Alcatel·Lucent

STRATEGIC WHITE PAPER

Smart Utility Telecommunications

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

Today's electric utilities face tremendous challenges. Demand is on the rise, and natural resources are increasingly precious. Expanding the electrical infrastructure to increase capacity is a complex and costly process, mired in questions about which options are the most sustainable for the long term. Regulations may specify a future target percentage to be generated from renewable energy sources. Integrating many widely dispersed solar, wind and geothermal energy sources as well as electric vehicles in the distribution network further increases this challenge. New capabilities to improve the real-time remote monitoring and management of power-system infrastructure will help to optimize operations, and communications are a necessary foundation for this optimization. IP/MPLS and Carrier Ethernet transport networks can support the full range of emerging new, IP-based operational and corporate applications: applications that current networks simply do not have the bandwidth or flexibility to handle efficiently. Alcatel-Lucent is driving the evolution of optical and microwave networks with the new packet-transport and IP/MPLS standards. More than 50 utilities have deployed the Alcatel-Lucent Mission-critical WAN Infrastructure to support new IP-based applications along with existing operational and corporate traffic on a reliable converged WAN.

Table of contents

1. Introduction

Today's electric utilities face tremendous challenges. Demand for electricity is continuing to climb, outstripping utilities' expansion and reconfiguration plans and leaving grids on every continent nearing or at maximum capacity.

At the same time, regulations are becoming increasingly stringent. Environmental pressures, future renewable-energy resource targets and fuel costs are escalating. Outages, especially extended ones, are unacceptable: the world's economies run on electricity, and they cannot afford down time.

Expanding the electrical infrastructure to increase capacity is a complex and costly process, mired in questions about which options are the most sustainable for the long term. Right now, utilities are aiming to better balance supply and demand and manage today's power grid more effectively.

New and emerging technologies are ripe with potential to increase utilities' control of and insight into their power networks. These technologies will require the interconnection of widely deployed smart devices and computers to allow a utility to appropriately adjust demand and power generation/ distribution — a step toward a true "smart grid". These capabilities will be particularly important in managing the future interconnection of many widely dispersed solar, wind and geothermal renewable energy sources as well as electric vehicles in the distribution network.

A transformation of today's wide area network (WAN) is typically a 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 utilities address these challenges with a converged backbone that enables always-on communications. This infrastructure connects existing utility sites and cost-effectively allows the inclusion of traffic with new smart metering distributed generation sites, and bandwidth scaling to accommodate new smart-grid applications that boost effectiveness. Built-in application awareness, traffic optimization and end-to-end management enhance effectiveness and flexibility.

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 allow 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 operational and corporate applications coming down the pipe: applications that current networks simply do not have the bandwidth and flexibility to handle efficiently. In addition, this combination allows convergence of the new traffic along with existing operational and corporate traffic in a single WAN for greater flexibility and efficiency because today's application-specific networks are eliminated.

It is important to note that what is driving utilities' need to enhance the WAN is not so much that today's WANs are inadequate for the purposes they serve: it is that very soon they will be required to perform new tasks with new purposes that are beyond their current capabilities. These transformed communications are needed as a foundation for a "smart grid". Yet this WAN must continue to provide carrier-grade reliability and manageability for the mission-critical operations traffic that is essential to the flawless, highly reliable provision of electricity.

2. Taking control

For utilities caught in the struggle to balance supply with demand while keeping costs down, improving asset efficiency is essential whether or not new generating stations are built. Even if the overall capacity of the grid is increased, additional assets must be well managed to ensure optimal performance.

Over the past ten years, communications networks have evolved from more-or-less passive systems of information transfer to active operations and corporate tools with strategic value for utilities. The networks have become key components in the highly reliable delivery of electricity to customers. New applications with direct impact on utilities' operations — for example, supervisory control and data-acquisition technology with an Ethernet interface (eSCADA) and smart metering — expand utilities' remote management and monitoring capabilities. 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, many utilities maintain segregated communications networks: one for operations and control functions associated with electricity-flow management, and one for corporate applications, including billing, engineering and human resources. In many cases, utilities' networks are divided up by application: a single network may be dedicated to protection, another to SCADA and telemetry, another for operational voice, and so on. This division is obviously highly inefficient and is due partly because the energy infrastructure and associated communications strategies date back to the 1950s and 1960s. These networks have evolved *ad hoc*, in a fit-for-purpose response to the changing communication needs of the power systems they support. Although the networks exist in an environment where asset life is measured in decades, holding to the status quo has increasingly become a high-risk proposition, technologically and financially.

