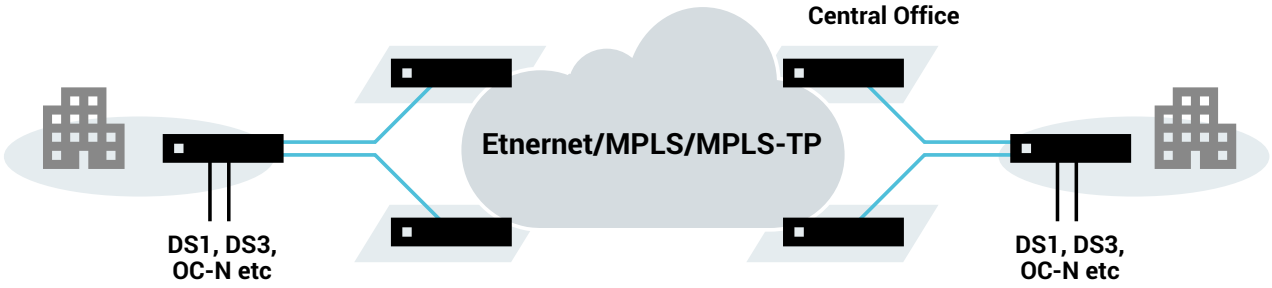
The new IP/MPLS network uses standards based circuit emulation (CES) approaches (SAToP and CESoPSN) to enable it to support all of the functionality required to provide voice trunks:

- DS1/DS3 hand-off to other suppliers
- OC-N hand-off to the voice gateway
- 50ms protection switching
- 10ms failure detection
- Voice-grade QoS

Where required, MPLS-TP provides an additional protocol stack to support deterministic capabilities.

This new network is fully interoperable with existing packet and DWDM networks.

Migrating Legacy Enterprise Services

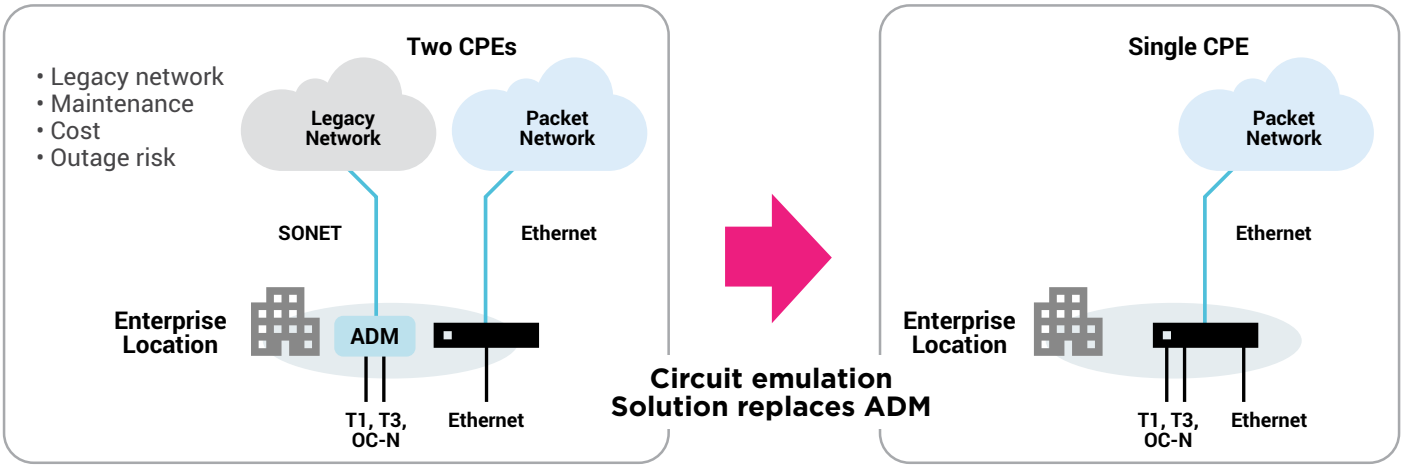


As mentioned previously, the packet network uses circuit emulation to provide enterprises with a reliable platform for supporting their legacy SONET services. Direct DS1, DS3, OC-3/12 interfaces allow existing services to be directly connected to this packet network.

