STRATEGIC WHITE PAPER

Enhanced Public-safety Communications

Increasing interoperability and boosting operational efficiency with the Alcatel-Lucent Mission-critical WAN Infrastructure

Effective communication is at the heart of public safety. State and local agencies can be staffed with well-trained, responsive personnel, but if they cannot share information, they cannot serve the public interest. Analog-to-digital upgrades of LMR/PMR networks and new collaborative applications are improving operational efficiency with enhanced voice capabilities. New sources of information, including streaming video and digital images that have shown promise in increasing mission effectiveness, are feasible today. However, their value is not fully realized without the required connectivity of cooperating-agency fixed sites, such as mobile radio cell sites, operations centers, dispatch centers and video-surveillance sources. To achieve such connectivity often requires extension of the network footprint while enhancing reliability and increasing bandwidth in support of new IP-based applications.

The Alcatel-Lucent Mission-critical WAN Infrastructure helps public-safety agencies address these challenges with a communications foundation that allows always-on communications to be securely shared among agencies. The WAN Infrastructure cost-effectively expands into new areas, scaling bandwidth to accommodate new applications that boost first-responder mission effectiveness. Built-in application awareness, traffic optimization and end-to-end management boost overall effectiveness and flexibility.

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1. Introduction

Today's public-safety agencies face tremendous challenges. Recent natural disasters and terrorist activities have highlighted the need for rapid, effective action. The impact on society and the expectation of a rapid recovery has never been higher and is continuing to climb. The environment that a first responder encounters continues to grow in complexity as new technologies are integrated into our everyday life and into terrorist threats. As a result, the involvement of specialists and experts, which often requires a coordinated multi-agency effort, is crucial for delivering the appropriate response and ensuring rapid recovery.

At the same time, regulations are becoming increasingly stringent. Environmental pressures and liability costs are escalating. Recovery periods, especially extended ones, are unacceptable. Public-safety agencies are therefore aiming to accelerate recovery and improve public safety and satisfaction, but budgets to fund even their existing capabilities are strained during these tough economic times.

New and emerging applications are ripe with potential to increase an agency's ability to better prevent, detect, alert, respond and rapidly recover. Remote video surveillance and sensors offer cost-effective critical infrastructure and perimeter protection. Upgrades to new digital land mobile radio (LMR)/ professional mobile radio (PMR) systems while expanding the network to eliminate areas that lack service are improving voice-communications capabilities. Streaming video and digital images have also shown promise to increase first-responder mission effectiveness and are feasible today.

A key challenge is to eliminate jurisdictional barriers to communication as a step toward a collaborative environment and greater first-responder effectiveness. Separate agency-specific networks often include incompatible LMR/PMR systems with limited or no interoperability. Communications between responders from multiple agencies at an incident may therefore be limited, and communications may be lost in a vehicle chase across jurisdictional boundaries. Enhancing network reliability is also a key challenge as the role of communications increases in the execution of the public-safety mission.

A transformation of today's agency-specific wide area network (WAN) is a typical first step in addressing these challenges and toward realization of the benefits of new applications. The transformation includes expanded bandwidth and network reach along with new capabilities to cost-effectively address the growing IP-based application traffic.

The Alcatel-Lucent Mission-critical WAN Infrastructure helps public-safety agencies address these challenges with a converged backbone that enables always-on communications to securely interconnect agencies. The infrastructure connects existing mobile-radio cell sites, buildings and video-surveillance sources while cost-effectively enabling the inclusion of new sites and bandwidth scaling to accommodate new applications that boost first-responder mission effectiveness. Built-in application awareness, traffic optimization and end-to-end management enhance effectiveness and flexibility. For the backhaul of LMR/PMR and future broadband wireless traffic, the WAN Infrastructure leverages the globally proven Alcatel-Lucent Mobile Evolution Transport Architecture, which has been deployed with more than 150 mobile carriers.

Carrier Ethernet is a fundamental technology in the multiservice Alcatel-Lucent Mission-critical WAN Infrastructure. The benefits of Ethernet are combined with the reliability, protection and operations, administration and maintenance (OA&M) provided by technologies such as SONET/ SDH, Wave Division Multiplexing (WDM) and Multi-Protocol Label Switching (MPLS). Within the WAN Infrastructure, Carrier Ethernet consists of Carrier Ethernet transport and IP/MPLS.

Growing packet traffic, with applications such as video surveillance and graphic-rich web-site content, is triggering change to facilitate efficient WAN transport. This shift often begins with evolution to a hybrid packet and circuit transport, with increased capacity, and then full packet convergence as packet traffic begins to dominate. MPLS Transport Profile (MPLS-TP) is the

evolution of SONET/SDH to better accommodate native packet applications while retaining Carrier-Ethernet transport performance. New Packet Optical Transport Systems, microwave packet radios and Zero Touch Photonics offer the resiliency, increased bandwidth capacity, effectiveness and flexibility to enable true, smooth network convergence.

To capitalize on the wide range of new time-critical applications that increase efficiency, IP/MPLS capabilities are being added in the WAN core. IP/MPLS provides the efficient foundation for this growing IP-based application traffic as well as multiservice flexibility to deliver mission-critical and legacy traffic in an operationally consistent manner. In a greenfield application or when packet traffic is the dominant traffic type, an end-to-end IP/MPLS WAN can be an appropriate architecture. IP/MPLS-based core and access enable the reliable support of all types of traffic in a single network with Carrier Ethernet to simplify and lower operating costs.

IP/MPLS with Carrier Ethernet transport supports the full range of new IP-based applications coming down the pipe: applications that current networks simply do not have the bandwidth and flexibility to handle efficiently. IP/MPLS with Carrier Ethernet transport also provides the required foundation for broadband streaming video, imaging and video-surveillance capabilities for enhanced mission effectiveness.

It is important to note that what is driving public-safety agencies' need to enhance the WAN is not so much that today's WANs are inadequate for the purposes they serve: it is that now they are required to perform new tasks with new purposes that are beyond their current capabilities. These transformed communications are needed as a foundation for a more collaborative, rapid multi-agency effort. Yet this WAN must continue to provide carrier-grade reliability and manageability for the mission-critical traffic that is essential to flawless, effective mission execution.

2. Taking control

With constrained funding, public-safety agencies are caught in the struggle to balance between the growing complexity of the environment in which they are responding and the need for rapid effective action. Removing barriers to multi-agency communications is essential whether or not a new source of information that includes streaming video, sensor data and digital imaging is available. Even if the amount and quality of information available to first responders are increased, additional information must be provided to the right people to ensure optimal performance.

