Alcatel-Lucent Municipal Network Solutions

Alcatel·Lucent

Enabling Community Prosperity Through Advanced Broadband Services

Overview

During the past few years, municipalities and public utilities have recognized the benefits of accessing global information. Broadband is particularly valuable in the areas of public safety, distance learning and telemedicine. However, many communities have poor access to information infrastructure and broadband services. With advanced applications and services becoming increasingly crucial, some municipalities and utilities are taking a proactive approach to broadband-access-network creation.

As a world leader in broadband access, optical and IP/multiprotocol label switching (MPLS) infrastructure, Alcatel-Lucent has been helping municipalities bridge the digital divide for many years, offering advanced technology to both promote economic development and enrich lives.

Bridging the Digital Divide

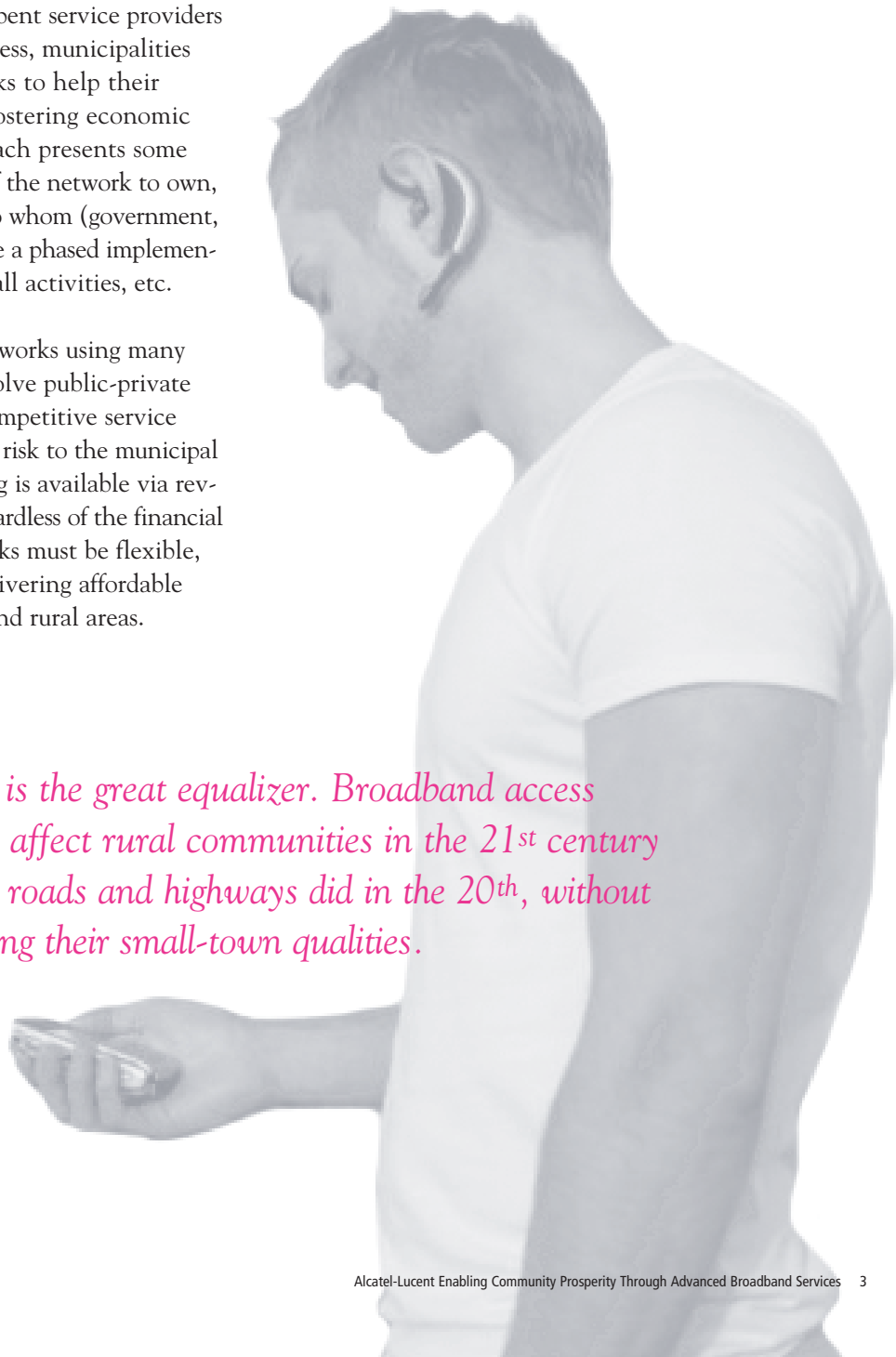
Customer Challenge

Until now, private-sector broadband buildouts have focused on major metro areas and wealthier suburbs, invariably leading to geographic disparity in network, service availability and pricing. In many cases, rural areas do not have access to any broadband services, never mind competing alternatives, creating economic, educational and quality-of-life disadvantages.

The growing public-sector interest in broadband communications is driven by the desire to make information available to everyone. Where incumbent service providers do not offer adequate broadband access, municipalities are building their own fiber networks to help their communities remain competitive, fostering economic development. This proactive approach presents some challenges, including what portion of the network to own, what services should be offered and to whom (government, businesses, residences), whether to use a phased implementation, billing, outsourcing some or all activities, etc.

Municipalities are building their networks using many different business models. Some involve public-private partnerships with incumbent and competitive service providers. In most cases the financial risk to the municipal tax base is minimal because financing is available via revenue bonds or from third parties. Regardless of the financial model, municipal broadband networks must be flexible, cost-effective and efficient while delivering affordable broadband services to underserved and rural areas.

Municipalities with existing metropolitan fiber networks for their government business are discovering that leveraging these assets to provide next-generation voice, video and data services can bolster their bottom line, as well as provide advanced services to citizens.



