WEST VIRGINIA OFFICE OF TECHNOLOGY
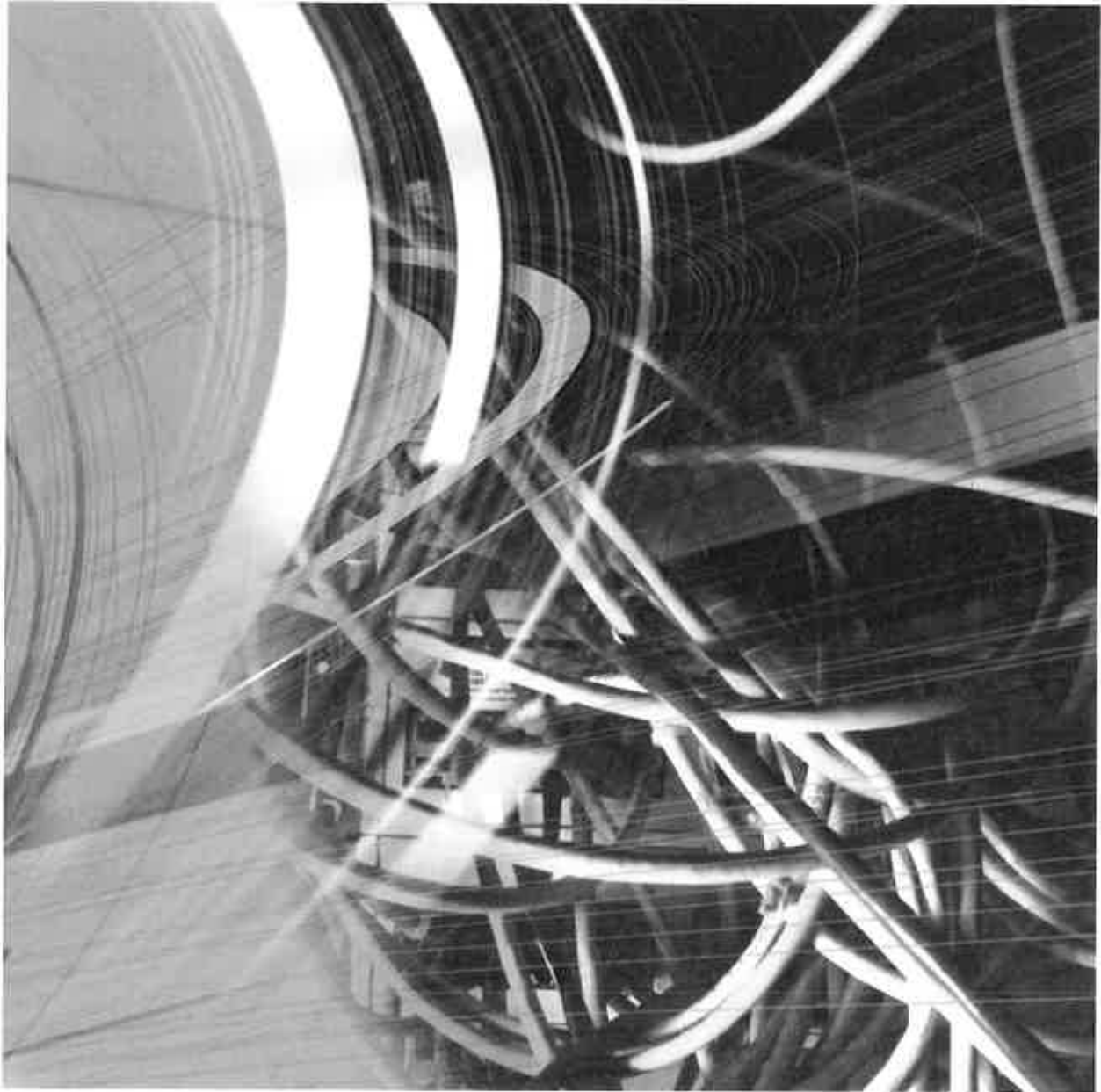# REPLACEMENT MPLS CONTRACT
REQUEST FOR INFORMATION
CRFI ISC1500000002

JULY 30, 2015

Alcatel·Lucent

West Virginia Office of Technology
Replacement MPLS Contract RFI
Proposal No. CRFI ISC1500000002

July 30, 2015

Guy L. Nisbet, Buyer Supervisor
2019 Washington Street East
Charleston, WV 25305
Email: Guy.l.nisbet@wv.gov

Subject: West Virginia Office of Technology Replacement MPLS Contract RFI
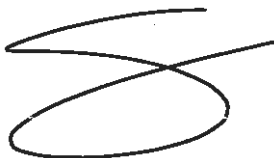
Dear Mr. Nisbet,

It is with great pleasure that Alcatel-Lucent submits the enclosed response to the State of West Virginia MPLS RFI. Alcatel-Lucent is a trusted leader in the MPLS product and services space, building and operating these networks for carriers, state and local governments, and a host of other industries.

To provide the State of West Virginia the flexibility to support current and future network services, including cloud-based services, while achieving cost savings over the present mode of operation, Alcatel-Lucent recommends evolving to a state owned and operated WAN infrastructure shared among all state government and education entities, including public safety agencies. Today's technologies make this all the more feasible. For example, a thin overlay of Software Defined Networking (SDN) for the Wide Area Network (WAN) can provide the State with an efficient management and security layer that spans all manner of on-ramps and off-ramps to the network, as well as operates across multi-vendor switching and routing platforms. This thin SDN layer is the enabler to speedy operations and management across the entire WAN. This is described in more detail in the response.

It is with these kinds of technologies that state governments can effectively operate and maintain a statewide WAN. Some state government customers have commissioned the Alcatel-Lucent Bell Labs Business Advisory team to assess the feasibility, benefits, and Total Cost of Ownership (TCO) of a state owned and operated WAN. Further discussion on this is welcomed.

Alcatel-Lucent stands ready to provide educational sessions to the State of West Virginia on the MPLS networking technologies and services described in this response.

Very best regards,

Shawn Bloomfield
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Alcatel-Lucent
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West Virginia Office of Technology
Replacement MPLS Contract
Request for Information# CRFI ISC1500000002
Proposal Number 15US58269401/ July 30, 2015

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Table of Contents

Alcatel-Lucent Response to West Virginia Office of Technology Replacement MPLS Contract Request for Information

West Virginia Office of Technology
Replacement MPLS Contract
Request for Information# CRFI ISC1500000002
Proposal Number 15US58269401/ July 30, 2015

Alcatel·Lucent

Introduction

The State of West Virginia is looking for a next generation network to replace the current state-wide network which is a mix of old and new technologies. The proposed solution should ease the transformation and the migration path of the current communications infrastructure to support new services, reduce operation costs, and increase operation security, resilience, and reliability. The network should be designed and dimensioned to be deployed in several phases.

What is driving such transformation is the growing use of bandwidth-intensive Internet Protocol (IP) applications and multi-agency, multi-application convergence, which places legacy data transport networks at a great disadvantage. Traditional data transport networks rely on circuit-switched technology which is optimized for voice, but lack the capacity and flexibility to support rich, multimedia content, and other bandwidth-intensive applications.

In addition, state and local governments are pressured to find innovative ways to modernize their information communications infrastructure to meet the bandwidth requirements of multiple agencies under increasing budget constraints.

An intelligent communications network for shared use among different agencies offers a framework to conserve financial and manpower resources by building a resilient, flexible, scalable and secure network foundation.

Present Mode of Operation

The current statewide, wide area network (WAN) operated by the State of West Virginia is a good example of a government network shared between government and education entities with multiple applications, over 2,000 costly leased lines, separate information communications infrastructures, and the need to support legacy interfaces/technologies as well as new cost effective packet networks for high reliability, scalability and future proof evolution.

Figure 1 illustrates our understanding of the current environment of the State of West Virginia statewide WAN as interpreted from the Request for Information (RFI).

West Virginia Office of Technology
Replacement MPLS Contract
Request for Information# CRFI ISC1500000002
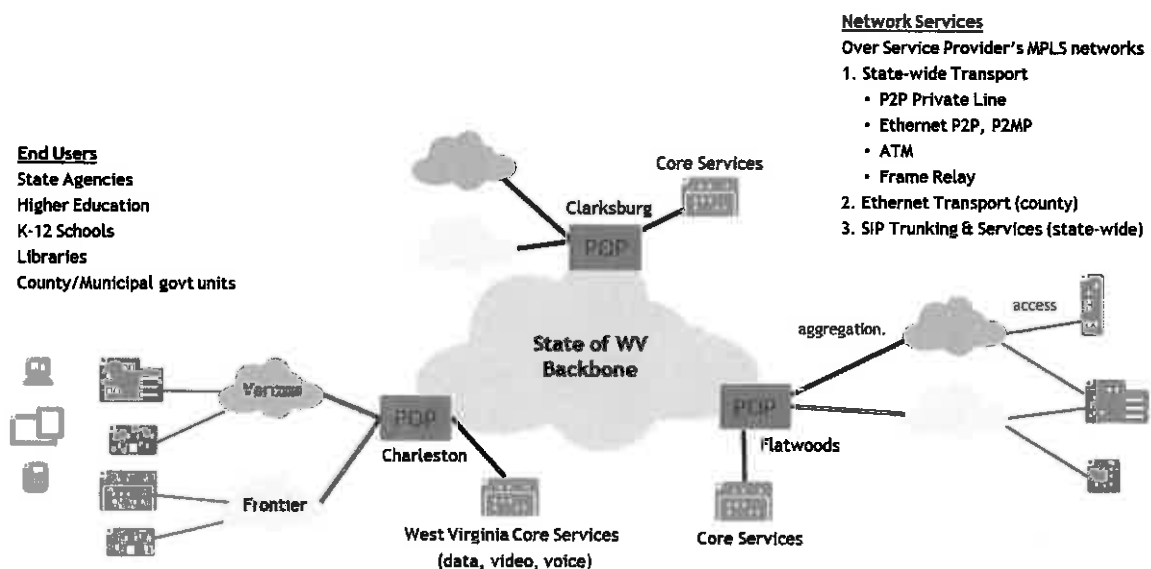Proposal Number 15US58269401/ July 30, 2015

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Figure 1.- Current environment of the State of West Virginia state WAN network

Today, the State of West Virginia maintains three points of presence (POP) and operates a backbone between these POPs to support the provided core services (data, video and voice). For state-wide transport services and end-user access to core services, over 2,000 access and aggregation circuits are leased from service providers to connect the end user sites to the three POPs.

Future Mode of Operation

To provide the State of West Virginia the networking flexibility to support both current and future services including cloud-based services, while achieving cost savings over the present mode of operation, Alcatel-Lucent recommends evolving to a state owned and operated WAN infrastructure shared among all the government and education entities, including public safety agencies.

Alcatel-Lucent proposes to the State of West Virginia to build a state-of-the-art, highly reliable and secure IP/MPLS network. The proposed solution provides a flexible, resilient converged infrastructure for the backhaul of the State of West Virginia core services (data, video, and voice) as well as the support of new bandwidth intensive applications.

Figure 2 illustrates a shared government network architecture capable of meeting and/or exceeding the Service Level Agreements (SLA) and performance requirements of the State of West Virginia.
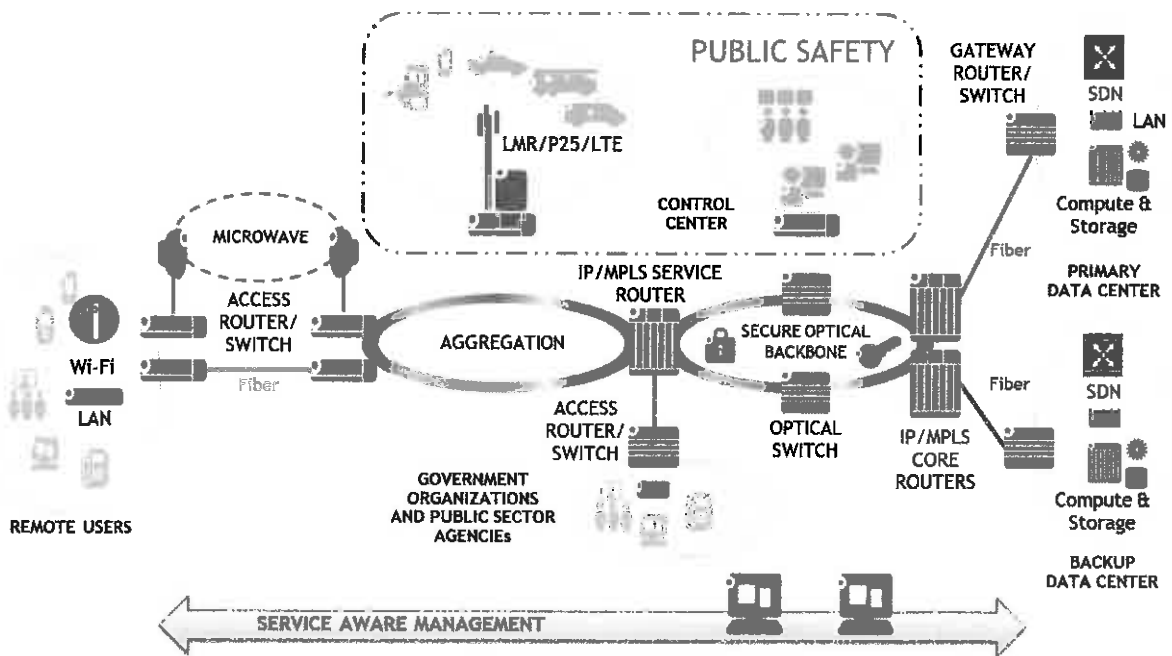
Figure 2. Proposed IP/MPLS Shared Government Network Architecture

In general, IP packet-switched networks are most cost-effective, easier to deploy and manage, and support significantly higher capacities than traditional circuit-switched networks. When combined with Multiprotocol Label Switching (MPLS), the network is able to deliver the predictability, security, and resilience to meet the stringent SLA and performance requirements of legacy circuit-switched services as well as new bandwidth intensive applications.

West Virginia Office of Technology
Replacement MPLS Contract
Request for Information# CRFI ISC1500000002
Proposal Number 15US58269401/ July 30, 2015

Alcatel·Lucent

IP/MPLS networks provide convergence capabilities to enable the information communications infrastructure sharing between multiple government, education and public safety entities while ensuring true multi-agency interoperability and cost savings resulting in a lower total cost of ownership (TCO) compared to the present mode of operation. Some of the benefits provided by an IP/MPLS network are:

- Lower TCO by consolidating multiple traffic types and applications (voice, video, and data) onto a common converged IP/MPLS network.
- Eliminate leased line costs and consolidate multiple agencies, departments and/or networks onto a single common information communications infrastructure, with guaranteed SLAs, using scalable and flexible Virtual Private Network (VPN) services for Frame Relay, ATM, Ethernet and IP services.
- Increased network scale and capacity via MPLS traffic engineering and Quality of Service (QoS).
- Increased security — isolate traffic using MPLS VPNs and encryption.
- Automate provisioning and rapidly activate service at new sites or incident locations.
- Achieve carrier-class reliability for mission-critical services based on MPLS path-protection and fast failover mechanisms.
- Allows the traffic prioritization of applications according to service priority levels defined by the State of West Virginia.
- End-to-end multi-domain IP management, including MPLS, microwave, optics, and LMR/P25/LTE.

Economic Benefits of Shared Government Networks

Recognizing the potential benefits network sharing offers to state and local governments, Alcatel-Lucent Bell Labs conducted an extensive analysis of possible sharing scenarios. The study focused on understanding real-life cases, short and long term economic advantages, as well as the impact network sharing will have on the service for all parties involved. The results show that in addition to delivering higher performance for all departments and agencies on the network and reducing overall operational costs, *state and local governments can realize new revenues streams from network sharing* to defray operating costs while reducing OPEX costs for all parties involved.

The Bell Labs analysis confirmed that an IP/MPLS network owned and operated by a state government can provide significant operational and financial benefits when compared to a network highly dependent on service provider leased lines for connectivity between government, education, and public safety entities.

The Bell Labs study was based on specific network assumptions and although the results can be extrapolated to other network scenarios to point to the significant economic benefits for a state government, a custom business case analysis will be essential to estimate the operational and financial benefits the State of West Virginia can realize from the proposed IP/MPLS network.

Alcatel-Lucent will be pleased to work with the State of West Virginia to prepare a custom business case analysis to estimate the savings on the TCO between the existing network architecture and the proposed IP/MPLS network architecture.

Alcatel-Lucent Differentiators

West Virginia Office of Technology
Replacement MPLS Contract
Request for Information# CRFI ISC1500000002
Proposal Number 15US58269401 / July 30, 2015

Alcatel·Lucent

Beyond the network feasibility and design consulting described above, Alcatel-Lucent is a market leader in the manufacturing and development of MPLS networking products and applications. Please find below a selection of differentiators of the Alcatel-Lucent product portfolio:

- **Integrated IP/MPLS router and microwave packet radio**
  - Elimination of multiple network managers ➔ Lower CAPEX and OPEX
  - Single Microwave/MPLS network element to manage instead of multiple network elements ➔ Lower OPEX
  - Reduced equipment space, sparing requirements, power consumption and cooling needs ➔ Lower CAPEX and OPEX
  - Multi-channel, multi-service, hitless adaptive modulation, packet compression, and higher modulation features that can provide between 15-30% extra capacity while maintaining availability and prolonging investments in antenna and microwave radio infrastructure ➔ Lower CAPEX
  - Streamlined installation and operations management ➔ Lower OPEX
- **Industry leading IP/MPLS platform**
  - Industry leading, in-house designed, purpose built service routing silicon delivering the lowest power consumption per bit transported ➔ Lower OPEX
  - Feature-rich and highly fault-tolerant common software operating system supported across all Alcatel-Lucent IP platforms ➔ Lower OPEX
- **Common network management platform**
  - Unified service-aware network management supported across all Alcatel-Lucent portfolio ➔ Lower CAPEX and OPEX
  - Simplified day-to-day network operations with greatly improved trouble-shooting capabilities (Fast detection, identification, and resolution of network problems with root-cause analysis) ➔ Lower OPEX
  - Simplified provisioning (Fast provisioning device, network, routing protocols, and service) ➔ Lower OPEX
  - Streamlined training, sparing, repairs, OSS integration ➔ Lower CAPEX and OPEX
  - Proven solution with over 600 customer deployments worldwide delivering significant and measurable savings resulting on one of the lowest TCO in the market

On top of the key differentiators listed above, the Alcatel-Lucent proposed IP/MPLS shared government network will be a highly robust multi-service network with an architecture that is poised to grow and expand. It will be able to scale in size and grow in capacity by fully utilizing the available network assets, including microwave spectrum, optical fiber, and low cost leased lines from internet service providers. The IP/MPLS network will also support a flexible range of point-to-point and multipoint VPNs for legacy, Ethernet, and IP services to fulfill the application needs of different organizations while maintaining Quality of Service (QoS) levels for all organizations at all times.

The highly reliable IP/MPLS network could be leveraged by the state-owned broadband middle-mile initiative should that come to fruition. The statewide WAN would be able to provide any mix of legacy services such as ATM, Frame Relay and TDM private lines as well as Layer 2 Ethernet (P2P, P2MP) and Layer 3 (IP VPN) services over fiber, microwave, or copper leased lines.

Rollout of the IP/MPLS network can be done in stages to best suit the State of West Virginia's evolving needs in terms of traffic growth, end user and application requirements, and available network assets such as fiber and/or microwave. Advanced QoS and high availability features assure optimal application performance and end-user experience while securely partitioning the traffic by

West Virginia Office of Technology
Replacement MPLS Contract
Request for Information# CRFI ISC1500000002
Proposal Number 15US58269401/ July 30, 2015

Alcatel·Lucent

customer (e.g. state agency, schools, libraries, public safety, etc.). The proposed shared communications infrastructure leverages the same technologies and solutions deployed by tier-1 service providers and by other state and local governments around the world.

Alcatel-Lucent's IP/MPLS Shared Network Architecture

Alcatel-Lucent's IP/MPLS shared government network solution is not just a plain IP/MPLS network. *It is a service-aware converged IP/MPLS network, fully integrated with transport technology.* It is an integral component of state and local governments' efforts to modernize their networks.

