

A Path to a Modern and Versatile Government Broadband Network

National governments—including civic, local district, unitary authorities, municipal, county, regions, state, and other global governing bodies—are struggling to solve multiple IT networking challenges. They need to consolidate and modernize their networks with efficient, high-performing solutions that support enterprise-wide cloud computing services and applications. At the same time, they need to prepare their networks to offer innovative services that will be expected of governments in the coming years, such as smart cities, intelligent transportation, enhanced public safety communications, and others. Many of these government bodies also want to expand their networks to offer community broadband services, which can generate new revenues while helping improve local economies and way of life.

The challenges are daunting and require a migration from outdated legacy approaches, such as Time Division Multiplexer (TDM)-based technologies, which cannot support the needed capabilities or scale with consolidation or service growth. The accepted solution is to shift to high-capacity technologies that are versatile and capable of meeting a wide range of current and future needs. The migration must be smooth and seamless, however, some of these government bodies can continue using their legacy networks for as long as necessary and shift over to routing and switching solutions when appropriate for their organizations.

This paper summarizes government networking challenges and opportunities and introduces Ciena's 6500 Packet Transport System (PTS), and a professional services framework for the network transformation. The 6500 PTS, a high-performing TDM-to-packet technology solution that can provide both legacy and routing and switching solutions services, enables of these government bodies to evolve their technologies gracefully and consolidate services on a single foundation.

The 6500 PTS is an ultra-high density Plesiochronous Digital Hierarchy (PDH), SONET, SDH, and GbE/10GbE to 100GbE aggregation packet-optical solution. It is a major component of Ciena's TDM-to-Packet Solutions portfolio, which also includes TDM Small Form-factor Pluggable (SFP) devices, TDM modules, a common

Ciena's 6500 PTS for TDM-to-packet migration and service modernization for government of these government bodies

- **A true packet-optical solution:** Ultra-dense 10/100/1GbE/10GbE, 40GbE/100GbE connectivity
- **Key applications:** DACS replacement, MSPP replacement, head-end ADM ring consolidation, and network modernization
- **Hardware:** 800G switch fabric 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 and Ciena's MCP tools to facilitate software controls and automation
- **Efficient:** Up to 5x lower power consumption and 10x space savings, depending on the application
- **High capacity:** Up to 4x more TDM circuit emulation capacity than competing solutions
- **Future-proof:** Supporting TDM business, Ethernet, and TDM-to-packet modernization

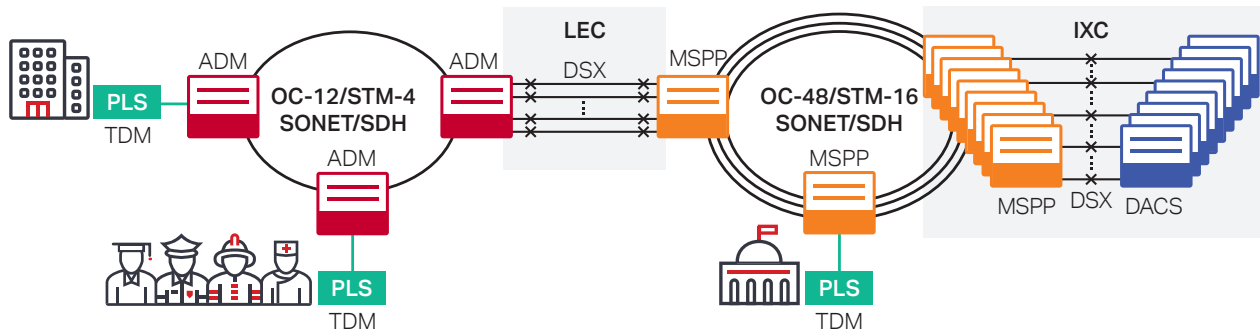


Figure 1. Government TDM network

Manage, Control and Plan (MCP) service management, and Ciena Services. The multiple platforms are available to ensure a successful technology migration for large and small government bodies and prepare their networks to offer modern broadband services and applications for internal government bodies and external end-users.