Broadband is the great equalizer. Broadband access promises to affect rural communities in the 21st century as much as roads and highways did in the 20th, without compromising their small-town qualities.

Alcatel-Lucent Municipal Broadband Solution

To ease the financial and political burdens of entering the broadband arena, Alcatel-Lucent has a three-step approach that lets municipalities reap the benefits of broadband while minimizing the impact of becoming a community network operator. This tiered approach allows municipalities to leverage their assets and rights-of-way to deliver revenue-generating services while building the necessary community-wide support.

FIBER DEPLOYMENT

The first step in Alcatel-Lucent's three-step approach involves deploying fiber-based networks to improve municipal operations. Applications to improve the effectiveness and efficiency of city government, such as video conferencing, critical-infrastructure video monitoring, collaboration tools and voice over IP (VoIP), are increasing the bandwidth needed between city facilities. Buying more capacity and leased lines from local carriers is an option; however, it can be a costly, and often only temporary, solution. By deploying an Ethernet/IP/MPLS-based fiber network between facilities, municipalities can eliminate the monthly fees associated with leased lines (see Figure 1).

To further OPEX reductions, technologies such as VoIP can be deployed over the new network, significantly reducing the expense of voice circuits at each facility. Fiber network ownership allows for virtually unlimited bandwidth to support current and future applications, helping municipalities improve collaboration and operating efficiencies.

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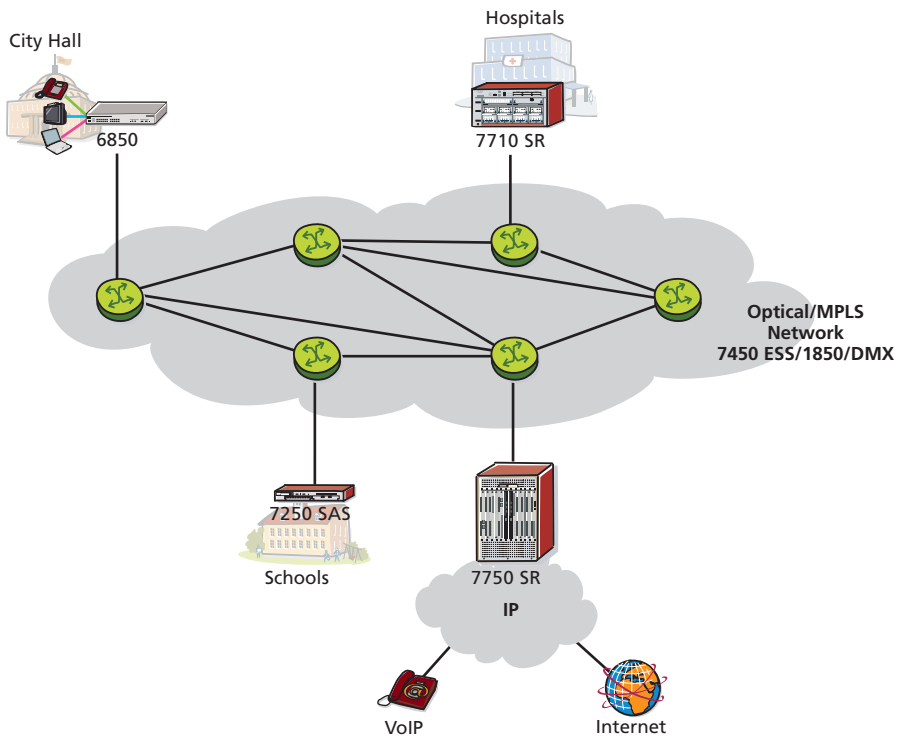
Figure 1. Step 1: Deploy fiber within the community to improve operations and communications between different government organizations