Figure 3 depicts a shared network architecture blueprint that encompasses a service-aware converged IP/MPLS network as the WAN and an SDN-powered enterprise network for the data center and branch edge network.
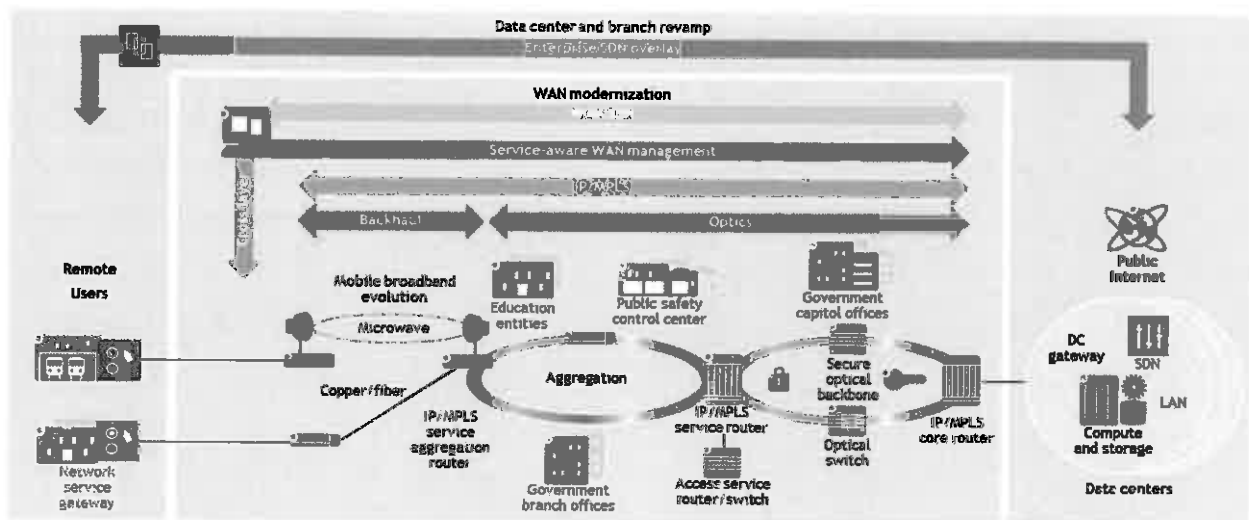

Figure 3. Alcatel-Lucent's Shared Network Architecture Blueprint.

While a shared network architecture achieves savings and increased efficiencies, there are always concerns that QoS objectives cannot always be met, jeopardizing application performance, particularly mission-critical applications such as land mobile radio (LMR) and Long Term Evolution (LTE) backhaul. To ensure performance, it is imperative that the shared network architecture exhibits the following crucial attributes:

1. QoS-enabled multiservice VPN

   Virtual private network (VPN) service is a necessary tool to carry many different applications' data with completely separate forwarding tables for IP, Ethernet and cross-connect for each VPN, thus enabling complete segregation among them. This requires a wide VPN portfolio capable of supporting Layer 1, Layer 2 and Layer 3 VPNs, either in point-to-point or multipoint configuration. To support collaboration among agencies, techniques like IP route leaking can be utilized in conjunction with a stateful firewall to allow collaborative inter-VPN communications. As multi-services are put on the same port in the same node, advanced service-aware hierarchical QoS is important to allocate sufficient bandwidth resources with the right priority to avoid performance compromise (Figure 4).
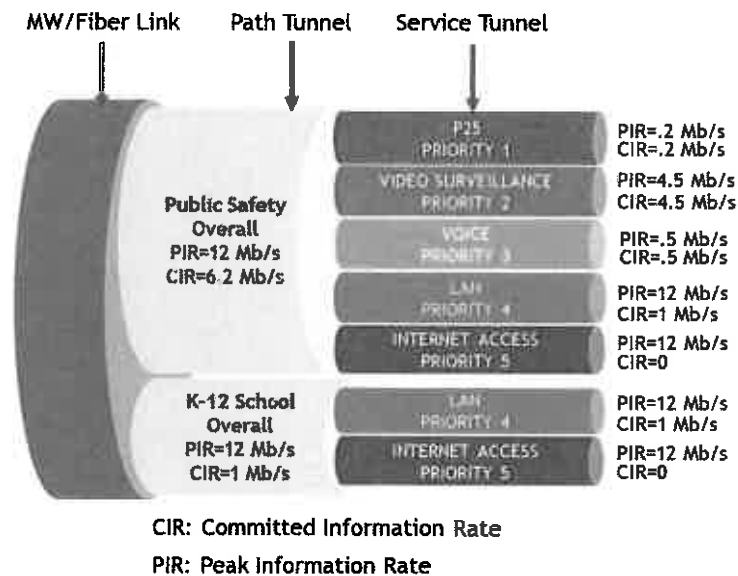
West Virginia Office of Technology
Replacement MPLS Contract
Request for Information# CRFI ISC1500000002
Proposal Number 15US58269401/ July 30, 2015

Alcatel·Lucent

MW/Fiber Link   Path Tunnel   Service Tunnel

		P25 PRIORITY 1	PIR=.2 Mb/s CIR=.2 Mb/s
		VIDEO SURVEILLANCE PRIORITY 2	PIR=4.5 Mb/s CIR=4.5 Mb/s
Public Safety Overall PIR=12 Mb/s CIR=6.2 Mb/s		VOICE PRIORITY 3	PIR=.5 Mb/s CIR=.5 Mb/s
		LAN PRIORITY 4	PIR=12 Mb/s CIR=1 Mb/s
		INTERNET ACCESS PRIORITY 5	PIR=12 Mb/s CIR=0
K-12 School Overall PIR=12 Mb/s CIR=1 Mb/s		LAN PRIORITY 4	PIR=12 Mb/s CIR=1 Mb/s
		INTERNET ACCESS PRIORITY 5	PIR=12 Mb/s CIR=0

CIR: Committed Information Rate
PIR: Peak Information Rate

Figure 4. Application Aware QoS-Enabled VPN Services

2. Fully integrated with transport technology

Whether it is an environmentally controlled office or a remote outpost, the transport network needs to reach all sites with high availability targets. Various transport technologies, whether optical fiber or microwave in licensed and unlicensed bands, must be flexibly utilized. Modern IP/MPLS routers now have natively integrated transport technologies such as CWDM, DWDM and microwave. Instead of deploying individual nodes and disparate network managers, a converged network with an IP/MPLS router and consolidated transport layer can now be managed by a cross-layer network manager (Figure 5).
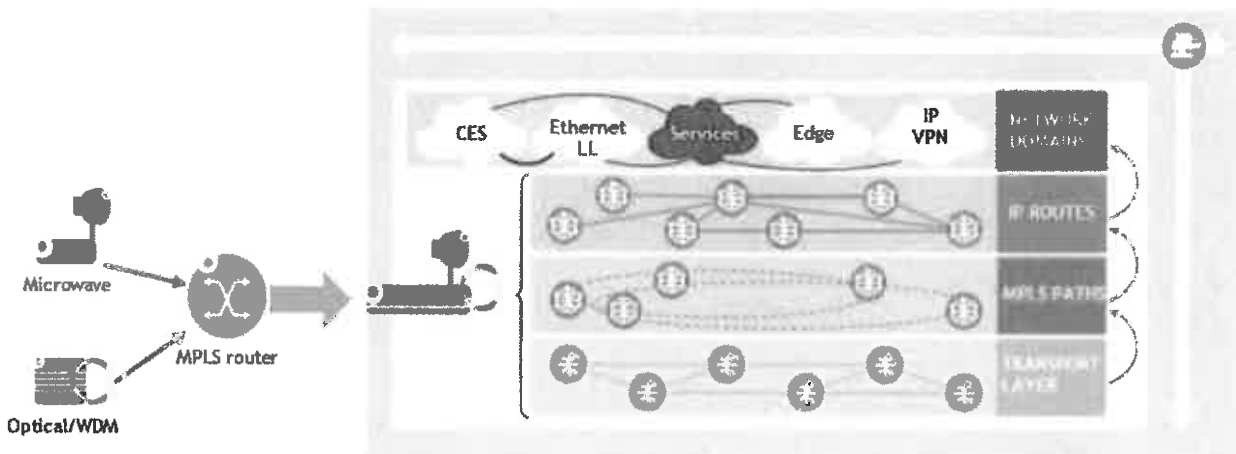
Figure 5. Cross-layer Network Manager

3. High scalability for future growth

West Virginia Office of Technology
Replacement MPLS Contract
Request for Information# CRFI ISC1500000002
Proposal Number 15US58269401/ July 30, 2015

Alcatel·Lucent

To meet future application needs, the network must scale in capacity, control plane and link bandwidth. An IP/MPLS router family ranging from a terabit core router supporting a 400 Gb/s slot in a central office setting to a multi-gigabit, hardened outdoor router allows state government to select a cost-effective choice dimensioned for projected traffic growth.

Scaling the transport infrastructure can be achieved by effectively utilizing fiber or microwave transport assets requires advanced techniques such as optical CWDM and DWDM, high-order 2048 QAM microwave modulation, MPLS-aware compression and Cross-Polarization Interference Cancellation (XPIC).

4. Enhanced resiliency and survivability

An IP/MPLS converged network attains high resiliency by design at various protocol layers. Nodal control and a hitless switching complex with 1+1 protection encompassing non-stop routing, signaling and services in a compact platform are among key design criteria. It also should include proven resiliency mechanisms:

- MPLS fast re-route (FRR)
- Label-switched path (LSP) make-and-break,
- Equal-Cost Multi-Path (ECMP) routing and pseudowire redundancy
- Ethernet link access group (LAG)

Furthermore, a network that carries mission-critical public safety radio communication traffic demands network robustness that can withstand multi-fault failures. It is notable that other types of packet transport technology, such as Carrier Ethernet, cannot offer the same level of resiliency as IP/MPLS.

5. Seamless TDM migration

While TDM network equipment and TDM services from carriers are being retired, many deployed legacy applications such as mission-critical communications infrastructure are here to stay for some years. To migrate TDM applications onto the network, it is imperative that low-speed interfaces such as E1/T1, E&M, FSX/FSO and serial are supported and that the network services can be provisioned with the acceptable range of delay and jitter. To ensure a smooth migration process, state government network operators also need to take certain engineering guidelines into consideration when designing the network.

6. Strong security

Following the ITU-T X.805 security framework, based on the Alcatel-Lucent Bell Labs security model, security considerations need to be given to both the infrastructure layer and services layer. For the infrastructure layer, it is necessary to protect management, control and data planes with comprehensive authentication and logging, packet filtering and IP Security (IPSec). For the services layer, features such as service-aware network group encryption (NGE), which encrypts at the MPLS layer, stateful firewall and network resource partitioning are pivotal to defend the service integrity. Encryption at optical and microwave layers are also available to protect the data.

7. Effective management

The traditional boundaries of element, network and service management have made the tasks of service provisioning, network configuration, performance monitoring and troubleshooting

West Virginia Office of Technology
Replacement MPLS Contract
Request for Information# CRFI ISC1500000002
Proposal Number 15US58269401/ July 30, 2015

Alcatel·Lucent

complicated, cumbersome and prone to errors. An effective service-aware manager helps operators gain high efficiency with an easy-to-use GUI, service templates and scripting, a scalable collection of network and OAM statistics, and powerful cross-layer fault correlation.

Moreover, users in various agencies and departments may want to view the performance and status of their services from time to time. A service portal, with proper customer policy enforced, can provide them instant access to their VPN and allow them to perform tasks within the scope of control policy (Figure 6).
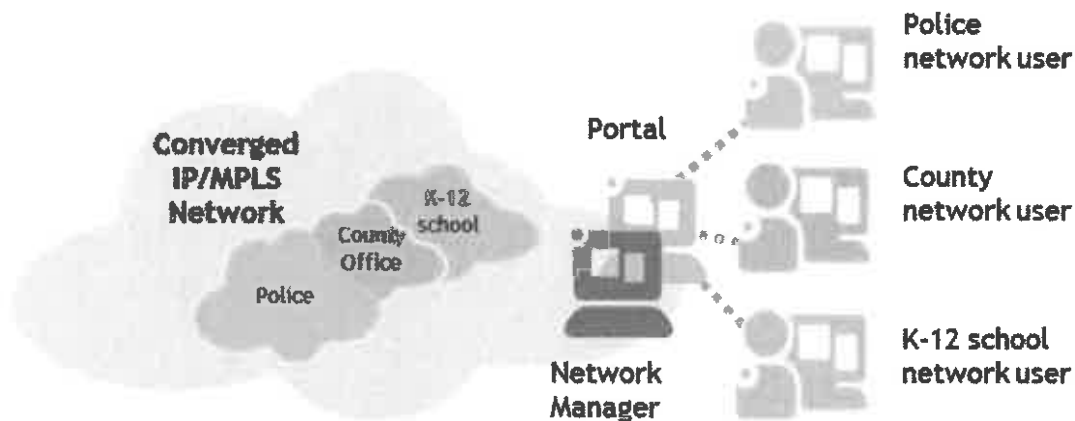

Figure 6. Service Portal allows various network users to manage their networks

8. Future evolution to Software Defined Networks (SDN)-based WAN

A converged IP/MPLS WAN solution can provide a robust, resilient, QoS-enabled, fully managed, shared, converged network that scales and reliably connects numerous agencies and applications. With the use MPLS traffic engineering, operators can also have full control of QoS performance for different services. For example, services carrying critical voice communications need to be placed on short-latency paths, while bandwidth-intensive services are placed on a high-bandwidth path. The traditional mode of operation is typically first to use off-line tools to compute a suitable path to fulfill a service requirement, then provision it via the network manager. Even if bandwidth consumption decreases over time, the path remains until the next cycle of network optimization. This may lead to an inefficient use of network resources. When users need a new application, they will need to wait for the network operators to provision a new service — a delay of days or weeks.

Driven by the prevalent use of applications powered by cloud computing, user applications are becoming increasingly dynamic. Bandwidth requirements and traffic patterns quickly change during emergencies when first responders download information from data centers to attain a broader situational awareness. It is necessary for the users themselves to have fuller control of network resources within an assigned boundary.

The SDN paradigm provides a dynamic and more efficient way to define provision and/or activate services in order to rapidly respond to changing needs. Leveraging centralized intelligence collected in the network, such as utilization and real-time delay performance as well as powerful analytics and self-tuned adaptive routing algorithms, through a standard RESTful API, services can be provisioned and placed on path fulfilling QoS requirements while optimizing overall network

West Virginia Office of Technology
Replacement MPLS Contract
Request for Information# CRFI ISC1500000002
Proposal Number 15US58269401/ July 30, 2015

Alcatel·Lucent

resource utilization. Should bandwidth usage of applications in the network change, paths for all services can be re-calculated to optimize QoS performance and network resource utilization.

Moreover, with the concept of network slicing, the shared network can be modeled as multiple virtual separate network infrastructures, one for each agency. Each network slice can have distinct network characteristics, like low latency to satisfy each user's unique requirements. With a service abstraction methodology, service provisioning and parameter changes can even be automated without operator intervention. By giving each agency the flexibility to utilize the network slice, they can now adopt new cloud-based applications rapidly.

An SDN-based WAN, resting on a converged network that is robust, resilient and QoS-enabled, enables operators to attain fully unified network control and service management, which can optimally utilize network resources and swiftly, while empowering users to respond to a dynamic on-demand communications infrastructure environment ushered in by the cloud era. This new paradigm can also be extended to manage a complex network architecture that spans disparate transport domains, technologies and vendors.

Alcatel-Lucent Product Portfolio

Alcatel-Lucent provides its ultra-broadband, IP and cloud communication network solutions to address state, local and federal government, public safety, utility, transportation, and health care organizations.

Alcatel-Lucent solutions are specifically well positioned by offering:

- **Cost-efficiency and robustness:** Alcatel-Lucent leverages its feature-rich commercial off-the-shelf (COTS) products, designed for high-availability carrier networks.
- **Optimization:** Alcatel-Lucent 5620 Service Aware Manager (SAM) is a unique end-to-end and cross-domain management system encompassing routing, microwave, transport and LTE equipment to simplify and speed up complex operations.
- **Smarter migration path:** Alcatel-Lucent products and services allow smart migration of legacy networks in silo systems to a single converged IP/MPLS communication infrastructure.
- **Reliability:** Alcatel-Lucent features such as a control plane with non-stop routing and signaling, switching fabric, fan and power supply redundancy together with the MPLS mechanism fortifies resiliency and maximizes end-to-end application availability.
- **Trust:** Alcatel-Lucent solutions are already in use or deployed around the world by state, local and federal government, public safety, utility, transportation, and health care organizations.
- **Network scaling:** Alcatel-Lucent offers fully integrated IP/MPLS and optics solutions addressing cross-government use cases.
- **Multi-layer OSI security:** Alcatel-Lucent offers Layer 1, 2, 3 and 7 product security solutions to protect mission-critical networks

Figure 7 illustrates the mapping of Alcatel-Lucent product portfolio to the shared government network architecture blueprint in Figure 3.
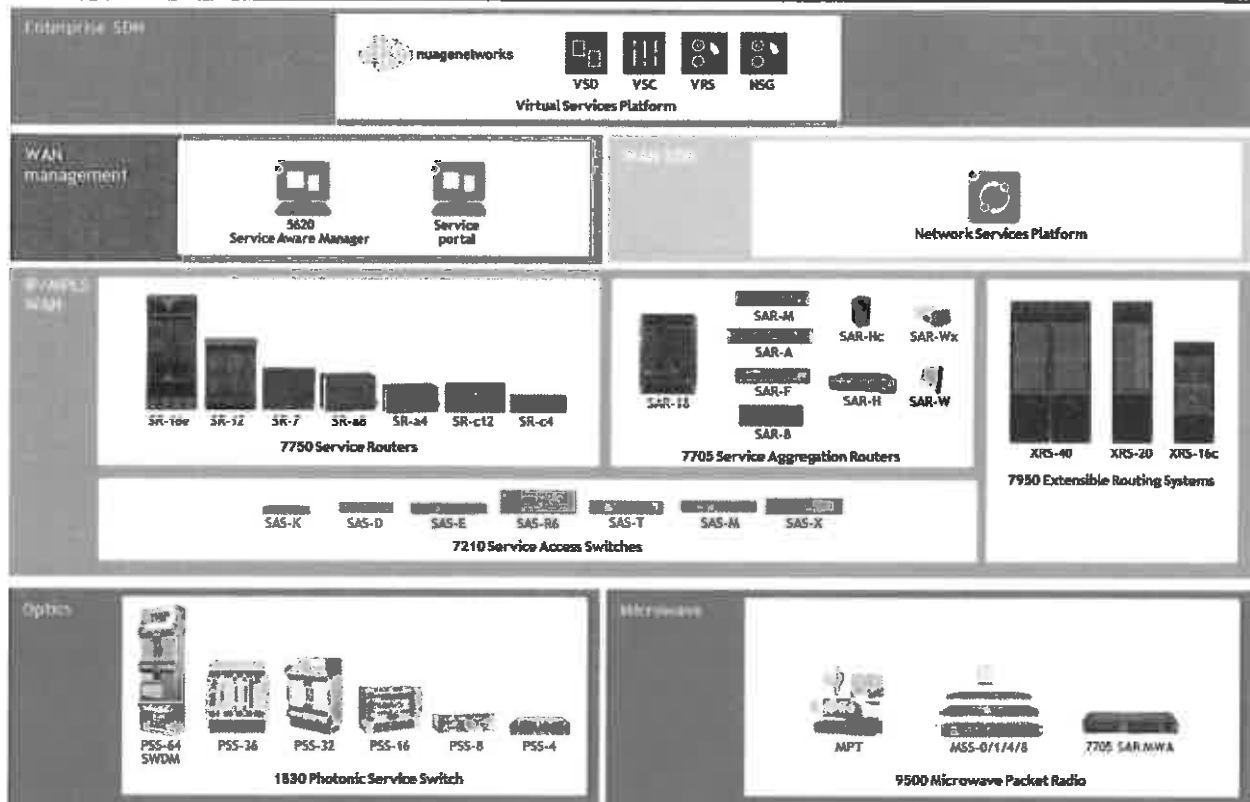
West Virginia Office of Technology
Replacement MPLS Contract
Request for Information# CRFI ISC1500000002
Proposal Number 15US58269401/ July 30, 2015

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Figure 7. Alcatel-Lucent Product Portfolio

Alcatel-Lucent Network Migration Proposal for the State of West Virginia

Alcatel-Lucent recommends a two-prong approach enabling graceful migration from current leased services to a State of West Virginia controlled shared network architecture as follows:

1. To address agencies/entities with stringent IP or Ethernet SLA requirements and/or ongoing need for legacy services such as ATM, Frame Relay and TDM private lines, Alcatel-Lucent recommends deploying a private IP/MPLS network owned by the State of West Virginia. In this shared services network, each agency/entity can be flexibly allocated any transport services (e.g. IP, Ethernet, ATM, Frame Relay, TDM), specific network bandwidth, QoS, end-to-end resiliency, security policies with guaranteed traffic isolation (Virtual Private Networks). Advanced QoS and High Availability features provided by Alcatel-Lucent's IP/MPLS portfolio assure optimal application performance and end-user experience while securely partitioning the traffic by customer (e.g. various state and local agencies, schools, libraries, etc).

    Alcatel-Lucent's field-proven IP/MPLS solution can operate over any combination of owned and leased facilities including fiber, copper and wireless, and can certainly leverage the State of West Virginia broadband middle-mile fiber network initiative recently announced.