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TDM obsolescence mandates upgrades, paving the way to modernization

Today's TDM-based SONET/SDH systems are rapidly becoming obsolete. Essential components, such as Digital Access Cross-connect System (DACS), Multiservice Provisioning Platform (MSPP), and Add/Drop Multiplexer (ADM) devices will be phased out of the market by 2022, according to IHS Markit.¹ Manufacturers are discontinuing product lines, spare parts are hard to obtain, legacy control software is difficult to update or integrate, and relevant technical expertise is in short supply. And, fundamentally, the technologies are too expensive to own and operate; they do not scale easily, often requiring excess capacity, they are power hungry, and they consume facility space.

Government bodies must evolve away from these technologies and migrate to modern, routing and switching networks. Running parallel networks is too costly and complicated. Fortunately, Ciena's 6500 PTS can provide DACS, MSPP, and ADM capabilities and even improve these functions with automation and adaptive techniques. Both legacy and routing and switching approaches can work on a single 6500 PTS foundation, providing operational and management efficiencies. Government bodies can transition their TDM

services at their own pace and then use the platform to offer a full range of modern, standards-based, commercial-grade IP and Ethernet services.

The 6500 PTS provides the following modernization benefits that are of particular interest to government bodies: 1) easy, resource- and cost-efficient scalability; 2) analytics-based intelligence that enables real-time awareness of services conditions and facilitates automation and adaptive techniques to ensure capacity, reliability, and resiliency; 3) routing and forwarding protocols and traffic engineering techniques to guarantee data reaches its destinations; 4) convenient backup at primary or secondary data centers without requiring complete redundancy; 5) robust security techniques that keep in-flight sensitive data secure, and network monitoring and control tools that pinpoint intrusions and block attacks.

Consolidating government networking silos with a unified enterprise architecture

Governments need to rein in and consolidate highly fragmented networks. Today, a government can serve hundreds of entities—from administration to educational, healthcare, library, and transportation systems to tax authorities, public safety bodies, and municipal utilities. Individual government bodies, however, have typically deployed their own technologies to meet specific service requirements and interconnect with other branches. The networking silos are costly to manage and prevent use of common features, toolsets, and services.

The fragmentation issue is spurring a "definite growing trend toward consolidating and unifying services across the enterprise," according to the National Association of State Chief Information Officers (NASCIO).² With the versatile, scalable, high-capacity, and high-performing 6500 PTS platform, governments can consolidate disparate TDM or routing and switching networks from multiple government

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

² "State CIO Priorities for 2018 - State Technology Leaders make Security and Cloud Services Top Priorities," National Association of State Chief Information Officers (NASCIO), Nov. 29, 2017.

bodies and build an enterprise architecture. Once built, the architecture can connect all entities to data center and cloud-based applications and support a range of new features and services, from sensor-based IoT applications to video surveillance or facial recognition tools, as well as real-time decision-making solutions for mission-critical services.

Using network infrastructure to offer community broadband services

National governing and municipal bodies are leveraging their fiber assets to offer community broadband services. They are extending their own infrastructures and augmenting them with assets from other government bodies, jurisdictions, and partners to build state-wide, multi-town, or community routing and switching networks that bring much-needed affordable services to rural and underserved areas. The networks are typically self-sustaining or profitable and “sources of civic pride” for the agencies, according to *Broadband Communities* magazine.³ While the networks fulfill a public need, customers do expect continuing innovation from their providers: *StateTech* reports, for example, that Chattanooga’s community network, EPB, is planning to offer telehealth services to customers to maintain its “competitive edge” in its market.⁴

Because public bodies typically rely on government funds to support their deployments, public bodies need to ensure they can deliver competitive, high-quality, cost-efficient services that are affordable to local users and benefit rural industries. Ciena’s 6500 PTS positions government bodies to compete for funds with the Ethernet, MPLS, and advanced MPLS-SR technologies commercial operators use, even while maintaining internal TDM services or migrating on the same equipment.