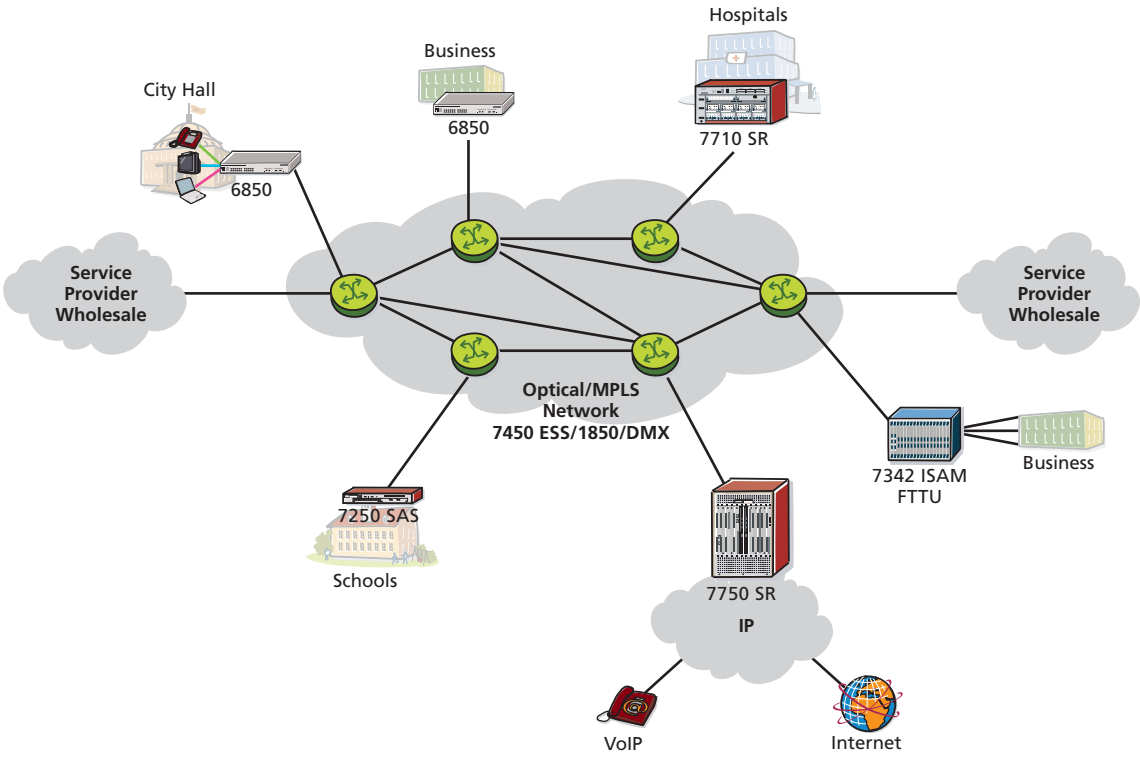


REVENUE GENERATION

The second step involves generating revenue by extending the network to provide wholesale and/or retail services. Hospitals, schools, government agencies, corporations and other businesses within the community all pay monthly fees to a service provider for telecommunications services. Many of these establishments are within easy reach of the new, community-wide fiber network and could be reached with a short build through municipally-owned rights-of-way. By using the municipality as their local service provider, these business and educational organizations can enjoy significant benefits, including lower-cost, higher-bandwidth services and high quality, reliable, responsive customer support, increasing their civic support by investing back into the local economy (see Figure 2).

This is an important transition stage because it allows municipalities to ease into the role of service provider, generates revenue to finance a community-wide buildout and builds the necessary public support based on positive customer feedback and success.

Figure 2. Step 2: Extend the network to provide wholesale and/or retail services that generate revenue and community support for a community-wide build out



FIBER TO THE HOME

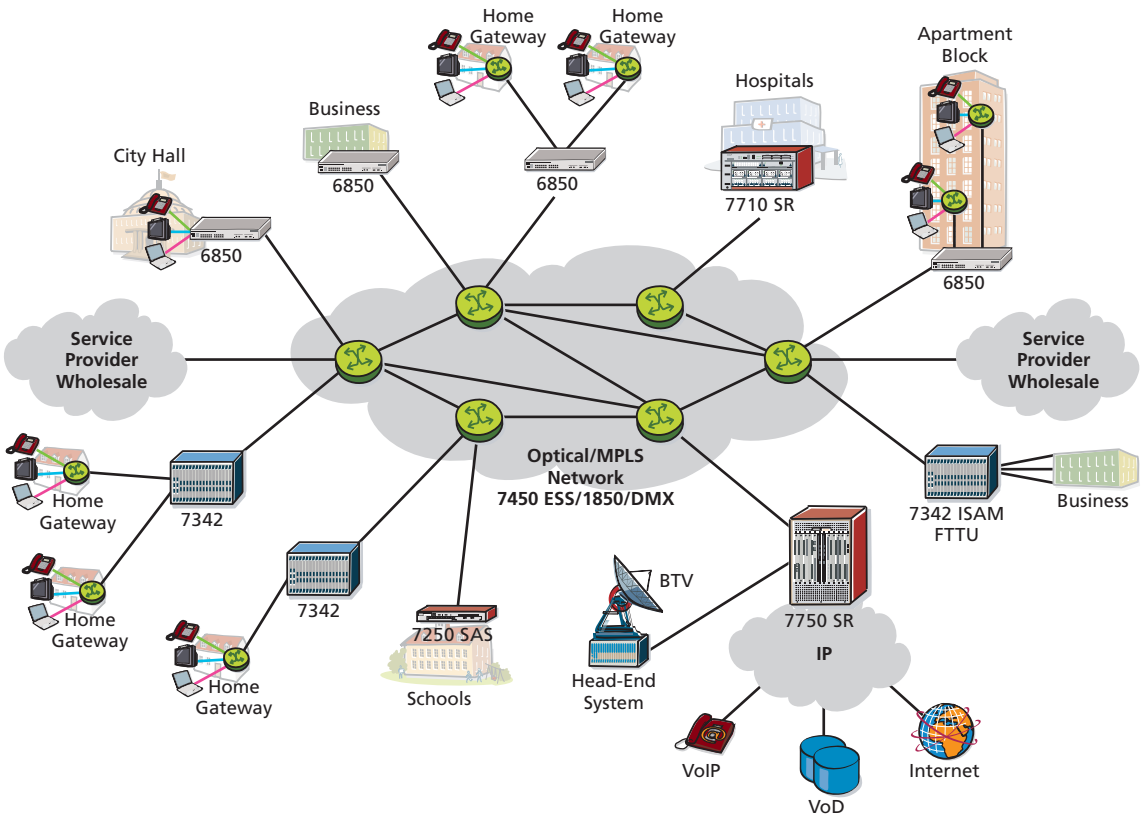
The final step in Alcatel-Lucent's three-step approach involves transitioning to a full, community-wide network buildout. Thanks to stages one and two, financial and political obstacles have been minimized, while operational issues have been identified and fine tuned. At this stage, residential subscribers are offered:

- Broadband data: Internet access and large file transfer
- Video: video on demand (VoD) and broadcast television (BTV)
- Voice services

These services are better, faster and cheaper than previously-available services, giving consumers choice and quality similar to, or better than, those available in major metropolitan areas (see Figure 3).

This is the Alcatel-Lucent Municipal Broadband Solution, a tiered approach to building a thriving community based on equal access to important community, residential and business services.

Figure 3. Step 3: Transition to a full community-wide network build out that supports advanced services similar to or better than those available in major metropolitan areas.