    Over 450 such private IP/MPLS networks have been successfully deployed around the world by state, local and federal governments, public safety, utility, transportation, and health care organizations. The leading products deployed in these IP/MPLS networks include the 7750 Service

West Virginia Office of Technology
Replacement MPLS Contract
Request for Information# CRFI ISC1500000002
Proposal Number 15US58269401/ July 30, 2015

Alcatel·Lucent

Router, 7705 Service Router, 7210 Service Aggregation Switch and 5620 Service Aware Manager (datasheets attached)

Alcatel-Lucent is also an expert in integrating underlying transport technologies into the solution such as:

a. Optical Wave Division Multiplexing (WDM) to increase fiber capacity up to 88 times and support data center interconnect applications such as transport of infiniband and fiber channel traffic. The leading product deployed for WDM optical networking is the 1830 Photonic Switch (datasheet attached).
b. Wireless Transmission (point to point and point to multipoint microwave) where fiber is not available or cost prohibitive. The leading microwave product deployed is 9500 Microwave Packet Radio (datasheet attached).
c. First mile wireline technologies such as GPON and DSL which may be applicable to the State of West Virginia in some urban and campus environments.

In addition, the Alcatel-Lucent IP/MPLS solution offers automated interworking of agency VPNs in the Wide Area Network (WAN) to Software Defined Networking (SDN) VPNs inside data centers. This interworking and automation provides agility in connecting end users to cloud-based services hosted in the State of West Virginia data centers and any partner Cloud Services Providers.

2. The second prong in the proposed solution leverages the power of the internet.   Where stringent SLA requirements or legacy services are not required, the State of West Virginia can benefit from the low cost and rapid site reachability of Internet Service Providers (ISPs) by deploying a highly automated SDN (Software Defined Network) overlay solution. This solution rides over the internet providing secure tunnels to connect agency/entity sites to each other and to the State of West Virginia POPs. This SDN overlay solution, known as Virtualized Network Services (VNS), supports L2 and L3 services, security policies, network address translation, service chaining, and dual uplinks for highest network availability. A self-service portal is available to enable agencies/entities to securely manage their own services within the constraints defined by the State of West Virginia network administrator.

With this two-prong approach, sites accessed through the private IP/MPLS network and sites accessed through VNS (over the internet) can be connected at existing State of West Virginia POPs to provide end-to-end services. If it is desired to keep the traffic more local, small scale POPs can be added to select IP/MPLS aggregations sites.

This highly flexible shared network solution easily scales to support any combination of state-wide and local county transport services. Each county or county-level entity can managed as a separate customer for network services and billing purposes.

Traditional network management systems take a single-domain approach resulting in a fragmented network management perspective. This can make it difficult to isolate faults impacting multiple domains, and introduces error-prone labor-intensive operations across the domains.

The Alcatel-Lucent Service Aware Manager (SAM) enables end-to-end and cross-domain management of routing and transport assets to simplify and speed up complex operations. It is quick and easy to configure and allows network elements to be changed, facilitates routing infrastructure and service, and resolves problems before they can affect network users. In short, the solution simplifies operations and reduces OPEX.

West Virginia Office of Technology
Replacement MPLS Contract
Request for Information# CRFI ISC1500000002
Proposal Number 15US58269401/ July 30, 2015

Alcatel·Lucent

Alcatel-Lucent Managed Services Capabilities

Most networks, such as the one the State of West Virginia intends to build, are complex and contain multiple technologies. These networks are usually built against tight deadlines and must be taken into production first time right with performance excellence to ensure that the underpinning business case justifying the investment is realized and customer satisfaction is exemplary from the beginning.

To maximize the pace of delivery and manage the associated risk, Alcatel-Lucent's Managed Services relieves our customers from the pressure and strain on resources by implementing its industrialized operational model and leveraging its global experience (over 20 years) of building, operating and managing telecommunications networks across the world – all measured against business outcome based SLAs and KPIs that we develop with our clients. Reasons our clients hire Alcatel-Lucent for their operational needs include their desire to achieve some of all of the following objectives:

- Lower Operational Expenses
- Ease the introduction of new technologies
- Address resource gaps, enhance skills and experience, or
- Focus on their core business.

Alcatel-Lucent Managed Services consists of 1,700 highly qualified professionals and manages over 80 networks that consist of over 300,000 network elements over which more than 100 million subscribers and users communicate every day. Our Managed Services infrastructure includes 4 Global Network Operations Centers, including Plano TX, and 17 Regional Network Operations Centers.

Our unique value proposition which minimizes the risks associated with the build and service delivery for the State of West Virginia Office of Technology's network, is that Alcatel-Lucent is a unique partner as it has a homogenous portfolio of technology and operational services in-house to Build, Operate, and Manage your network. The resulting benefits are:

- Our Operations Staff are experts in our own technology.
- That intimate knowledge is core to the high operations performance levels our customers ask Alcatel-Lucent to deliver against.
- We have short lines of communication to the relevant product houses. Meaning, our engineers do not have to deal with complex relationships of working with 3rd Parties to drive continuous improvement and swiftly resolve network issues.

Severity Level (SL) (Incident Type)	Incident Response	Incident Escalation Timeline	Incident Resolution
SL1 Critical Alarm	15 mins or less	SL1 Issues will be escalated to the next level within 15 mins	4 hours or less
SL2 High Alarm	20 mins or less	SL2 Issues will be escalated to the next level within 30 mins	8 hours or less

West Virginia Office of Technology
Replacement MPLS Contract
Request for Information# CRFI ISC1500000002
Proposal Number 15US58269401/ July 30, 2015

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SL3 Medium Alarm	30 mins or less	SL3 Issues will be escalated to the next level within 4 hours	24 hours or less

The Alcatel-Lucent Managed Services organization exceeds 95% of contractual SLAs. This is a result of deploying high levels of intelligence at the front line with high quality professionals and an advanced, automated OSS environment. Over 80% of all tickets that are opened are resolved at first contact, which drives lower OPEX and higher quality of service to our customers' end users. A sample of Alcatel-Lucent and 3rd Party network elements that Alcatel-Lucent currently has under operational management includes:

- 33,000 + Optical Network Elements
- 35,000 + IP/Ethernet Network Elements
- 32,000 + Radio Network elements

The Managed Services support for the State of West Virginia's new network would be delivered from the existing GNOC in Plano, TX. The Plano NOC is fully compliant with industry and regulatory standards and best practices as defined in ISO/IEC15288, INCOSE, CMMI & PMI. It is a double-walled building with a F3 tornado rating, zero earthquake zone location, and supplied by a UPS plant with dual generators, diverse power feeds, and redundant telecom facilities. Its data communications infrastructure is a DMZ with back-to-back firewalls and physical security designed around US Government NSA/CFIUS (Committee on Foreign Investment in USA) requirements.

Alcatel-Lucent's Plano NOC, which would be the NOC servicing the State of West Virginia, is meeting 99% of its SLAs in 2015. It is on track to exceed its already exceptional 2014 performance of 97%. Please find below SLA performance date for April through June 2015 (data for a longer sample period can be provided):

- April 2015 - 34,876 tickets opened. 268 tickets missed. 34,608 tickets met. Performance of 99.2%.
- May 2015 - 30,652 tickets opened. 357 tickets missed. 30,295 tickets met. Performance of 98.8%.
- June 2015 - 28,678 tickets opened. 282 tickets missed. 28,396 tickets met. Performance of 99.0%.

As an overview, Alcatel-Lucent Managed Services portfolio consists of the below functions which we can tailor to our customers' individual needs:

- Centralized / Remote Operations Support Package
  - Service Desk
  - Change Management Governance
  - Operate Acceptance
  - Network Monitoring and Surveillance
  - Network Resolution Management
  - Network Performance
  - Access Management
- Technical Support & Fulfillment Engineering
  - Platform / Lifecycle Management

West Virginia Office of Technology
Replacement MPLS Contract
Request for Information# CRFI ISC1500000002
Proposal Number 15US58269401/ July 30, 2015

Alcatel·Lucent

- o Capacity Analysis & Planning
- o Optimization Analysis & Planning
- o Disaster Recovery Planning
- o Advanced Technology Support
- o Network Provisioning
- Field Assurance Package
  - o Scheduling and Dispatch Coordination
  - o Corrective and Preventive Field Services
  - o Provisioning Field Services

The minimum network operations solution Alcatel-Lucent recommends to its clients, regardless of which type telecommunications network that is to be managed, consists of the following scope:

- Service Desk (SPOC)
- Change Management Governance
- Network Monitoring and Surveillance
- Advanced Technical Support (ATS)
- Network Utilization and Performance Reporting
- Field Dispatch Coordination
- Trouble Lifecycle Management
  - o Field Dispatch Coordination*
  - o Escalation to Technical Support
  - o Vendor Escalation and Management

*Alcatel-Lucent at all times recommends that clients have both corrective and preventive field maintenance solutions in place contracted either through Alcatel-Lucent or by its own existing (contracted) field force organization with whom Alcatel-Lucent can work via a Letter of Agency authorizing Alcatel-Lucent to manage the Field Maintenance contracts on behalf of the client.

The above mentioned services can be delivered in various ways, depending on what our clients' specific needs and requirements are. Most models fall in one of 4 categories described below.

1. Outsourcing:
   - On Shore outsource of network operations from Alcatel-Lucent's Plano TX Global Network Operations Center.
   - Off Shore outsource of network operations from one of Alcatel-Lucent's low cost GNOCs in Romania and Poland.
2. Hybrid Network Operations Solutions, e.g:
   - Out of office hours Network Operations support as an extension to our clients existing Operations.
   - Onsite (at customer's NOC premises) Alcatel-Lucent monitoring/level 1 services with level 2 and 3 functions delivered remotely by Alcatel-Lucent.
   - Customer performs the monitoring functions and escalates to Alcatel-Lucent to provide Level 2 and/or Level 3 support
3. Operations Assistance:
   - Placement of Operational Resident Engineers to support the customers' Operations organization with specific Subject Matter Expertise. This can be combined with any option.

West Virginia Office of Technology
Replacement MPLS Contract
Request for Information# CRFI ISC1500000002
Proposal Number 15US58269401 / July 30, 2015

Alcatel·Lucent

4. Niche Operations Solutions, e.g.:
   - Sophisticated network element management support.
   - Network Provisioning services.

Alcatel-Lucent Managed Services does not just focus on cost reduction. Lowering OPEX is a key driver behind outsourcing decisions and often addresses financial pressure in the short term. However, it is the combination of the quality of network performance plus removing inefficiencies out of network operations that in the long run will have the desired game changing impacts for our clients both in terms of end-user satisfaction as well as financial performance.

Alcatel-Lucent Hosted SIP Trunking Services

Option 1: Introduce Alcatel-Lucent RAPPORT Solution

Alcatel-Lucent Rapport™ is a new cloud communication and collaboration software platform for service providers, Governments and large enterprises. Rapport radically changes how communication services are delivered and consumed shifting the focus to service innovation and growth. By significantly reducing the cost and complexity of communication networks, Rapport allows State of West Virginia customers to embed and integrate voice, video and messaging services into any application, so as to enrich existing services or create new ones. Based on a fully re-architected version of Alcatel-Lucent IMS, Rapport embraces the cloud to automate lifecycle management and launch new services more quickly.

The Alcatel-Lucent Rapport™ solution delivers a flexible set of hosted enterprise services from a common IMS core network. These services can include unified communications, IP Centrex, PBX hosting and customer contact solutions that work across both fixed and wireless access networks and devices

The Alcatel-Lucent Rapport™ Reduce enterprise costs dramatically for the communications and IT infrastructure that is already in place, while empowering enterprise lines of business with a best-of-breed application-centric approach

- Enables SIP Trunking, converting fully meshed inter-PBX trunking to a far more efficient star topology
- Allows common dial plan and network simplification that removes application silos and reduces management costs
- Reduces development interval with REST APIs for easier deployment & integration of enterprise-specific services
- Offers a variety of hosted enterprise services for PBX optimization, unified communications, and flexible routing
- Reuses common IMS session control infrastructure for most cost effective deployment of new capabilities
- Complies fully to industry standard interfaces from 3GPP, 3GPP2, TISPAN, IETF with proven interoperability

Improve competitive agility for both the carrier, Government and the enterprise through APIs that make it easy to deliver the New Conversation Experience

- Enables IMS as a real engine for rapid innovation with easy-to-use REST APIs
- Leverages a dynamic ecosystem of versatile application partners and innovation environment

West Virginia Office of Technology
Replacement MPLS Contract
Request for Information# CRFI ISC1500000002
Proposal Number 15US58269401/ July 30, 2015

Alcatel·Lucent

- Delivers five nines availability to the enterprise session control infrastructure, decreasing downtime of business applications
- Allows the enterprise to deploy applications with end-to-end QoS capabilities and controls
- Supports any size of enterprise operation with seamless and efficient scaling
- Enables easily deployed enterprise fixed-mobile convergence on a common IMS core

Option 2: Introduce the hosted SIP Trunking Services

In the technical VoIP arena, Alcatel-Lucent Managed Services has significant experience in building and managing both premise-based solutions as well as hosted solutions. In fact, over the years, Alcatel-Lucent has successfully supported some of the largest Service Providers in the world. We have a deep level of understanding with a variety of softswitch solutions as well as the corresponding Session Border Controller (SBC) environment.

Performance-wise, we have a long track record of providing reliable service with VoIP SLA's being met over 99% of the time. Highlights of our VoIP services include the following:

1. Alcatel-Lucent has numerous engagements whereby we manage the customer equipment and the corresponding network. This includes monitoring and resolving fault, performance, and capacity issues as well as full service provisioning services.
2. Alcatel-Lucent can also host VoIP deployments if the customer wants to avoid an on-premise solution. Services offered in this mode are the same as in a managed solution with the exception that ALU also monitors and manages the connectivity between the customer premise and the ALU data centers.
3. Alcatel-Lucent's data centers offer a robust High Availability, geographically diverse solution offering the customer superior uptime.
4. Alcatel-Lucent has a deep knowledge of the SBC environment allowing us to adapt operations to specific customer scenarios that other Service Providers may deflect back to the customer.
5. In our operations solution, actively detects Distributed Denial of Service conditions which can significantly degrade customer services. In this case, ALU can detect and implement controls which limit the DDOS activity and minimize the impact to customers.
6. ALU MS has the ability to detect potential customer misconfigurations from excess signaling traffic on the customer network. While the behavior does not tie up TG's or RTP bandwidth, the excess signaling traffic can significantly impact device processing which will impact call processing for that customer causing the issue, and all other customers on the platform. In this case, ALU can activate controlled restrictions minimizing the traffic impact.
7. Alcatel-Lucent Managed Services is disciplined in managing the customer solution. Maintenance is planned and communicated well in advance and changes are documented, reviewed and deployed in a manner that protects the service.
8. Although flexible, our pricing is typically framed as OPEX so customers have a predictable view of their costs. This OPEX pricing model includes
   a. Alcatel-Lucent provided hosting environment - Secure, locally and/or geo-redundant options
   b. Alcatel-Lucent purchase of the VOIP platform (HW, SW, Licensing)
   c. Alcatel-Lucent network operations services of the VOIP platform:
      i. Network Monitoring and Surveillance
      ii. Network Resolution Management
      iii. Advanced Technology Support
      iv. Network Performance

West Virginia Office of Technology
Replacement MPLS Contract
Request for Information# CRFI ISC1500000002
Proposal Number 15US58269401/ July 30, 2015

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v.   Access Management
vi.   Capacity Analysis & Planning (HW and License Management)
vii.   Optimization Analysis & Planning
viii.   Network Provisioning Support
ix.   Service Desk (SPOC)
x.   Change Management Governance
xi.   Platform / Lifecycle Management

Summary

Because every success has its network, Alcatel-Lucent invents and delivers dynamic and resilient networks to support the proposed IP/MPLS shared government network to the State of West Virginia. Alcatel-Lucent is a leading IP networking, ultra-broadband access and cloud technology specialist. Our mission is to create networks at scale, and to apply our expertise and passion to the implementation of dynamic and secure networks adapted to the requirements and priorities of the state & local government agencies around the world.

We can bring state-of-the-art technologies to the State of West Virginia shared communications infrastructure enabling it to scale in size and grow in capacity by fully utilizing the available network assets and capacity, including microwave spectrum, optical fiber, and low cost leased lines from internet service providers.

The proposed shared government network architecture is based upon an IP/MPLS network that will provide a highly robust multi-service, multi-agency shared network enabling full interoperability and new financial benefits resulting in lower TCO as well as an efficient platform for future expansion to address any communications needs that may arise by any agency/entity connected to the proposed IP/MPLS network.

The proposed IP/MPLS shared communications infrastructure will also support a flexible range of point-to-point and multipoint VPNs for legacy, Ethernet, and IP services to fulfill the application needs of different organizations while maintaining the stringent SLAs requirements of the types of traffic (voice, data, video, etc.).

We are committed to earning the State of West Virginia's trust. We operate according to the highest ethical standards, embedding responsible innovation at the heart of our activities and supply-chain partnerships.

We actively participate in standards development for cost-efficient multivendor interoperability and implement standard carrier-grade technology as well as standard RFCs so that customers are not locked into a vendor-specific feature.

We innovate for you. We conceive and invent the future through open collaboration with customers, stakeholders and our Bell Labs researchers, pushing the limits of communications and shaping the digital world. We combine the world's best network of minds with a 'startup culture' eager to solve today's major challenges and develop breakthrough technologies such as cloud-based services leveraging the SDN functionalities to implement a cost effective platform to provide branch networking services to all the remote users/branches of the State of West Virginia government, education, and public safety agencies/entities.

Finally, to complete the value that Alcatel-Lucent brings to the table, with our Managed Services organization, the State of West Virginia has the option to secure a partner that not only has the

West Virginia Office of Technology
Replacement MPLS Contract
Request for Information# CRFI ISC1500000002
Proposal Number 15US58269401/ July 30, 2015

Alcatel·Lucent

industry leading technology, but also can smoothly bring the newly built network into operation for an agreed term after which it can transition the Operations under the State of West Virginia's control when it is ready to do so, all in-house. It is the true definition of an end-to-end solution to take the State of West Virginia from the present into the future.

nuagenetworks

Virtualized Network Services
SDN solution for enterprises

Nuage Networks™ Virtualized Network Services (VNS) is a fresh approach to business networking that seamlessly links your enterprise's locations regardless of size or geography while reducing the requirement for custom networking.

With Nuage Networks VNS the network that underpins your business locations is unshackled to deliver services where you need them, when you need them. You gain the flexibility and functionality you need to drive your business into the cloud era.

Nuage Networks VNS provides a comprehensive networking service that removes the limitations that exist with traditional Virtual Private Networks (VPNs). Solution benefits include:

- Centralized management and control of the network service tailored to the individual requirements of your business

- Separation of the network service from the network transport, which provides you with flexibility to choose branch connectivity from all available providers

- Quick and simple move, add and change requests to ensure your network services match your dynamic business environment

- Advanced functionality that reduces the requirement for specialist security and network devices at your remote locations

- Increased network-wide visibility to reduce the costs associated with compliance and auditing

What are Virtualized Network Services?
Software Defined Networking (SDN) has delivered significant benefits to datacenter networks unleashing the true power of the cloud.

Nuage Networks brings the same benefits to business connectivity services with Virtualized Network Services. Nuage Networks VNS is a new wide area network service construct that provides you with the flexibility to adapt to the ever-changing business environment you work in.

Traditional VPN services are based on set functionality that can be deployed across the widest customer base with little room for per-enterprise customization. This forces you into the complex world of custom branch networking to achieve network capabilities that match your specific business needs.

HIGHLIGHTS

- Completely self managed via intuitive GUI making moves, adds and changes instantaneous and completely reactive to your changing business environment

- Your network service is independent of the transport utilized, which provides maximum flexibility when selecting a service provider and access technology

- Network complexity is reduced by embedding advanced network functions such as firewalling directly into the service

- Improved management visibility assists with industry regulated auditing and compliance

Nuage Networks VNS gives you the power to centrally manage and deploy your network services. The comprehensive solution puts you in charge of all aspects of service creation and ongoing management without increasing the demands on your IT and Networking teams.

The solution includes three key functions that work in concert to lower your operational overhead while increasing the network's ability to respond to your demanding business needs.

