WHITE PAPER

Elegant Migration from TDM to a Modern Routing and Switching Network

Migrating away from legacy networking technologies is always a challenge. But done right, the process can lead the way to better and higher performing infrastructure that benefits both end users and network operators. The challenge and opportunity are of strategic interest to network operators today as they transition away from TDM technologies—which are rapidly going obsolete—toward IP/MPLS approaches. These deliver the best-possible system performance at all times, guarantee their ability to support legacy customers and new business services, and help operators pursue emerging opportunities, such as backhaul for 5G.

The forces for TDM-to-packet migration and modernization are similar, whether the network operator is a telecommunications service provider, an investor-owned utility, or a government agency that owns and operates its own networks. Fundamentally, network operators must be able to accommodate and manage legacy TDM business services on networks that also provide end-to-end IP and Ethernet connectivity for the customer base and support enterprise business services. Operators want to build these services on programmable, dynamic IP/MPLS foundations that can facilitate a menu of enhanced and differentiated services such as carrier-grade gigabit broadband, cloud computing, virtualized business services, data center interconnects, and voice, video, and mobile backhaul.

While operators are under pressure to migrate their systems, they must find a way to manage the transition. Running parallel networks is costly and complex, and ultimately unrealistic. A more practical approach is to deliver TDM, Ethernet, and IP services on the same equipment, using a converged network that can support all needs and provide a seamless experience for customers, regardless of the technology used at the beginning or end of their connections.

This paper characterizes the TDM-to-packet migration challenge and modernization opportunity for operators. It recommends a converged technology approach that operators can use to migrate from TDM-to-packet and 'evolutionize' the new routing and switching infrastructure, from access to metro sites, into scalable, adaptive systems. It also introduces a set of solutions from Ciena that enables this capability and streamlines deployment. Featured components include TDM Small Form-factor Pluggable (SFP) devices, TDM service modules, the 6500 Packet Transport System (PTS), as well as specialized Ciena Services that help operators plan and execute successful projects.

TDM obsolescence challenges and opportunities

Two primary factors are driving the migration from TDM-to-packet. The first factor is the imminent phase-out of legacy TDM technologies traditionally used by service providers, Investor-Owned (IO) utilities, and government agencies; second is the need to use modern routing and switching networking techniques to improve network efficiencies, serve users better, and open up new business opportunities.

TDM phase-out

The networking industry has been well-served by TDM technologies such as SONET, SDH, and PDH, but the equipment is becoming obsolete and will be largely phased out by 2022, according to IHS Markit.[1] Equipment vendors are now building IP/MPLS solutions only and discontinuing TDM product lines. As a result, replacements and spare parts for TDM products are difficult to obtain and network providers have few, if any, options when they need to fill empty equipment slots or maintain old hardware. To make matters worse, legacy control software is difficult to upgrade or integrate and relevant technical expertise is in short supply. Operators need solutions and tools that can support legacy, Ethernet, and IP technologies for as long as needed and allow a changeover with minimal network disruption.