Ciena’s response for government bodies: The 6500 PTS

Ciena’s 6500 PTS is purpose-built to address the phase-out of TDM services with techniques that enable TDM-to-packet migration, as well as Ethernet services. Its primary applications for government bodies include DACS and MSPP replacement, head-end ADM ring consolidation, and network modernization. As soon as the platform is installed for any of these applications, government bodies simplify their systems and gain high-performing packet-optical networks that can be used for enterprise-wide or community broadband services.

Converged solution: One key value of the 6500 PTS is its ability to deliver TDM and routing and switching services on a single, common platform to avoid running parallel networks. The 6500 PTS allows both networking approaches to coexist as long as necessary while giving government bodies the capability 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. Government bodies can simply designate the preferred option when they remove their DACS, MSPP, and ADM components and deploy the 6500 PTS. The solution even allows government bodies to use the existing local timing distribution for the legacy systems, so they can maintain the same clock they previously used.

Packet-optical foundation: Built on Ciena’s 6500 S-Series foundation, the 6500 PTS’s key features include an 800G network processor that uses the most advanced merchant silicon, as well as a family of circuit packs and circuit emulation modules that enable government bodies to pick and choose the services they want to offer. The platform can meet any government bodies’ need for TDM-to-packet migration, providing connectivity for PDH, T1/T3, 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: MCP software simplifies multilayer management and control so engineers can plan, provision, and launch both TDM and routing and switching 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, returning control of the network and services back to the operator, making network operations simple, secure, and highly cost-effective with a single unified approach.

³ “A Record Increase in Municipal Fiber Broadband,” by Masha Zager, *Broadband Communities*, October 2017, p. 18.

⁴ “Chattanooga’s Broadband Investment Opens the Door to Telehealth,” in *StateTech*, by Phil Goldstein, Aug. 23, 2018.

Programmability and adaptiveness: The 6500 PTS is programmable and adaptive, making use of an advanced Ethernet and OTN switch 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)—essential capabilities for modern, scalable, routing and switching networks.

Service velocity: Ciena’s Zero-Touch Provisioning (ZTP), also available with the 6500 PTS, 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. Government bodies can roll out services faster, at lower cost.

Ciena’s 6500 PTS
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DACS replacement: Consolidating three components into one

Government bodies use a lot of private-line services or copper-based pairs to connect to a local exchange or a switching or data center. DACS, commonly referred to as Integrated Services Digital Network (ISDN), digitizes voice, text, e-mail, and video data for transmission over the same copper pairs between the end-user and switching center.

With traditional DACS equipment discontinued by manufacturers or reaching end of life, government bodies can adopt 6500 PTS as a standalone solution to perform DACS functions. For this application, the 6500 PTS uses circuit emulation to ‘switch’ the DACS services, perform low- and high-level grooming, packetize the data on the 6500 switch fabric, and send it out over the government body’s SONET/SDH network to its intended end-points.

Many government bodies are already using Ciena’s 6500 S8 or S14 packet-optical platform. If they have available slots in the chassis, they can perform the DACS functions on the existing unit by simply upgrading the existing switch fabric card and adding optical and PDH circuit packs. The 6500 PTS shares the same 6500-S8, 6500-S14, and switch fabric card, making life simpler for technicians and encouraging cost-effective re-use of the equipment as spares.

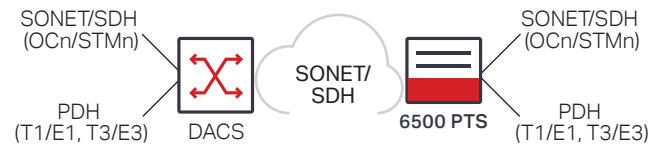


Figure 2. 6500 PTS DACS consolidation

In both new deployment and upgrade scenarios, government bodies that use the 6500 PTS are able to eliminate three legacy DACS functions at each control center: 1) multiple DACS units that perform low- and high-level grooming; 2) TDM platforms used for DS-1 handoffs to DACS units; 3) and TDM platforms used to aggregate DS1 traffic from the network. The 6500 PTS can accommodate 1,000 to 2,000 DS1s depending on which chassis is used (8-slot or 14-slot).