FIGURE 1. Nuage Networks Virtualized Network Services
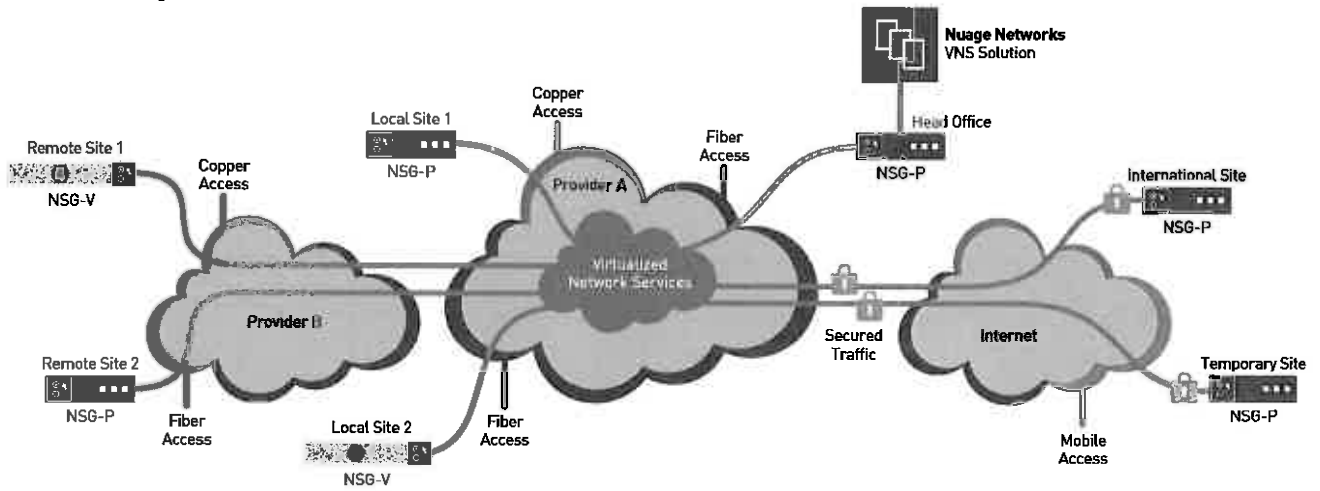
Solution Components

Virtualized Services Directory

The Virtualized Services Directory (VSD) is a programmable policy and analytics engine. It provides a flexible network policy framework that enables network administrators to define and enforce the business policies being applied across the network service in a user-friendly manner.

The VSD contains a network service directory that supports role-based administration of network resources. It is where network configuration including moves, adds and changes are centrally managed via an intuitive graphical user interface.

From within the VSD network administrators can centrally view and change the running policies on the network including deployment of new policies on a single, multiple or network-wide basis. The VSD is also the point for network traffic collection where site-specific and network-wide trending reports are available. The VSD also provides sophisticated rules for collecting information on the status of your network service. This includes functions such as collection frequencies and rolling averages that allow you to build comprehensive Threshold Crossing Alerts (TCA) for both current and historic information on the service performance.

Statistics are aggregated over hours, days and months and stored in a Hadoop® analytics cluster to facilitate data mining and performance reporting.

Information security and compliance functions are also completed through the VSD. This reduces the overhead associated with network availability compliance and auditing for industry regulation such as the Sarbanes-Oxley Act.

Network functions for the service are selected via the VSD's Network Functions Store. This provides a comprehensive set of common network functions, such as firewalling, load balancing, IP address management, and domain name services that can be selected and inserted directly into the network service. This reduces the requirement for dedicated network elements to be deployed at your remote locations and eases your overall investments to deploy and maintain your network.

Through its partner program, Nuage Networks is working with leading network function suppliers to supplement the store's default functions .

The VSD can be deployed as a stand alone or clustered solution depending on scaling needs.

Virtualized Services Controller

The Virtualized Services Controller (VSC) is the industry's most powerful SDN controller. It functions as the robust network control plane for the network services, maintaining a full view of the network and service topologies.

Through the VSC, virtual routing and switching constructs are established to program the network-forwarding plane using the OpenFlow™ protocol. Multiple VSC instances can be federated within and across the network by leveraging Multi-Protocol Border Gateway Protocol (MP-BGP) — a proven and highly scalable network technology that allows the network service to grow with the requirements of your business whether you are operating across the country or around the globe.

Network Services Gateway

The Network Services Gateway (NSG) constitutes the network-forwarding plane for the network service at the central and remote locations of your business. With support for both a hardware and software image deployment, the NSG provides maximum flexibility to meet the demands of your central and remote locations.

The hardware-based option includes four form-factors to meet the diverse throughput, network interface and network functionality requirements of your locations. The software image can utilize the available x86-based virtualized compute platforms you may have at your sites.
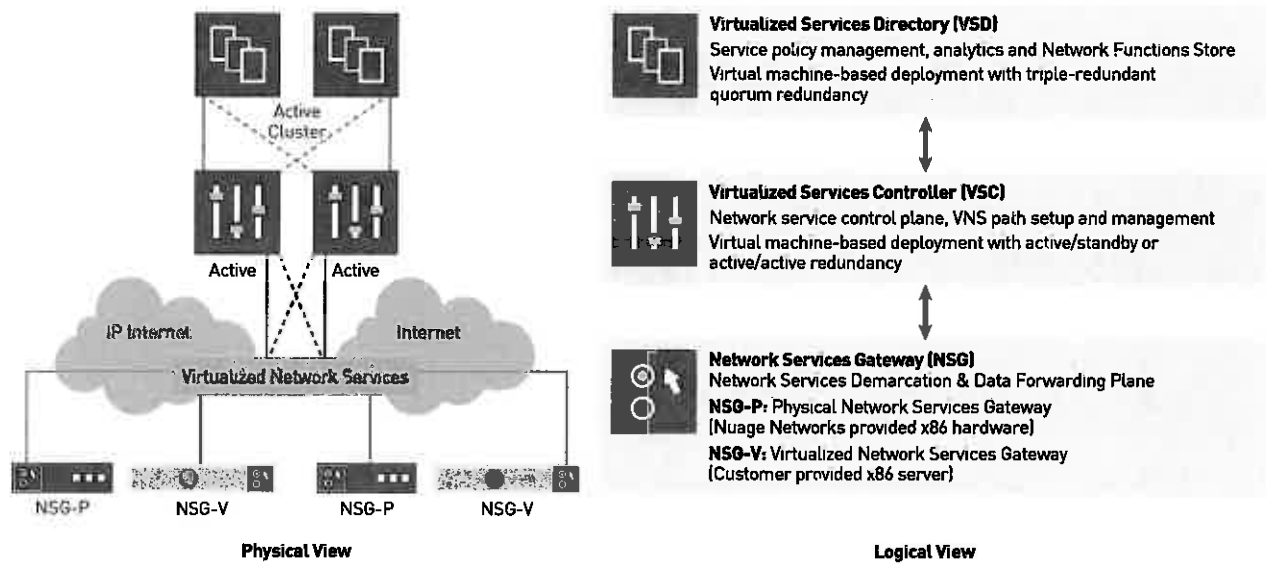
The NSG encapsulates and de-encapsulates user traffic, enforcing Layer 2 to Layer 4 network policies as defined by the VSD. Advanced services including network functions such as load balancing, firewalling, DNS, DCHP and security protocols, such as IPSec, can be enabled via the Network Functions Store within the VSD. These services can be applied to the NSGs centrally on a service-wide or location-specific deployment model. This ensures that your network service is always configured with the standard policies applicable to your business.

Deployment of the NSG is provided by the innovative bootstrapping functionality of the Nuage Networks VNS solution. When a new NSG is connected to the network, it calls home to the VSC and is authorized by the VSD. From there a two-step authentication process is initiated to bring the new site on to the network service.

The automated nature of this bootstrap function reduces the requirement for specialist networking resources at your remote locations. In most cases your branch staff can unbox and plug in the NSG themselves, which lowers the costs of service deployment.

FIGURE 2. Nuage Networks Virtualized Network Service components

Virtualized Services Directory (VSD)
Service policy management, analytics and Network Functions Store
Virtual machine-based deployment with triple-redundant quorum redundancy

Virtualized Services Controller (VSC)
Network service control plane, VNS path setup and management
Virtual machine-based deployment with active/standby or active/active redundancy

Network Services Gateway (NSG)
Network Services Demarcation & Data Forwarding Plane
NSG-P: Physical Network Services Gateway
(Nuage Networks provided x86 hardware)
NSG-V: Virtualized Network Services Gateway
(Customer provided x86 server)

Physical View   **Logical View**

Technical Specifications

SPECIFICATIONS	
Centralized service definition and endpoint management	■ Centralized service policy definition and auditing for all endpoints ■ Template-based service definition for intelligent endpoints ■ Root and organization level permission-based multitenant systems ■ Time-based automated endpoint configuration update ■ Centralized software lifecycle management ■ Auto-discovery of intelligent endpoints ■ Secure automated bootstrap of endpoints
OSS/BSS integration	Northbound API access through RESTful APIs for all VSD functions
Architecture scalability	■ Federated controller scale-out architecture based on MP-BGP ■ Routing engine powered by robust Alcatel-Lucent Service Router Operating System (SR OS)
Network services	■ Inet, L2-managed, L2-unmanaged, L3 and L4 VPN support ■ VLAN, VXLAN or MPLSoGRE encapsulation options ■ Ingress QoS with configurable rate limiting parameters and DSCP re-write options ■ Egress shaping for network and access ports with hierarchical QoS classes ■ DHCP services ■ Static routes ■ 1:1 Network Address Translation ■ IPv4 PAT on uplink IP or a configured IP from a PAT address pool ■ Automatic VPN creation between different entities belonging to a security domain ■ Hub-and-spoke or full mesh security through VXLANoIPSEC with centralized secure key generation and distribution* ■ Secure control plane connections ■ Service chaining to virtualized network functions ■ Application-aware traffic redirect capability ■ Full mesh, hub and spoke, and hybrid connectivity models ■ Control plane and data plane interoperability with provider edge devices
Authentication	■ LDAP integration for user authentication ■ Endpoint authentication through certificates
L2 – L4 security	■ Ingress and egress access control list (ACL) ■ Reflexive ACL with dynamic policy creation in both directions for UDP
Analytics and reporting	■ Fully programmable and extensible engine based on Hadoop clusters with real-time analytics support ■ TCA-based analysis engine with configurable collection timers ■ Drilldown capabilities into individual elements, ideal for troubleshooting and capacity planning based on historical event correlation ■ Encrypted channel for stats collection ■ Port mirroring to remote location ■ Export logs to external logging servers
Deployment models	■ Software image running on reference hardware ■ Software image deployed as virtual machine

* Roadmap

Alcatel-Lucent 7705 Service Aggregation Router

Release 7.0

The Alcatel-Lucent 7705 Service Aggregation Router (SAR) portfolio delivers industry-leading IP/MPLS and pseudowire capabilities in compact platforms that can reliably and securely aggregate multiple media, service and transport protocols on an economical packet transport infrastructure.
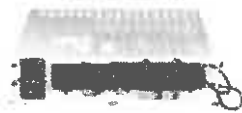
7705 SAR-18

7705 SAR-8

7705 SAR-X

7705 SAR-A

7705 SAR-M

7705 SAR-H

7705 SAR-Hc

7705 SAR-W

7705 SAR-Wx

The Alcatel-Lucent 7705 SAR portfolio provides multiservice adaptation, aggregation and routing on a modern Ethernet and IP/MPLS infrastructure. Leveraging the powerful Alcatel-Lucent Service Router Operating System (SR OS) and the 5620 Service Aware Manager (SAM), the 7705 SAR is available in compact, low-power-consumption, indoor and outdoor platforms that deliver highly available services and applications over flexible network topologies.

The Alcatel-Lucent 7705 SAR is well suited to the aggregation and backhaul of mobile traffic, including 2G, 3G, Long Term Evolution (LTE), LTE Advanced, Land Mobile Radio (LMR) and Private Mobile Radio (PMR). Its rich feature set facilitates fixed-mobile convergence, provides cost-effective scaling and supports the transformation to IP/MPLS networking. Business services modernization is supported in the transition from legacy networks to a consolidated, packet-based operation. Utilities, transportation and government/military applications benefit from the 7705 SAR's legacy service support, quality of service options, security and reliability. Significant reductions in equipment footprint are achievable, along with reduced energy costs.

Networking

The 7705 SAR is distinguished by its segment-leading scale. The IPv4 and IPv6 forwarding information base (FIB) scale, labeled number of Border Gateway Protocol (BGP) routes, the number of MPLS labels for tunnels and service scaling and their proportion to BGP peers are unmatched. This degree of scale gives network operators the highest potential to grow their networks, adding unprecedented numbers of end users and applications, without having to make additional capital investment.

A full suite of Layer 2 (L2) and Layer 3 (L3) routing and switching technologies are supported under virtual private network (VPN) or global routing table (GRT) including, but not limited to, the following.

- Extensive IP routing protocol support
  - Intermediate System-to-Intermediate System (IS-IS)
  - Open Shortest Path First (OSPF) and OSPFv3
  - Routing Information Protocol (RIP)
  - BGP with multiprotocol extensions
  - RFC 3107-labeled routes
- Multiprotocol Label Switching (MPLS) with 7705 SARs configurable as either Label Edge Routers (LERs) or Label Switching Routers (LSRs)
- Label Distribution Protocol (LDP)
- Resource Reservation Protocol – Traffic Engineering (RSVP-TE)
- Targeted LDP (T-LDP)
- Ethernet services including Ethernet LAN (E-LAN), Ethernet Private Line (EPL), Ethernet Virtual Private Line (EVPL) with null, dot1q and QinQ encapsulation
- TDM circuit emulation over a wide variety of physical (DS1/E1, DS3/E3) and channelized ports (OC-3/STM-1, etc.)
  - Structure Agnostic TDM over Packet (SAToP)
  - Circuit Emulation Service over Packet-Switched Network (CESoPSN)
  - MEF 8
- Interworking pseudowires with Frame Relay, High-Level Data Link Control (HDLC), Multi-Class Point-to-Point Protocol (PPP) (MCPPP), Multi-Link PPP (MLPPP) and Ethernet encapsulation
- ATM pseudowires with Inverse Multiplexing over ATM (IMA)
- Frame Relay pseudowires
- HDLC pseudowires
- Generic Routing Encapsulation (GRE)

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The 7705 SAR enables the use of residential-type internet access instead of a dedicated leased line service as an economical alternative for small cell backhaul applications. By using an IP unnumbered interface, the 7705 SAR is able to connect using the single IP address provided by the internet service provider (ISP). Dynamic Host Configuration Protocol (DHCP) support allows the 7705 SAR to accommodate IP address changes from the ISP. The 7705 SAR's robust security features ensure secure transport over the public internet.

Resiliency
The 7705 SAR provides excellent resiliency to link or equipment failures through redundancy and the ability to quickly reroute traffic. The chassis-based models have redundant control and switch fabric modules. Redundant power feeds and cooling fans are available in various models across the portfolio. Fanless and conformal-coated variants extend the 7705 SAR solution into even harsher environmental conditions. Further redundancy can be achieved using link redundancy via the Link Aggregation Group (LAG) protocol, primary and secondary Label Switched Paths (LSPs), redundant pseudowires and MPLS tunnels. Operators can also use load balancing across multiple uplinks via IP equal-cost multi-path (ECMP) routing with L3, L4 or even General Packet Radio Service (GPRS) Tunneling Protocol (GTP) tunnel endpoint identifier (TEID)-based hashing, and hybrid synchronization solutions where the master makes use of one technology but relays via another. All these techniques can be combined for a resilient end-to-end network offering.

In the event of a fault, the 7705 SAR delivers network reconvergence in tens of milliseconds using a strong suite of dynamic routing and recovery capabilities such as Fast Reroute (FRR) and BGP protocol independent convergence (PIC) by making use of techniques such as Constraint-based Shortest Path First (CSPF) routing and 10 ms Bidirectional Forwarding Detection (BFD).

Services
Because the 7705 SAR uses the same feature-rich SR OS software platform that is used across the entire Alcatel-Lucent IP service router portfolio, it supports a consistent feature set and operational model across the network from the access to the core. This simplifies service definition and implementation; definition and support of service level agreements (SLAs); operations, administration and maintenance (OAM); quality of service (QoS) implementation and fault management. With its unique architecture, the 7705 SAR's industry-leading routing performance is unaffected by additional service and management processing requirements.

The MEF 1.0- and 2.0-compliant 7705 SAR provides industry-standard Carrier Ethernet E-LAN, Ethernet Line (E-LINE), and Ethernet Tree (E-Tree) services for ease of network interoperability and lower operations costs.

It provides MPLS VPN services including pseudowires, L2 Virtual Private LAN Service (VPLS), and L3 Virtual Private Routed Network (VPRN) to separate traffic between different applications or organizations. GRE is also supported. Circuit emulation services including CESoPSN and SAToP ensure that all information required by a TDM circuit is maintained across the packet network. Transporting TDM traffic over native Ethernet services by means of MEF 8 is also supported.

These tunneling and emulation protocols facilitate the transport of legacy services over the packet network, allowing operators to realize savings from converging disparate legacy networks onto a single IP/MPLS infrastructure. They also provide the opportunity to derive new sources of revenue by offering their end users new services such as IP VPN and Internet Enhanced Services (IES).

Synchronization
To support mobile base station requirements and the migration of TDM-based services onto the packet network, accurate synchronization and microsecond timing is critical. The 7705 SAR portfolio supports external reference timing, line timing, adaptive clock recovery (ACR), differential clock recovery (DCR) timing, synchronous Ethernet, and timing distribution using IEEE 1588v2. The 1588v2 Master Clock and Boundary Clock functions are also supported. In addition, various models support transparent clock and time-of-day output. Several models have integrated Global Navigation Satellite System (GNSS) receiver capability. This can allow 1588v2 grandmasters to be enabled for frequency, phase and time distribution. The 7705 SAR-H also supports synchronization output according to IRIG-B (B000/B127).

Timing accuracy and performance over packet are enabled with a combination of built-in architectural features, Alcatel-Lucent Bell Labs algorithms and powerful QoS mechanisms, which minimize the delay and delay variation experienced by synchronization traffic. A built-in Stratum-3 clock is provided to assist with synchronization maintenance if a primary source is unavailable.

Quality of service and traffic management
SR OS software provides unmatched quality of service (QoS) on the 7705 SAR. The same level of industry-leading deep buffering and support for ingress and egress shaping that is available on Alcatel-Lucent's edge and core routing platforms is also available on the 7705 SAR low-cost aggregation platform. Consistency of traffic engineering and shaping across the network provides higher packet routing performance overall with differentiated service treatment to ensure timely delivery of high-priority and mission-critical data. This not only facilitates the convergence of multiple services over a single uplink but also allows for advanced service offerings, more efficient network resource usage, and increased end-user satisfaction.

To ensure fairness, the 7705 SAR's traffic management policies use detailed classification and hierarchical scheduling mechanisms including: minimum/maximum, queue type-based weighted round robin, and strict priority and profiled scheduling, as well as multi-tier policing to differentiate and prioritize individual services and flows. The 7705 SAR also allows individual services to burst up to line rate when aggregate bandwidth is available, while meeting the performance parameters, such as committed information rate (CIR), peak information rate (PIR), delay, jitter and packet loss, of each individual service.

Hierarchical quality of service (H-QoS) is implemented with two tiers of shaping, both at the forwarding class or class of service level and at the service access point (SAP) level, in addition to the shaping done at the port level on both ingress and egress ports.

Operations, administration and maintenance

To promote rapid deployment and high service availability, the Alcatel-Lucent 7705 SAR portfolio has a full set of operations, administration and maintenance (OAM) features including:

- LSP ping and traceroute
- LDP tree trace
- Virtual circuit connectivity verification (VCCV) ping and VCCV traceroute
- VPRN ping and VPRN traceroute
- Media Access Control (MAC) ping and MAC traceroute
- Customer premises equipment (CPE) ping
- Ethernet OAM functions, such as:
  - ¬ IEEE 802.3ah: Ethernet in the first mile
  - ¬ IEEE 802.1ag: Connectivity fault management
  - ¬ ITU-T Y.1731: Ethernet OAM mechanisms for fault and performance management
  - ¬ Note: ITU-T Y.1731 and IEEE 802.1ag facilitate in-service performance management (delay, jitter and packet loss, including ITU-T Synthetic Loss Measurement) and both one-way and round-trip fault management tests.
- IP OAM functions using Two-Way Active Measurement Protocol (TWAMP)
- ITU-T Y.1564 (RFC 2544) in-service throughput tests without user intervention for L2, L3 and L4 with configurable TCP/User Datagram Protocol (UDP) headers
- Per-port loopback with MAC swap
- Auto configuration (plug-and-play)

This robust feature set ensures rapid fault detection as well as efficient troubleshooting.

The 7705 SAR is managed by the Alcatel-Lucent 5620 Service Aware Manager (SAM) for assured, simplified and integrated operations across both network and service management domains. The 5620 SAM provides a powerful and common platform for managing IP/MPLS and Ethernet services from end to end. In particular, SLAs can be proactively monitored by the Service Aware Agent (SAA). For example, high-accuracy, one-way delay measurements can be used to closely assess ongoing network latency. This powerful SAA capability allows the specification of test suites, policies and schedules. The tests are then auto-created, and the test results are automatically compared to pre-defined SLA metrics. Any problems detected are automatically reported through the SAA to operations staff. An auto-discovery protocol (ADP) can provide rapid automated commissioning of remote devices. The 5620 SAM works in conjunction with additional tools such as the Control Plane Assurance Manager (CPAM) and the Reporting and Analysis Manager (RAM).