Over the past decade, communications networks have evolved from more-or-less passive systems of information transfer to active tools with strategic value for public-safety agencies. The networks have become key components in the delivery of appropriate incident responses and rapid recovery. New applications with direct impact on public-safety agencies' operations — voice collaboration, digital imaging and streaming video — expand the agencies' ability to rapidly coordinate and equip first responders with critical information from specialists and new sources. However, for these advantages to be realized, the WAN must change: to deliver the required bandwidth and efficiently support the applications' IP-based traffic.

Today, each public-safety agency typically maintains a segregated communications network for each application. A single network is dedicated to primarily mobile first-responder voice communications (LMR/PMR), another for voice communications among the agency's fixed sites, another for data, and so on. This inefficiency is due partly to the *ad hoc* evolution of these networks, in fit-for-purpose responses to changing communication needs. Although network asset life is measured in decades, maintaining the status quo has become increasingly high-risk as first responders serve and protect the public in an evermore complex environment.

By enhancing microwave and optical transport technology and adopting IP/MPLS technology, public-safety agencies have the opportunity to converge their WANs and enjoy a whole range of benefits, including greater flexibility, lower costs and improved security.

WHAT IS IP/MPLS?

IP/MPLS uses multiprotocol label switching to deliver IP-based applications traffic and services. MPLS is designed to achieve high reliability in converged WANs and has the ability to assign and guarantee Quality of Service (QoS) for specific traffic. IP/MPLS is particularly valuable for its openness and interoperability, bandwidth efficiency, and its flexibility for supporting mission-critical operations and IT voice/data applications.

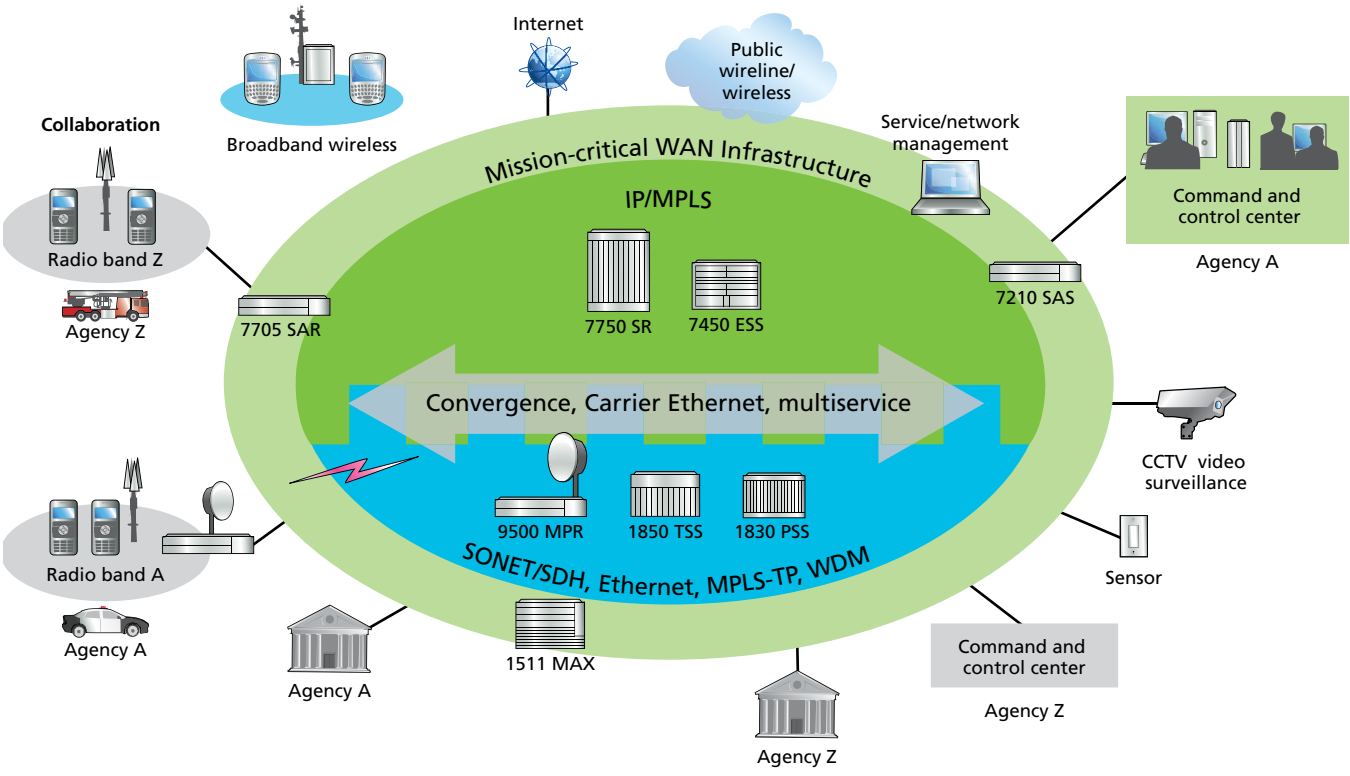
Mission-critical information can be rapidly communicated with extremely high reliability in such a converged environment. The physical connectivity of an agency's fixed sites with a common WAN for all types of communication — voice, data, video, and so on — provides a key communications foundation for better intra-/interagency communication. At the same time, IP traffic associated with digital LMR/PMR, voice, data and other new applications, including voice collaboration and streaming video to improve productivity and security, is also supported. One network can host the full suite of applications traffic required by the public-safety agency while protecting critical traffic to ensure that it always receives priority treatment.

In addition, centralization allows greater information sharing and compilation, which is essential for public-safety agencies preparing to interconnect with cooperating agencies for a coordinated multi-agency effort.

2.1 What the converged network looks like

The Alcatel-Lucent Mission-critical WAN Infrastructure, shown in Figure 1, utilizes a combination of IP/MPLS, SONET/SDH, Ethernet and MPLS-TP capabilities to support the convergence of legacy and growing IP traffic reliably, flexibly and cost-effectively in a broad range of applications. Microwave transport is deployed where fiber connectivity between sites is not available, and WDM is used to scale fiber capacity.