By enhancing optical and microwave transport technology and adopting IP/MPLS technology, utilities 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 flexibility for supporting mission-critical operations and IT voice/data applications.

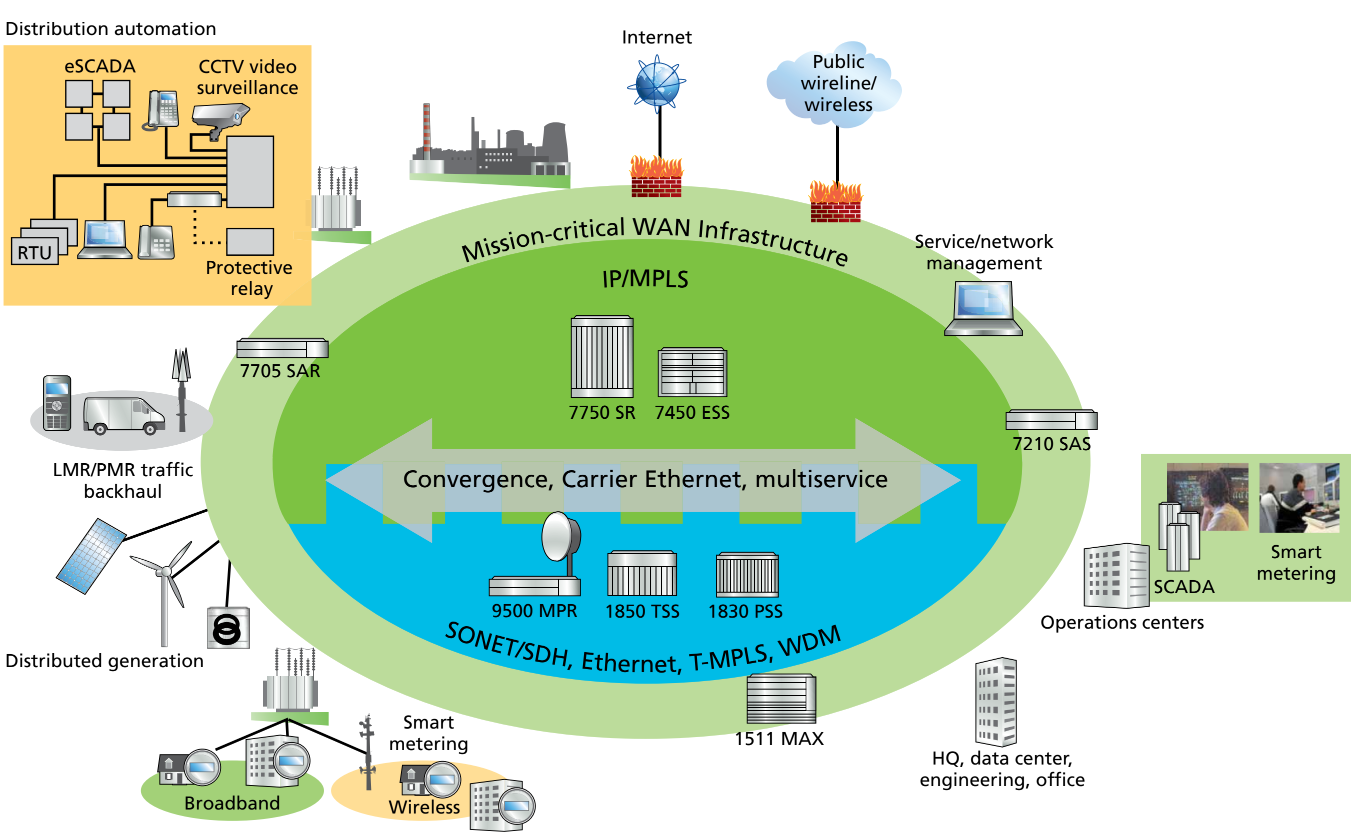
Mission-critical operations information can be communicated with extremely high reliability in such a converged environment. This is essential for the new capabilities used to manage the electric grid. At the same time, IP traffic associated with collaboration, Voice over Internet Protocol (VoIP), surveillance and IP-based digital land mobile radio (LMR)/professional mobile radio (PMR) applications to improve productivity and security is also supported. One network can host the full suite of operations and corporate applications that a utility requires while protecting critical traffic to ensure that it always receives priority treatment.