1 IHS Markit Optical Network Hardware Tracker Q4 2019 (subscription required)

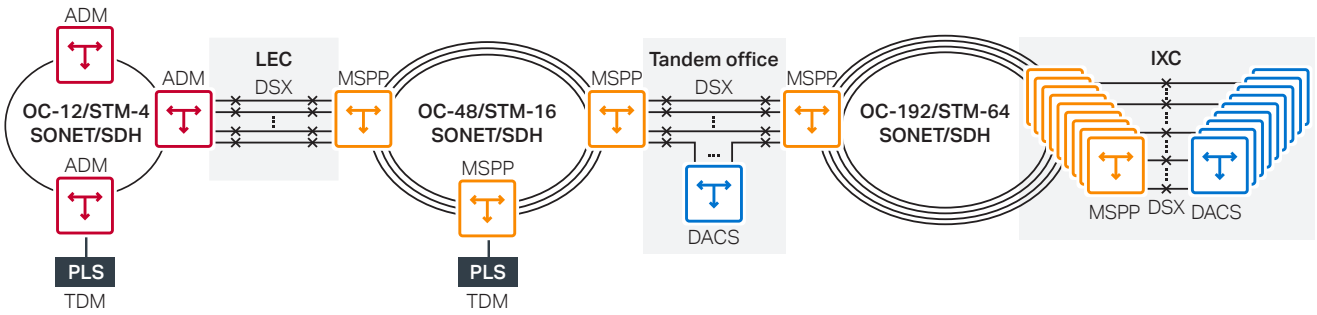

Figure 1. Service provider TDM network

Service providers

Most service providers are already using IP/MPLS networks to offer IP and Ethernet services in their markets, but they are still operating many TDM networks on legacy equipment to offer switched voice, video, and data services, as well as private-line services for residential and enterprise customers. The operators need to migrate TDM customers to IP/MPLS solutions that can support a full range of broadband, voice, cloud-computing, data center interconnects, and other networking services.

Before beginning the migration, operators must be confident they can offer their customers equivalent or better performance on the network and install and launch the new infrastructure without interrupting services. Operators want to ensure their new technologies can scale rapidly and respond dynamically to changing conditions. The network must also enable the operator to offer differentiated services that provide long-term value, such as virtualized managed services, to attract new enterprise customers and provide new revenue streams.

IO utilities

IO utilities often act as their own network providers, and they have used TDM technologies for years to monitor and control the grid. As they evolve from TDM systems, IO utilities want to build modern networks that provide automation and adaptive capabilities that can enhance sensor communications used for teleprotection, SCADA, advanced meter reading, and, in particular, smart grid and other mission-critical services. The advanced capabilities will help minimize power line failures, isolate faults, and prevent cascading outages to ensure day-to-day reliability of electricity services.

Along with operational needs, utilities have many business applications for a modern routing and switching network. They want to use the network internally to improve Information Technology (IT) processes. They also want an infrastructure that will enable them to offer revenue-generating, carrier-grade broadband services to the customer base. Already, IO utilities in some regions are using networks to offer Internet Protocol (IP) and Ethernet services for residential and enterprise

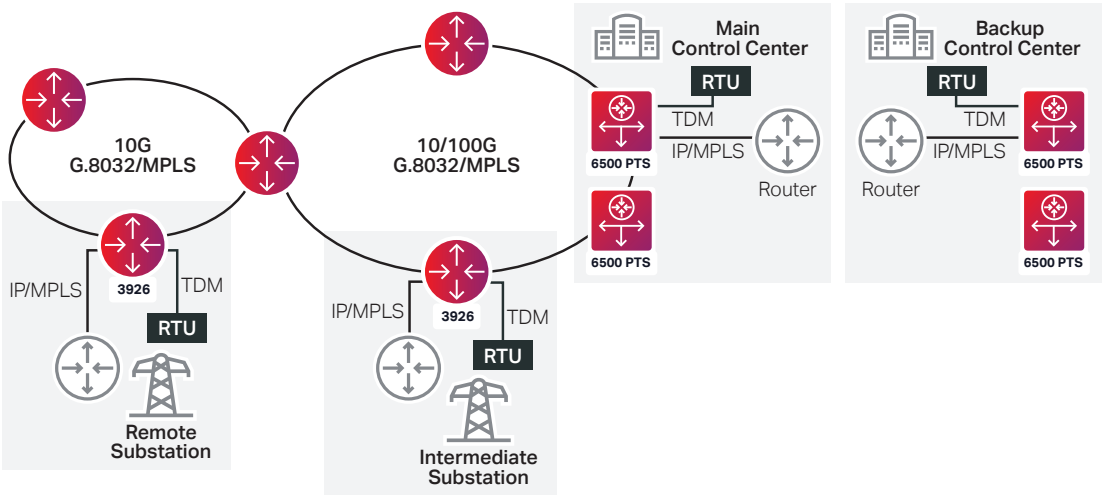

Figure 2. IO utility TDM network

customers, and more utilities are expected topursue similar strategies, using their new routing and switching infrastructure to offer broadband, cloud-computing, data center interconnects, and other networking services.