Figure 1. Public-safety WAN communications transformation with the Alcatel-Lucent Mission-critical WAN Infrastructure



2.2 Role of Carrier Ethernet with Carrier Ethernet transport and IP/MPLS

The Alcatel-Lucent Mission-critical WAN Infrastructure delivers multiservice support, allowing the convergence of all traffic in a single reliable, secure and scalable Carrier Ethernet-based network. Ethernet, as a packet-based data communications technology, has had appeal for WAN applications for several years because of the desire to build infrastructure based on Ethernet's attractive economics (high performance/price ratio and low cost per transported bit). Combined with Ethernet's ease of use, familiarity and virtual ubiquity in LANs, it is easy to see why public-safety agencies have attempted to capitalize on what was once a "best-effort," only-in-the-LAN technology.

The term "Carrier Ethernet" was defined and promoted by the MEF (formerly Metro Ethernet Forum) to differentiate from traditional LAN-based Ethernet. This has helped take Ethernet outside the LAN to become more of a WAN technology. The benefits of Ethernet are combined with the reliability, protection and OA&M provided by technologies such as SONET/SDH, WDM and MPLS.

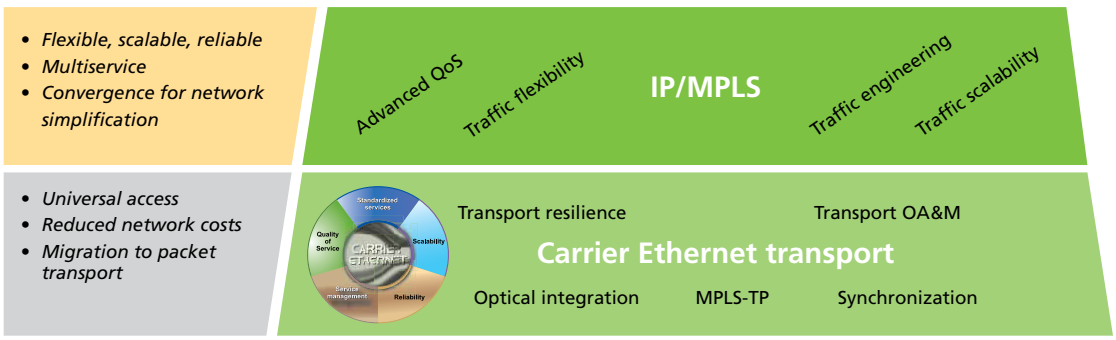
WHAT IS CARRIER ETHERNET TRANSPORT?

Carrier Ethernet transport combines the traditional efficiencies of Ethernet with the carrier-class transport capabilities of OA&M, manageability and protection. With low-cost Ethernet interfaces, EoS efficiently delivers Carrier Ethernet transport for the increasing packet traffic while the majority of traffic is TDM. As packet traffic begins to dominate, MPLS-TP becomes the choice for Carrier Ethernet transport. This connection-oriented packet-transport technology, based on MPLS frame formats, provides resiliency and OA&M capabilities similar to SONET/SDH while maintaining the benefits associated with packet-based networking. MPLS-TP evolves to enable operational convergence with IP/MPLS domains.

Carrier Ethernet is a fundamental technology throughout the Alcatel-Lucent Mission-critical WAN Infrastructure. Carrier Ethernet consists of the following, as shown in Figure 2:

- *Carrier Ethernet transport* – Provides cost efficient, resilient, bulk transport, with:
  - ¬ Flexibility to route and monitor capacity where and when it is required
  - ¬ Operational efficiency
- *IP/MPLS* – Allows abstraction of the service layer from the transport layer, with ubiquitous, scalable, far-reaching and operationally consistent means of delivering mission-critical, legacy and new broadband-multimedia packet applications traffic and the associated attributes (for example, high availability, QoS, traffic engineering, ease of provisioning, flexibility)

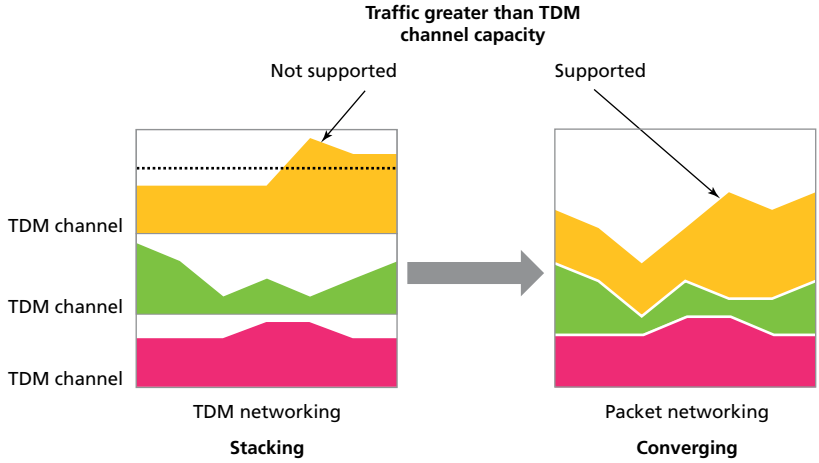
Figure 2. Alcatel-Lucent Carrier Ethernet



Microwave and optical SONET/SDH transport evolve with the addition of Ethernet capabilities to provide Carrier Ethernet transport. This evolution is essential as IP traffic increasingly dominates the network with new applications for bandwidth efficiency and seamless traffic migration.

Rather than stacking individual TDM channels to increase bandwidth for the support of increasing applications traffic, TDM, IP and ATM are converged and packetized for more efficient support while providing priority to mission-critical traffic (see Figure 3). This is particularly important for cost-effective support of new bandwidth-intensive IP applications that include streaming video and digital imaging. With constrained funding, current investments must cost-effectively scale to address many years of new applications-traffic growth.