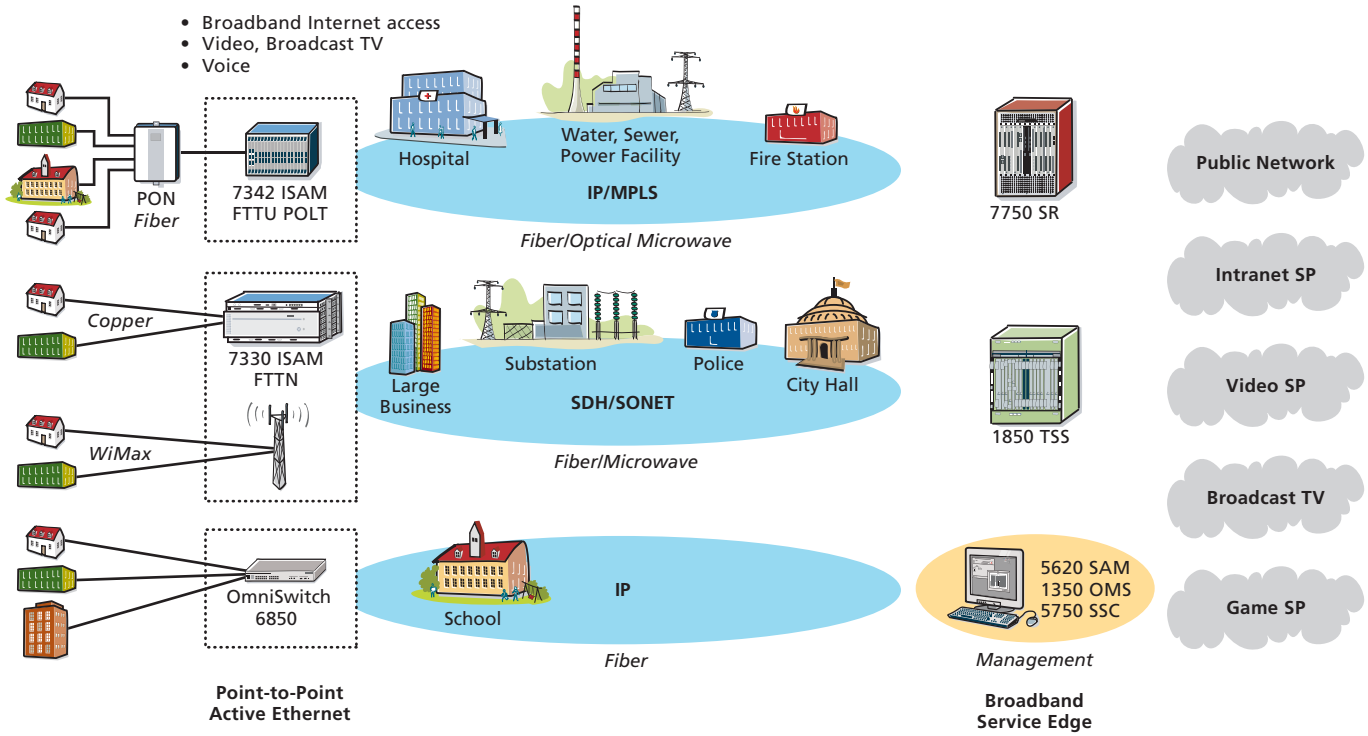
The Alcatel-Lucent Solution

Network Equipment in the Municipal Broadband Solution

Built around Alcatel-Lucent's carrier-grade equipment, the Alcatel-Lucent Municipal Broadband Solution provides an ideal infrastructure for delivering communication, information and entertainment services (see Figure 4):

- Broad access portfolio cost-effectively satisfies a range of applications
- Rich, scalable service-delivery infrastructure for an open network/wholesale model, or end-to-end turnkey solution for retail
- End-to-end service and network management simplifies operations, improves customer satisfaction and reduces OPEX

Figure 4. Alcatel-Lucent Municipal Broadband Solution Architecture



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SERVICE-ORIENTED ETHERNET SWITCH

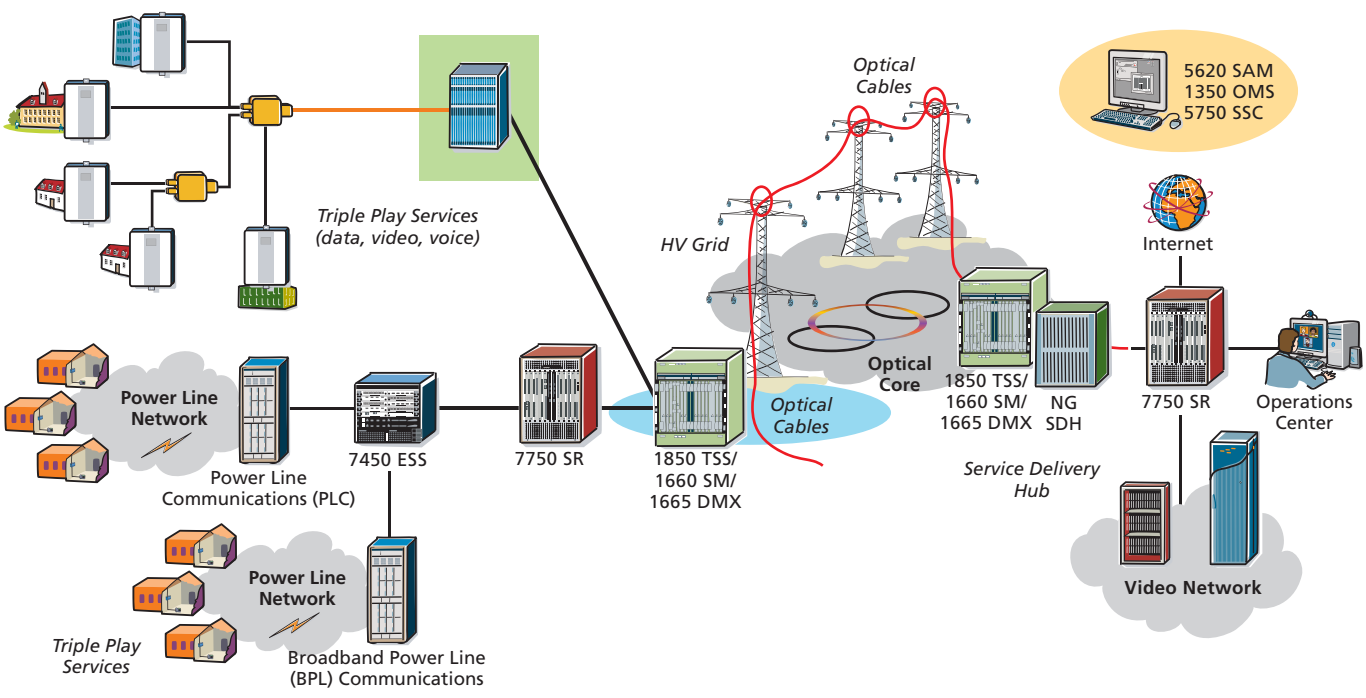
The Alcatel-Lucent 7450 Ethernet Service Switch (ESS) is a carrier-class switch/router specifically designed to provide scalable, point-to-point and multipoint connectivity services. Unlike traditional Ethernet switches (developed to provide best-effort connectivity and lacking in scalability, reliability and service orientation), it can support tens of thousands of services per device and scale to hundreds of thousands of services per area. The Alcatel-Lucent 7450 ESS target services include:

- Virtual leased line (VLL): point-to-point Layer 2
- Virtual private LAN service (VPLS): multipoint Layer 2
- VPLS-based, IP-multicast video distribution

The Alcatel-Lucent 7450 ESS provides transport and aggregation for residential broadband services, business Ethernet services and internal communications on a converged network.

For broadband solutions, Alcatel-Lucent has an unusually broad portfolio of transport/aggregation solutions to cost-effectively support a diverse range of applications (see Figure 5). This includes microwave products for terrains where fiber deployment is not feasible, or can be more economically served via a wireless solution. When combined with an Ethernet switch or optical Ethernet products as part of an overall broadband transport solution, common management simplifies and reduces OPEX.

Figure 5. Municipal Utility/Utelco Network



TRIPLE-PLAY SERVICE ROUTER

The Alcatel-Lucent 7750/7710 Service Routers (SRs) are the industry's first routers designed and optimized for delivering high-performance voice, video and data services. By adding the Alcatel-Lucent 7750/7710 SR, municipalities can offer IP VoD, broadband Internet-service access and full voice services across their networks, reliably scaling to tens of thousands of subscribers. The enhanced quality of service (QoS) capabilities ensure delay-sensitive applications, such as voice and video, get priority. Applications such as Internet access, are still given full service level agreement (SLA) bandwidth on a per-user, per-service basis, tailoring and maximizing network resources.

CONFERENCING AND COLLABORATION

Alcatel-Lucent's industry-leading collaboration tools empower municipalities to enable voice-, video- and data-conferencing services over one integrated system. This includes instant conference-bridge setup, allowing different agencies and departments, regardless of network location, to launch one bridge with four different purposes — voice interaction, video interaction, data instant messaging and application sharing — and to invite parties to the conference instantly. The system also includes an automated distribution messaging system that performs outdialing based on a call list — used, for example, as a reverse-911 notification system.

CARRIER-GRADE PON SOLUTION

The Alcatel-Lucent Municipal Broadband Solution includes passive optical network (PON)-based fiber access for ultra high-speed connectivity, consisting of the Alcatel-Lucent 7342 Packet Optical Line Terminal (P-OLT) and various types of customer premises equipment (CPE) optical network terminals.

The Alcatel-Lucent 7342 P-OLT is a highly-scalable fiber-access aggregation platform. It leverages Alcatel-Lucent's leadership in broadband access, including a broadband customer base of over 100 million worldwide. Plug-in modules can support up to 64 CPE devices for a total of 4,608 subscribers in a single chassis. It is ideal for municipal access networks because it supports a pay-as-you-grow architecture. This keeps CAPEX low: simply add a line card every time you want to add an additional 64 subscribers.

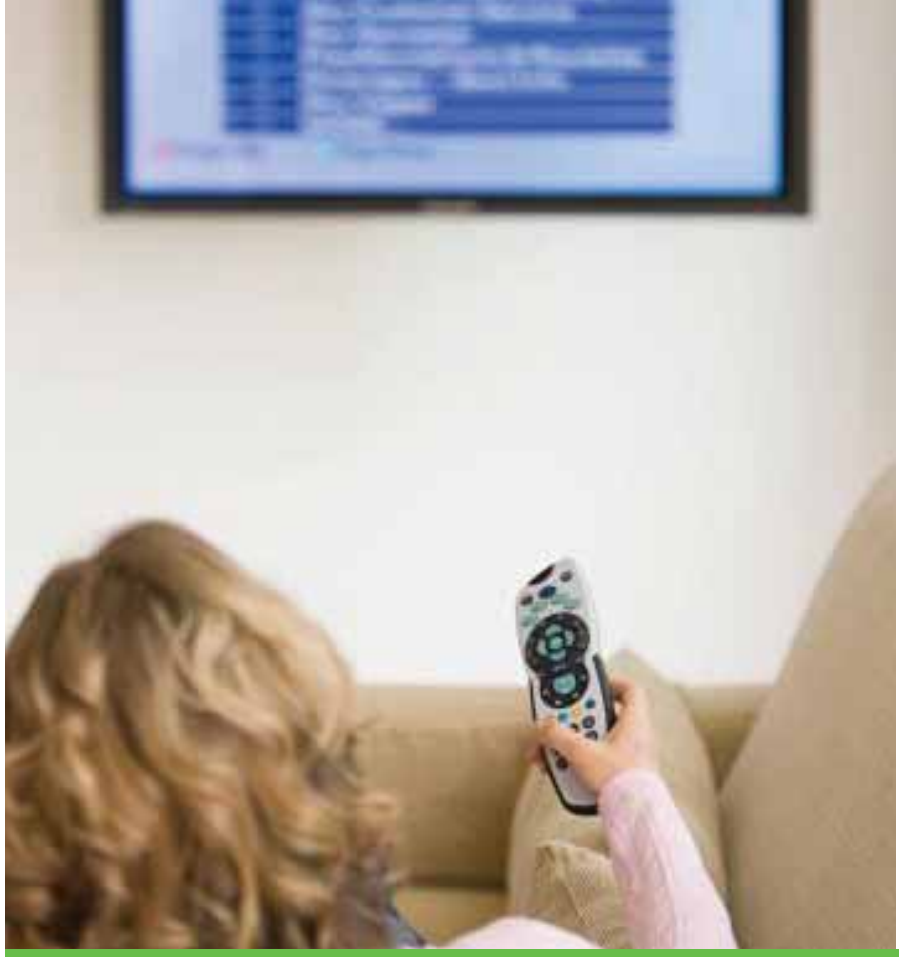
Residential voice services in a PON solution are provided on the municipal network using VoIP, and are connected to a Class 5 switch with a General Bandwidth G6 voice gateway, or connected directly to a softswitch. This architecture is ideal for supporting an open-access infrastructure because any number of voice or data service providers can easily connect to the network.