Security

The Alcatel-Lucent 7705 SAR portfolio incorporates security features to maintain network integrity in the face of cyber-attacks. Access control lists, filters and authentication of signaling messages provide mechanisms to protect management, control and data planes, helping to prevent session hijacking, spoofing, denial of service attacks and other malicious behaviors. Strong access security is provided by Simple Network Management Protocol (SNMP) v3 confidentiality, integrity features and Secure Shell (SSH) and IP Security (IPSec) encryption.

Network address translation (NAT) capabilities allow private networking schemes to be carried across a public infrastructure. IPSec on the Gigabit Ethernet adapter cards provides the ability to establish highly secure traffic streams. Stateful firewalls, IPSec and NAT functionality provide the flexibility to backhaul traffic over any media including the public Internet. MPLS-based network group encryption (NGE) provides efficient, scalable, resilient protection for any-to-any L2 and L3 services. NGE implementation for any size group is fast and simple using the 5620 SAM. The option to either encrypt IP traffic via IPSec or to encrypt service traffic (including native Ethernet traffic, IP VPN services or even TDM traffic) via NGE offers a comprehensive and unique vision to end-to-end security.

The above security features enable the 7705 SAR portfolio to be part of a North American Electric Reliability Corporation (NERC) Critical Infrastructure Protection (CIP) compliant network.

Diverse form factors and interfaces

For maximum deployment versatility, the Alcatel-Lucent 7705 SAR portfolio is packaged in a wide range of form factors to accommodate the density and types of services required at any location. It provides both indoor and outdoor mounting solutions combined with extended temperature range and power-over-Ethernet (PoE) options.

The 7705 SAR portfolio accommodates fiber, copper and microwave with support for the full range of legacy and new interfaces as listed in the tables below.

Features and benefits

FEATURES	BENEFITS
Extension of dynamic service routing IP/MPLS capabilities to remote sites, hubs, branch offices, and network edge in compact form factors with low power consumption	Modular, flexible architecture alleviates the burden of complex pre-engineering and future scenario planning. Compact, rugged form factors allow deployment in remote sites including outdoor installation.
Dense adaptation of multiple converged services onto an efficient, economical packet infrastructure with appropriate QoS treatment	Energy-efficient platforms carrying multiple traffic types reduce power and cooling costs. Powerful QoS improves the user experience.
Powerful, service-aware OAM capabilities, complemented by the Alcatel-Lucent 5620 SAM portfolio, for GUI-based network and element configuration, provisioning, and fault and performance management	Rapid fault detection and powerful commissioning and troubleshooting tools can improve operations staff's productivity and reduce network downtime, helping to reduce operations costs and improve end-user satisfaction.
Cost-effective migration from TDM-based backhaul to economical and flexible IP/MPLS-based aggregation and routing, leveraging a wide range of first-mile media	Transition from TDM-based connectivity to modern Ethernet and/or IP-based networking infrastructures can reduce recurring operating expenditures such as line lease costs.
Resiliency and redundancy, including hitless control and switch module failover (Alcatel-Lucent 7705 SAR-8 and 7705 SAR-18), synchronization redundancy, network uplink resiliency and redundancy of power feeds, plus temperature hardening (except Alcatel-Lucent 7705 SAR-18)	Advanced resiliency features can improve network uptime, enhancing customer retention and increasing revenues for critical services.
Breadth of synchronization solutions with flexible operation, redundancy and independent validation of accuracy	Accurate synchronization allows cost-effective deployment over packet infrastructure and improves the user experience (for example, less data loss and fewer dropped calls in mobile applications)..

Alcatel-Lucent 7750 Service Router
Release 13

The Alcatel-Lucent 7750 Service Router (SR) portfolio of multiservice edge routers is designed for the concurrent delivery of advanced residential, business and wireless broadband IP services on a common IP edge routing platform.

7750 SR-12e

7750 SR-12

7750 SR-7

7750 SR-a8

7750 SR-a4

7750 SR-c12

7750 SR-c4

The Alcatel-Lucent 7750 Service Router (SR) delivers the performance, service richness and intelligence to drive the converged IP network edge. Leveraging 400 Gb/s FP3 network processing (NP) silicon technology, the seven-variant portfolio scales capacity from 90 Gb/s to 9.6 Tb/s and delivers up to 36 x 100GE, 60 x 40GE and 360 GE ports.

With support for a comprehensive suite of Layer 2 and Layer 3 routing capabilities, advanced traffic management, Hierarchical Quality of Service (H-QoS) and specialized service-aware application processing, this feature-rich multiservice routing platform enables the full range of advanced business, residential and mobile services without sacrificing performance. It integrates IPv4/IPv6, MPLS, Ethernet, Provider Backbone Bridge (PBB), and MPLS - Transport Profile (MPLS-TP) protocols with a broad range of Ethernet and multiservice interfaces.

Alcatel-Lucent has expanded the 7750 SR portfolio with two new variants. Available in 200 Gb/s and 400 Gb/s variant options, the compact 7750 SR-a fits in a 300-millimeter cabinet and delivers high-density GE and 10GE interfaces, high performance 40GE and 100GE interfaces, and full system redundancy. For details, refer to the 7750 SR-a data sheet.

The comprehensive 7750 SR feature set enables the best-of-breed IP edge routing applications, which include:
- A Broadband Network Gateway (BNG) for residential subscriber management
- A multiservice edge router for business VPN, cloud and data center interconnect services
- An aggregation router for mobile backhaul
- A mobile packet core gateway (EPC SGW/PGW in LTE and GGSN in 2G/3G)
- A WLAN gateway for Wi-Fi* network aggregation
- A security gateway (SeGW) for macro, small cell and carrier Wi-Fi networks

Furthermore, the 7750 SR is Metro Ethernet Forum (MEF) Carrier Ethernet (CE) 2.0 certified, enabling the delivery of CE 2.0 certified services across all four MEF service types – E-LAN, E-Line, E-Tree and E-Access. The 7750 SR also simplifies the operations of a converged IP-optical network. It supports GMPLS User-Network Interface to enable dynamic provisioning of optical transport connections between the 7750 SR and optical network elements. It incorporates options for optical extension shelf capabilities, as well as cross-layer network visibility to facilitate optical integration.

Features

400 Gb/s FP3 silicon
At the heart of the 7750 SR is the Alcatel-Lucent award-winning FP NP silicon, which is an essential element in the quest for no compromise, high-speed, intelligent services that can adapt to evolving customer requirements. Alcatel-Lucent has a proven track record as an innovator and industry leader in network processor silicon technology. The Alcatel-Lucent third-generation FP3 is the world's first 400 Gb/s network processor that optimizes 10 Gb/s, 40 Gb/s, and 100 Gb/s networks and provides a clear path to 400 Gb/s networking. FP3 network processors enable line interfaces to scale to 100 Gb/s and beyond, while concurrently supporting deterministic, processing-intensive edge routing and mobile gateway services without performance impact.

Proven, highly resilient operating system
The Alcatel-Lucent Service Router Operating System (SR OS) is a carrier-grade, highly fault-tolerant and feature-rich operating system that operates across the entire Alcatel-Lucent Service Router portfolio. With a single operating system across all platforms, operators can be assured of consistent and reliable operations and management when deploying Ethernet (VLL, VPLS), IP/MPLS (IP VPN), legacy (ATM, TDM, POS), and/or mobile services and applications on an Alcatel-Lucent service router network.

Defining High availability
High availability is more than just redundant hardware. In addition to redundant common equipment and line card redundancy, the SR OS supports numerous features that minimize service disruption. These features include non-stop routing, non-stop services, stateful failover, in-service software upgrades (ISSUs), fast reroute, pseudowire redundancy and innovative multi-chassis resiliency. To facilitate IP-optical integration, the 7750 SR incorporates options for OES capabilities, as well as cross-layer network visibility and wavelength tracking. Further, the 7750 SR supports service assurance and monitoring tools across IP, MPLS and Ethernet domains.

Alcatel·Lucent

Advanced Hierarchical QoS

With today's IP traffic streams, including a range of services consisting of video applications, voice, best-effort Internet access, and mission-critical business services, QoS becomes a critical element for delivering both best-effort and service level agreement (SLA)-based services on a common platform. The Alcatel-Lucent 7750 SR sets the standard with its advanced and highly flexible Hierarchical QoS (H-QoS) implementation with hardware support for multi-tiered shaping and policing hierarchies. Designed as a service delivery platform, the 7750 SR provides the tools to define and deliver the most stringent SLAs for high value, differentiated services.

Integrated service intelligence

To further differentiate services, the Alcatel-Lucent Multiservice Integrated Service Module (MS-ISM) and Multiservice Integrated Service Adapter (MS-ISA) leverage embedded subscriber, service and application intelligence to enable advanced applications and services. With the MS-ISM and MS-ISA, operators can quickly introduce high-touch packet operations for deeper levels of integrated service capabilities to support multiple advanced applications and services wherever a 7750 SR is located. Compared to dedicated network elements, the MS-ISM and MS-ISA provide tighter management integration, higher performance and scale, and consume less energy. Applications supported include Application Assured VPN services, mobile security gateway, WLAN Gateway, L2TP Network Server (LNS), Network Address Translation (NAT), Dual-Stack Lite AFTR services, IPSec services and advanced video services.

Service-aware management

The 7750 SR family is managed by the Alcatel-Lucent 5620 Service Aware Manager (SAM) for assured, simplified, and integrated operations across both network and service management domains. The Alcatel-Lucent 5620 SAM is designed to manage services and provide service-level visibility into the network for small- and large-scale service deployments. The Alcatel-Lucent management offering includes additional tools such as the Alcatel-Lucent 5650 Control Plane Assurance Manager (CPAM) and the Alcatel-Lucent 5670 Reporting and Analysis Manager (RAM), which work in conjunction with the 5620 SAM.

Benefits

Innovative, differentiated services

Support for advanced applications and services allows service providers to capitalize on information embedded in the network and distinguish services. Leveraging this intelligence enables lifestyle-centric consumer service packages, provides enterprises with more visibility on applications running on their networks and protects customers from security and Internet threats. Subscriber, service and application awareness can be used to provide differential QoS treatment of higher value traffic streams and manage the online experience. Guaranteeing a superior quality of experience (QoE) for certain applications and metering them separately for billing permit tiered pricing for different levels of service.

Reduced operational costs

By combining services on a 7750 SR-based converged provider edge, network operations are simplified because all services run over platform with a consistent feature set, operational model and management. As legacy services are migrated to converged service networks, the legacy networks that carried the service can be decommissioned, further simplifying overall network operations and expenditure. In addition, the 7750 SR has numerous features for automated provisioning of subscribers and services based on service templates and interacting with other operational systems for authentication, authorization, and billing, which all but eliminates the need for individual, manual service provisioning.

Investment protection

From its introduction, the 7750 SR portfolio has evolved with customer feature and scaling requirements. FP NP silicon technology ensures 7750 SR platform capacity and service scale can continually evolve in step with customer requirements, while maximizing investment protection.

Environmentally friendly

Pioneering advances in power efficiency are incorporated into each member of the Alcatel-Lucent 7750 SR portfolio, reducing the expense of both powering and cooling when comparing products with less advanced silicon technology. Combined with environmentally sensitive manufacturing processes, careful materials selection and a view to sustainable product life cycle management, the 7750 SR portfolio assists service providers in reducing their environmental impact.

Hardware overview

The Alcatel-Lucent 7750 SR supports the following hardware and media modules:

- **Switch Fabric Module (SFM5-12e)** – The SFM5-12e enables 400 Gb/s line rate connectivity between all slots of the 7750 SR-12e chassis. The fabric cards are 3+1 redundant with active-active loadsharing design. The SFM5-12e is a full-height card that is modular in design and houses the pluggable CPM5 for investment protection.

- **Switch Fabric Module (SFM5-7, SFM5-12)** – The SFM5-7 and SFM5-12 enable 200 Gb/s (redundant) line rate connectivity between all slots of the 7750 SR-7 and SR-12 chassis. The fabric cards are 1+1 redundant with active-active loadsharing design. The SFM-7 and SFM5-12 are full-height cards that are modular in design and house the pluggable CPM5 for investment protection.

- **Control Processor Module (CPM5)** – The CPM5 is a pluggable module housed within the SFM5-12e, SFM5-12 and SFM5-7. The CPM5 provides the management, security and control plane processing for the Alcatel-Lucent 7750 SR-12e, SR-12 and SR-7. Redundant CPMs operate in a hitless, stateful, failover mode. Central processing and memory are intentionally separated from the forwarding function on the interface modules to ensure utmost system resiliency.

- **Switch Fabric/Control Processor Module (SF/CPM)** – The SF/CPM provides data plane and control plane functionality in a full-height module. The SF/CPM is 1+1 redundant with an active-active loadsharing design and is housed in an SR-12e, SR-12 and SR-7. Redundant SF/CPMs operate in a hitless, stateful, failover mode. Central processing and memory are intentionally separated from the forwarding function on the interface modules to ensure utmost system resiliency.

- **Input/Output Modules (IOMs)** – IOMs are supported on the 7750 SR-12e, SR-12 and SR-7 and are optimized for flexibility in deploying a variety of mobile, multiservice and Ethernet-based applications. Each IOM supports up to two MDAs and can also be used to house Integrated Service Adapters.

- **Media Dependent Adapters (MDAs)** – MDAs provide modular physical interface connectivity and are available in a variety of interface and density configurations.

- **Compact Media Adapters (CMAs)** – CMAs are interface adapters supporting lower speed services and port densities. CMAs are supported on the 7750 SR-c12 and SR-c4 platforms.

- **Integrated Media Modules (IMMs)** – IMMs are line cards providing integrated processing and physical interfaces on a single board. IMMs provide high-capacity Ethernet interfaces, including variants with integrated tunable DWDM optics and are supported on the 7750 SR-12e, SR-12 and SR-7 platforms.

- **Multiservice Integrated Service Modules (MS-ISMs)** – MS-ISMs are full-height resource modules that provide specialized processing and buffering for advanced applications. They are supported on the SR-12e, SR-12 and SR-7 variants.

- **Multiservice Integrated Service Adapters (MS-ISAs)** – MS-ISAs are resource adapters that provide specialized processing and buffering for advanced applications and are supported on all platforms.

- **Mobile Gateway Integrated Service Modules (MG-ISMs)** – MG-ISMs are full-height modules that fit into any 7750 SR Input/Output (I/O) slot to provide the SGW or PGW functionality for LTE or GGSN functionality for 2G/3G.

Table 1. Technical specifications for the Alcatel-Lucent 7750 SR portfolio*

	7750 SR-c4	7750 SR-c12	7750 SR-7	7750 SR-12	7750 SR-12e
System throughput	• Integrated 90 Gb/s • switch fabric (half duplex)	• Redundant CFM-XP switch fabric • 90 Gb/s (half duplex) with 1+1 redundancy	• Switching capacity: 2 Tb/s (half duplex, redundant) • Per-slot throughput: 200 Gb/s (full duplex, redundant)	• Switching capacity: 4 Tb/s (half duplex, redundant) • Per-slot throughput: 200 Gb/s (full duplex, redundant)	• Switching capacity: 9.6 Tb/s (half duplex, non-redundant) or 7.2 Tb/s (half duplex, redundant) • Per-slot throughput: 400 Gb/s (full duplex, redundant)
Built-in network interfaces	• 2 x 10GBASE (LAN/WAN PHY) XFP • 10/100BASE Management Ethernet RJ-45	• 10/100BASE Management Ethernet RJ-45	–	–	–
Number of MDAs per chassis	2	6	10	20	18
Number of CMAs per chassis	4	8 (plus 2 MDAs)	–	–	–
Number of IOMs/IMMs/ISMs per chassis	–	–	5	10	9
Common equipment redundancy	• Power entry modules (PEMs), fans	• CFM-XP, PEMs, fans	• SFM5-7, CPM5, SF/CPM, PEMs, fans	• SFM5-12, CPM5, SF/CPM, PEMs, fans	• SFM5-12e, CPM5, SF/CPM, Mini-SFM, advanced power equalizers (APEQs), fans
Hot-swappable modules	• MCM-XPs, MDAs, ISAs, CMAs, PEMs, fans	• CFM-XP, MCM-XPs, MDAs, ISAs, CMAs, PEMs, fans	• SFM5-7, CPM5, SF/CPM, IOMs, MDAs, IMMs, ISMs, ISAs, VSMs, EFTs	• SFM5-12, CPM5, SF/CPM, IOMs, IMMs, ISMs, MDAs, ISAs, PEMs, VSMs, EFTs	• SFM5-12e, CPM5, SFM/CPM-12e, Mini-SFM-12e, IOMs, MDAs, IMMs, ISMs, ISAs, VSMs, APEQs, EFTs
Dimensions**	• Height: 13.8 cm (5.4 in), 3 RU • Width: 44.5 cm (17.5 in) • Depth: 47 cm (18.5 in)	• Height: 22.2 cm (8.8 in), 5 RU • Width: 44.5 cm (17.5 in) • Depth (with cable management): 60 cm (23.6 in)	• Height: 35.6 cm (14 in), 8 RU • Width: 44.5 cm (17.5 in) • Depth: 64.8 cm (25.5 in)	• Height: 62.2 cm (24.5 in), 14 RU • Width: 44.5 cm (17.5 in) • Depth (without cable management): 64.5 cm (25.4 in) • Depth (with cable management): 76.5 cm (30.1 in)	• Height: 97.8 cm (38.5 in), 22 RU • Width: 44.5 cm (17.5 in) • Depth: 76.2 cm (30 in)
Weight**	• Empty: 13.6 kg (30 lb) • Loaded: 21.8 kg (48 lb)	• Empty: 16.5 kg (36.4 lb) • Loaded: 45.4 kg (100 lb)	• Empty: 41 kg (90.4 lb) chassis weight with factory installed fan tray and air filter • Loaded: 70.5 kg (155.4 lb)	• Empty: 56.4 kg (124.3 lb) • Loaded: 155.7 kg (343.3 lb)	• Empty: 79.4 kg (175 lb) • Loaded: 249.5 kg (550 lb)
Power	DC power: • Voltage: -40 V DC to -60 V DC • Current: 9 A to 14 A • 1+1 redundancy AC power: • Input voltage: 110 V AC to 240 V AC • Current: 2.3 A to 5.5 A • 50 Hz to 60 Hz	DC power: • Voltage: -40 V DC to -60 V DC • Current: 22 A to 28 A • 1+1 redundancy AC power: • Input voltage: 220 V AC to 240 V AC • Current: 6 A • 50 Hz to 60 Hz	DC power: • Voltage: -40 V DC to -72 V DC • Current: 52 A to 93 A • 1+1 redundancy External AC power (option): • Input voltage: 200 V AC to 240 V AC • Output voltage: 42 V DC to 56 V DC • Current: 50 A	DC power: • Voltage: -40 V DC to -72 V DC • Current: 90 A to 162 A • 1+1 redundancy External AC power (option): • Input voltage: 200 V AC to 240 V AC • Output voltage: 42 V DC to 56 V DC • Current: 50 A	DC power: • Voltage: -40 V DC to -72 V DC • Current: 60 A max • 4+1 redundancy External AC power (option): • Input voltage: 200 V AC to 240 V AC • Output voltage: 42 V DC to 56 V DC • Current: 50 A
Cooling	Side-to-side air flow	Side-to-side air flow	Side-to-back air flow	Front-to-back air flow	Front-to-back air flow

* For details on the Alcatel-Lucent 7750 SR-a4 and Alcatel-Lucent 7750 SR-a8, refer to the Alcatel-Lucent 7750 SR-a data sheet.

** Dimensions and weights are approximate and subject to change. Refer to the appropriate Installation Guide for the current dimensions and weights.