In addition, centralization allows greater information sharing and compilation, which is key for utilities preparing to contend with a mass exodus of baby boomers from the workforce. As individuals of the "boom" generation retire and take valuable technical knowledge with them, their knowledge must somehow be captured, preserved and easily distributed to other workers.

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. Power-utility 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 on 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 utilities have attempted to capitalize on what was once a "best-effort," only-in-the-LAN technology.

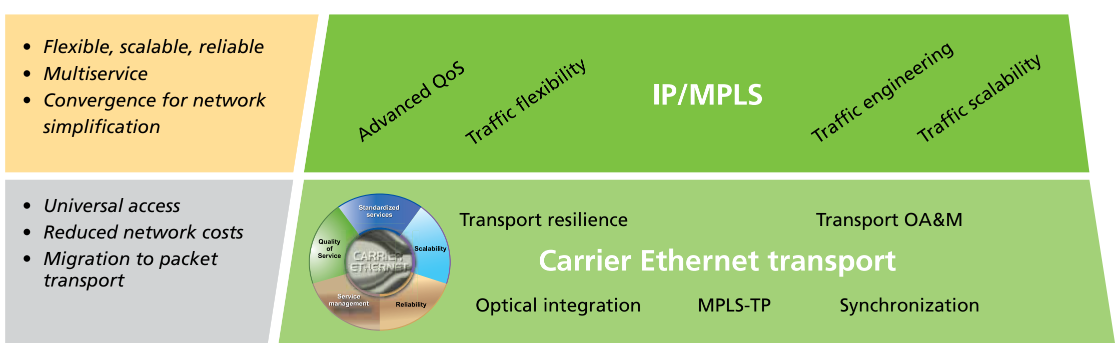
The term "Carrier Ethernet" was defined and promoted by MEF (formerly Metro Ethernet Forum) to differentiate from traditional LAN-based Ethernet. This has helped take Ethernet outside the LAN to become more of a WAN technology. The benefits of Ethernet are combined with the reliability, protection and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

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 their associated attributes (for example, high availability, QoS, traffic engineering, ease of provisioning, flexibility).

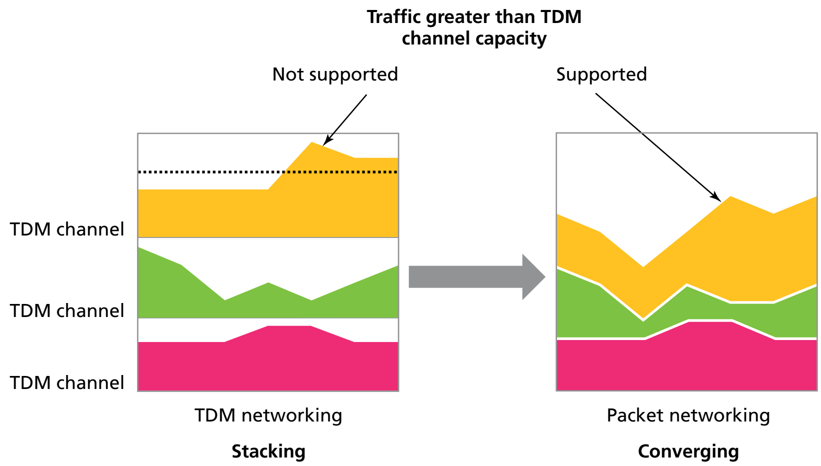
Figure 2. Alcatel-Lucent Carrier Ethernet



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 as IP traffic begins to dominate with new bandwidth-intensive IP applications that include video surveillance 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 in most utility 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.