Figure 3. Transforming to packet networking to optimize overall bandwidth

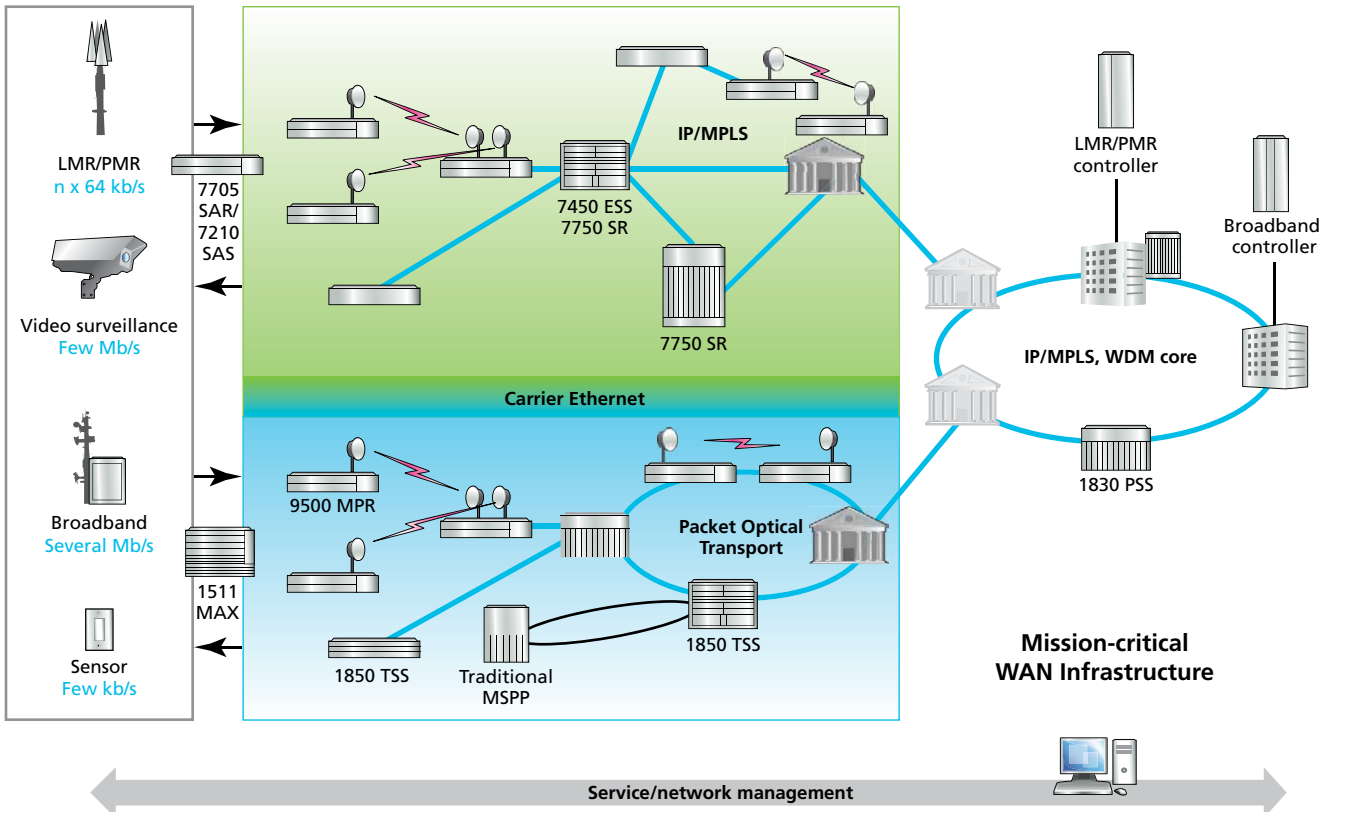


Efficient Carrier Ethernet transport can be realized with the SONET/SDH network support of increasing packet traffic using Ethernet over SONET/SDH (EoS) while the majority of traffic is TDM. The increasing packet traffic is supported using low-cost Ethernet interfaces while offering carrier-class capabilities for OA&M, manageability and protection. Because TDM traffic is still the majority of traffic on most public-safety WANs, multiservice provisioning platforms (MSPPs) are well suited to provide Carrier Ethernet transport by adapting a Circuit-Switched technology, SONET/SDH, to transparently carry IP/Ethernet traffic.

A new category of transport devices, Packet Optical Transport Systems, allows public-safety agencies to leverage their existing SONET/SDH networks while concurrently deploying and migrating to robust packet transport with feature-rich Ethernet — all using the same Packet Optical Transport platform. These platforms effectively support both TDM and packet traffic in any ratio, SONET/SDH and Ethernet, and the emerging MPLS-TP. Seamless TDM-to-packet migration can be achieved with Packet Optical Transport while realizing the benefits of Carrier Ethernet transport.

The expansion of a WAN to bring together communications for a growing number of agencies and new packet-applications traffic often compels the addition of an IP/MPLS core to a solution with Carrier Ethernet transport, as shown in Figure 4. IP/MPLS flexibly delivers the required performance of new packet and legacy applications traffic in a converged network in an operationally consistent manner. Alcatel-Lucent carrier-grade "always-on" Carrier Ethernet solutions over IP/MPLS are engineered for high reliability. Convergence across the core IP and optical layers enables continuously scalable and dynamic bandwidth. Integrating the optical and IP domains using cross-layer automation greatly improves operational efficiencies while reducing costs and carbon footprint.

Figure 4. Alcatel-Lucent Mission-critical WAN Infrastructure enables cost-effective, reliable IP transformation for a range of topologies



In a greenfield application or when the majority of traffic is packet-based, a fully converged, IP/MPLS-based Alcatel-Lucent Mission-critical WAN Infrastructure can be the optimal path. From a network-architecture perspective, this consists of a converged IP/MPLS-based core, complemented by a converged IP/MPLS-based access. Transformation to an all-IP/MPLS WAN provides the required scalability, reliability and QoS while dramatically simplifying the network and lowering operating costs. This single converged, multiservice network, which leverages the power and commonality of Ethernet and IP and is application-aware, can cost-effectively enable the creation and delivery of more dynamic, flexible application traffic to boost first responder effectiveness.

The converged Alcatel-Lucent Mission-critical WAN Infrastructure simplifies and reduces operating expenditures (OPEX) with end-to-end service and network management that includes integrated MPLS/microwave management and optical/microwave transport management. This evolution to a converged network is essential for improving management efficiencies and lowers the skill barrier for staff. In addition, a converged network provides industry-standard interfaces for Operations Support System (OSS) integration.

This infrastructure builds on key elements of the Alcatel-Lucent High Leverage Network™ strategy for carriers. High availability, scalability, and application awareness ensure the delivery of all essential information, when and where it is needed, for a coordinated multi-agency response. Real-time, mission-critical operations information and routine voice and data information are reliably communicated in this converged environment, intra-agency and/or securely between agencies.

WHAT IS THE ALCATEL-LUCENT HIGH LEVERAGE NETWORK?