Table 2. Alcatel-Lucent 7750 SR IMM support by chassis type

IMM TYPE	PORTS PER IMM	CONNECTOR TYPE	SR-7	SR-12	SR-12e
100GBASE	4	CXP and CFP4	–	–	√
100GBASE	1, 2	CFP	√	√	√
100GBASE/10GBASE	1/10	CFP/SFP+	√	√	√
100GBASE + 7x50 ISA2	1	CFP	√	√	√
100GBASE IMM (DWDM tunable optics)	1	LC	√	√	√
40GBASE	3, 6	QSFP+	√	√	– / √
40GBASE/100/1000BASE	3/20	QSFP+/SFP	√	√	√
10GBASE	40	SFP+	–	–	√
10GBASE/100/1000BASE	10/20	SFP+/SFP	√	√	√
10GBASE + 7x50 ISA2	10	SFP+	√	√	√
10GBASE	12, 20	SFP+	√	√	√
10GBASE	5, 8	XFP	√	√	√ / –
10/100/1000BASE	48	SFP	√	√	√
10/100/1000BASE-TX	48	RJ-45	√	√	√

Table 3. Alcatel-Lucent 7750 SR MDA types and support by chassis type

MDA TYPE	PORTS PER MDA	CONNECTOR TYPE	SR-c4	SR-c12	SR-7	SR-12	SR-12e
Ethernet MDA-e							
10GBASE	10	SFP+	–	–	√	√	√
100GBASE	1	CFP2	–	–	√	√	√
Ethernet MDA-XP							
1000BASE	10/12/20	SFP	√ / – / √	√ / – / √	√	√	√
10/100/1000BASE-TX	20	RJ-45	√	√	√	√	√
10/100/1000BASE-TX	48	6 x mini RJ-21	–	–	√	√	√
10GBASE/1000BASE (LAN/WAN PHY)	2+12	XFP/SFP	–	–	√	√	√
10GBASE (LAN/WAN PHY)	1/2/4	XFP	√ / √ / –	√ / √ / –	√	√	√
High-Scale MDA							
1000BASE	10	SFP	–	–	√	√	√
10GBASE	1	XFP	–	–	√	√	√
SDH/SONET MDA-XP							
OC-192c/STM-64c	2	XFP	–	–	√	√	√
SDH/SONET MDA							
OC-3c/STM-1c/OC-12c/STM-4c (Multirate)	16	SFP	√	√	√	√	√
OC-48c/STM-16c	4	SFP	√	√	√	√	√
Any Service Any Port (ASAP) MDA							
Channelized DS3/E3 ASAP	4/12	1.0/2.3 connectors	√	√*	√	√	√
Channelized OC-3/STM-1 ASAP	4	SFP	√	√*	√	√	√
Channelized OC-12/STM-4 ASAP	1	SFP	√	√*	√	√	√
Asynchronous Transfer Mode (ATM) MDA							
ATM OC-3c/STM-1c/OC-12c/STM-4c (Multirate)	4	SFP	√	√*	√	√	√
ATM OC-3c/STM-1c	16	SFP	–	–	√	√	√
Other							
Versatile Service Module-XP	N/A	N/A	–	–	√	√	√

* A limit of two MDAs of type ASAP or ATM is supported in the 7750 SR-c12.

Table 4. Alcatel-Lucent 7750 SR CMA support by chassis type

CMA TYPE	PORTS PER CMA	CONNECTOR TYPE	SR-c4	SR-c12
1000BASE	1/5	SFP	√	√
DS3/E3	4	1.0/2.3 connectors	√	√
10/100BASE-TX	8	RJ-45	√	√
1000BASE	1	SFP	√	√
Channelized OC-3/STM-1 CES	1	SFP	√	√
OC-3c/STM-1c/OC-12c/STM-4c (Multirate)	2	SFP	√	√

Table 5. Alcatel-Lucent 7750 SR MS-ISA and MS-ISM support by chassis type

ISA/ISM TYPE	SR-c4	SR-c12	SR-7	SR-12	SR-12e
Multiservice Integrated Service Adapter (MS-ISA)*	√	√	√	√	√
Multiservice Integrated Service Module (MS-ISM)*	–	–	√	√	√
Mobile Gateway-Integrated Service Module (MG-ISM)**	–	–	√	√	–

* Consult the MS-ISM and MS-ISA data sheet for details
** Consult the MG-ISM data sheet for details. Support requires MG-SR-OS.

Technical specifications

Environmental specifications

- Operating temperature: 5°C to 40°C (41°F to 104°F)
- Operating relative humidity: 5% to 85%
- Operating altitude: Up to 4000 m (13,123 ft) at 30°C (86°F)

Safety standards and compliance agency certifications

Safety
- EN 60950-1 2nd Ed CE Mark
- IEC 60950-1 2nd Ed CB Scheme
- CSA/UL 60950-1 2nd Ed NRTL
- FDA CDRH 21-CFR 1040
- IEC/EN 60825-1
- IEC/EN 60825-2

EMC emission
- ICES-003 Class A
- FCC Part 15 Class A
- EN 55022 Class A
- CISPR 22 Class A
- AS/NZS CISPR 22
- VCCI Class A
- BSMI Class A
- IEC/EN 61000-3-2 Power Line Harmonics
- IEC/EN 61000-3-3 Voltage Fluctuations and Flicker

EMC immunity
- EN 300 386
- EN 55024
- IEC/EN 61000-4-2 ESD
- IEC/EN 61000-4-3 Radiated Immunity
- IEC/EN 61000-4-4 EFT
- IEC/EN 61000-4-5 Surge
- IEC/EN 61000-4-6 Conducted Immunity
- IEC/EN 61000-4-8 Magnetic Immunity
- IEC/EN 61000-4-11 Voltage Interruptions

Telecom
- Telcordia GR-253-CORE
- IEEE 802.3 (Gigabit Ethernet, Ethernet)
- ANSI T1.105.03
- ANSI T1.105.06
- ANSI T1.105.09
- ANSI T1.403 (DS1)
- ANSI T1.404 (DS3)
- ITU-T G.957
- ITU-T G.825
- ITU-T G.824
- ITU-T G.823
- ITU-T G.813
- ITU-T G.707
- ITU-T G.703

Environmental
- ETS 300 019-1-1 Storage Tests, Class 1.2
- ETS 300 019-1-2 Transportation Tests, Class 2.3
- ETS 300 019-1-3 Operational Tests, Class 3.2
- ETS 300 019-2-4, pr A 1 Seismic
- ETSI EN 300 753 Acoustic
- ETSI EN 300 132-2 Power Supply Interface
- WEEE
- RoHS
- China RoHS

Network Equipment Building System (NEBS)
- NEBS Level 3 compliant
  - Telcordia GR-1089-CORE
  - Telcordia GR-295-CORE
  - Telcordia GR-63-CORE
- RBOC requirements
  - ATT-TP-76200
  - ATT-TP-76200 section 13, TEER per ATIS-0600015.02
  - VZ.TPR.9205 TEER per ATIS-0600015.02
  - VZ.TPR.9305

MEF Certifications
- CE 2.0
  - Certified (across all four MEF service types - E-LAN, E-Line, E-Tree and E-Access)
- CE 1.0 (MEF 9 and MEF 14)
  - Certified

Alcatel·Lucent

ALCATEL-LUCENT 5620 SERVICE AWARE MANAGER
RELEASE 12

The Alcatel-Lucent 5620 Service Aware Manager (SAM) takes service providers well beyond the traditional boundaries of element, network and service management. The 5620 SAM enables end-to-end management of the all-IP network to help service providers quickly gain the efficiencies they need to beat the competition.

The 5620 SAM maximizes operational efficiency network-wide across the domains of Alcatel-Lucent IP and IP-integrated optical networks from access to metro to core – and in wireless LTE networks from RAN to backhaul to packet core. Fast and easy provisioning reduces time to market and increases flexibility when launching new services. Proactive troubleshooting helps resolve problems before they affect customers, and ease of integration within the existing operational environment helps service providers get the most from their investments.

Network management and Operations Support System (OSS) mediation capabilities provided by the 5620 SAM can be categorized into the following focus areas: Infrastructure Management, Infrastructure Assurance, Service Management and Service Assurance.

Tightly integrated within the 5620 SAM, the **Alcatel-Lucent 5650 Control Plane Assurance Manager (CPAM)** enables proactive assurance by delivering unprecedented visibility into the dynamic multivendor IP/MPLS routing plane and services. Augmenting the 5620 SAM with **custom service portals** and **pre-certified OSS partner application integrations** speeds deployment and further enhances the fit into even the most complex networks.

Independently proven to deliver quick and continuing return on investment, the 5620 SAM is deployed in the networks of more than 600 service providers, including some of the world's largest and most advanced networks for mobile, residential, enterprise and converged services.

DELIVERING UNMATCHED OPERATIONAL EFFICIENCY
END TO END ACROSS THE ALL-IP NETWORK

5620 SERVICE AWARE MANAGER

FEATURES	BENEFITS
Easy-to-use GUI and templates accelerate maintenance tasks	Minimized time and costs associated with the errors that commonly occur when a command-line interface (CLI) is used
Deployment automation for network upgrades, configuration, provisioning and performance validation through flexible scripting options and rules-based triggers	Rapid introduction of new services and technologies that meet SLAs
Common provisioning for different service types [Layer 2 and Carrier Ethernet, WDM and optical transport network (OTN), Layer 3 MPLS VPNs and MPLS-TE]	Reduced cost of delivering multi-technology composite services by minimizing the risk of misconfigurations
Efficient collection of network statistics, OA&M diagnostics and state KPIs for service level agreement (SLA) monitoring, including at-a-glance dashboards	Proactive prevention of potential service-affecting problems before they impact customers
Powerful fault correlation and advanced troubleshooting visualization that help to quickly pinpoint the root cause of problems to speed resolution	Simplified problem isolation to quickly understand services-impact, diagnose problems and resolve them
Open interfaces that enable integration with custom web portals, OSSs and Business Support Systems (BSSs)	Increased productivity and flexibility with a management solution that easily adapts to allow cost-effective integration into the existing operational environment, enhancing workflows and processes

INFRASTRUCTURE MANAGEMENT

Alcatel-Lucent 5620 SAM network infrastructure management provides base FCAPS management with many advanced extensions. It accelerates configuration of network infrastructure by providing easy-to-use forms, as well as scripting to automate parameter configuration. External systems are able to access infrastructure management functionality through an open OSS interface. (See Table 1 for feature summary.)

More efficiency through service-aware model

The 5620 SAM service-aware management model maps relationships between services to network infrastructure across the multiple underlying technology layers of the all-IP network that services delivery depends on. This model enables many infrastructure management tasks to be performed more efficiently. For example, infrastructure provisioning, maintenance and audits can be performed in bulk across a multitude of network elements. In addition, the model delivers an effective top-down approach to troubleshooting, which enables more rapid problem isolation to pin-point issues before they impact services.

Automated deployment and management

The advanced 5620 SAM scripting framework enables programmatic control to automate deployment of infrastructure, significantly reducing misconfigurations so services can be delivered faster and more reliably. Automation eliminates the need to individually configure each device in the service path – including everything from network and quality of service (QoS) policy configuration, to device operating system upgrades and provisioning for even the most complex end-to-end services spanning multiple technology domains.

After deployment, automated setup of comprehensive OA&M diagnostics suites can be used to valid that performance requirements and SLAs are met. For ongoing day-to-day operations, network auditing and reporting as well as bulk maintenance changes can also be automated. Scripts can be triggered by events (for example, after the discovery of a network element), scheduled or run on-demand. Control scripts can also use rules-driven logic to run other scripts.

OSS integrations may maximize efficiency by triggering 5620 SAM scripts for pre-processing. External applications listening to events through the 5620 SAM OSS interface may trigger scripts based on events. (See Figure 1.)
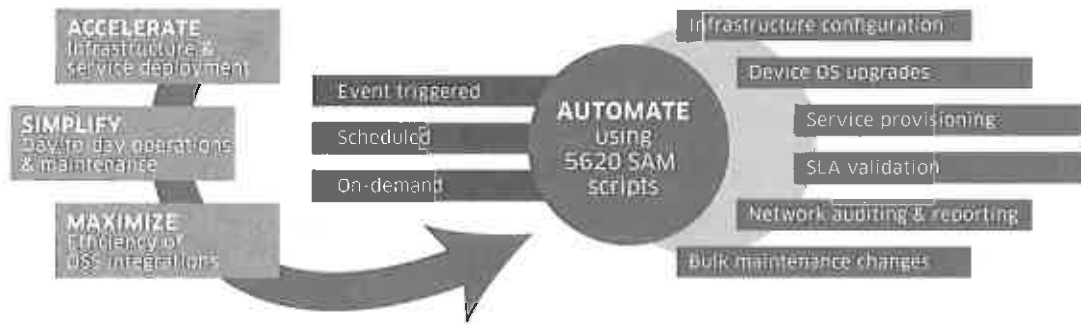
Figure 1. Automation through 5620 SAM scripts

Table 1. Alcatel-Lucent 5620 SAM network infrastructure deployment, maintenance and management feature summary

CATEGORY	FEATURES
Network discovery and inventory	• Subnet-based auto-discovery of in-band and out-of-band network elements • Real-time synchronization with network element changes • Configurable MIB polling policies and schedules – for accounting statistics or OA&M tests, for example • Highly scalable alarm and SNMP statistics collection • Network inventory hierarchy views and equipment views
Configuration and maintenance	• GUI-based configuration with concurrent, multiple object editing • Step-by-step form entry to simplify complex tasks and user-entry fields to add additional guidance • Device configuration, including for physical and logical resources, buffers, queuing and QoS marking/forwarding • Routing domain management including Interior Gateway Protocol (IGP) and Border Gateway Protocol (BGP) • Automated setup for IEEE 802.1ag/ITU-T Y.1731 standards-based Ethernet OA&M and MEF 35 service OA&M performance monitoring • Rules-based backup, restore, upgrade of device software • Network configuration and policy audits to detect differences from a golden or device-specific configuration • Script management with control script logic-driven workflow execution • GUI builder to design customized forms and selection menus to set parameters for scripts
Infrastructure provisioning	• Rules-based bulk parameter configuration and auto-creation of objects, such as tunnels • Network service distribution point (SDP) provisioning • MPLS label-switched path (LSP) provisioning with automatic bidirectional, meshed SDP binding creation during service creation • Post-discovery control scripts to automate deployment and management for any managed devices. (See Figure 1.) • Third-party device provisioning using CLI scripts with security and version control
OSS interface	• Open north-bound interface enables external applications to integrate with full access to 5620 SAM managed infrastructure data

INFRASTRUCTURE ASSURANCE

Alcatel-Lucent 5620 SAM network infrastructure assurance provides comprehensive physical and logical network topology views, as well as infrastructure fault correlation, alarm management, OA&M test-suites and integrated route analytics. (See Table 2 for feature summary.)

View of all physical, routing, MPLS, service infrastructure layers

A variety of views and icon status indicators help to quickly diagnose and resolve service-affecting problems, from simple to complex. Service tunnel and physical topology maps allow visualization of all network resources. The integrated 5650 CPAM enables visualization and highlighting of Layer 2 and Layer 3 services on an IGP topology.

Advanced troubleshooting

Enabled by a sophisticated correlation and rules engine, advanced fault management visualization allows better sight into the magnitude and impact of faults within massive volumes of assurance data to help eliminate manual troubleshooting.

At-a-glance, network-wide distribution views, grouping correlated alarms to independent problems, help to determine which fault to investigate first by giving an understanding of which problems have the largest magnitude of impact. Problems can easily be isolated through clear views that show the root-cause of a fault, including an impact tree of correlated faults.

Fault impact network hierarchy views give an understanding of affected infrastructure, and provide simple, more efficient cross-navigation workflows to configuration forms to accelerate problem resolution.

(See Figure 2.)

**Figure 2. Advanced fault management visualization**
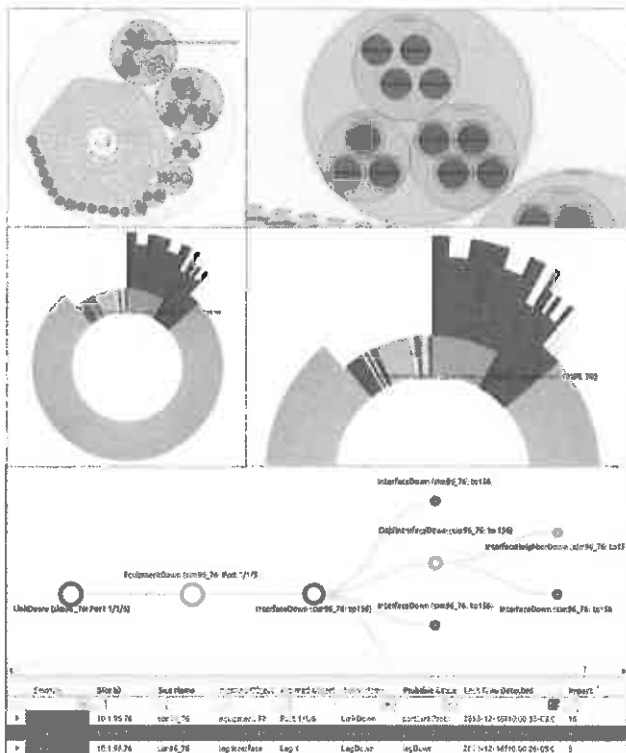
Health and performance supervision

Highly scalable collection of real-time and historical statistics (such as for equipment and interfaces) provides comprehensive information needed to detect and troubleshoot performance issues.

OA&M test suites can be scheduled and compared to configurable parameters – such as jitter, delay and packet-loss metrics – to proactively detect network and service degradation. Rules-based alarm notifications, such as threshold-crossing alerts and escalating test failure alerts, further automate assurance and adherence to SLAs.

Infrastructure-specific fault summary views and supervision dashboards enable operators to see fault trends, KPIs and other summary health indicators that enable proactive monitoring at-a-glance. (See Figure 3.)

Figure 3. Infrastructure health and performance supervision
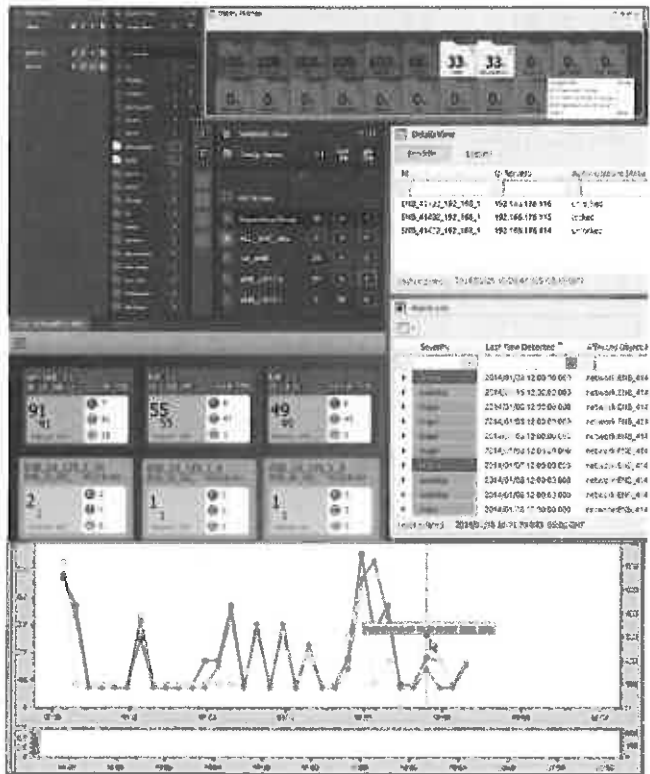
Power management dashboards for specific device types provide summary views into power consumption totals and utilization trends for individual network elements or zones.

Custom applications for SLA reporting

Alcatel-Lucent network management services offer turn-key development of custom 5620 SAM web apps, such as for SLA reporting. Based on the 5620 SAM web apps framework, custom apps can be developed quickly and cost effectively to address specific process and workflow requirements, resulting in more operational flexibility.

Network auditing

Automate network auditing and perform mass validation of configuration and policies distributed across many network elements against a common "golden" configuration or policy. Use managed CLI scripting to compare configuration on third-party devices. For example, comparison tools may be used after changing device OS release versions to ensure that the previous configuration remains the same.

Alcatel-Lucent network management services also offer custom scripting development and expert hands-on training on 5620 SAM scripting.

Table 2. Alcatel-Lucent 5620 SAM network infrastructure assurance feature summary

CATEGORY	FEATURES
Topology maps	• Physical topologies that support IEEE 802.1ab link adjacencies • IGP/BGP routing, MPLS, and multicast topologies through integrated 5650 CPAM • Topology overlays provide fault status and additional troubleshooting information, such as port and link utilization statistics, or OA&M test results with trace highlighting after point-and-click execution from a map
Alarm lists	• Multiple instances of alarm windows with custom filters • Direct navigation from alarms to affected and related objects • Extensive alarm filtering and search capabilities (including advanced logical constraint-based filtering through web GUI) • Customizable alarm information fields, including user-entry text fields • Flexible definition of rules for fault escalation, de-escalation and severity assignment
Advanced fault management visualization	• At-a-glance fault summary dashboards to view top unhealthy network elements with status KPIs and drill down to detailed alarms • Advanced fault visualization delivers an understanding of which faults to investigate first • Alarm correlation through rules engine to identify root cause of problem from symptoms • Network-wide distribution views grouping correlated alarms make magnitude of problem impact clear • Root-cause alarm impact tree visualization to easily navigate to root-cause or related alarms in tree • Top problem views enable a quick view of problem volume distribution based on alarm type • Network element investigation views allow easy access to device-specific configuration and alarm details • Network infrastructure hierarchy visualization for fault impact also provides cross-navigation to forms for further investigation • Web-based GUI for wider accessibility
Accounting and performance statistics collection	• Distributed, load-balanced statistics collection for accounting and performance data • Real-time and historical statistics retention and graphing

Infrastructure health and performance supervision	• Real-time and historical statistics to detect and troubleshoot performance issues
	• On-demand OA&M test tools to gain performance metrics such as latency, delay and packet loss
	• Proactive assurance with scheduled OA&M test suites to continually assess performance across various technology layers
	• Automatically generated OA&M tests based on object or topology changes
	• Set threshold-crossing alerts for specific KPIs to notify operators immediately of emerging issues
	• Web-based domain-specific dashboards to summarize network health at-a-glance:
	  ¬ Infrastructure supervision with network element health status and KPIs
	  ¬ Power consumption totals and utilization trends per network element or zone
	• Custom 5620 SAM web applications for SLA reporting developed by Alcatel-Lucent network management services

Network management integrated route analytics (5650 CPAM)	• Multivendor control plane visualization to detect and rapidly resolve routing issues • Tracking of changes from baseline configuration and topologies to current state • Auditing of IP/MPLS configuration and routing policy deviations from saved snapshot points • Path and prefix health and troubleshooting views • Auto-triggered OA&M testing and alarms on routing changes • Offline simulation tools to reduce risk of unexpected routing behavior after planned network updates • Management and troubleshooting for multicast and 1588v2 PTP synchronization
OSS interface	• Open north-bound interface enables external applications to integrate with full access to 5620 SAM alarm, statistics and OA&M data

Assurance and management of third-party devices

5620 SAM Generic Network Element (GNE) support enables integration and discovery of third-party equipment for topology display, alarm surveillance (with MIB trap-to-alarm mapping), and statistics collection (interface MIB). Third-party support is also enabled for configuration and script management with deployment audits and validation.

