# UPSCALING THE METRO

## DEPLOYING THE 7950 XRS IN THE METRO CORE

APPLICATION NOTE

Alcatel·Lucent

# ABSTRACT

The metro network is under pressure: mobile broadband, emerging cloud-optimized services, and increasing consumption of video on both fixed and mobile devices are causing an explosive growth of traffic. With the decentralization of content storage and data center server capacity, metro network traffic patterns are shifting. By 2017, metro traffic growth is expected to far exceed that of backbone traffic.

As the center of gravity in terms of traffic growth is shifting from the access to the metro, the metro core is a critical new architectural element to successfully address these new challenges and enable service providers to move their metro networks forward.

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# THE METRO IN TRANSFORMATION

The metro network is on the cusp of several transformative changes:

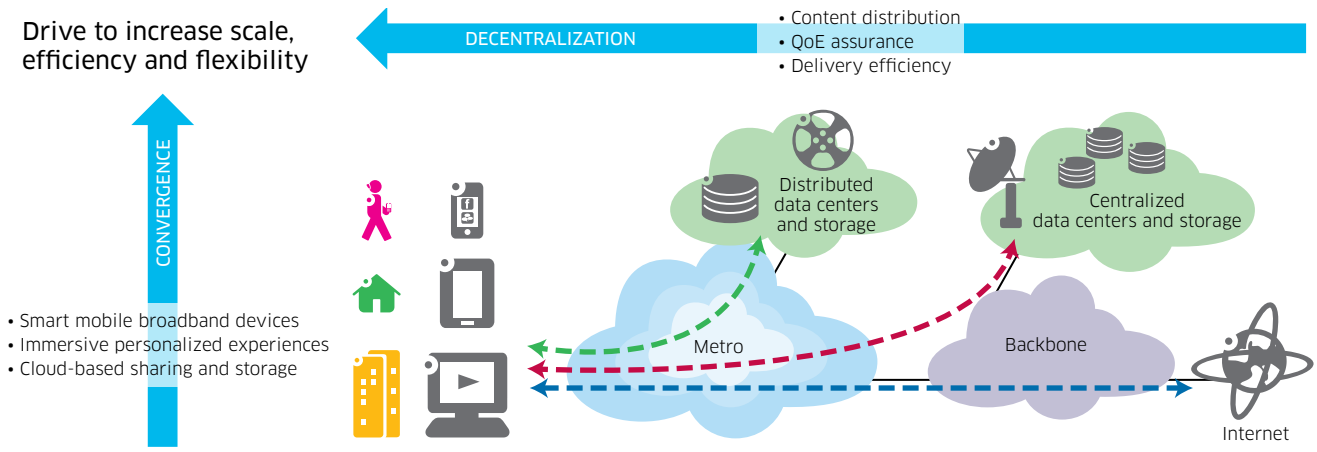
- Scale for explosive traffic growth and a changing traffic mix
- All-IP service convergence on a common packet infrastructure
- Cloud-service optimization with distributed compute and storage

Metro traffic is soaring due to the rollout of 4G mobile broadband; emerging cloud-based services, applications and content; ubiquitous video on smart mobile devices and multiple screens in the home, and higher capacity demand from business users — and wholesale users as well. However, as ultra-fast, next-generation broadband access technologies are deployed, new bandwidth bottlenecks begin to emerge in the aggregation, edge and core of the network that must be addressed in a cost-effective manner.

Residential, business and mobile technologies have all converged on IP and share the same networking needs for reliable and scalable packet transport, switching and routing. For service providers, this opens new opportunities to improve network efficiency through the consolidation of several service-specific aggregation networks on a converged, packet-based aggregation infrastructure.

The evolution to a more distributed service infrastructure reduces network delivery costs for cloud-based content and applications, and improves their performance by reducing latency and jitter. This evolution is adding substantial new traffic flows from local caches and data centers to existing traffic flows from centralized service infrastructure and Internet peering points (Figure 1). As a result, far more traffic will circulate within the metro than before and the metro network architecture must evolve to accommodate this shift efficiently.

**Figure 1. Metro evolution - The new center of traffic growth**




This application note examines these issues in detail and proposes an innovative approach to address them by introducing a metro core.

# INTRODUCING THE METRO CORE

The metro core is a new architectural element providing an aggregation and distribution hub for subscriber and service traffic in the metropolitan area network. The metro core acts as a regional backbone providing connectivity between the various access and aggregation networks within a given metropolitan area and switching intra-metro traffic and connects into a national backbone network to enable connectivity with other metropolitan, regional and national networks.