CPE in the Municipal Solution

HIGH-BANDWIDTH CPE WITH TDM-OVER-IP AND ADVANCED QoS

Business customers and multitenant office complexes with extremely-high bandwidth requirements (1 Gb/s), such as hospitals, schools and enterprises, can obtain cost-competitive solutions by using the Alcatel-Lucent 7250 Services Access Switch. This MPLS-enabled platform is extremely flexible, with several interfaces and features:

- Two small form-factor pluggable (SFP) Gigabit Ethernet (GigE) uplinks, two SFP GigE subscriber connections
- 8 10/100BaseT, 12 SFP 100BaseFX subscriber connections
- One or two 4-T1 access modules supporting subscriber connections
- Advanced QoS and bandwidth management



RESIDENTIAL NETWORK TERMINAL

The Alcatel-Lucent 7342 Home Optical Network Terminal (H-ONT) is a device that can be mounted on the inside or outside of a residential dwelling. It offers:

- One or two Ethernet subscriber connections for up to 100 Mb/s connectivity
- Two or four POTS telephone lines for up to four separate phone numbers
- One coaxial cable connection for radio frequency (RF) video (cable TV, for example)
- VoIP software client for POTS-to-VoIP interworking
- IPTV support using IGMP multicast

MULTI-DWELLING TERMINAL

The Alcatel-Lucent Fiber to the Unit (FTTU) 7342 Multi-Dwelling Unit ONT (MDU-ONT) is the smallest ONT exclusively dedicated to meeting the broadband needs of apartment dwellers. Typically mounted in the building's basement, it is capable of serving voice, video and data by using the building's existing telephone cabling (category 3 twisted pair cable type [Cat 3]), or via Cat 5 cabling. Total interfaces are:

- 12 very-high-data-rate DSL (VDSL2) or 12 GigE subscriber interfaces (one per residential unit)
- 1 75 Ohm video coaxial (35 decibel ratio of watts [dBm], to feed 12 residential units)
- 24 POTS telephone interfaces (2 per residential unit)

BUSINESS NETWORK TERMINAL

The Alcatel-Lucent 7342 Business Optical Network Terminal (B-ONT) is a device that can be mounted on the inside or outside of a business building. It supplies:

- 1 GigE subscriber connection for up to 1,000 Mb/s connectivity
- Eight POTS telephone lines for up to eight separate phone lines
- One coaxial cable connection for RF video (cable TV, for example)
- Up to two T1 subscriber connections to support legacy applications such as private branch exchange (PBX) trunking