Government agencies

State, county, and municipal governments can serve hundreds of entities—from education, healthcare, library, and transportation systems to tax authorities, public safety agencies, and municipal utilities. The individual agencies typically have deployed TDM technologies to meet their specific service requirements. The networking silos are costly to manage and prevent use of common features, toolsets, and services.

Governments are striving to consolidate these disparate TDM systems on modern, high-performing networks that can support enterprise-wide architectures connecting all entities to data centers and cloud services. They need the new architecture to support future-oriented services—from sensor-based IoT applications to video surveillance, facial recognition, and real-time decision-making solutions for a range of smart city, intelligent transportation, and public safety applications. Many governments also want to expand their infrastructure to build state-wide, multi-town, or community routing and switching networks that improve local economies and ways of life. They want to build these networks with the same Ethernet and MPLS technologies commercial operators use, even while maintaining internal TDM services or migrating to IP/MPLS on the same equipment.

The TDM migration goal: Modernize and evolutionize

Operators have a near-term motivation to migrate from TDM-to-packet, but the objective comes with a longer-term goal: creating an advanced routing and switching network that can manage all of an operator's services better and expedite the delivery of new and enhanced features, especially virtualized services, to current and future customers.

Evolutionize your routing and switching networks

In addition to carrying TDM traffic, a modern network should provide a IP/MPLS foundation, Ethernet and MPLS switching capabilities, and support advanced segment routing and traffic engineering techniques that optimize traffic and facilitate use of Software-Defined Networking (SDN). This combination of critical features makes it possible to support the market's demands for gigabit-broadband connections while making it easier for providers to create, provision, spin up, and manage services and resources. Operators also want the capability to evolutionize their networks with automation features and analytics that make their systems dynamic, with the ability to adapt to change.

Equipped with these capabilities, operators can confidently offer Software-Defined Wide Area Networks (SD-WANs), Virtual Network Functions (VNFs), virtualized managed services, Ethernet Virtual Private Networks (EVPNs), and other compelling solutions to enterprise customers. Enterprises, in turn, can use the capabilities to control their own destinies and lower their costs by avoiding use of complex hardware solutions that are built with more features than they actually need.

Converged networking to streamline modernization

A service provider can implement and manage all of these capabilities on a converged network, supporting both legacy and modern services on a common infrastructure that spans from access nodes at the edge of the network to aggregation, metro, and core sites. A converged network avoids the need to deploy overlays, enabling various types of TDM traffic to run over Layer 2 Ethernet or Layer 3 MPLS services. Convergence also allows the operator to interconnect routing and switching networks so they can seamlessly interconnect customer Ethernet traffic to the MPLS network without requiring additional physical components.

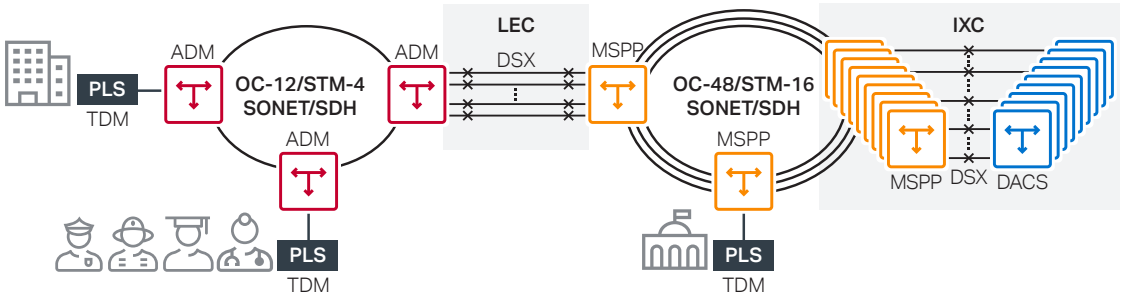

Figure 3. Government TDM network

Ciena, leveraging its experience in TDM, Ethernet, and IP technologies, offers a portfolio of purpose-built solutions that enable small and large operators to converge legacy Ethernet and IP services on access, aggregation, and metro networks.