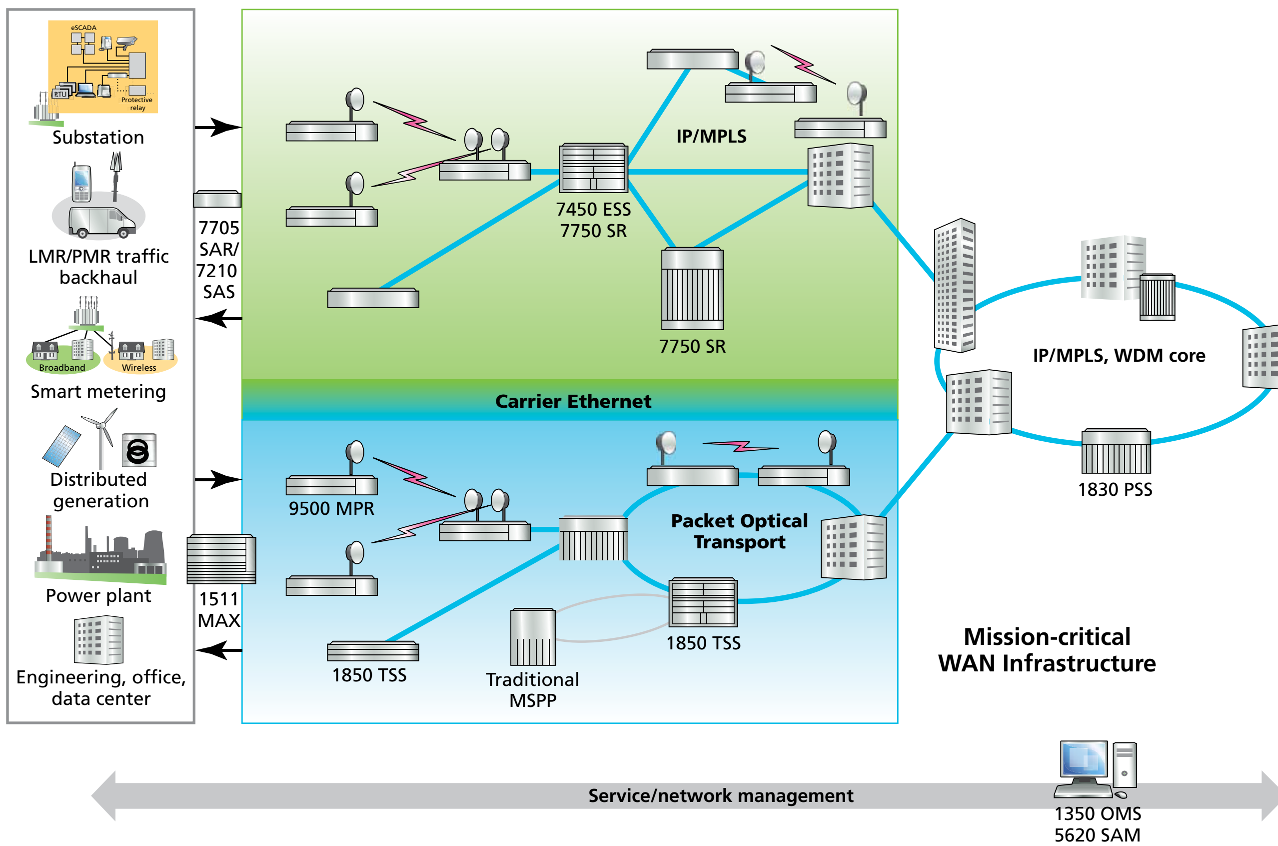
WHAT IS CARRIER ETHERNET TRANSPORT?

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 allow operational convergence with IP/MPLS domains.

A new category of transport devices, Packet Optical Transport Systems, allows utilities 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 amount of 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 effectiveness.

Such a converged network model 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 as baby boomers with application-specific network knowledge retire. 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 and ensures the delivery of essential information, when and where it is needed. High availability, scalability and application awareness advance the delivery of all information needed to maintain the seamless, trouble-free delivery of electricity.

WHAT IS THE ALCATEL-LUCENT HIGH LEVERAGE NETWORK?