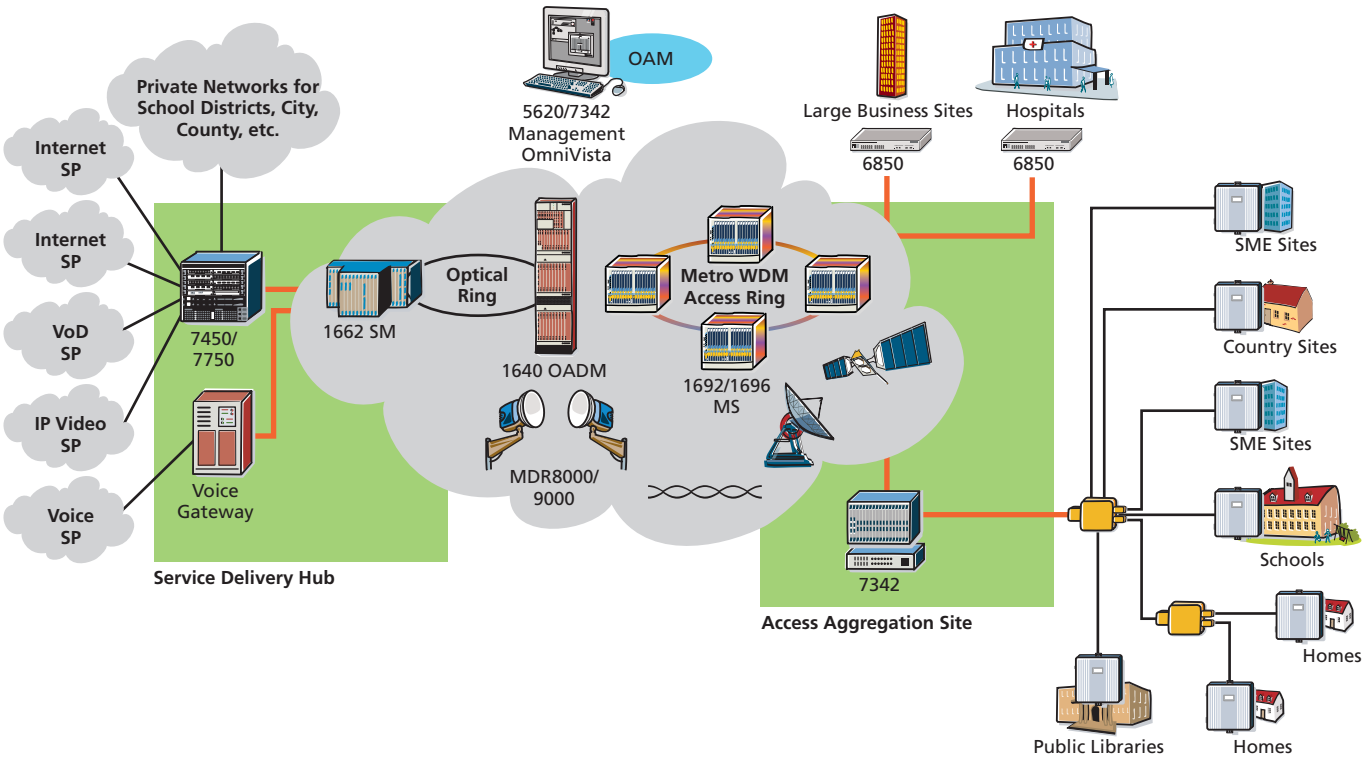
WORKGROUP SWITCHING

Ideal for deployment within municipal facilities, the Alcatel-Lucent OmniSwitch 6850/6200 Series consists of advanced, stackable, fixed-configuration, triple-speed (10/100/1000) Ethernet switches (see Figure 6). These switches provide wire-rate Layer 2 forwarding and Layer 3 routing with advanced services, and 10 Gb support. The Alcatel-Lucent OmniSwitch 6850/6200 switches increase network performance, improve application response times, secure the local area network (LAN) and enhance user productivity. Advanced features enable services such as video conferencing, VoIP and multimedia collaboration. Switches are available in 24- or 48-port versions with multiple fiber and copper-based GigE uplinks.

VOICE OVER IP

Alcatel-Lucent's OmniPCX products and technology enable all locations in a municipality, school and/or business network to interact, using the latest in reliable VoIP systems. These systems include the newest IP phone sets capable of providing high-quality voice service and of supporting almost any XML application. The voice system offers a single, reliable communication server that supports analog, digital, IP, wireless and soft phones. The platform can be redundantly deployed to provide a recovery mechanism in case of failure. The Alcatel-Lucent OmniPCX can be combined with the Alcatel-Lucent OmniAccess and Alcatel-Lucent OmniSwitch Ethernet switches and routers as part of the corporate voice and data building infrastructure.

Figure 6. End-to-End Service Transport



Solution Benefits

Open Access

To allow multiple voice, video or data service providers on the network, the Alcatel-Lucent Municipal Broadband Solution creates an open network based on Layer 2 VPLS. It leverages MPLS for a scalable, reliable and operationally-efficient solution. Relying on MPLS-based redundancy methods, the core of the network ensures the fast reroute times essential when offering and guaranteeing SLAs to service-provider customers.

Core System Redundancy and Reliability

Core infrastructure components of the Alcatel-Lucent Municipal Broadband Solution support the highest levels of redundancy, including:

- Box-level redundancy where desired (redundant core routers, for example)
- Full system-redundancy capabilities (redundant power supplies, switch fabrics, central processing units [CPUs], etc.)
- Redundant connections between devices
- Sub 50 ms restoration times on critical links
- Redundant servers for VoIP

Pay-as-You-Grow Architecture

Every component of the Alcatel-Lucent Municipal Broadband Solution supports a pay-as-you-grow architecture. This allows a municipality to add equipment and incur CAPEX only when the customer base grows, and to offset this expense with additional revenue. If competitive pressures or growth requirements necessitate expansion, remote offices can be easily added in neighboring communities by simply adding as many remotely-deployed Alcatel-Lucent PON shelves, Alcatel-Lucent 7450 ESS switches and CPE devices as needed, without any disruption of service.

Voice-Service Scalability

As the subscriber base grows, more modules can be added to the General Bandwidth G6 Alcatel-Lucent OmniPCX for increased capacity. Up to 14 telephony processor modules (TPM) may be added for a combined total of 3,360 simultaneous calls or 20,160 phone lines per chassis with 6:1 oversubscription.

Voice-Service Reliability

Reliable voice services are made possible by an Alcatel-Lucent Municipal Broadband Solution that includes a General Bandwidth G6 voice gateway with redundant connections to Class 5 switches from any number of upstream local exchange carriers. Every component in this carrier-class solution is redundant. It features protected cards, circuits, backplanes, switch fabrics, interfaces, power supplies and control modules. A battery backup at the customer premises also provides up to eight hours of talk time during residential power failures.

IP Video Support

IP video requires a multicast router designed specifically for handling the immense task of IGMP-query generation and report reception, as well as IP-video unicast and multicast forwarding. The Alcatel-Lucent 7750 SR, when used in conjunction with the Alcatel-Lucent 7450 ESS and the Alcatel-Lucent 7340 P-OLT, enables the Alcatel-Lucent Municipal Broadband Solution to provide the ultimate platform for delivering all types of IP video. Processing power, bandwidth concerns and QoS handling are all optimized, allowing the network to efficiently scale to support thousands of simultaneous video users.

Today, Alcatel-Lucent has the best broadband PON (BPON) solution in the industry, with full IP-networking support, and expects to have a fully standards-compliant gigabit PON (GPON) solution early next year, with four times the bandwidth and unmatched optical performance.

RF Video Support

Alcatel-Lucent partners with industry leaders in solutions for digital and analog RF-video support that delivers standard and high-definition broadcast video as well as VoD and pay-per-view. Solutions support the National Television Standards Committee (NTSC) video standard and a frequency range of 50 MHz to 870 MHz. In addition, the solutions support interactive TV applications, VoD and personal video recorder (PVR) over coaxial in-home wiring.