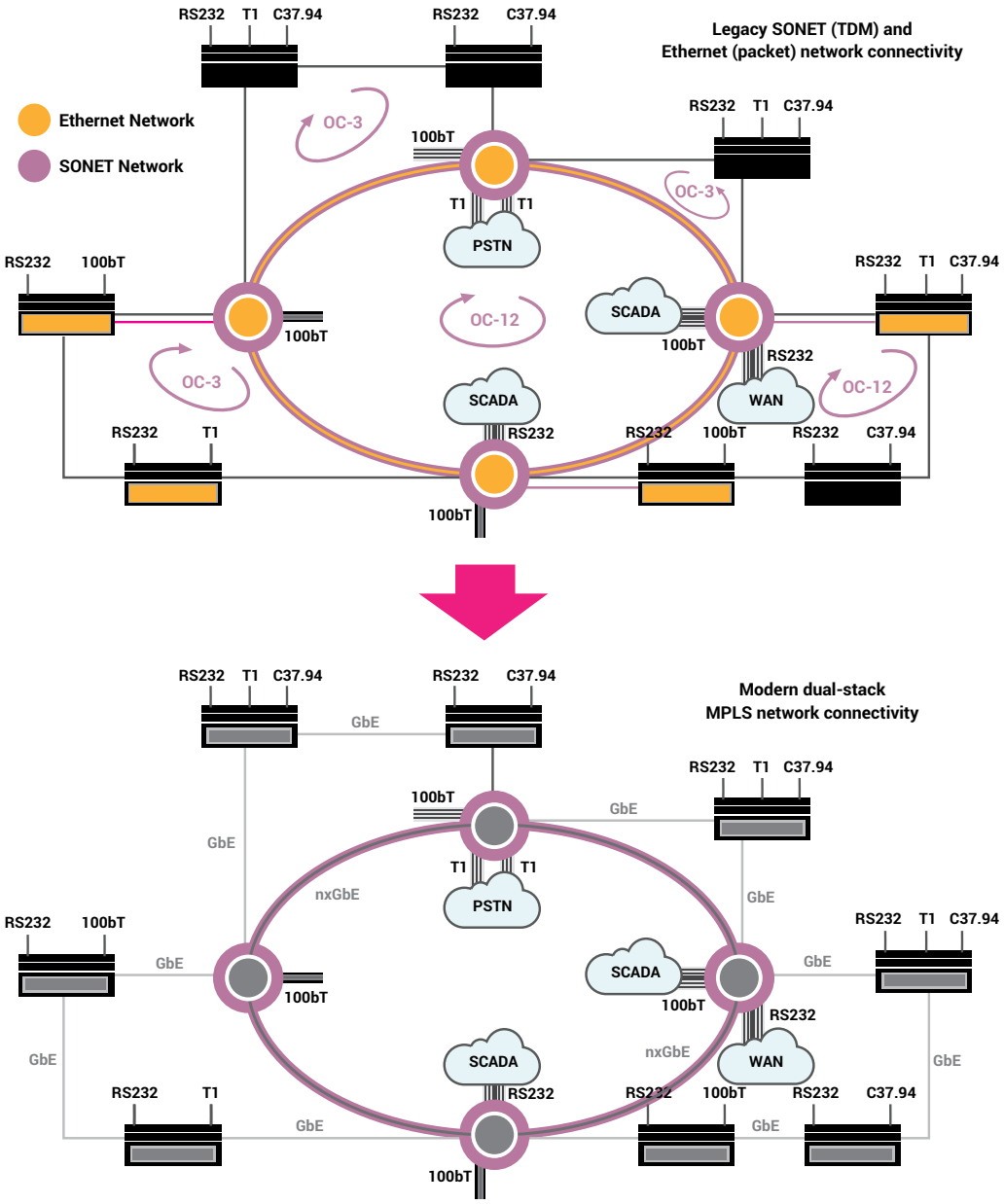
Where the service requires high availability the packet network supports a number of resilience options, these provide the same level of service resilience as were present on the legacy SONET network:

- G.8032v1 - recommended for access protection
- MC-LAG (Multi-Chassis Link Aggregation Group) – allows the traffic to be shared over multiple chassis and provides redundancy in the event one of the chassis fail
- LDP (Label Distribution Protocol) - used to provide end to end protection

Moving to a packet network has the added advantage that it can simplify Enterprise Access. Running the SONET services on the packet network gives operators the opportunity to consolidate all enterprise services onto a single CPE, simplifying the access network and the operational expenses associated with running two networks. In addition, as customers transition their services from SONET to IP, the transition becomes far simpler. Finally, this approach allows operators to upsell new IP based services to the customer, without the need to deploy new infrastructure.



Migrating the Legacy Networks used by Utilities



In the legacy network, specialized SONET equipment designed to carry SCADA and other TDM traffic includingT1, RS232, and C37.94 Tele-protection traffic. At interconnection points, ports on the SONET equipment is reserved to route traffic between rings. A packet network carries Ethernet traffic for the IT services.

In the migrated network, the two separate networks are converged onto a single packet network (although some utilities may still prefer to keep separate physical devices for their IT and OT networks). This is only possible if the packet network can meet the strict protection and latency requirements required for tele-protection and the TDM traffic. So the MPLS-TP, is used to provide this guaranteed deterministic performance.

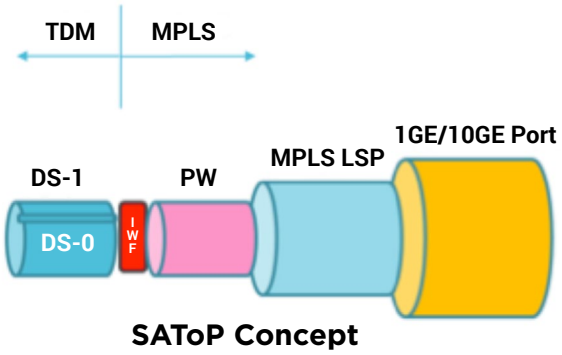
Migration Technology

Circuit Emulation

Circuit emulation (CES) technology is used to allow legacy SONET services to be mapped onto the packet network. There are different circuit emulation standards to cater for different operational scenarios.