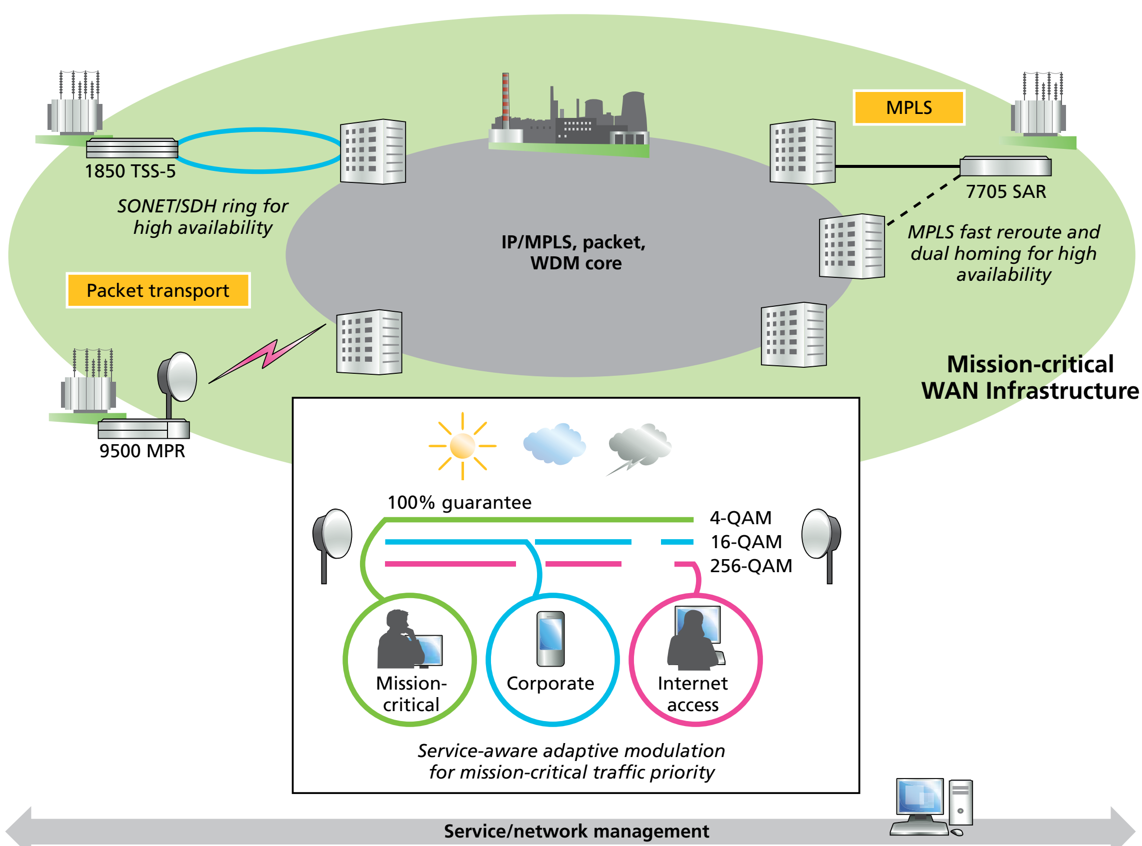
The Alcatel-Lucent High Leverage Network is a fully converged network that provides continuous scaling of bandwidth across multiple dimensions, from access to transport, at the lowest total cost of ownership (TCO). At the same time, the network is equipped with built-in application awareness, QoS and traffic optimization to provide the appropriate levels of network intelligence at the optimum cost. In addition, the Alcatel-Lucent 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 electric networks and their associated communications networks are not equipped to support dynamic, real-time measurement and control functions. Utilities, while tending to be cautious, prudent investors in upgrades and next-generation systems, recognize the limitations of their current networking environments, and many are likely to take action on this front over the next several years.

Key capabilities are cost-effective support for IP traffic in connection with new eSCADA and smart metering. Utilities appreciate that these advancements will improve real-time remote monitoring and responsiveness to demand as it changes and will also increase asset efficiency. At the same time, utilities want the assurance that enhancing their WANs will not compromise the delivery of legacy SCADA, teleprotection/control relay, voice and data traffic. A service-oriented, IP/MPLS-optimized WAN delivers that assurance: optical and microwave transport guarantees the best information flow at the lowest cost per bit, as shown in Figure 5. The IP/MPLS solution allows utilities to continue supporting control relay/teleprotection traffic on their highly reliable SONET/SDH networks.

Figure 5. Reliable and scalable TDM and packet traffic support



Superior bandwidth utilization for increasing IP traffic improves worker productivity by allowing more flexible combinations of information: by converging legacy and IP traffic in a single network, information previously available in only one system — for example, engineering diagrams and customer-specific network details — can be accessed at the same time, improving the productivity of remote workers, repair teams, and so on. An IP/MPLS WAN also can efficiently replicate and send traffic to a second operations center to increase reliability and help address security regulations.

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 to Carrier Ethernet transport, with more Ethernet and IP capabilities to transparently aggregate and switch increasing volumes of packet traffic at a level of reliability that matches TDM.