The Alcatel-Lucent High Leverage Network is a fully converged network that provides continuous scaling of bandwidth across multiple dimensions, from access to transport, at the lowest total cost of ownership (TCO). At the same time, the network is equipped with built-in application awareness, QoS and traffic optimization to provide the appropriate levels of network intelligence at the optimum cost. In addition, the High Leverage Network offers high reliability and availability, improved security, application assurance and enhanced policy management.

3. New applications, new capabilities

The majority of today's public-safety agency communication networks are not equipped to support dynamic communications and real-time monitoring. Key capabilities that are driving changes in the agency WANs include enhancing intra-/interagency communications, LMR/PMR digital upgrades, remote monitoring, and rapid first-responder access to new broadband applications that include new sources of streaming video and digital images.

3.1 Convergence and physical connectivity: the foundation for effective intra-/interagency communications

The environment in which first responders operate continues to grow in complexity as new technologies are integrated into our everyday life and into terrorist threats. The involvement of specialists and experts in a coordinated multi-agency effort is often critical for delivering the appropriate response and ensuring rapid recovery. What information, in which network, is appropriate to securely share for a specific incident? To effectively address this question, agencies are first converging their existing traffic as well as new IP-based applications traffic onto a common WAN backbone. At the same time, agencies are extending their WAN footprint to include key cooperating-agency sites in a single converged network.

Within this common WAN, a virtual private network (VPN) can be created to securely transport an agency's traffic between its sites along with the flexibility for interagency sharing of specific information at designated times, such as data for computer-aided dispatching. This new connectivity may also allow improvements in reliability, including new redundant physical paths and back-up centers: when an agency's dispatch center goes down, calls may be rerouted to another agency's dispatch center that is also connected to the WAN, creating redundancy that may not have previously been feasible. This WAN transformation is often in conjunction with a multi-agency and/or regional initiative to modernize communications and may require the resolution of organizational issues as part of the transformation process.

Converging legacy and new IP applications traffic in a single network also improves an agency's productivity. Information that was previously available in only one system — for example, 911/112 reports and live roadside-surveillance feed — can be accessed at once in new combinations to improve rapid decision making and productivity.

Transformation by adding IP/MPLS and Carrier Ethernet transport capabilities typically occurs in phases that are driven by specific traffic growth and the existing WANs' capacity, reach and lifecycle stage. Managing the whole is simpler and less expensive than managing current application-specific networks because of the addition of end-to-end IP/MPLS/Ethernet service management and common optical and microwave transport management.

Advantages are amplified because there is a single network to manage instead of multiple, application-specific networks, each of which could require separate management. Security policies can be centralized, ensuring their application and improving their enforceability. IP-address management is also centralized, along with distributed protection, for a truly secure, scalable solution.

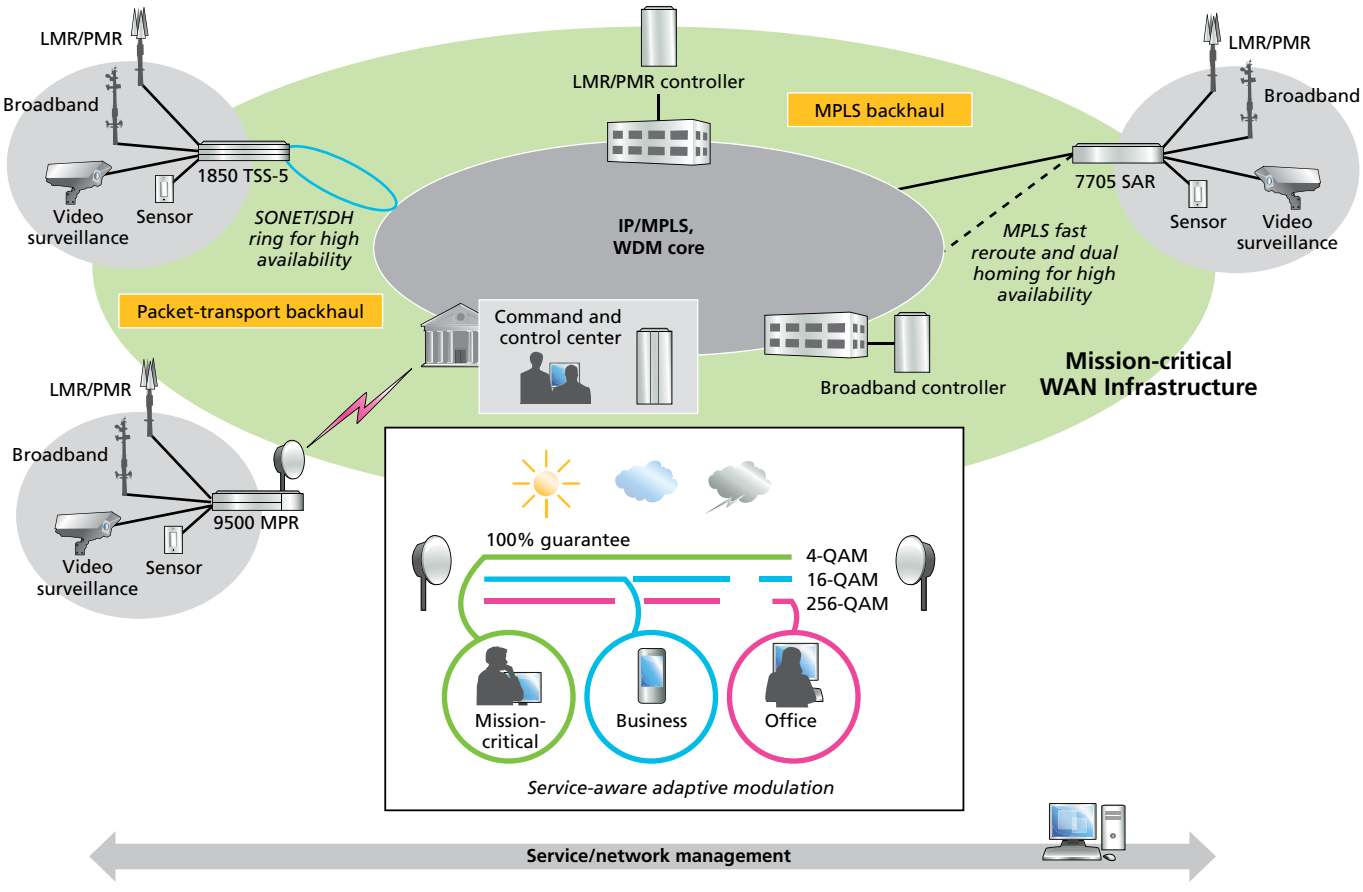
3.2 LMR/PMR upgrades

Agencies are evolving LMR/PMR networks based on industry-standard technologies such as Association of Public-Safety Communications Officials – International (APCO) Project 25 (P25) and Terrestrial Trunked Radio (TETRA) to improve their capabilities and performance. The evolution includes upgrades of older analog radio-access systems to digital systems with improved voice quality, more advanced data capabilities, more efficient use of spectrum, and extended coverage to remote areas as well inside buildings and underground. These advances are triggering the need for a backhaul solution with an expanded bandwidth capacity and extended network footprint, equipped with Ethernet interfaces to support the increasing IP traffic.

