Circuit Emulation Service

TEJAS® NETWORKS

Best in class Network Modernization Approach

Circuit Emulation enables telecom operators to translate legacy systems using TDM signals such as E1/DS1, E3/DS3, STM-n/OC-n to appropriate packet formats and carry them on a modern packet transport network. Tejas Circuit Emulation Service (CES) cards have one of the most advanced implementations of the circuit emulation function in the industry today. This paper provides an overview of Circuit Emulation technology, compelling reasons for legacy systems to upgrade and how CEM products from Tejas Networks can help with smooth transition to ensure a resilient and high performance deployment.

White Paper

Introduction

Digital revolution has heralded the arrival of significant demands on the traditional network architecture hitherto employed by majority of the telecom service providers. There is an explosive growth of mobile devices and data intensive services overloading these networks. Networks are required to become `digital highways of the future' carrying data-traffic at increased speed and lower latency.

In the 1960s, the first digital modernization of the global telecommunications network introduced TDM interfaces. Over the next half century DS1, DS3 and eventually OC-n interfaces became the de facto standard for transport networks. These networks are unable to meet the increased demands of bandwidth intensive services. Network evolution to support the new requirements will need smooth transition of the legacy interfaces to optimize revenue and cost. Circuit Emulation of packet switched services allows traditional circuit-switched traffic to be transported over packet networks. This is done by packetizing the incoming traffic, labeling each service with a unique identifier and transporting the traffic to the destination node.

Tejas Networks offers best in class Circuit Emulation services which can upgrade the extensively used legacy system to leverage on the high speed and lower latency made possible by the next generation networks. Benefits include flexibility for adding new services, reducing operational costs while creating a stable platform for existing and new services.

Key drivers for transition from Legacy Optical Networks

SONET/SDH was the most widely used transmission technology deployed by many telecom carriers in the past owing to robust and efficient transport of voice traffic and leased-line applications over long distances. Using SONET enabled interoperability between equipment of different manufacturers. Gradually, these networks were used to carry data traffic as well. With the exponential growth in network traffic, the demands have far exceeded the capacities of SONET and SDH. The key drivers to network modernization are listed below:

- Limitations with the technology - The highest deployed rate is limited to 40 Gb/s for the OC-768 or STM-256 circuit.
- Non availability of components - Spending on the SONET/SDH infrastructure and product development has rapidly declined with most equipment suppliers ceasing to invest in these products. With ageing equipment, telecom operators are saddled with expensive maintenance contracts, non-availability of replace parts, no new feature upgrades.
- Reliability - System reliability is questionable given the aging equipment. Maintaining existing SLAs for uptime with these drawbacks is impossible. Service degradation eats into the revenue stream and eventually leads to customer churn.
- Higher OPEX - SONET/SDH legacy infrastructure not only takes up larger space but also consumes large amounts of power in comparison to the next generation packet platforms. This results in increased operational costs.
- Complex setup and maintenance - Legacy SONET/SDH have complex manual management systems that require high setup time. This severely impairs the ability to dynamically configure the system for variable data demands.

Circuit Emulation (CEM)

Legacy systems use circuit switched technologies such as Asynchronous Transfer Mode (ATM), Frame Relay, Ethernet or time-division multiplexing (TDM). The ideal solution is to replace the entire legacy infrastructure and make it packet based. This is however prohibitively expensive from the CAPEX standpoint. Even if operators may provide for an end to end packet switched network, they still need to allow transport of circuit switched traffic over the packet network, since all legacy equipment may not be replaced at the same time. Globally, there continues to exist a large circuit based TDM network infrastructure built over many years for applications such as 2G backhaul, broadband services, enterprise leased lines, utility communications etc. Associated with these networks is a large deployed base of customer access interfaces based on PDH/SDH technologies, which service providers want to retain for a few more years because replacing these overnight could result in customer churn or because they are bound by long-term service contracts.

Circuit emulation service is a proven approach used to convert the circuit based traffic into packets which are then transported over packet networks. Circuit emulation service leverages the strengths of the packet networks while using the existing legacy infrastructure.