IETF RFC 4553
SAToP (Structure-Agnostic TDM over Packet)

- Complete DS1s and DS3s into pseudowires
- Maintains all the framing structure
- Agnostic to payload – voice, video, data
- Bulk transport over MPLS networks
  - SONET ADM replacement
  - DCS replacement
  - Private line replacement
  - Lease line cost avoidance
  - Voice trunking



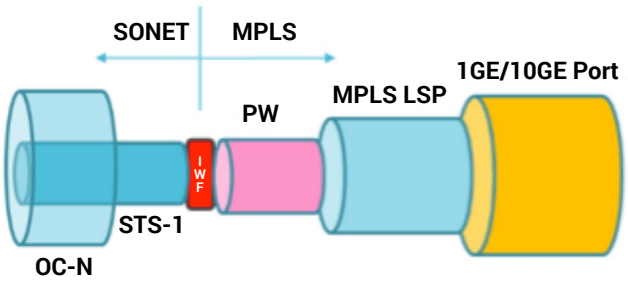
SAToP Concept

IETF RFC5085 CESoPSN
(Structure-Aware TDM Circuit Emulation Service over Packet Switched Network)

- Provides individual DS0 visibility
- Needed for 1/0 DCS replacement

IETF RFC 4842
SONET Circuit emulation over packet

- Emulates SONET path structures
- STS, VT1.5, VT11, etc.
- SONET path payload agnostic



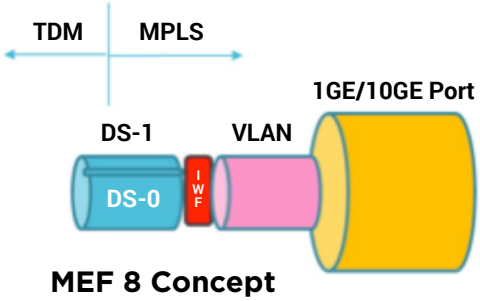
SONET CEP Concept

MEF 8 PDH over Metro Ethernet

- DS0, DS1, DS3 (E3 / E1) over Ethernet
- Structure agnostic (DS1, E1, DS3, E3) like SAToP
- Structure-aware mode (n x64kbps aware) like CESoPSN
- Basic mode
- (No SONET path over Ethernet)

MEF 3

- Circuit Emulation Service Definitions



MEF 8 Concept

Timing and Synchronization

The SONET network was key for providing timing and synchronization. Migrated networks must be able to provide the same timing and synchronization capabilities that SONET provided, with timing from an internal or external clock source and timing distribution achieved with SyncE and/or 1588v2.

Deterministic Packet Transport

Traditional IP/MPLS based packet transport technology is not suitable for SONET services that require a high degree of predictability or need low latency and deterministic packet transport is required. As mentioned previously, the need for predictable low latency is very common in the OT networks of strategic industries. For those strategic industries that have started the migration journey, MPLS-TP has become the widely accepted packet transport technology of choice to deliver these deterministic services. Far simpler than RSVP-TE (the IP/MPLS bsed approach) it has the added advantage of providing extensive OAM and operational processes similar to SONET networks being retired.

SONET to Packet Migration is an Opportunity for Operators

It is true; networks operators are being forced to migrate or retire their old SONET networks and this is a project they would rather not have to perform as it will take time and money and brings no incremental revenue.

However, at the end of this migration they have a next generation converged transport network and this opens up huge new revenue opportunities. Ribbon's Neptune IP transport portfolio provides the converged IP edge platforms that operators need to successfully complete SONET to packet migration. With its unique Elastic MPLS capabilities, Neptune is able to support dual stack IP/MPLS and MPLS-TP along with Segment Routing and Carrier Ethernet transport. This full range of IP transport technologies mean that Neptune is ideally positioned to support operators as they migrate their SONET services and then look to take full advantage of the opportunities opened up by 5G, Gigabit FTTP and the digitized cloud economy.

Contact Us Contact us to learn more about Ribbon solutions.

About Ribbon

Ribbon Communications (Nasdaq: RBBN) delivers communications software, IP and optical networking solutions to service providers, enterprises and critical infrastructure sectors globally. We engage deeply with our customers, helping them modernize their networks for improved competitive positioning and business outcomes in today's smart, always-on and data-hungry world. Our innovative, end-to-end solutions portfolio delivers unparalleled scale, performance, and agility, including core to edge software-centric solutions, cloud-native offers, leading-edge security and analytics tools, along with IP and optical networking solutions for 5G. We maintain a keen focus on our commitments to Environmental, Social and Governance (ESG) matters, offering an annual Sustainability Report to our stakeholders. To learn more about Ribbon visit **rbbn.com**.