Ciena's portfolio includes a variety of TDM Small Form-Factor Pluggable (SFP) devices and TDM modules that can carry TDM business traffic on routing and switching infrastructure while enabling the operator to future-proof the edge with virtualized services. The 6500 PTS, an ultra-high-density routing and switching platform for high-volume aggregation and metro networks, provides an advanced Ethernet/OTN switching fabric that can support connectivity and consolidation for a broad range of TDM protocols as well as Ethernet, IP, and MPLS, and advanced techniques provided by Ciena's Adaptive Network™. Services can be managed from the edge to the core with common tools, including Ciena's Service Aware Operating System (SAOS) and Ciena's Manage, Control and Plan (MCP) domain controller. The solutions are supported by Ciena Services, a team of engineers and consultants who can help operators plan, build, and successfully complete their TDM-to-packet and modernization projects.

Network edge solutions

Convenient TDM-to-packet devices for legacy and modern IP/MPLS services

For providers that need solutions at the edge of the network, Ciena offers a family of TDM SFPs and modules that use Pseudowire Emulation (PWE) and circuit emulation technologies to keep TDM services up and operating while the operator migrates.

TDM SFPs for routing and switching equipment

Ciena offers a family of SFPs that use PWE to create a virtual, dedicated lane for TDM services on infrastructure that can also carry IP/MPLS traffic for newer applications. The SFPs are designed for use when legacy traffic requires just a few ports at a given service endpoint. The SFPs are easily added, with plug-and-play convenience, to designated ports on Ciena's selection of 39xx or 51xx Routing and Switching solutions.

Ciena's SFPs can accommodate a wide range of TDM interfaces, including DS1/E1, DS3/E3, OC-3/STM-1, and OC-12/STM-4. Depending on the interface needed, the SFP will create the pseudowire using the most applicable technique, such as Virtual Container over Packet (VCoP), channelized SONET/SDH over Packet, or transparent PDH over Packet.

TDM service modules that transition to virtual platforms

If more TDM endpoints are needed, Ciena's 3926 offers 82 Gb/s of non-blocking capacity in a compact one rack unit (1 RU) platform that transports traffic over MPLS. The 3926 is equipped with native 1/10GbE interfaces and an expansion slot capable of receiving a TDM circuit emulation module that can carry TDM services over the network. The 3926 can also receive an Intel x86 serve module, enabling operators to future-proof the edge of the network with virtual services.

Operators planning strategically for the future can use the TDM circuit emulation module where legacy services are required to carry up to 16 DS1 or E1 services. When the operator is ready to modernize the services, it can plug in the Intel x86 server module to host distributed VNFs to support virtual managed services, firewalls, encryption, routing, and other capabilities on the platform. The built-in MPLS foundation positions the operator to support seamless MPLS and IP services and use segment routing and advanced traffic management techniques.

Plug-and-play

All of Ciena's TDM SFPs and service modules can be configured and managed easily with Ciena's software tools. These include the SAOS, which streamlines provisioning and troubleshooting to minimize operational expenses and accelerate the delivery of services and the MCP domain controller. Ciena's Zero-Touch Provisioning (ZTP) expedites service turn-up while providing line-rate, built-in service activation testing with no additional cost or equipment.

Aggregation and metro network solutions: The 6500 Packet Transport System (PTS)

Ciena's 6500 PTS is purpose-built to enable TDM-to-packet migration, as well as IP and Ethernet services. Its primary applications include DACS and MSPP replacement; head-end ADM ring consolidation; TDM-to-Ethernet gateway functions; routing, switching, and transport; and network modernization. As soon as the platform is installed for any of these applications, operators simplify their systems, gain a high-performing IP/MPLS network that can carry TDM traffic for as long as needed, and establish all the capabilities they need to provide future-oriented, innovative adaptive routing and switching services to their customers. The 6500 PTS also reduces the number of components used in the network, which simplifies operations and reduces power consumption and facility space requirements.