Circuit switched equipment continuously transmits and receives data bits with fixed delay. The continuous bit stream transmission with a fixed delay is achieved by clock synchronization between the transmitter and receiver. For voice-based services, this worked well as the circuit switching ensured guaranteed permanent transmission. The drawback however is, the bandwidth and flexibility will take a hit. In contrast, packet transmission is not continuous and transmission has a variable delay between packets. The circuit emulation service must ensure that the circuit switched equipment can continue to transmit and receive data bits with fixed delay even though the connectivity happens via a packet switched network.

The continuous bit stream generated by the circuit switched endpoint is converted into a series of packets by the CEM card for transmission over pseudowires on the packet network. The circuit switched data (payload) is encapsulated with SAToP or CEP control word, IP/UDP/MPLS headers before transmission. The pseudowires emulate a point to point connection over a packet switched network. The packet network may be Internet Protocol (IPv4/IPv6) or Multi-protocol Label Switching (MPLS).

Requirements from Circuit Emulation Service

Circuit emulation service is required to meet the below-listed requirements:

- Maintain accurate synchronization information for incoming circuit switched circuits
- Stringent latency, jitter and wander performance for end-to-end for reliable transmission
- Sub-50ms protection switching in the case of voice and other mission-critical services
- Real-time performance monitoring and fault management capabilities such as service loopbacks
- Scalability to emulate thousands of low-speed circuits for large-scale carrier networks that continue to support circuit switched interfaces at the customer end for business reasons

The above requirements can only be achieved by guaranteeing adequate bandwidth, prioritization and buffering along the end-to-end path to minimize packet losses, delays or reordering.

Circuit Emulation Protocols

- Structure-Agnostic Time Division Multiplexing (TDM) over Packet (SAToP) defined by RFC 4553 SAToP encapsulation method provides a simple emulation service. The RFC 4553 d*e*scribes a method for encapsulating Time Division Multiplexing (TDM) bit-streams (T1, E1, T3, E3) as pseudowires over packet switched networks. It addresses only structure-agnostic transport. It is ideal for transporting a complete TDM stream without consideration for framing.

- SONET/SDH Circuit Emulation over Packet (CEP) defined by RFC 4842 During normal operation, SONET/SDH payloads are fragmented, prepended with the appropriate headers, and then transmitted into the MPLS network.
- MEF 8 - Implementation Agreement for the Emulation of PDH Circuits over Metro Ethernet Networks MEF 8 provides precise instructions for implementing interoperable CES equipment that reliably transports TDM circuits across Metro Ethernet Networks while meeting the required performance of circuit emulated TDM services as defined in ITU-T and ANSI TDM standards.

Clock Recovery Mechanisms

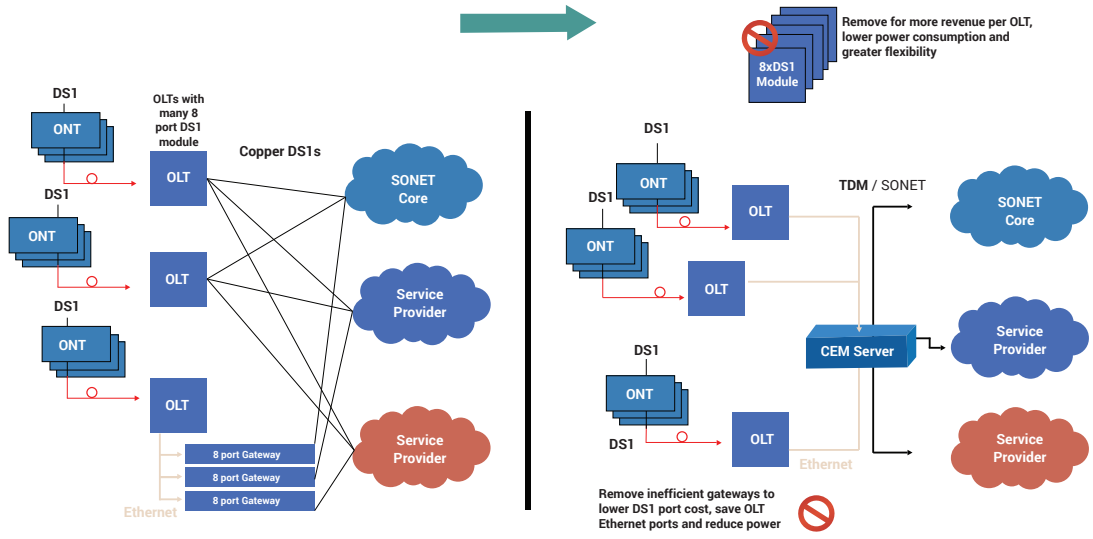
The key challenge of a circuit emulation service is to align the clock rate of the TDM transmitter and the TDM receiver to minimize jitter and wander. ITU-T recommendations G.823 and G.824 define the maximum wander for TDM interfaces.