Government bodies that adopt this solution for DACS gain a future-oriented technology that will provide long-term value, even after the body upgrades. Better yet, government bodies will be able to use the switch fabric provided with the 6500 PTS to build a carrier-grade infrastructure immediately, establishing the capability to offer Ethernet-based WAN services for the government enterprise and support new, revenue-generating opportunities.

ADM ring consolidation to free up space and reduce energy consumption

Government bodies use SONET/SDH to bundle all T1/E1 and T3/E3 connections onto one continuous optical fiber infrastructure to enable data transmission between small and large remote offices and company headquarters.

The deployments have the following three components:

- 1. Links**—Interoffice facilities, local access, and alternate wire centers
- 2. Access ports**—Central office facilities used to enter/exit the ring, including DS1/E1, DS3/E3, OC-3/STM-1, OC-12/STM-4, OC-48/STM-16, OC-192/STM-64
- 3. Nodes**—SONET/SDH ADMs, located on premises or in the central office

ADMs function as the on/off ramp to the network. Data streams for multiple customers are multiplexed into a single beam of light, carried to the local office/exchange, demultiplexed, and electrically terminated to a patch panel for connection to the high-speed network.

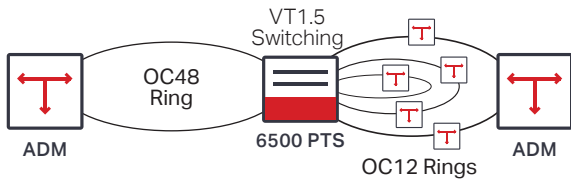


Figure 3. 6500 PTS ADM consolidation

ADMs have been highly popular, so it is not surprising to see many ADM rings of various speeds, and from various vendors, in a network. Historically, the private or leased-line services could never scale efficiently, allowing capacity to increase only from T1/E1 to T3/E3 (or 1.544 Mb/s to 44.736 Mb/s). The connections were also inefficient—with no low-order grooming, only multiplexing, most of these connections did not use all the bandwidth and often transmitted empty time slots.

Today, with traditional ADM equipment discontinued by manufacturers or reaching end of life, government bodies can adopt 6500 PTS as a standalone solution to perform ADM functions. For this application, the 6500 PTS consolidates ADM optical rings of various sizes, performs low-level grooming, and sends data out over the government bodies' SONET/SDH high-speed network to the switching center.

MSPP replacement: Consolidating services on a flexible, high-capacity routing and switching foundation

Government bodies use SONET/SDH-based MSPP solutions to consolidate services from different types of networks on the same infrastructure. Depending on their particular operational and service requirements, government bodies have used MSPPs to deliver TDM- and Ethernet-based services for a variety of business applications, as well as broadband services and even mobile backhaul.

Traditionally, MSPP technologies have been deployed at the edge of the metropolitan network. Most of these systems are aging and have discontinued hardware with outdated software. They also take up a lot of space and use a lot of power. Letting these platforms continue to rust is not viable. It also increases risk, because government bodies may not have the ability to update the legacy security software to protect the network against modern, sophisticated security attacks.

Ciena's 6500 PTS can provide a convenient, secure replacement for MSPP applications, whether the government body adopts the platform as an upgrade or new deployment. Government bodies can consolidate multiple MSPPs on the

6500 PTS, saving even more space and power, while providing a central point for grooming and managing all traffic. Traffic can be created and terminated for a variety of encapsulation protocols, including GFP-F, PoS, FR, MLFR, and PPP. The 6500 PTS solution also supports end-to-end Ethernet services and transporting all traffic via the routing and switching network to its destinations.

The 6500 PTS can consolidate substantial volumes of MSPP traffic, ensuring the capacity to consolidate multiple services for dozens of government bodies on an enterprise architecture. Along with providing MSPP services, governments that deploy the 6500 PTS platform can take advantage of its advanced technologies to offer high-performance broadband services in their communities.