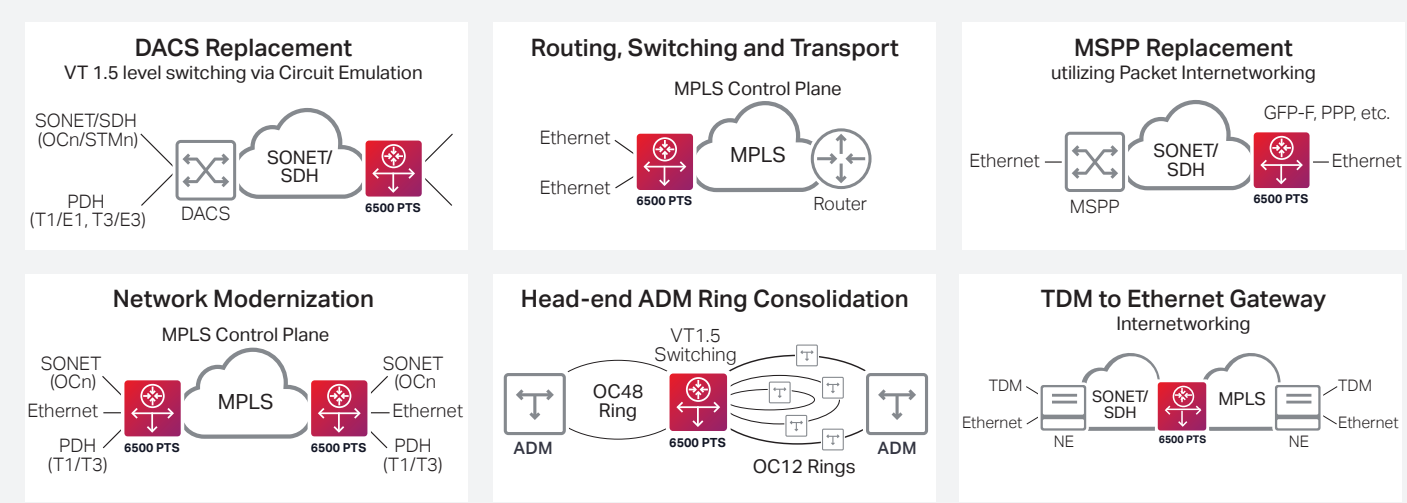

Figure 4. 6500 PTS applications

Depending on their needs, operators can implement six TDM-to-packet applications on the 6500 PTS. The applications can be implemented as standalone 6500 PTS upgrades on existing Ciena 6500-S8 or 6500-S14 routing and switching platforms if slots are available. The capabilities are also available with all new deployments of the 6500 PTS. The applications and capabilities include the following:

DACS replacement: The 6500 PTS can replace Digital Access Cross-connect System (DACS) and associated components by using circuit emulation to 'switch' the DACS services, perform low- and high-level grooming, framing the data, and send it out over the operator's SONET/SDH network to intended endpoints or a switching center.

ADM ring consolidation: The platform provides Add-Drop Multiplexer (ADM) functions by consolidating ADM optical rings, performing low-level grooming, and sending data out over the provider's SONET/SDH network to the switching center.

MSPP replacement: The 6500 PTS can consolidate numerous Multiservice Provisioning Platforms (MSPPs), providing a central point for grooming and managing all traffic for a wide range of encapsulation protocols to enable end-to-end Ethernet services.

TDM-to-Ethernet gateway: The 6500 PTS can act as a gateway between TDM and modern IP/MPLS domains by replacing the transcode multiplexing (transmux) functions normally required to connect TDM private-line services to the digital fiber-optic network. For this function, the 6500 PTS maps private-line services into Label Switched Path (LSP) tunnels over an MPLS network.