**Figure 2. Metro network architecture**

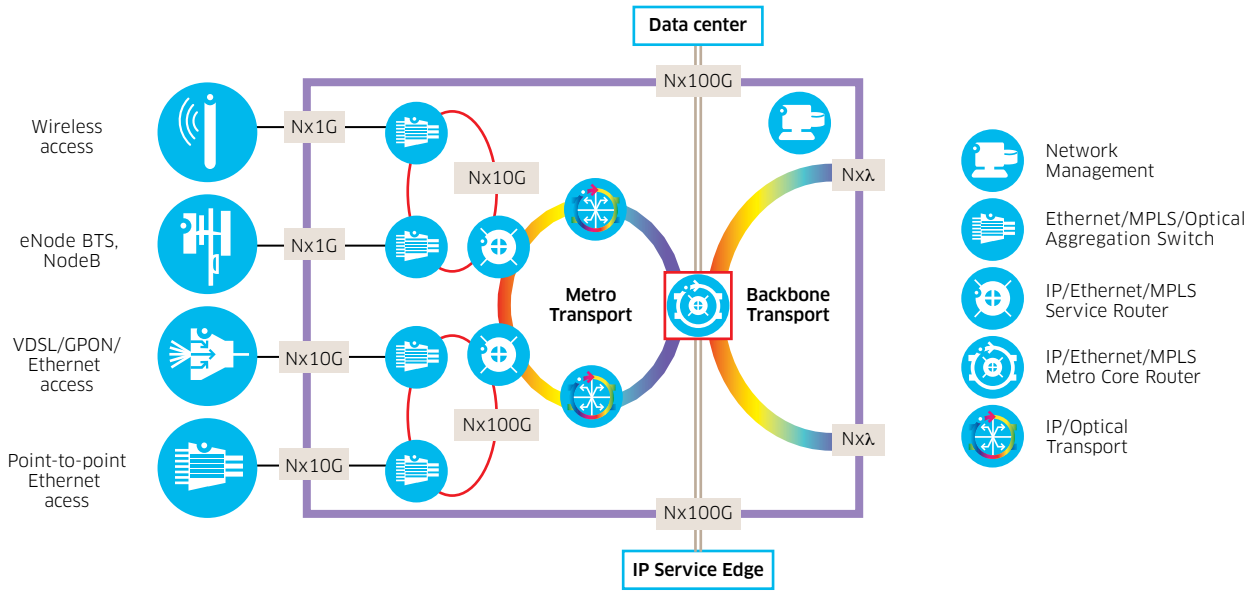



Figure 2 depicts a functional architecture of the metro network. The metro core sits at the junction between metro and backbone transport, data center and IP edge. In this strategic position it performs several critical roles:

- Aggregation point for the various purpose-built metro aggregation networks already in place
- Attachment point for data center infrastructure and IP service edge infrastructure
- Access point for the metro network with the IP/MPLS backbone(s) and Internet

A number of essential functionalities are required to make the metro core most cost effective:

- Ethernet and IP/MPLS aggregation services to interconnect aggregation networks
- IP/MPLS core routing — in the metro and potentially also the national backbone(s)
- Layer 2/3 virtual private network (VPN) services to support Carrier Ethernet and IP service delivery

In addition the metro core may provide:

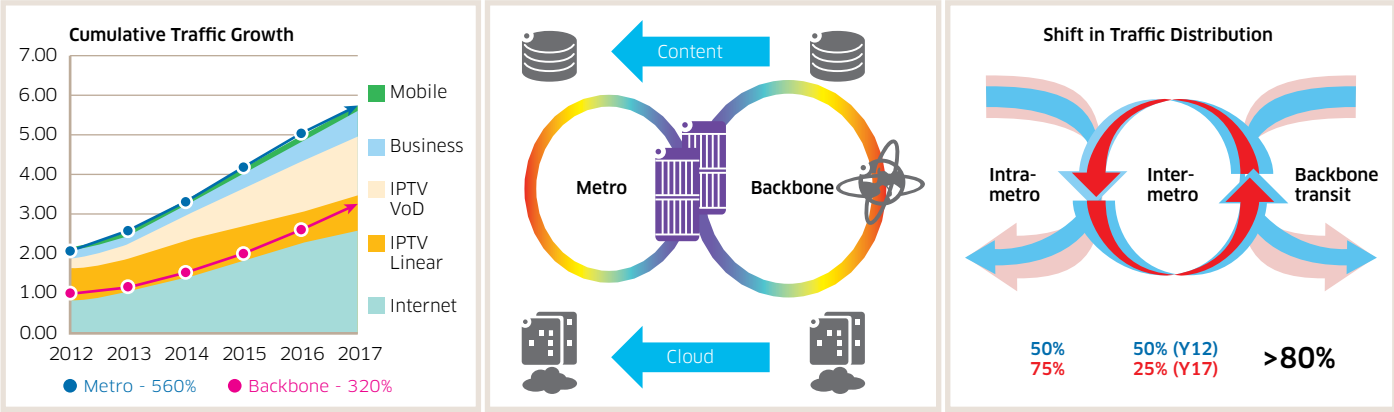
- Internet peering, to provide a common Internet hand-off point in the metro
- Data center interconnect, with compute and storage resources for cloud-based services

Service providers traditionally assign these various roles and functionalities to different, role-specific network equipment. While they recognize that the ability to combine several roles on a common, versatile metro core platform can potentially reduce the cost and complexity in the metro network, and improve reliability, the priority is to cost effectively address the evolving mix of service traffic in the next 5 to 10 years. This is the business case for introducing a metro core.