The Alcatel-Lucent 5650 CPAM provides multivendor route analytics that inherently supports third-party IP routing devices.

Route analytics

The Alcatel-Lucent 5650 CPAM is tightly integrated within the Alcatel-Lucent 5620 SAM to deliver a seamless multivendor route and path analytics within the Alcatel-Lucent Service Aware Management assurance offering. Together, they help to proactively assure the network and isolate potential problems before they affect services. The 5650 CPAM provides simplified control plane management through its real-time and historical visualization, troubleshooting, and analysis. With 5650 CPAM unprecedented end-to-end IP/MPLS infrastructure visibility and analysis enable an understanding of how the control plane topology and protocol changes impact IP routing, MPLS paths, service infrastructure and services. (For examples of 5620 SAM integrated route analytics, see Figure 4.)

The 5650 CPAM provides health monitoring for IGP (OSPF and IS-IS) and MPLS paths as well as BGP and IP-VPN prefixes that tracks change history, event statistics and reporting for impact analysis. It also automates path and service tunnel OA&M testing on IP or MPLS path changes to alert operators when performance issues emerge after re-routes occur. Protocol configuration audits combine IP/MPLS protocol configuration data from the 5620 SAM with 5650 CPAM change history tracking information to enable detection of misconfigurations. Offline simulation tools

Figure 4. Control plane assurance with the 5650 CPAM
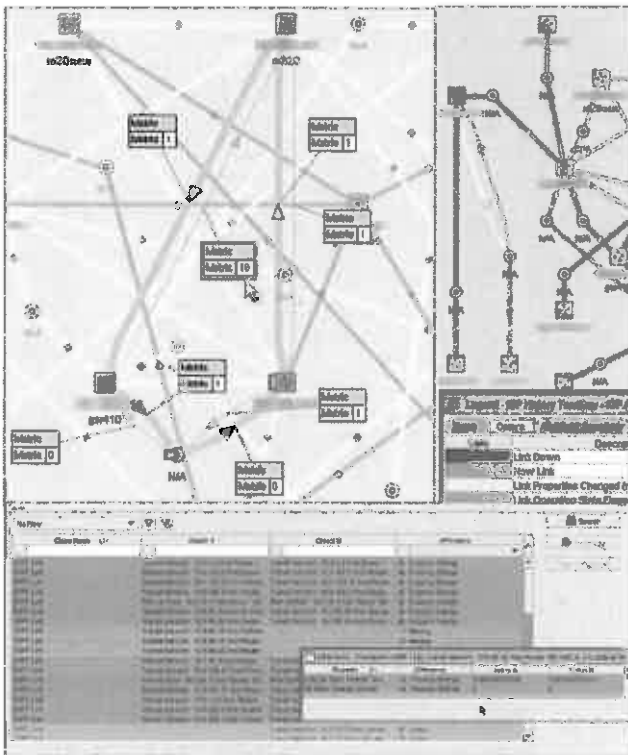
enable planned changes to be validated before being made in the live network and reduce the risk of maintenance or upgrades impacting performance due to unexpected routing behavior. The 5650 CPAM also provides management and troubleshooting for multicast as well as for 1588v2 PTP synchronization.

The 5650 CPAM uses 5620 SAM servers, databases and its OSS interface, making it a low-cost, low-risk investment. The two products share common user interface components for ease of use, a consistent operator experience and reduced training costs. The single northbound API enables operators to complement traffic engineering and capacity planning applications with route analytics efficiently with the benefits of reduced OSS integration costs and lower deployment risks.

SERVICE MANAGEMENT

Alcatel-Lucent 5620 SAM service management maximizes efficiency of service operations network-wide across the domains of the all-IP network. It accelerates service deployment with service templates and scripts for provisioning, rules-based QoS and accounting policy assignment, and automated SLA validation. External systems are able to access service management functionality through an open OSS interface. (See Table 3 for feature summary.)

Flexible provisioning options

Templates and workflows enable point-and-click service creation. Operators are guided step-by-step as they set up complex services for rapid provisioning and fewer errors. Templates also enable operators to customize and standardize their provisioning workflow to match internal processes. Layer 2 and Layer 3 services are provisioned in the same way, reducing delivery costs for different service types.

Provisioning verification

Newly activated services can be validated using a service test suite. Tests are automatically extended as services expand so test coverage does not drop off over time. Individual component tests for the newly provisioned entity are automatically created and include detailed test results.

Service accounting

The 5620 SAM collects accounting statistics to meet a wide range of billing requirements. Setup is accelerated by per-service accounting policy assignment that controls statistics collection for related service access ports. Third-party billing systems can also benefit from aggregated accounting statistics that are grouped per service, since it simplifies integration effort through using the 5620 SAM OSS interface.

Automated service deployment

The advanced 5620 SAM scripting framework enables programmatic control to automate service provisioning and accelerate time-to-market for new services. Everything can be automated from service creation to QoS policy assignment to service accounting policy setup for even the most complex end-to-end services spanning multiple technology domains. After deployment, setup of service test suites can be automated so that SLAs are continuously monitored. (See Figure 1 for more details on automation through 5620 SAM scripts.)

Services management

Services management provide a centralized view for listing services, performing maintenance and troubleshooting, including search filters, status indicators, and cross-navigation to configuration forms and topology maps for each corresponding service.

Table 3. Alcatel-Lucent 5620 SAM services deployment, maintenance and management feature summary

CATEGORY	FEATURES
Rapid service creation	• GUI-based service provisioning with concurrent, multiple object editing • Step-by-step form entry using service templates simplifies complex tasks with reduced user-entry fields • Network SDP provisioning • Rules-based auto-creation of service tunnels • Per-service policies on services to control statistics collection for billing requirements • Post-discovery control scripts to automate deployment and management for any managed devices (See Figure 1) • Third-party device provisioning using CLI scripts with security and version control
Provisioning and service deployment validation	• Single-click service validation through auto-generated OA&M tests • Per-service network policy audits • Scripting-based service deployment audits and SLA validation
Services management support	• Layer 2 Ethernet (VPLS, VPWS/VLL), Layer 3 IP-VPN, dynamic VPN (RADIUS policy auto-provisioned) and subscriber services • Composite services that combine multiple services into a unified managed service • Service connection admission control (CAC) to automate tunnel selection based on tracked bandwidth bookings
Cross-domain services management support	• IP-integrated optical transport services with WaveTracker power monitoring and light path tracing for DWDM and OTN, including for Layer 0 OCh or OTU, Layer 1 ODU and Layer 2 EPL or EVPL • IP-integrated Ethernet packet-based microwave services and 1588v2 PTP synchronization services • Data center dynamic virtualized services and SDN management for Nuage Networks, including for VXLAN, EVPN and SD-VPN
OSS interface	• Open north-bound interface enables external applications to integrate with full access to 5620 SAM managed services data

SERVICE ASSURANCE

The Alcatel-Lucent 5620 SAM delivers comprehensive service assurance from continuous SLA, performance and health monitoring, service topology visualization, and service impact fault visualization, as well as advanced service-to-infrastructure correlated troubleshooting. (See Table 4 for feature summary.)

Service topologies

Service topologies help operators to proactively detect and troubleshoot service-affecting problems, from simple to complex. The 5620 SAM provides visualization for both Layer 2 and 3 service topologies, and IP/MPLS integrated optical transport services. Composite services can be created to enable better end-to-end service assurance for more complex service architectures that combine multiple service technologies. OA&M diagnostics may also be enabled to allow SLA validation right from the service topology map using service tests with views of result summaries.

Together, the 5620 SAM and 5650 CPAM deliver multi-layer visualization and topology overlays to enable operators to see how services are tied to multiple network infrastructure layers.

SLA monitoring and service test management

Extensive collection of service performance statistics and comprehensive SLA monitoring tools let operators verify services end to end as well as individual service segments. Service test suites can simultaneously test every aspect of a group of services, including multi-layer OA&M validation of service infrastructure performance. Test suites can also be set up to provide continual scrutiny of KPIs across various technology layers. In addition, performance monitoring thresholds set on activating OA&M test suites and statistics counters enable operators to be alerted as issues emerge.

Third-party service performance management OSS integrations benefit from highly scalable statistics collection enabled through the 5620 SAM OSS interface.

Service supervision

At-a-glance dashboards for services and service group monitoring provide web-based summaries and detailed supervisory views for monitoring service health using fault trends and KPIs.

Root-cause and service-impact analysis

The 5620 SAM allows operators to quickly pin-point the root-cause of a problem and determine which customers are affected through sophisticated visual insight. This service impact visualization is made possible through a comprehensive service-aware infrastructure model and an advanced alarm correlation engine that ties network infrastructure events to impacted services.

Service correlation rules combined with advanced fault management visualization enable easy service impact assessment of faults to help identify priority for investigation and accelerate troubleshooting. At-a-glance network-wide alarm distribution views give an understanding of problems with the most services impact. Problem diagnosis is simplified through clear views that show the root-cause of a fault, including an impact tree of correlated faults. (See Figure 2 for examples of advanced fault management visualization.)

Third-party fault management OSS integrations, enabled through the 5620 SAM OSS interface, also benefit from configurable alarm suppression capabilities.

Table 4. Alcatel-Lucent 5620 SAM service assurance feature summary

CATEGORY	FEATURES
Topology maps	• Service topologies give fault status view of underlying network infrastructure involved in the delivery of a service • Service topologies give an end-to-end service view for composite services that tie together multiple cross-technology segments • Topology overlays provide fault status and additional troubleshooting information, such as performance statistics, or OA&M test results with trace highlighting after point-and-click execution from a map
Service supervision	• At-a-glance web-based dashboards for services and service group monitoring • High-level summaries and detailed supervisory views for monitoring service health using fault trends and KPIs

SLA monitoring and Service Test Manager (STM)	• OA&M and Service Assurance Agent (SAA) test validation of end-to-end services and underlying network layers
	• Proactive monitoring with scheduled OA&M test suites to continually assess performance across various technology layers
	• Service infrastructure performance statistics provide additional service KPIs
	• Threshold-crossing alerts triggered on out-of-bound KPIs notify operators immediately of emerging issues before SLAs are violated
	• Tightly integrated with 5650 CPAM for:
	  ¬ Monitoring health of high-priority service paths and prefixes
	  ¬ Auto-triggered service infrastructure testing and alarms on routing changes

Root-cause and service impact analysis	• Advanced alarm visualization delivers an understanding of which problems impact the most services • Alarm correlation through rules engine to identify root cause of problem from symptoms • Root-cause alarm impact tree visualization to easily navigate to root-cause or related infrastructure and service alarms in tree • Service infrastructure hierarchy views show impacting alarms and provide cross-navigation to specific forms for further investigation • Web-based GUI for wider accessibility
OSS interface	• Open interface enables external applications to integrate with full access to 5620 SAM service assurance and accounting data

PLATFORM

Alcatel-Lucent 5620 SAM base platform provides the architecture, security and other facilities utilized by all 5620 SAM applications. It also provides a north-bound interface for OSS/BSS application integration. (See Table 5 for the platform feature summary.)

Scalable, secure and flexible system architecture

High availability, system redundancy and fast system failover options allow operators to implement a highly secure network operations environment. The distributed architecture enables support for the largest networks and a massive volume of statistics.

Server virtualization

The 5620 SAM virtualized server deployment enables NMS or IT administrators to easily integrate the 5620 SAM into their standardized environment, reducing OPEX and taking advantage of generic solutions for redundancy and backup/restore. Leverage existing IT technologies such as SAN capabilities for data replication, as well as hypervisor monitoring and maintenance tools.

The 5620 SAM supports service virtualization options using VMware vSphere and Linux KVM hypervisors.

User security with scope of command and span of control

Scope of command allows network administrators to define each operator's access to operations and commands. With span of control, network administrators can subdivide network resources and assign operators clear ownership, based on security privileges for their geographic location, organizational group, job function or individual responsibilities.

OSS/BSS integration

Full access to 5620 SAM functionality and network infrastructure/service management data is provided through an open OSS interface. All 5620 SAM applications, including the 5650 CPAM, share this common north-bound API accessible from a single platform.

External applications may integrate using request-based XML queries, which provide XML results for efficient parsing, as well as Java Messaging Service (JMS) notifications to trigger event-driven behavior.

OSS integrations may also maximize efficiency by triggering 5620 SAM scripts for pre-processing. External applications subscribed to JMS events through the 5620 SAM OSS interface may trigger scripts through the XML API based on these events. (See Figure 1 for more details on automation through 5620 SAM scripts.)

Typical OSS/BSS integrations would include applications for service activation/provisioning, fault management, performance reporting, SLA management, billing, traffic engineering, and network capacity planning.

Alcatel-Lucent OSS Connected Partner Program

The Alcatel-Lucent OSS Connected Partner Program further reduces OSS integration time and costs by certifying integration of the Alcatel-Lucent 5620 SAM with applications from industry-leading independent software vendors.

Table 5. Alcatel-Lucent 5620 SAM platform feature summary

CATEGORY	FEATURES
Architecture	• Distributed, high-availability architecture for redundancy and fast system failover • Server virtualization options using VMware vSphere and Linux KVM hypervisors
Security	• Operator profile management, including for controlled user access to NMS functions and network resources • User/OSS client activity logs • Server hardening to industry-standard best practices (for port use, protocol use, authentication, authorization, and so on) • RADIUS/TACACS+ authentication • SNMPv3 trap authentication • SSHv1/v2 to device and SFTP from device • Database error monitoring to scan for SQL injection attacks
OSS/BSS integration	• Open, bidirectional XML and JMS interfaces • Allows many simultaneous operational 5620 SAM OSS clients — 30 for XML API and 10 for JMS • Software development kit with sample code and developer's guide • Custom OSS web application interfaces developed through the Alcatel-Lucent Service Portal • Alcatel-Lucent OSS Connected Partner Program certifies integration between the 5620 SAM and market-leading OSS applications

TECHNICAL SPECIFICATIONS

Operating environment

The Alcatel-Lucent 5620 SAM, Release 12, operates on the following:
• Main, database, auxiliary servers and clients
  - x86 platforms supported: HP® or Oracle® Sun®
  - Operating systems supported: Red Hat® Enterprise Linux® (RHEL) 6 or Oracle® Solaris™ 10
  - Databases supported: Oracle® Database 11g
  - Virtualization: VMware vSphere ESXi 5.0, 5.1 and 5.5 and Linux KVM on RHEL 6.3/6.4/6.5 using QEMU version 0.12.1.2
• Additional clients:
  - Microsoft® Windows® 7 Professional (32-bit and 64-bit editions)
  - Microsoft® Windows® Server 2008R2*/2012 (also for client delegate servers; *including support for Citrix XenApp 6.5)

Note: Hardware recommendations may vary depending on scale of deployment. Contact your Alcatel-Lucent representative for the Alcatel-Lucent 5620 SAM Planning Guide for hardware requirements and platform sizing recommendations.

Minimum hardware requirements for Alcatel-Lucent 5620 SAM, Release 12

| APPLICATION	X86 HP OR ORACLE SUN
5620 SAM main server: • It is recommended that the 5620 SAM server be installed on a workstation separate from that of the 5620 SAM database for large-scale deployments	• 1 quad core CPU • 16 GB RAM • 2 disk drives, minimum 146 GB each
5620 SAM database (Oracle Database 11g): • Stores network objects and configuration • 5620 SAM server can be installed on a workstation separate from that of the 5620 SAM database for large-scale deployments • RAID 0 and 1+0 technologies are supported • Storage area network (SAN) storage is supported with 4 GB or faster optical connections with dedicated Fibre Channel connection between hosts and storage arrays	• 1 quad core CPU • 16 GB RAM • 4 disk drives recommended, minimum 146 GB each
5620 SAM auxiliary statistics collector server: • Dedicated server required for large-scale deployments • For 5620 SAM logToFile large-scale collection • Dedicated server required for call trace and debug trace data collection	• 2 quad core CPUs • 24 GB RAM • 8 disk drives, minimum 146 GB each
5620 SAM client: • GUI presentation front end • Only one client should be installed per platform	• 1 CPU, 2 GHz or higher • 1 GB dedicated RAM • 1 GB available disk space • 1280 × 1024 display resolution
5620 SAM client delegate and third-party remote display server: • Single client install for multiple GUIs for multiple users • Citrix is recommended third-party remote display software • X11 protocol and native X displays supported	• 4 CPU cores • 16 GB dedicated RAM • 1 GB available disk space For a maximum of 15 concurrent GUIs. Increased hardware specifications are required as number of concurrent GUIs increases.

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ALCATEL-LUCENT 1830 PHOTONIC SERVICE SWITCH (PSS-16 AND PSS-32)
RELEASE 7.0

The Alcatel-Lucent 1830 Photonic Service Switch (PSS) supports next-generation wavelength division multiplexing (WDM) multiservice packet-optical transport from access to core. The scalable Alcatel-Lucent 1830 PSS with high-performance 100G transport drives lower total cost of ownership (TCO) and extends network life cycles.

The 1830 PSS transforms traditional WDM into a flexible transport layer with managed agile photonics, multilayer switching and services, and network intelligence. The platform supports a wide range of applications and services such as business services, mobile and broadband backhaul, multicast video, Data Center Interconnect (DCI) and Cloud. With 1830 PSS platforms ranging from access to converged Optical Transport Network (OTN)/WDM core, operators can optimize multiservice networks to meet unpredictable traffic demands in the cloud services era.
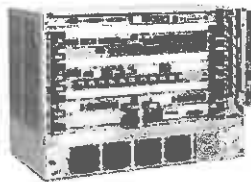
1830 PSS-16
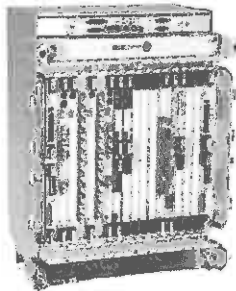
1830 PSS-32

The Alcatel-Lucent 1830 PSS portfolio provides terabit OTN switching and photonics capacities. The Photonic Service Engine (PSE) enables high-performance 100G and an evolutionary path to 400G transport. Leveraging an intelligent control plane and integrated data, control and management planes, the 1830 PSS simplifies network management for maximum multilayer performance and efficiency.

The 1830 PSS is a multi-reach platform that spans access, metro, regional, and long-haul applications and supports a wide range of data rates, enabling service delivery in a variety of environments and applications:

- Broadband transport networks for telecommunications operators and enterprises operating as Telcos to provide high-bandwidth connectivity over long distances of up to 4000 km
- Metropolitan or national research networks for sharing IP and Fiber Channel (FC) connectivity and enabling grid computing applications
- Campus networks for data center protection or data sharing for private and public organizations, including universities, hospitals, banks and airports
- Multi-campus networks for long-distance cooperation among public and private organizations and optimization of leased dark fiber
- Support for the full range of network topologies, including ring, point-to-point, spokes and hub, and arbitrary optical mesh topologies

KEY FEATURES

- A static, tunable/reconfigurable optical add/drop multiplexer (T/ROADM) with single wavelength add/drop granularity
- Colorless and any direction add/drop capabilities
- Up to 88 wavelengths and 50 GHz ITU WDM per fiber pair
- Bidirectional dense WDM (DWDM) transmission support over a single strand of fiber for fiber-exhausted metro sites
- Support for Generalized Multiprotocol Label Switching (GMPLS) to further enhance network flexibility and improve resiliency with photonic restoration
- OTM-0.1 through OTM-0.4 interfaces and ODU0/1/2/2e/3/4/flex mapping/ multiplexing structures according to G.709
- 200 Gb/s, 100 Gb/s, and 40 Gb/s channel capacity, with best-in-class SD-FEC, PDM-16QAM (200 Gb/s), PDM-QPSK (100 Gb/s) and PDM-BPSK (40 Gb/s) to support upcoming traffic needs with no interference with existing 10 Gb/s channels deployed
- Support for optional Raman amplification for extended span application using integrated Raman or hybrid (Raman/EDFA) amplifiers
- GMPLS/ASON enabling cross-layer automation and highly available networks resilient to multiple failures with flexible restoration options
- Wavelength Tracker™ monitors and traces each wavelength at any point in the network including intra-nodal fiber

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connections allowing industry-leading photonic operations, administration and management (OAM)

- Measurements of in-band OSNR for each channel carried on the optical line

KEY BENEFITS

- T/ROADM technology allows operators to provision and reconfigure wavelengths remotely, while adding "any-wavelength-to-anywhere" flexibility to their network infrastructure and enabling a dynamic photonic layer for cloud architectures
- Flexible grid-ready OTS line provides investment protection for carriers
- T/ROADM, optical path tracing, and power monitoring reduces the overall complexity and cost of network wavelength management equivalent to managing SDH/SONET traffic, making it easier to engineer, implement and maintain networks
- Reduces operating expenditures (OPEX) with a high-density, low-power per bit design
- Sophisticated design tools and self-tuning features simplify, optimize and accelerate planning for new networks or upgrades. These tools fully automate network installation, provisioning and commissioning, while unparalleled optical performance is guaranteed for the most stringent long-reach applications.