As shown in Figure 5, the Alcatel-Lucent Mission-critical WAN Infrastructure delivers reliable backhaul for today's LMR/PMR traffic and cost-effectively scales for future broadband-wireless traffic support. The infrastructure includes Ethernet interfaces for new IP-based traffic and TDM interfaces for legacy radio-access systems at sites that multiple agencies share. The Alcatel-Lucent Mission-critical WAN Infrastructure leverages the globally proven Alcatel-Lucent Mobile Evolution Transport Architecture, deployed for more than 150 mobile carriers.

To keep first responders connected, LMR/PMR coverage can be extended inside buildings and tunnels. Each building or tunnel is unique, and so are its radio frequency needs. Alcatel-Lucent has deployed purpose-built wireless solutions using a mix of technologies, including distributed antenna systems and radiating cable systems in more that 50 buildings and tunnels.

Figure 5. Reliable and scalable cell-site backhaul of analog and digital/IP LMR/PMR traffic



Microwave packet radio, which is capable of handling multiple packet types natively, introduces a new concept in backhaul applications: the ability to transport multimedia traffic efficiently and still support legacy TDM traffic. Microwave packet radio aggregates packet and legacy TDM traffic, increases bandwidth utilization, and optimizes Ethernet connectivity, enabling the non-linear cost-capacity model required to support broadband traffic. Microwave packet-radio technology is a long-term enabler for public-safety agencies to smoothly transition their backhaul networks from TDM to IP and include broadband wireless, realizing dramatic reductions in operating costs: for example, up to 40 percent TCO reduction with the Alcatel-Lucent 9500 Microwave Packet Radio (MPR) compared to a TDM current mode of operation.

WHAT IS MICROWAVE PACKET TECHNOLOGY?

Alcatel-Lucent microwave packet-radio technology uses a multiservice aggregation layer to provide the capacity to use Ethernet as a common transmission layer to transport any kind of traffic. All traffic is converged over a single packet-transport layer using industry-standard pseudowire and circuit-emulation technologies. Service awareness supports different traffic types with different requirements and priorities, optimizing bandwidth with the option of overbooking radio capacity for non-real-time traffic and variable bit-rate traffic.

IP-based mobile-radio access solutions for voice make it easier to patch together first responders with different radio systems as well as link them with personnel at fixed sites using Voice over IP (VoIP) using collaboration applications. Seamless handoffs between dispatch centers as a pursuit crosses a jurisdictional boundary are feasible with dual-mode phones and IP-based traffic supported on a common WAN.

3.3 Remote monitoring

Closed-circuit television (CCTV) or video surveillance and remote sensors help facilitate early detection as well as serve as a deterrent to improve public safety. Physical assets can also be protected and centrally monitored by extending WAN communications to these sites. Video surveillance can help protect critical infrastructure and in high-crime areas. The converged WAN can cost-effectively scale to deliver several megabits of bandwidth per site: a typical requirement for solutions with enhanced capabilities such as high resolution and remote operation. Using a combination of an IP multicast protocol and MPLS-based Virtual Private LAN Service (VPLS), video-surveillance traffic can be easily distributed to primary and secondary remote monitoring centers for increased reliability and flexibility.

3.4 Broadband applications

Access to high-speed data and multimedia allows first responders to have a virtual "desktop in the field" and enhances communication among first responders and remote emergency-response coordinators. Arming first responders with advanced multimedia capabilities allows them instant access to mission-critical data, giving agencies the ability to exchange information such as surveillance and tactical video, digital imaging, 3-D mapping/geographic information system (GIS) and remote database access across jurisdictional boundaries. This accurate, up-to-date information can help save lives and minimize additional risks to the public.

Broadband wireless solutions supplement and enhance current LMR/PMR networks with advanced multimedia capabilities. Alcatel-Lucent broadband is based on standardized, commercial technologies, for solutions that leverage the economies of scale of Fourth-Generation (4G) networks and allow full interoperability between public-safety broadband and commercial wireless networks.

Public-safety agencies must find cost-effective backhaul solutions that can match capacity requirements. In such a network, carrier-grade optical and microwave transport continues to serve as the foundation, supporting a mixture of TDM and IP/Ethernet traffic with high availability and scalability. This SONET/SDH-based transport continues to evolve, with more Ethernet and IP capabilities to transparently aggregate and switch growing volumes of packet traffic at a level of reliability that matches TDM. New microwave packet radios offer the resiliency, increased bandwidth capacity, effectiveness and flexibility to enable true network convergence. WDM is added in areas where fiber capacity is exhausted to cost-effectively increase bandwidth capacity. The addition of Zero Touch Photonics capabilities further simplifies WAN operations.

Capacity is just one element to consider in planning for the addition of broadband capabilities for mobile first responders. When broadband is added to existing voice, multiple traffic types are simultaneously introduced, with different requirements in terms of capacity, availability, quality and use of available resources. The Alcatel-Lucent Mission-critical WAN Infrastructure supports LMR/PMR traffic backhaul and cost-effectively scales with the addition of Ethernet interfaces to support this new, IP-based broadband multimedia traffic.