Routing, switching, and transport: The 6500 PTS operates as a standard MPLS switch for transmitting traditional Ethernet services. Operators can use this application to interconnect Layer 2 (Ethernet) and Layer 3 (MPLS) services, offer advanced segment routing and traffic engineering techniques to establish seamless services, optimize use of the network for traffic, facilitate scalability and support the use of SDN, and allow use of virtualized services.

Network modernization: Providers can use the 6500 PTS to migrate legacy TDM services to a next-generation IP/MPLS network that uses MPLS and Ethernet switching techniques and advanced routing capabilities as a foundation for future IP services. Providers can use the platform to offer standards-based carrier-grade services without restrictions or compromise, enabling a full range of WAN services, including high-quality gigabit-broadband connections, voice and video, data center interconnects, cloud services, virtualized managed services, and mobile backhaul.

Accelerate modernization
Find out how

6500 PTS technical features and capabilities

The 6500 PTS is a converged networking solution built on a IP/MPLS foundation, giving TDM network operators all the features and capabilities they need to modernize their services on future-oriented networks, such as the Adaptive Network.

Network convergence

The 6500 PTS delivers TDM, Ethernet, and IP services on a single, common platform to avoid running parallel networks. Both networking approaches can coexist as long as necessary, giving operators the ability to offer advanced IP and routing capabilities when they are ready to migrate. The converged approach simplifies the network and minimizes transition costs.

Advanced timing and synchronization

The heartbeat of any circuit-based network is timing. The 6500 PTS supports several timing modes, including an internal clock, BITS, Line, Synchronous Ethernet, and 1588v2-Grand Master, boundary, and ordinary clock support. Selecting a timing solution is a straightforward and convenient process. Network operators simply designate their preferred option when they remove their DACS, MSPP, and ADM components and deploy the 6500 PTS. If an operator needs to keep its legacy timing solution, the many timing interfaces of the 6500 PTS enable operators to use same clock they previously used.

IP/MPLS foundation

Built on Ciena's 6500 S-Series foundation, the 6500 PTS's key features include an 800G Ethernet/OTN switch that uses the most advanced merchant silicon, as well as a family of circuit packs and circuit emulation modules that enable operators to pick and choose the services they want to offer. The platform can meet any operator's need for TDM-to-packet migration, providing connectivity for PDH, T1/E1, T3/E3, SONET/SDH, ADM/MSPP, and DACS 3/3 and 3/1 while supporting Ethernet and IP protocols. It is energy-efficient and highly scalable in a compact unit, reducing requirements for power and floor space. Services can easily scale to provide ultra-dense 10/100/1GbE/10GbE, 40GbE/100GbE connectivity.

One network, one management and control system

Ciena's MCP domain controller simplifies multi-layer management and control so operators can plan, provision, and launch TDM, Ethernet, and IP services. It includes software control and automation tools that leverage data collected from the network, predictive analytics, and network policies to constantly assess operating needs and conditions. MCP removes chaos, giving the operator control of the network and services while making network operations simple, secure, and highly cost-effective with a single unified approach.

Adaptive and programmable networking

The 6500 PTS is adaptive and programmable, making use of an advanced Ethernet/OTN fabric to support TDM circuit emulation, Ethernet, IP, and MPLS technologies. The 6500 PTS can support any number of new network architectures such as seamless MPLS or Segment Routing (SR), which are essential capabilities for adaptive and scalable routing and switching.

Service velocity

Ciena's ZTP simplifies device deployment, system and service turn up, and enables performance testing to be run from the network operations center. This improves efficiency and eliminates the need for on-site personnel or adjunct test equipment. Operators can roll out services faster at lower cost.