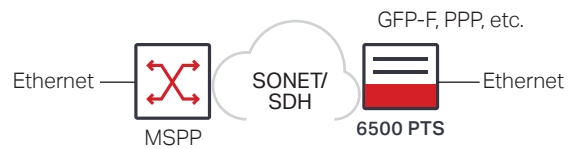


Figure 4. 6500 PTS MSPP consolidation

Network modernization: Delivering broadband services across the government enterprise and beyond

The 6500 PTS is a foundation for network modernization. Government bodies that adopt the solution for DACS, MSPP, ADM, or all three applications can operate a next-generation packet-optical network that can use MPLS and Ethernet switching techniques and advanced routing capabilities. Government bodies can use the MPLS switch to modernize their TDM networks, enabling migration of TDM services to an MPLS-protected core network. The 6500 PTS operates as a standard MPLS switch for transport and switching of Ethernet services and a pathway to future IP services that can be used across the government enterprise and beyond.

As most telecommunications operators have demonstrated, the transition to routing and switching architectures offers a means to access and scale connectivity for legacy services. This is becoming a critical capability for those who need to maintain productivity while reducing costs and enabling delivery of TDM services.

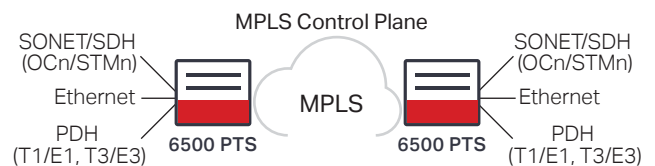


Figure 5. 6500 PTS network modernization

Government bodies, too, will find that the modernized network positions their organizations to offer carrier-grade, revenue-generating WAN services, including high-quality gigabit-broadband services for their internal enterprise, cloud services, Data Center Interconnect services, voice, video, and mobile backhaul, and residential and business customers. Government bodies that use the 6500 PTS to deploy broadband services can have confidence they will be able offer standards-based, commercially competitive services without restrictions or compromise. They will have the capability to evolve with networking trends and the capacity to develop new business.

Solutions for smaller government bodies or satellite offices

Smaller government bodies or satellite offices that may not need the capacity of the 6500 PTS for current or future services can use Ciena's various TDM-to-packet solutions to keep their legacy networks up and operating as they migrate.

For example, they can employ Pseudowire Emulation (PWE) technologies to continue using TDM services alongside routing and switching services until the legacy technology is no longer necessary.

Ciena implements PWE capability with SFP devices that are easily added to its 51xx or 39xx routing and switching solutions. The SFP devices make use of PWE to create a virtual, dedicated lane for TDM services on infrastructure that can also carry routing and switching traffic for newer applications. The pluggable devices are useful when legacy traffic requires just a few ports at a given service end-point.

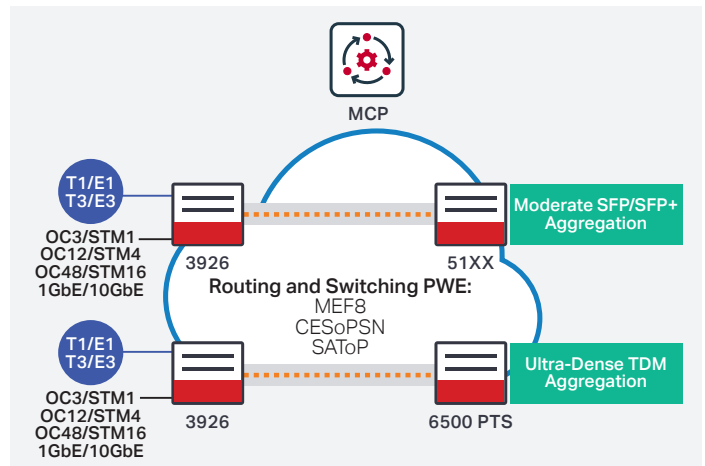


Figure 7. Ciena's 3926 Platform

If more TDM end-points are needed, Ciena's 3926 offers 82 Gb/s of non-blocking capacity in a compact one rack unit (1 RU) platform. The 3926 future-proofs the edge with a field-replaceable module for TDM service and, when the government body is ready, can provide distributed Virtual Network Function (VNF) hosting on an Intel x86 server module.