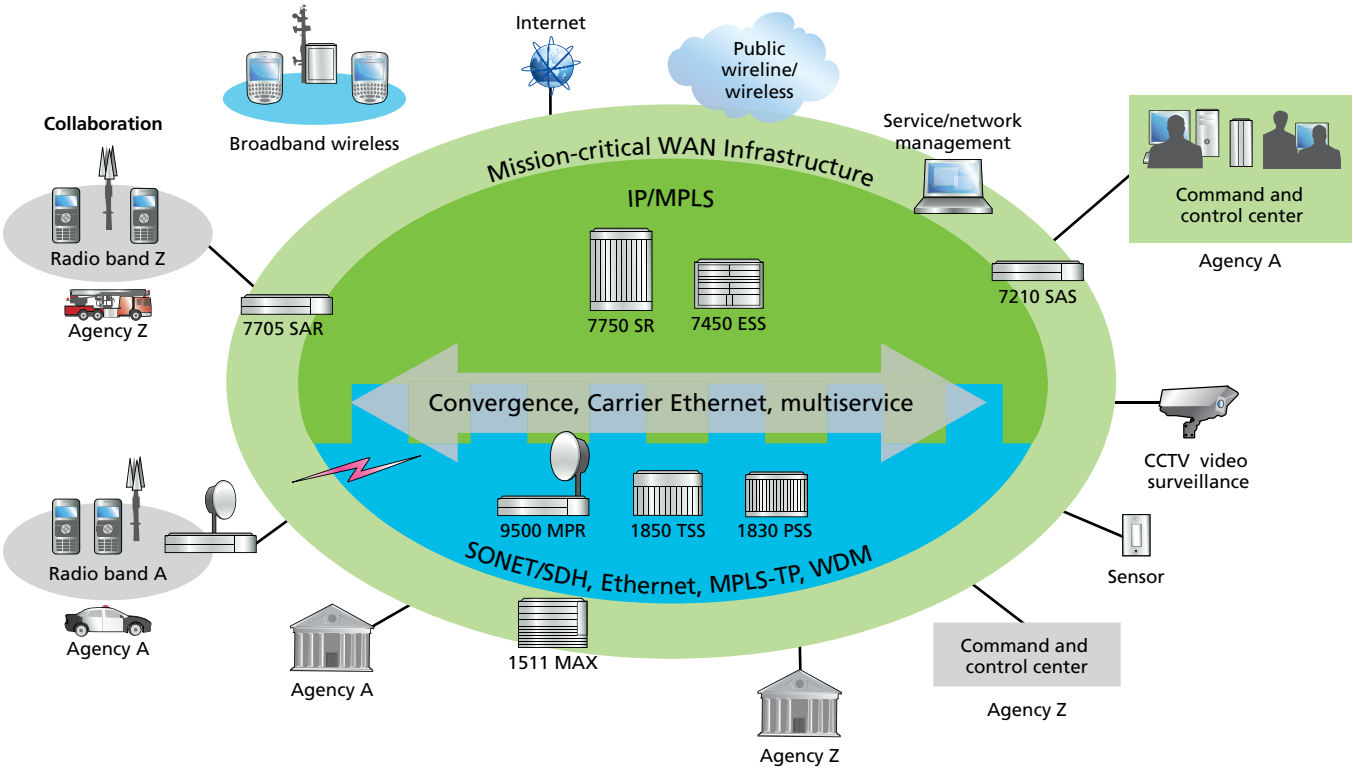
4. Enabling operational optimization

Service-oriented IP/MPLS and Carrier Ethernet transport networks have the inherent capability of supporting new applications, which provide new ways for employees to work efficiently, share information and interact responsively. New information systems provide the ideal opportunity for public-safety agencies to reclaim this knowledge, centralize it, and make it accessible to the whole organization. The appropriate WAN gives workers seamless and secure access to centralized information no matter where they are, helping to boost productivity.

It is ironic that, when all is calm, communication traffic is at a minimum and the public-safety network is nearly idle aside from internal administrative applications. For example, packet-based video-surveillance systems only update video frames when there is a change in the video picture, and packet voice communication rarely transmits silence. Both of these techniques save considerable amounts of bandwidth when used correctly. However, as soon as peace is shattered by fast-moving vehicles, riots or other threats to public safety, data throughput increases instantaneously. CCTV video traffic increases, security and emergency-services voice traffic increases, and collaboration tools such as database queries and document transfers become commonplace, loading the network.

The products that comprise the Alcatel-Lucent Mission-critical WAN Infrastructure, shown in Figure 6, have been designed from the ground up for high availability, using advanced hierarchical QoS technology that guarantees on-time delivery of the most critical and time-sensitive communications. Alcatel-Lucent Carrier Ethernet allows specific application traffic to be optimized using service-adapter modules, within Ethernet service switches and service routers, that are targeted to enhance specific application flows. In this manner, intelligence can be applied only when needed and without burdening the remainder of the traffic.

Figure 6. Alcatel-Lucent Mission-critical WAN Infrastructure for reliable communications with selected application-traffic optimization and reduced OPEX



The evolution of a public-safety agency's WAN by adding IP/MPLS or a new microwave link often allows the agency to cost-effectively introduce a higher level of redundancy to parts of its network where SONET/SDH is not present, making extensive use of Ethernet interfaces to reduce costs. The continuing evolution of current optics and microwave technology with Carrier Ethernet transport allows the reliable, scaled aggregation and transport of any traffic type, at the lowest cost per bit. The widespread value that next-generation SONET/SDH and WDM are bringing to TDM support has emerged during the lengthy TDM evolution. The addition of MPLS-TP extends this value as packet traffic dominates and provides further evolution toward operations consistency across transport and IP/MPLS domains, simplifying operations and cost. These technologies can simultaneously handle both TDM and IP, reducing investment risk and allowing seamless switching between the two depending on the traffic mix.

Advanced service- and network-management systems allow for centralized network management and advanced diagnostic capabilities, minimizing TCO and reducing down time. A Forrester® Research, Inc. study identified a 75-percent increase in provisioning productivity and 20 percent fewer dispatches with Alcatel-Lucent 5620 Service Aware Manager (SAM) management of four carrier networks, with infrastructure similar to that of a large multiple public-safety agency WAN.

5. Ensuring security

Securing critical infrastructure is of paramount importance to public-safety agencies worldwide, both from physical and electronic threats. Optical and microwave SONET/SDH networks are, by definition, carrier-grade, implementing security at the physical layer. Using MPLS, which is also carrier grade, network virtualization is possible with separate virtual networks for different voice, video and data applications such as VoIP, video surveillance and LMR/PMR traffic backhaul. These virtual networks are securely separated as if they were individual networks. Using MPLS VPN technologies, it is possible to provision virtual networks with controlled levels of security and QoS for different applications or agencies. For example, a VoIP application can be provisioned with reserved bandwidth to ensure the quality of the conversation, even during peak usage. Within the Alcatel-Lucent Mission-critical WAN Infrastructure, a VPN can be created with MPLS for secure inter-agency sharing of specific information at designated times.