New Packet Optical Transport Systems and microwave packet radios offer resiliency, increased bandwidth capacity, effectiveness and flexibility to allow 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.

Microwave packet radio, which is capable of handling multiple packet types natively, introduces a new concept in transport applications: the ability to transport IP-based 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 utilities to smoothly transition their networks from TDM to IP, realizing a dramatic reduction in operating costs; for example, a 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-RADIO 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.

Transformation by adding IP/MPLS and Carrier Ethernet transport capabilities typically occurs in phases that are driven by specific traffic growth and the existing WAN's 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.

The 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.

IP transformation is bringing together dozens of applications. The required number of IP addresses can easily more than double when additional IP data devices are combined with a new VoIP network — a potential danger to corporate networks that can harm their user communities and introduce potential error to service provisioning. A centralized IP address-management capability can protect these business systems and make them more reliable, helping utilities to configure, automate, integrate and administer IP services efficiently across their entire networks locally or regionally.

3.1 Making more of metering, renewable energy and emerging smart grid applications

Smart metering is a key application because it allows the utility to better manage changing supply and demand: peaks are now getting sharper while generating capacity is flat. Smart metering can be used to condition users to use electricity at off-peak times. Essential to making smart metering work is a communications network that can support the resulting two-way traffic between users and utilities. With smart metering, a utility can more closely monitor industrial/residential usage and better match it to the output of electric plants that are operating near their peak capacity. This oversight helps minimize costs, retain industrial customers, improve overall customer satisfaction and satisfy emerging regulatory requirements. In some jurisdictions, smart meters are already a requirement and utilities must upgrade their networks to support their deployment.

Smart metering is not simply for monitoring peak consumption: it can be used to monitor overall consumption, helping to shift — with raised customer awareness — a certain amount of electricity to times when power from renewable resources is available to comply with regulations. With good public awareness and the right tools, such as metering, utilities can effectively move users away from peak consumption.

Smart meters individually create low volumes of network traffic, but they will eventually number in the hundreds of thousands or millions: a significant number of new devices that are connecting to the network and engaging in parallel communications sessions. This traffic from a utility's last-mile fixed or wireless communications solution will need to be aggregated in the WAN and transported to the appropriate center. The intelligence and capacity of IP/MPLS in such a circumstance becomes indispensable.

The need for improved communications networking and smart metering also comes into play for sources of renewable energy. For example, wind turbines are often located in areas where traditional utility communications networks have not previously been situated. IP/MPLS affords a simple, less costly option for these new sites to support predominantly IP-based operations traffic.

Similarly, utilities can expect to see widespread deployment of intelligent electronic devices (IEDs) in substations as part of the data-network evolution. Utilities can capitalize on their existing WAN architectures to migrate to standards-based solutions with Ethernet IEDs.

Longer-term, such information will contribute to the implementation of "smart grids". One of the characteristics of a smart grid is the broader distribution of power-generation stations, as opposed to today's typical model of a few large stations serving vast areas.

Integrating many widely dispersed business and residential renewable solar, wind and geothermal energy sources as well as electric vehicles in the distribution network can introduce challenges of maintaining grid stability. For example, 1000 new energy sources would periodically contribute power to a distribution network if 0.1 percent of its 1 million customers elected to resell. Such a scenario further increases the need for more centralized control and monitoring capabilities, which are enabled by reliable two-way communications.

3.2 Becoming an alternative carrier

The concept of the "Utelco", or utility telecommunications service provider, is taking hold in many parts of the world. Business users and alternative/mobile operators are increasingly interested in the applications and outsourced network services Utelcos can offer. Utilities' brands and their widespread presence in national and international territories strengthen the opportunities. Utility telecommunications networks with IP/MPLS and Carrier Ethernet transport enable the full portfolio of TDM, IP and Ethernet virtual private network (VPN) services.