Ciena's 6500 PTS for TDM-to-packet migration and service modernization

- **A true IP/MPLS solution:** Ultra-dense 10/100/1GbE/10GbE, 40GbE/100GbE connectivity
- **Key applications:** DACS replacement; MSPP replacement; head-end ADM ring consolidation; TDM to Ethernet gateway; routing, switching, and transport; and network modernization
- **Hardware:** 800G Ethernet/OTN switch and a portfolio of ultra-dense Ethernet and Optical/Ethernet circuit packs, PDH circuit emulation modules, and PDH circuit packs
- **Programmable and adaptive:** Advanced merchant silicon, supporting next-generation routing and switching
- **Service velocity:** Ciena's ZTP to simplify deployment, Ciena's MCP domain controller that facilitates software control and automation, and Ciena's SAOS
- **Efficient:** Up to 5 times lower power consumption and 10 times space savings depending on the application
- **High-capacity:** Up to 4 times more TDM circuit emulation capacity than competing solutions
- **Future-proof:** Supporting TDM business, Ethernet, and TDM-to-packet modernization

Ensuring a smooth migration with Ciena Services

Migrating a network from TDM-to-packet can be challenging, and network operators often find it difficult to plan, start, or execute on schedule. Even operators with in-house planning and engineering teams struggle with the scale and complexity of these projects. Often, their legacy systems and processes and out-of-date inventory and circuit office records present significant barriers to successful completion. Establishing a baseline of the current network is essential and fundamental to getting a project off to a good, and correct, start.

Ciena's professional service engineers and consultants are uniquely positioned to guide customers successfully through the migration process to the Adaptive Network. Ciena Services include five project phases: Strategy, Evaluation, Planning, Execution, and Closure.

During the strategy phase Ciena Services experts work closely with the operator to capture and evaluate goals and establish key success metrics. Working together, we define the scope of the project, align teams on goals and objectives, and build a robust business case to create greater certainty of ROI.

We develop a complete understanding of your network during the evaluation phase. We apply our proprietary analytics technology to extract and map network data from all sources creating a single unified view of the network. This provides the critical foundation for analysis and decision making and enables the creation of an optimal execution plan.

The planning phase determines optimal use cases, and project managers and engineers work closely with customer technical and operations teams to plan the migration. We ensure mission-critical services remain available throughout the migration and every avenue is explored to dramatically reduce operational risks.

After spending significant time on strategy, evaluation, and planning, our experts deploy the new 6500 PTS equipment and migrate associated services. This phase includes pre- and post-migration testing to ensure that each step in the deployment is performed properly and the network operates as it should. Experience, a proven methodology, data analysis, automation procedures, and preparation all came together to minimize risk and ensure successful delivery.

During Closure Ciena conducts an audit, completes OSS/BSS updates and decommissions and removes legacy equipment in a sustainable fashion reducing power consumption and the use of rack space. We can also provide training to help the operator's teams learn how to operate and manage their new infrastructure and services.

From Strategy through Closure, Ciena uses a set of software tools and automated provisioning solutions that enable expedited planning with fewer mistakes. The process also optimizes use of onsite resources, based on the business outcomes desired, to reduce costs. The entire end-to-end process leverages Ciena's deep understanding of telecom and expert project management. Ciena's project managers employ best practices, such as the Project Management Institute (PMI) Project Management Body of Knowledge (PMBOK), and diligently apply lessons learned from all of their engagements to ensure consistent, positive experiences for each customer. Ciena Services allows operators to mitigate risks, migrate faster, and realize their strategic business outcomes.

The bottom line: TDM-to-packet migration is a welcome opportunity for operators

Network operators are compelled to migrate away from TDM systems due to technology obsolescence, but the pressure to change opens up a welcome opportunity to build better, fully modernized networks. As they craft their migration strategies, telecommunications service providers, IO utilities, and government agencies are looking for solutions that can accommodate legacy services for as long as necessary while establishing versatile, adaptive routing and switching foundations that are dynamic and responsive to change and support a full range of capabilities, from gigabit-broadband to cloud computing, data center interconnects, and virtualized managed services for enterprise customers.

The best approach is to converge legacy and future technologies on the same equipment. Ciena's solutions for TDM-to-packet migration—including TDM SFPs, TDM service modules, and the 6500 PTS, combined with MCP domain controller and associated software tools—provide everything operators need to build converged networks that streamline the migration and modernization process for edge, access, and metro aggregation sites. Ciena Services partners with operators to help guide them through the process.