- Differential Clock Recovery (DCR) A common reference clock is used for both the transmitter and receiver. The timestamp is inserted during encapsulation into the transmitted packet which is then used by the receiver for clock recovery.
- Adaptive Clock Recovery (ACR) The jitter buffer fill level is used in a control loop to adjust the TDM clock rate. Using the Jitter buffer fill level at the TDM transmitter and TDM receiver as the input variable, the TDM clock rate is adjusted. As the buffer fill level increases the TDM clock rate is increased to prevent overflow and when the buffer fill level decreases the clock rate is decreased.

Tejas Circuit Emulation Solution

Tejas optical networking products are multi-purpose platforms that provide a robust, dense, reliable, proven and cost-effective solution to support circuit emulation services. These provide advanced features for tomorrow's mobile backhaul, enterprise, business, data center, cloud and infrastructure services. The same platform is capable of hosting a variety of technologies (DWDM, ROADM, OLA) and services (SONET/SDH, OTN, Ethernet). Even though more services move from TDM to Ethernet, a few TDM circuits are expected to remain in the network for specific customer services and support of legacy infrastructure. Circuit Emulation reduces the cost and simplifies the management of these services using an all packet transport network.

Tejas Network Management System gives the end users total control, visibility and ability to configure, operate and monitor the network end to end. All standard network management features like fault management, configuration, administration are fully supported and adhered to in the comprehensive TejNMS software suite.



Fewer customers per OLT, lower power consumption, less space required.

More customers per OLT, lower power consumption, less space required.

Benefits of Tejas Circuit Emulation Solutions

- One of the densest realizations of CES functionality that includes both structure-agnostic and structure-aware emulation services as per relevant ITU/IETF/MEF standards.
- Supports emulation of a wide range of TDM interfaces including E1/DS1, E3/DS3, STM-1/4/16/64 and OC-3/12/48/192 circuits. Both lower-order and higher-order traffic can be circuit emulated up to very high capacities.
- Both SDH and SONET interfaces can be circuit emulated with advanced features such as DS3 transmux, support for emulation of EC1 interfaces and portless circuit emulation.
- Implementations are fully interoperable with third-party standards-based offerings.
- Adaptive Clock Recovery (ACR) or Differential Clock recovery (DCR) is used for clock extraction. The CES module has a stable clock source with temperature controlled crystal oscillators.
- The implementation supports PCM30 and PCM31 framing of E1s with flexible and fully reconfigurable timeslots and the ability to raise alarms for E1s.
- Synchronization information of these packetized TDM signals is maintained and distributed end-to-end through packet-based methods or Synchronous Ethernet (SyncE) as defined in physical layer standards ITU G.8261 and ITU G.8262

Conclusion

As more services move from circuit switched to packet switched, circuit emulation reduces the cost and simplifies the management of legacy services using an all packet transport network. Tejas Networks offers one of the most robust, economical and complete CEM solutions in the market today with comprehensive management using the network management system (TejNMS). Tejas CEM technology is a field-proven solution that is widely deployed over networks around the world.

TEJAS® NETWORKS

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