3.2.1 Broadband services for economic development

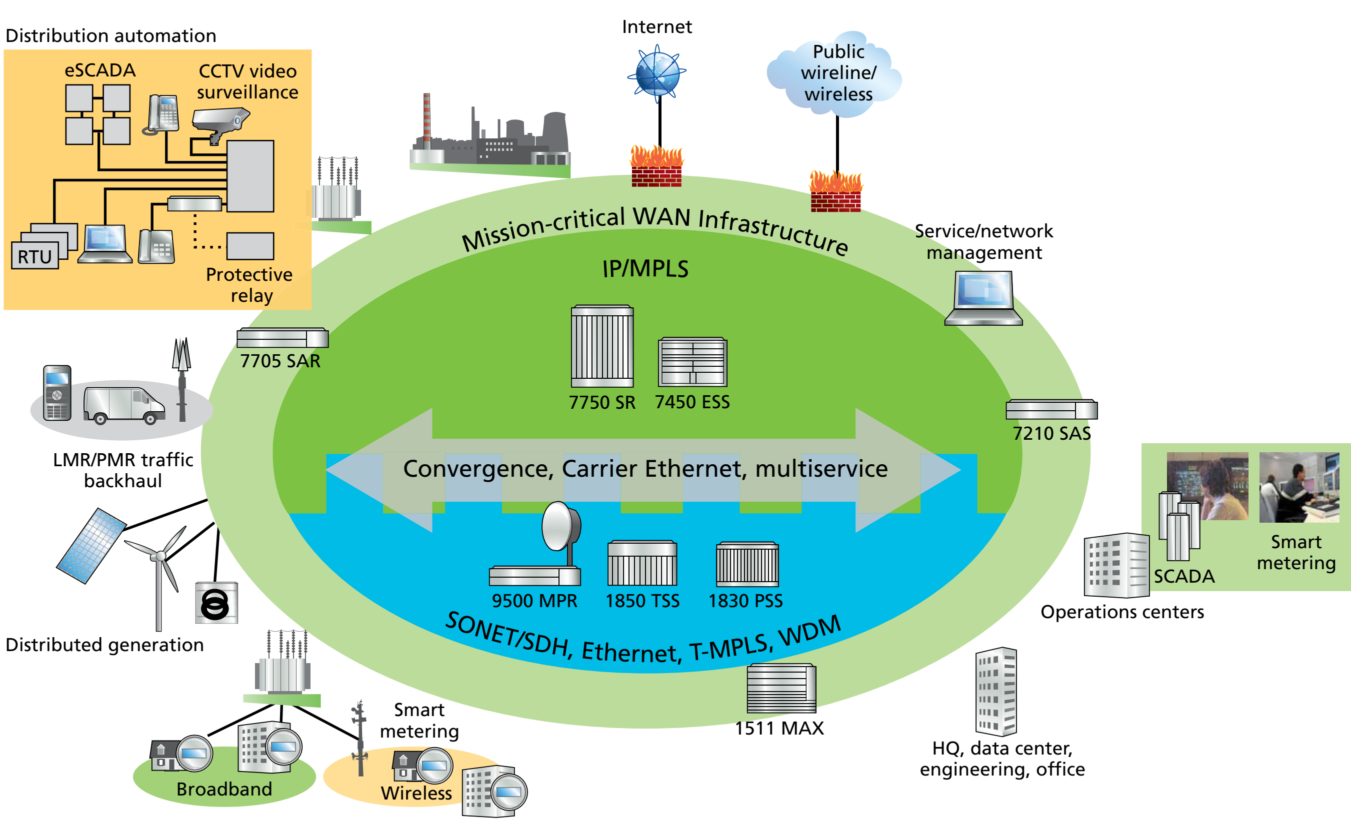
Some utilities in Europe and North America have introduced broadband services to support economic and social development in areas that lack broadband Internet access. Two-way smart-metering communications are also supported as a network service, and IP/MPLS is an important part of the overall solution in such cases. As part of a scalable Ethernet transport network, IP/MPLS provides QoS, efficient multicasting and reliability to support a superior user experience. An IP/MPLS network also offers the flexibility to cost-effectively introduce a full range of reliable Layer-2 and Layer-3 VPN services to businesses for their economic development and revenue growth.

4. Enabling operational optimization

Service-oriented IP/MPLS and Carrier Ethernet transport have the inherent capability of supporting new corporate applications, such as unified communications, multichannel contact center, enterprise resource planning and customer-relationship management. These applications provide new ways for employees to work efficiently, share information and interact responsively with customers. New information systems provide the ideal opportunity for utilities 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. With the sophisticated Alcatel-Lucent Mission-critical WAN Infrastructure in place, utilities continue to realize high communications reliability, flexibility due to fiber and fixed wireless topologies in the WAN, QoS, and as previously mentioned, scalability to meet changing and growing traffic needs.