Bandwidth

In the access network, the Alcatel-Lucent Municipal Broadband Solution provides a full service access network (FSAN) standards-compliant broadband PON (GPON) for up to 100 Mb/s capacity per user. Each fully-loaded Alcatel-Lucent 7342 P-OLT shelf has 18 GPON line cards, supporting up to 4,608 subscribers. Each GPON line card has four PON ports, each port can support up to 64 subscribers. The system includes 2.5 Gb/s downstream and 1.25 Gb/s upstream capacity for a given GPON.

In addition, the Alcatel-Lucent 7342 P-OLT has advanced dynamic bandwidth allocation (DBA) mechanisms, ensuring unused bandwidth is available to support data burst rates up to 1 Gb for each subscriber. Bandwidth can also be reserved for critical services such as voice and IP video. Any given user can have a minimum of 20 Mb/s of reserved bandwidth. MPEG-4, widely recognized as the next video-compression technology, is supported enabling each building to have several high-definition television (HDTV) channels running simultaneously, providing high-quality VoD services. These features, coupled with the QoS and traffic-shaping mechanisms of the Alcatel-Lucent Municipal Broadband Solution, combine to create an unprecedented end-user experience.

In the core, the Alcatel-Lucent Municipal Broadband Solution is unequaled. There is no product on the market that can scale QoS-enabled bandwidth quite like it.

In addition to higher-speed access technology, Alcatel-Lucent has an IP-optimized non-blocking architecture unique in the industry, but essential for successful IP service convergence. Today, Alcatel-Lucent has the best GPON solution in the industry with full IP-networking support.

The final result is end-to-end transport of services (see Figure 6).

Security

Network security is critical for ensuring services are reliably delivered with protection from various potential threats and vulnerabilities, including uncontrolled or unauthorized, peer-to-peer connectivity, theft of service and denial-of-service attacks. The Alcatel-Lucent Municipal Broadband Solution defends against these threats and potential vulnerabilities with numerous mechanisms, including:

- Blocking of Ethernet forwarding between access interfaces
- Blocking of Ethernet broadcasts and Address Resolution Protocols (ARPs) between access interfaces
- Source-address filtering
- Per-customer interface queuing and control traffic filtering
- Per-interface filter counts
- Interface service mirroring

QoS Scalability

Traditional Ethernet/IP switches and routers do not provide the robust QoS required in a next-generation IP-services network. To ensure that voice, video and data receive the required network resources and treatment, the Alcatel-Lucent Municipal Broadband Solution implements a full suite of QoS mechanisms.

The solution includes numerous innovative QoS features to ensure predictable performance in the Ethernet/IP network:

- Optimal and predictable delay/jitter characteristics for voice and video traffic
- Hierarchical QoS (H-QoS) with a minimum of two levels to provide bandwidth partitions for specific content sources
- Support for flow-based queuing with at least eight QoS queues per VLAN and hundreds of queues per GigE for fine-grain content differentiation
- Wire-speed, ingress and egress policing and shaping on all queues, per port
- Per-queue rate shaping to committed information rate/peak information rate (CIR/PIR) at ingress and egress for thousands of queues per physical port
- Accurate per-queue usage-based accounting
- Counters per individual queue and individual rule with extensive logging capabilities
- Wire-speed, deep packet inspection for Layer 2 and Layer 4 classification and marking for service and content differentiation
- Classification and marking based on arbitrary byte offset, application type and user datagram protocol (UDP)/TCP port number

Complete, Effective Management

One of the most critical components to a highly-functional, responsive and always-on network is a full set of management tools and capabilities to acknowledge, interrogate and resolve network issues immediately. It must also include the ability to avoid network problems before they happen through planning and testing tools. Alcatel-Lucent has industry-leading management tools with these capabilities, and much more, significantly simplifying the management of complex networks, providing statistics and billing information and reducing the cost of managing broadband services.

Alcatel-Lucent's full range of management tools include the Alcatel-Lucent 5620 Service Aware Manager, the Alcatel-Lucent 5750 Subscriber Services Controller, the Alcatel-Lucent 5650 Control Plane Assurance Manager, the Alcatel-Lucent 1353 and 1354 Element and Network Managers, the Alcatel-Lucent 5526 Access Management System and more, all working together to provide unparalleled control of your network resources.

Help Making it Happen

Many municipalities and utilities today face the challenge of rapidly introducing new services for the residential and business markets, reducing cost and enhancing their customer's experience. Most realize that moving to an IP infrastructure, including DSL, wireless, optical and other technologies, is key to fast cost-effective service creation. Alcatel-Lucent has been the strategic partner of most operators and many municipalities and utilities managing a transformation. IP transformation can be a complex and risky journey and has impacts across all assets and activities: network, applications, operations support system (OSS), processes and organization. To support our customers in their transformation programs, Alcatel- Lucent has developed proven capabilities in Consulting, End-to-End Solution Design & Integration, Deployment & Migration, Program Management and Operation Support Services.

For municipalities electing to directly sell broadband services to residential and business customers, Alcatel-Lucent can provide marketing and business-development collateral, helping in developing, pricing and marketing broadband services.

The Alcatel-Lucent Advantage

Municipalities throughout the world are bridging the digital divide and furthering economic development by promoting broadband services in their communities. Municipal broadband networks help fill important unmet needs in underserved and rural areas while enabling municipalities to leverage resources through a variety of public-private partnership business models, providing open access to affordable, high-quality broadband services to all citizens.

Alcatel-Lucent is the broadband industry leader in every region of the world, with a market share of 38 percent and over 100 million cumulative DSL lines shipped. No other supplier can match Alcatel-Lucent's breadth and depth of expertise and flexibility in providing integrated solutions for broadband data, video and voice services to service providers, municipalities, utilities and enterprises.

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