Both of these solutions, as well as the 6500 PTS, minimize OPEX and accelerate service velocity with Ciena's ZTP for service turn-up while providing line-rate, built-in service activation testing with no additional cost or equipment.

Ciena's routing and switching solutions
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Ensuring a smooth migration with Ciena Services

Migrating a network from TDM-to-packet can be challenging to plan and start, and government bodies often find it difficult to plan, start, or execute on schedule. Even government bodies that have in-house planning and engineering teams struggle with the scale and complexity of these projects. Often, 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 good and correct start.

Ciena's professional service engineers and consultants help guide customers successfully through this process to build the Adaptive Network™. Ciena Services include five

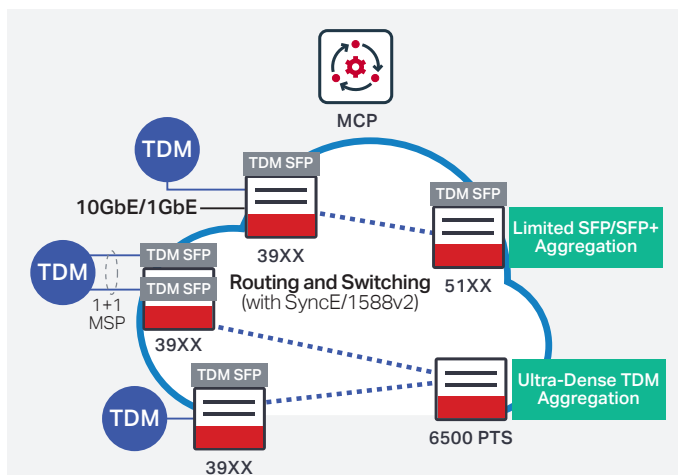


Figure 6. TDM-to-packet SFP routing and switching solution

project phases: initiation, discovery, planning, execution, and closure. During initiation, Ciena consultants meet with each government body to establish a project team and success criteria specific to the government body. Ciena then extracts and synthesizes network data from multiple sources to establish a baseline of the network. These baselines are then validated with physical audits of the legacy network. Once the baseline is validated, Ciena engineers plan each migration, balancing business and technical requirements to develop a step-by-step Engineering Method of Procedure (EMOP) that must be executed for each scheduled maintenance window or upgrade, including contingency plans. Concurrent with the planning phase, Ciena deploys the new 6500 PTS equipment and executes premigration tests to ensure the success of each window. Following each window, Ciena executes post-migration tests to ensure the network is operating as expected and customer traffic is flowing as it should. During closure, Ciena decommissions and removes legacy equipment to reduce power consumption and use of rack space. Ciena can also provide staff and training to help government body teams learn how to operate and manage their new infrastructure and services.

From discovery through closure, Ciena uses a set of software tools and automated provisioning solutions that enable expedited planning to eliminate mistakes. The process also optimizes use of onsite resources, based on the business outcomes desired, to reduce costs. The entire end-to-end process is underpinned by Ciena's deep understanding of telecom and expert project management. Ciena 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 projects to ensure consistent, positive experiences for each customer. Ciena services allow government bodies to mitigate risks, migrate faster, and realize their strategic business outcomes.

The bottom line

Government bodies need to migrate away from their out-of-date DACS, ADM, and MSPP equipment while developing the capability to support new routing and switching interface and bandwidth demands. Ciena's TDM-to-packet solutions, including the 6500 PTS, allow government bodies to remove aging equipment while providing TDM services and, if they want, consolidate multi-agency services on an enterprise architecture or offer robust Ethernet services to residential and business customers. Government bodies can leverage Ciena Services to develop successful planning and engineering procedures and carry out the deployment and migration, partnering closely with in-house teams or working independently, if the government body prefers.

Ciena provides both the technology foundation as well as the tools state, county, and local government bodies need to solve their most pressing TDM-to-packet evolution challenges. National government bodies can be confident, knowing it is possible to get started building a modern, consolidated government network.

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