TECHNICAL SPECIFICATIONS

Optical layer intelligence and Wavelength Tracker optical power management

- Optical layer path tracing and power monitoring on a per-unique-wavelength service basis
- View of all wavelengths present on a selected fiber pair
- Supports standard 50 GHz grid and FlexGrid ready architecture
- Integrated fault isolation and sectionalization at the optical layer
- Automated optical layer with dynamic power equalization
- Integrated fault correlation

Multi-degree T/ROADM and ROADM

- WSS-based ROADM technology
- Multi-degree node support (up to 20 degrees)
- Colorless and multidirectional add/drop
- Tunable mux/demux for remote network traffic reconfiguration

Full range of service interfaces

- SDH: STM-1/-4/-16/-64/-256
- SONET: OC-3/-12/-48/-192/-768
- Ethernet: FE, GE, 10 GE LAN and WAN, 40 GE, 100 GE
- Video: SD-SDI/HD-SDI/3D-SDI
- SAN: FC-100 (1G FC), FC-200 (2G FC), FC-400 (4G FC), FICON or FICON Express, FC-800 (8G FC), and FC-1200 (10G FC) and IB DDR (5G)
- Transponderless (direct connect) transport of ITU grid wavelengths from external equipment
- Interoperable with SDH/SONET add/drop multiplexing (ADM) and optical cross-connects (OXCs), 2R and 3R transport mode
- Pluggable interfaces (SFP/XFP/SFP+/QSFP+/CFP/CFP2)

Carrier Ethernet

- The following L2 muxponders support a range of MEF CE 2.0 certified Carrier Ethernet services, which are detailed in their respective data sheets:
  - 1/10 GE Carrier Ethernet x WDM/OTN integrated L2 muxponder (2 slot)
    - 22 x 1 GE/FE SFP client ports
    - 4 x 10 GE/OTU-1e/OTU-2e XFP flexible client or line ports
    - 64 Gb/s switching capacity
  - 1/10 GE Carrier-grade L2 muxponder (1 slot)
    - 10 or 12 x 1 GE/FE SFP client ports (future expansion to 24 with CSFP)
    - 4 x 10 GE/OTU-1e/OTU-2e XFP flexible client or line ports
    - Backplane mate interfaces for protection
    - 64 Gb/s switching capacity
  - 8 x 10 GE Carrier Ethernet x WDM/OTN integrated L2 muxponder
    - 8 x 10G flexible client or line ports; 4 x 10 GE/OTU-1e/OTU-2e XFP, 2 x 10 GE/OTU-2e SFP+, 2 x 10 GE SFP+, 4 VOA SFPs
    - Backplane mate interfaces for protection
    - 120 Gb/s switching capacity

Electro optics

- 10G 12 x Any Transponder
  - Line side: Up to 2 DWDM ports with OTN framer and Wavelength Tracker
  - Client side: Up to 12 x OC-3/12, 4 x OC-48, 8 x GE, 2 x OTU-1, 12 x SD-SDI, 4 x HD-SD; up to 6 x STM-1e SFP supported
- 40 Gb/s optical interfaces
  - 4 x 10 Gb/s mux OT
    - Line side: NRZ-DPSK, 43 Gb/s, 100 GHz spacing
    - Client side: 10 GE, OC-192, STM-64 or G.709 OTU-2
  - 4 x 10 Gb/s add/drop OT
    - Line side: P-DPSK, 43 Gb/s, 50 GHz (C-band) spacing
    - Client side: OC-768, STM-256, OTU-3
  - 4 x 10 Gb/s coherent mux OT
    - Line side: Coherent PDM-BPSK, 43 Gb/s, 50 GHz (C-band) spacing
    - Client side: 10 GE (LAN/WAN), OC-192/STM-64, OTU-2, 8G FC
  - 1 x 40G coherent add/drop OT
    - Line side: Coherent PDM-BPSK, 43 Gb/s, 50 GHz (C-band) spacing
    - Client side: OC-768, STM-256, OTU-3
- 100 Gb/s optical interfaces
  - 130 Gb/s coherent SD-FEC mux OT
    - Line side: Single carrier DP-QPSK, 130 Gb/s, 50 GHz (C-band) spacing
    - Client side: 10 GE, OC-192/STM-64, OTU-2, OTU-2e, OTU-1F, FC-800
  - 10 x 10 Gb/s FlexGrid coherent mux OT
    - Line side: Coherent PDM-QPSK 100 Gb/s
    - Client side: 10 GE (LAN/WAN), OC-192/STM-64, OTU-2, 8G FC
- 100G/200G high-capacity muxponder; FlexGrid tunable (C-band):
  - Line side: 130 Gb/s SD-FEC single carrier using DP-QPSK, or 260 Gb/s SD-FEC single carrier using DP-16QAM (available R7.0.1)
  - Client side: 1 x 100 GE or 2 x 100 GE

Data Center Interconnet and encryption

- 4 x 10 Gb/s WDM encryption solution
  - Line side: OTU-2
  - Client side: 10 GE LAN, 10G FC, 8G FC, OTU-2, OTU-2e
  - Wavelength Tracker, on-demand latency measurement; latency optimization; 1 x IFB 5 Gb/s (DDR)
  - ¬ 100G high-capacity multiprotocol muxponder
    - Line side: OTU-4 using 4 x 28 Gb/s superchannel
    - Client side: 10 SFP+ and 1 QSFP+ ports; supports 10 GE, 40 GE, 100 GE, 8/10/16G FC, Infiniband SDR/DDR, OTU-2, OTU-2e, and OTU-1f
- Universal encryption module providing AES-256 encryption

GMPLS/ASON control plane

- Automatic topology discovery
- Autodiscovery of services and resources
- WDM-optimized path computation
- Unconstrained wavelength path setup
  - ¬ Routing over a feasible path
  - ¬ Routing with regeneration definition
- Wavelength path rerouting with wavelength path conversion
- Restoration
  - ¬ Source-based restoration
  - ¬ Protection restoration combined
- Nominal route
- Operator control over connection parameters
- Shutting down of links

Scalability

- In-service network scalability from one to hundreds of wavelengths without service disruption
- Optional egress and ingress broadband amplifiers
- Network planning independent of traffic forecast

Flexible protection options

- Flexible protection/restoration options on a per-wavelength service basis
- Diverse routed protection
- Optical channel-dedicated and shared-protection options
- 1 + 1 client protection
- OTS and OMS level photonic protection
- Fiber-level facility protection

Integrated SLA support and monitoring

- Proactive service management for wavelength services
- G.709 compliant
- Flexible service-level alarms
- Ethernet service-level agreement (SLA) management utilizing IEEE 802.3ah, 802.1ag and ITU-T Y.1731

Carrier class availability

- Delivers 99.999% availability
- NEBS Level 3 compliant
- All cards hot-swappable
- Non-stop distributed, reliable and scalable software architecture

Optical reach

- 4000 km at 10 Gb/s
- 3500 km at 40 Gb/s
- 4000 km at 100 Gb/s

Network management

- Full-featured operations, administration, maintenance and provisioning (OAM&P) management functionality
- Management support for
  - ¬ Alcatel-Lucent 1350 Optical Management System (OMS)
  - ¬ Alcatel-Lucent 5620 Service Aware Manager (SAM)
  - ¬ Alcatel-Lucent 1340 Integrated Network Controller (INC)
  - ¬ Alcatel-Lucent 1354 Regional Network Manager–Photonic Manager (RM-PhM)
- Network management interfaces
  - ¬ Web GUI
  - ¬ CLI
  - ¬ TL-1 and SNMPv3
- Network management access: Ethernet port (RJ-45)
- Secured protocols (https, SSHv2, SSL, RADIUS)
- Craft interface serial RS-232 with DB-9 connector
- Alcatel-Lucent Advanced Engineering Planning Tool simplifies network design and system installation

SAN and security certification

- Brocade certification
- EMC certification
- FIPS certified

MEF certification

- MEF CE 2.0 certification

Physical dimensions (PSS-16)

- Height: 355.6 mm (14 in.)
- Width: 483 mm (19 in.)
- Depth: 300 mm (12 in.)

Physical dimensions (PSS-32)

- Height: 622 mm (24.5 in.)
- Width: 483 mm (19 in.)
- Depth: 300 mm (12 in.)

Optical amplifier

- Dual-stage, broadband erbium-doped fiber amplifiers (EDFAs)
- Amplifiers optimized for coherent transmission
- Unidirectional and bidirectional amplifiers
- Raman amplifier
- Hybrid Raman/EDFA (integrated Raman and modular EDFA amplifier)
- Very high power non-Raman for ultra long-haul applications (output power: +26 dBm)
- High power (output power: +23 dBm)
- Variable EDFA gain designs (low gain < 17 dB to high gain > 30 dB)
- Mid-stage access supports DCUs
- Wavelength range: 1529 nm to 1565 nm (C-band)

Optical supervisory channel

- Selectable bit rates
  - ¬ 100 Mb/s bidirectional 100Base-FX
  - ¬ 155 Mb/s bidirectional OC-3/STM-1

Operating environment

- Power
  - ¬ 48 V DC or 115 V/240 V AC (with external converter)
  - ¬ 400 W to 1270 W per shelf
- Operating temperature: 0°C to 50°C (32°F to 122°F)
- Shock/vibration: GR-63-CORE
- Humidity: 5% to 95%

ALCATEL-LUCENT 9500 MICROWAVE PACKET RADIO
ANSI

The Alcatel-Lucent microwave transmission portfolio sets the standard for innovation in delivering faster, more efficient microwave links with flexible networking and simplified operations. Proven in more than 500 networks worldwide, the portfolio has been deployed in a wide range of applications, including 2G, 3G and 4G/LTE mobile backhaul, high-capacity long-haul, and mission-critical networks for industries. The Alcatel-Lucent packet microwave solutions support a smooth transition to all-IP networks for increased capacity at a lower total cost of ownership (TCO).

Microwave Service Switch-8 (MSS-8)

Microwave Service Switch-4 (MSS-4)

Microwave Service Switch-1 (MSS-1)

Microwave Service Switch and Power Injector (MSS-O)

Microwave Packet Transport (MPT-HLC)

Microwave Packet Transport (MPT-HQAM) Multipurpose Outdoor Unit (ODU)

Traditional microwave networks are under pressure to support the growing adoption of packet-based applications and services. Voice demand is shifting to data demand as mobile subscribers surf the Internet, download apps and consume mobile video. Enterprise services are evolving to IP and must support higher-bandwidth applications, including video. To respond, operators need cost-effective and reliable solutions that maximize radio link performance, support advanced packet networking and simplify operations.

BUILD FASTER, MORE EFFICIENT MICROWAVE LINKS

Faster, longer, more efficient radio links enable the delivery of more revenue-generating services to more locations. The unique features of the Alcatel-Lucent microwave portfolio let operators deliver more data with superior performance while using less spectrum and equipment. These features include:

- Advanced packet compression techniques that increase channel capacity by up to 300 percent
- Scalable multichannel microwave links that support increased capacity and reliability
- Adaptive modulation that extends across multiple channels to sustain maximum performance in all environments

BOOST CAPACITY AND RELIABILITY WITH ADVANCED NETWORKING

Advanced networking support drives reliability and scale to ensure end-user quality of experience (QoE) is maintained as network demands increase.

With Alcatel-Lucent microwave solutions, operators get advanced Carrier Ethernet networking capabilities that can double network capacity while delivering high availability. These capabilities include:

- Unique ring and mesh topology configurations that can double network capacity, improve reliability and reduce network costs
- Integrated IP-microwave solutions that reduce space and power consumption
- The ability to support TDM, ATM, Ethernet and IP services on a single packet-based network

SIMPLIFY OPERATIONS WITH AN END-TO-END APPROACH

The Alcatel-Lucent end-to-end portfolio is an industry first: a complete family of microwave solutions that addresses all network sizes and locations including tail, hub and backbone. With an approach that uses common equipment and software across all sites, Alcatel-Lucent helps operators streamline management processes and reduce TCO. Alcatel-Lucent solutions offer:

- Common radio transceivers that reduce the need for spares across all applications
- A flexible range of right-sized Indoor Units (IDUs) optimized to reduce space and power consumption
- Common software and network management that simplify operations across the network

MICROWAVE APPLICATIONS

Mobile backhaul

Microwave access to cell sites is an important building block for the delivery of mobile services. Today, more than 50 percent of the world's cell sites are connected to the network over microwave access. As both macro and small cell sites transition to packet-optimized, higher-speed 4G/LTE services, the Alcatel-Lucent portfolio provides cost-effective solutions to support this evolution.

Long-haul transport

The Alcatel-Lucent portfolio supports long-distance, high-capacity microwave applications. It offers flexible, secure, scalable and highly reliable solutions that also support a seamless TDM-to-packet migration path option.

Mission-critical networks

Wireless transmission is a key require-ment for power utilities, transportation and public safety. These industries often need to reach remote areas over difficult terrain. Alcatel-Lucent low-risk, high-availability microwave solutions support these mission-critical requirements. They also provide full support for IP transfor-mation and can be delivered as part of an end-to-end approach that spans fixed and wireless networking.

FEATURES

- Dual receivers option for space diversity
- Highest density and highest reliability in the market: intelligent nodal IDU supporting up to 24 ODUs with built-in redundancy and no single point of failure
- Up to 1 Gb/s of IP traffic in a single carrier, multiservice switching capacity up to 16 Gb/s
- Multichannel aggregation up to 4+4 radios with enhanced bandwidth utilization
- Hitless and errorless service-driven adaptive modulation
- Cross Polarization Interference Cancellation (XPIC), enabling channel reuse and double capacity
- Packet throughput booster/header compression
- 5.8 GHz unlicensed, 6 GH to 38 GHz licensed bands
- 60 GHz and 80 GHz support
- Full outdoor configurations supported:
  - ¬ 1+0 and 2+0 with XPIC
  - ¬ with MSS-O full outdoor option add multichannel LAG, 1+1 HSB/SD/FD, 2 x 1+0 repeater
- Packet and hybrid mode support for optimized and smooth migration to packet networks
- Multiservice Packet Ring ITU-T G.8032 v2
- Ethernet OAM IEEE 802.1ag and ITU-T Y.1731
- ITU-T G.8261/8262 Synchronous Ethernet
- IEEE 1588v2 tunneling with ultra-low Packet Delay Variation (PDV)
- SDH/SONET transport, up to 8 STM-1/OC-3 interfaces
- Up to 192 E1/DS1
- Up to 12 DS3 Interfaces
- Up to 54 Gigabit Ethernet (GE) interfaces
- Multiservice aggregator with embedded Circuit Emulation Service (MEF 8) capabilities for Carrier Ethernet Transport

TECHNICAL SPECIFICATIONS

Configuration options

- Radio terminal
- Radio repeater
- Multidirectional radio node
- Aggregation shelf (no RF)

Radio-to-MSS connections

- Up to 24 radio transceivers
- Any combination of outdoor or indoor transceivers

Operating frequencies

- Frequency bands:
  - ¬ HC/HQAM = 5.8/L6/ U6/7/8/11/15/18/23/38 GHz
  - ¬ MPT-XP = L6/U6/7/8 GHz
  - ¬ MPT-HL/HLC = 5.8/L6/U6/UU6/7/8/ 11 GHz
- Modulation supported: adaptive modulation from QPSK to 1024 QAM
- Channel Spacing supported: from 5 MHz to 60 MHz
- System Gain:
  - ¬ At QPSK, up to 132.5 dB
  - ¬ At 256 QAM, up to 112 dB
  - ¬ At 1024 QAM, up to 103.5 dB
- Throughput per RF channel:
  - ¬ Up to 1 Gb/s with Packet Throughput Booster

Radio frequency transceiver

- Synthesized source

User interfaces

100% front access for all interfaces

- OC-3 access card
  - ¬ 2 x OC-3 each
- DS1 access card
  - ¬ 32 x DS1 each
- DS3 access card
  - ¬ 2 x DS3 each
- Control and switching module
  - ¬ 4 x 10/100/1000Base-T
  - ¬ 2 x Small Form Factor Pluggable (SFP)
- 8 x Ethernet access card
  - ¬ 10/100/1000Base-T
  - ¬ 4 x SFP
- MSS-1: 16 DS1, 4 x 10/100/1000 RJ-45, 2 x SFP
- MSS-O: 3 x 10/100/1000 RJ-45, 1 x SFP

Synchronization

- Any synchronization solution in hybrid and packet mode
- Clock distribution options
  - ¬ DS1
  - ¬ External reference sync-in/sync-out (2 MHz, 5 MHz, 10 MHz)
  - ¬ Synchronous Ethernet (Sync E) + SSM G.8264
  - ¬ Built-in Stratum 3 clock
  - ¬ IEEE 1588v2
- Line clock recovery
  - ¬ ACR, DCR

Dimensions and weight

MPT-HL/HLC (2.5 RU)

- Weight:
  - ¬ 1+1 and 2+0: 13.2 kg (29 lb)
  - ¬ 1+0: 9.1 kg (20.0 lb)

IDU (rack, desk or wall-mount)

- MSS-8 (2 RU)
- MSS-4 (1 RU)
- MSS-1 (1/2 RU)
- Weight:
  - ¬ Fully equipped: <6 kg (13.2 lb)
  - ¬ Basic configuration: 2.5 kg (5.5 lb)

MSS-O

- Weight 4.2 kg (9.2 lb)
- Height: 34.5 cm (13.6 in)
- Width: 21.1 cm (8.3 in)
- Depth: 6.6 cm (2.6 in)

ODU

- Weight: 6.5 kg (14.3 lb)
- Height: 27.9 cm (11 in)
- Width: 27.9 cm (11 in)
- Depth: 16.51 cm (6.5 in)

Power supply

MSS-4/8

- Standard: -48 V DC to -60 V DC
- Optional: -24 V DC to -60 V DC

MSS-1

- ±24 V DC to ±48 V DC

MPT-HL/HLC

- ±24 V DC to ±60 V DC

MSS-O

- 110/230 V AC

Services

- Network and transmission design and planning
- Hotline
- Express repair and return, swap and repair, and spare-parts management
- On-site visits, urgent interventions, technical assistance
- Training from theory to installation
  - ¬ Alcatel-Lucent University
  - ¬ Customer premises
- Bundled services during warranty period and warranty extensions

Standards compliance

Environmental

- EMC: EN 55022 Class B, EN 301 489-1/ EN 301 489-4
- Safety: EN 60950-1
- Ecological: ECMA TR/70
- Temperature
  - ¬ MSS-O/1/4/8: -40°C to +65°C (-40°F to +149°F)
  - ¬ ODU: -33°C to +55°C (-27°F to +131°F)
  - ¬ MPT-HL/HLC: -5°C to +55°C (23°F to 131°F)
- NEBS Level 3
- Telcordia GR-63
- Telcordia GR-1089
- Telcordia GR-3108

Networking and services

- IEEE 802.1p/Q VLAN tagging
- IEEE 802.3 10Base-T
- IEEE 802.3u 100Base-TX
- IEEE 802.3x Flow Control
- IEEE 802.3z 1000Base-SX/LX
- IEEE 802.1d Bridging
- IEEE 802.1ad Link aggregation
- IEEE 802.1ag Ethernet OAM
- IEEE 802ab 1000Base-T
- MEF 9
- MEF 14
- MEF 22

Network and element management

- Optional 256-bit AES Encryption compliant with FIPS 140 Standard
- Secure FTP for software download and backups.
- IPv4/IPv6 management
- Integrated network management in a Microsoft™ Windows® environment
- Embedded web browser for NE supervision
- Software-based configuration by PC
- Intuitive supervision systems
- SNMPv2/v3 agent with TCP/IP rerouting capability
- Interoperability with all Alcatel-Lucent wireless microwave and transmission equipment
- Fully compatible with the Alcatel-Lucent TSM-8000 and Alcatel-Lucent 5620 Service Aware Manager (SAM)

Traffic management and QoS

- Marking based on:
  - ¬ Layer 2 (802.1p)
  - ¬ Layer 3 (DiffServ)

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