Evolving from many application-specific networks to a service-oriented IP/MPLS network allows for centralized security-policy enforcement and the implementation of sophisticated electronic security measures that protect communications from being compromised.

6. The Alcatel-Lucent offering

As a proven telecommunications partner, Alcatel-Lucent understands public-safety agency-specific communications requirements. The company's market-leading communications portfolio delivers solutions for mission-critical communications in complex environments. With the Alcatel-Lucent Mission-critical WAN Infrastructure, public-safety agencies gain the benefits of:

- *End-to-end, carrier-grade infrastructure* – Alcatel-Lucent provides a rugged, reliable, scalable and secure WAN built on innovative, high-reliability products and backed by our expertise in delivering complex, mission-critical networking to meet public-safety agency requirements. Alcatel-Lucent solutions incorporate non-stop routing, redundancy, MPLS fast rerouting in IP/MPLS parts of the network, and ring protection for optical and microwave packet networks.
- *Cost-effective growth and convergence of growing packet (digital LMR/PMR, video surveillance, broadband applications) and legacy traffic* – Alcatel-Lucent solutions deliver a flexible, scalable WAN with carrier-grade IP/MPLS and Ethernet capabilities, leveraging our broad, industry-leading access, IP, optical and microwave portfolio for cost-effective support of a range of applications.
- *Simplified mission-critical WAN transformation and reduced OPEX* – The Alcatel-Lucent MPLS/Ethernet solution provides end-to-end IP/MPLS and Ethernet service management and integrated optical/microwave transport management, which cost-effectively address a range of applications with common management to simplify the network and reduce costs. Centralized security-policy administration and distributed protection simplify, scale and enhance security.
- *Packet evolution of transport networks* – The long-standing leadership of Alcatel-Lucent in optical SONET/SDH and WDM technologies provides the right solutions to evolve and transform current optical and microwave networks, supporting increasing packet-based traffic with Carrier Ethernet transport.
- *Reduced risk and WAN transformation costs* – The Alcatel-Lucent Worldwide Services team provides end-to-end solution support with multivendor capabilities.

The Alcatel-Lucent Mission-critical WAN Infrastructure is a key component of the Alcatel-Lucent Dynamic Communications for public-safety agencies.

6.1 Innovations in eco-sustainability

Innovations in eco-sustainable networks and applications can help public-safety agencies to reduce costs while dramatically reducing their environmental footprint. Key focus areas for Alcatel-Lucent are energy efficiency, a reduced carbon footprint and environmental sustainability. Alcatel-Lucent helps public-safety agencies realize benefits by reducing TCO and CO_2 emissions with a holistic approach across each network layer. Some proof points include:

- Packet microwave and optical transport platforms that use 62-percent to 65-percent less power per transported bit than traditional platforms by forwarding traffic to the most efficient and economic layer — packet, circuit or optics/wavelength
- IP/MPLS platforms that leverage intelligent dynamic powering methods and operate at voltages and frequencies that are no higher than necessary to achieve the desired functionality and performance

7. Conclusion

The environment that first responders encounter continues to grow in complexity as new technologies are integrated into everyday life and into terrorists threats. Public-safety agencies are keenly aware of the pressure they are under: to better prevent incidents, deliver effective action for rapid recovery, and improve public safety and satisfaction. Agencies also appreciate the need to advance the information that is rapidly available to first responders, along with the capabilities that new IP-based applications can bring to improve first-responder effectiveness as well as other areas of operation. At the same time, public-safety agencies may need to transform their networks to eliminate barriers to intra-/interagency communications, enabling the coordinated effort that is often crucial to delivering the appropriate response and ensuring rapid recovery.

A transformation of today's agency-specific WAN is a typical first step in addressing these challenges and toward the realization of the benefits of new applications. The transformation includes expanded bandwidth and network reach along with new capabilities to cost-effectively address the growing IP-based application traffic. A transformed WAN also provides the required foundation for broadband streaming video, imaging and video-surveillance capabilities. Any capital investment is significant, and the solution needs to be flexible, proven and reliable. Carrier-grade is the only acceptable level of quality to bring to mission-critical infrastructure such as this.

Alcatel-Lucent is driving the evolution and convergence of today's WANs with new IP/MPLS and packet transport standards, and our Mission-critical WAN Infrastructure has been deployed by more than a dozen public-safety agencies. The company is an expert multivendor integrator in mission-critical communications projects. With our broad microwave, IP/MPLS and optical portfolio, end-to-end management, public-safety industry experience and the Mission-critical WAN Infrastructure offering, Alcatel-Lucent has all the elements that public-safety agencies require to simplify and reduce WAN-transformation risks.

8. Acronyms

4G	Fourth Generation
1511 MAX	Alcatel-Lucent 1511 Media Access Cross-Connect
1830 PSS	Alcatel-Lucent 1830 Photonic Service Switch
1850 TSS	Alcatel-Lucent 1850 Transport Service Switch
5620 SAM	Alcatel-Lucent 5620 Service Aware Manager
7210 SAS	Alcatel-Lucent 7210 Service Access Switch
7450 ESS	Alcatel-Lucent 7450 Ethernet Service Switch
7705 SAR	Alcatel-Lucent 7705 Service Aggregation Router
7750 SR	Alcatel-Lucent 7750 Service Router
9500 MPR	Alcatel-Lucent 9500 Microwave Packet Radio
APCO	Association of Public-Safety Communications Officials – International
ATM	Asynchronous Transfer Mode
CCTV	closed-circuit television
EoS	Ethernet over SONET/SDH
GIS	geographic information system
IP	Internet Protocol
IT	information technology
LAN	local area network
LMR	land mobile radio
MEF	former Metro Ethernet Forum
MPLS	Multi-Protocol Label Switching
MPLS-TP	MPLS Transport Profile
MSPP	multiservice provisioning platform
OA&M	operations, administration and maintenance
OPEX	operating expenditures
OSS	Operations Support System
PMR	professional mobile radio
P25	Project 25 (APCO-25)
QoS	Quality of Service
SDH	Synchronous Digital Hierarchy
SONET	Synchronous Optical Network
TCO	total cost of ownership
TDM	Time Division Multiplexing
TETRA	Terrestrial Trunked Radio
VoIP	Voice over IP
VPLS	virtual private LAN service
VPN	virtual private network
WAN	wide area network
WDM	Wave Division Multiplexing

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