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 and the use of advanced hierarchical QoS technology, guaranteeing that the most critical and time-sensitive communications are delivered on time. 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 optimization and reduced OPEX



The evolution of a utility's WAN by adding IP/MPLS often enables the utility 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 allows the scaled aggregation and transport of any client 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 power-utility WAN.

5. Ensuring security

Securing critical infrastructure is of paramount importance to governments worldwide, both from physical and electronic threats. New standards are quickly emerging: for example, the North American Electric Reliability Council (NERC) approved eight new cybersecurity standards (CIP-002-1 to CIP-009-1) in June 2006. NERC CIPs provide an auditable guide covering a variety of areas related to cybersecurity. Industry members must comply, and compliance is likely to require significant updates to their security infrastructure.

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 internal and external communications, operational data and customer information from being compromised. Optical and microwave SONET/SDH networks are, by definition, carrier-grade, implementing security at the physical layer.

Physical assets can also be protected and centrally monitored through the IP/MPLS network. To improve security at unstaffed and staffed substations, digital video-surveillance tools can be deployed. These tools typically require bandwidth of 64 kb/s to 384 kb/s for solutions involving compression and 1 Mb/s to 2 Mb/s for solutions with enhanced capabilities: bandwidth that the converged network can deliver. Video-surveillance traffic can be easily distributed to a primary and secondary remote-monitoring center for increased reliability and flexibility using a combination of an IP multicast protocol and MPLS-based virtual private LAN service (VPLS).

6. The Alcatel-Lucent offering

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

- *End-to-end, carrier-grade infrastructure* – Alcatel-Lucent provides 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 energy-industry 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 (eSCADA, video surveillance, smart metering 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 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 Mission-critical WAN Infrastructure incorporates our experience from more than 50 deployments worldwide. 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 energy.

6.1 Innovations in eco-sustainability

Innovations in eco-sustainable networks and applications can help utilities to reduce costs while reducing their environmental footprint. Key focus areas for Alcatel-Lucent are energy efficiency, a reduced carbon footprint and environmental sustainability. Alcatel-Lucent helps utilities 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

Utilities are keenly aware of the pressure they are under: to balance supply and demand by exerting greater efficiency and control over electricity consumption. Utilities also appreciate the need to advance their power networks with the capabilities that new, IP-based applications can bring, to improve not only grid management but also many other areas of their operations and corporate functions. At the same time, in certain regions, whether or not they appreciate the benefits, utilities may have to act now in response to external factors; for example, the mandatory inclusion of new applications such as smart metering.

Whether acting on their own momentum or in response to changing regulatory or public-policy requirements, utilities are still likely to be justifiably careful in their decision making. At their scale, any capital investment is significant, and the solutions utilities adopt need to be flexible, proven and reliable. Business cases must be compelling in terms of operational savings and measurable results, and technologies must be supported with success in the field. 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 50 utilities worldwide. The company is an expert integrator in mission-critical communications projects. Utilities can reduce risk and WAN-transformation costs with an end-to-end solution backed by multivendor Alcatel-Lucent Worldwide Services capabilities. With our optics, microwave and IP/MPLS portfolio, energy-industry experience, and the Mission-critical WAN Infrastructure offering, Alcatel-Lucent has all the elements that utilities need to simplify their WAN transformations and reduce OPEX while achieving greater control over their power networks.

8. Acronyms

1350 OMS	Alcatel-Lucent 1350 Optical Management System
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
ATM	Asynchronous Transfer Mode
CCTV	closed-circuit television
EoS	Ethernet over SONET/SDH
eSCADA	supervisory control and data-acquisition technology with an Ethernet interface
HQ	headquarters
IED	intelligent electronic device
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
NERC	North American Electric Reliability Council
OA&M	operations, administration and maintenance
OPEX	operating expenditures
OSS	Operations Support System
PMR	professional mobile radio
QoS	Quality of Service
RTU	remote terminal unit
SCADA	supervisory control and data acquisition
SDH	Synchronous Digital Hierarchy
SONET	Synchronous Optical Network
TCO	total cost of ownership
TDM	Time Division Multiplexing
Utelco	utility telecommunications service provider
VoIP	Voice over IP
VPLS	Virtual Private LAN Service
VPN	virtual private network
WAN	wide area network
WDM	Wave Division Multiplexing

Alcatel·Lucent