## The case for a metro core

Many service providers have already started to implement a network convergence strategy from the backbone out, to consolidate packet traffic on one or two (private and public) IP/MPLS backbone networks. The metro is the next logical step. A recent study[1] by Bell Labs found that the cumulative metro traffic is growing by 560 percent, almost twice as fast as backbone traffic, which is forecasted to grow 320 percent in the same period (Figure 3, left).

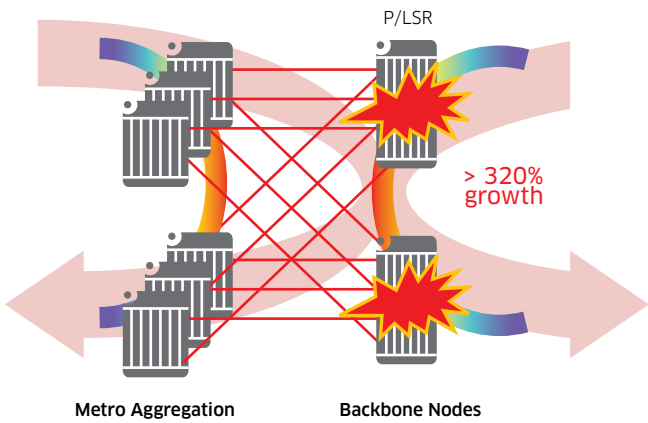
**Figure 3. Traffic evolution in the metro**




The root cause is that the combined growth of business, mobile, cloud and video-on-demand (VoD) traffic amounts to roughly the same as cumulative Internet traffic growth. However, while the majority of Internet traffic is forwarded to the backbone network, the remaining traffic will predominantly be confined to the metro network. Moreover, the ongoing decentralization of IP edge, content caching and cloud application servers in local central offices and data centers further supports this trend to traffic localization in the metro (Figure 3, middle). The result is a shift in the traffic distribution. The study predicts that by the year 2017 up to 75 percent of all traffic generated in the metro will remain within the metro network, with only 25 percent remaining as outbound traffic (Figure 3, right).

Most metro networks (Figure 4) were designed with the assumption that the majority of all metro traffic is destined to centralized content servers, data centers and Internet peering points connected by an IP/MPLS backbone. These designs typically have clusters of metro aggregation nodes feeding into backbone routers. Because aggregation routers have no or limited capabilities to efficiently switch intra-metro traffic themselves, it falls to the backbone nodes to switch this intra-metro traffic, in addition to inter-metro and backbone transit traffic.

**Figure 4. The metro scalability bottleneck**



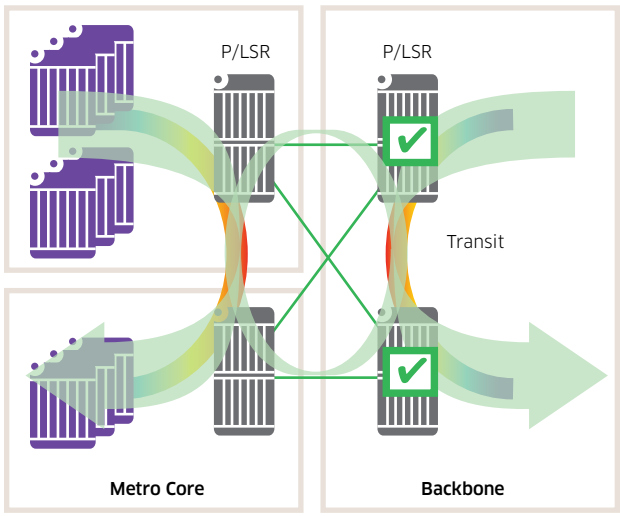

Since a rapidly growing portion of metro traffic growth will remain local, this further compounds the 320 percent scaling requirement that backbone routers already face over the next 5 years. The installed base of core routers has predominantly been designed and optimized for 10 G and 40 G port speeds and scale poorly for 100 GigE and n x 100 GigE link groups that are increasingly required in the metro.

1 Metro network traffic forecast. Alcatel-Lucent Bell Labs. Oct 2013

Upgrading the installed base of core routers is typically a costly investment that only offers temporary relief. Many metro network architects are facing the issue of how to scale capacity in the most cost-efficient way.

Many operators today will look to address growing metro traffic demand by scaling the backbone nodes. This continues to be a valid approach and the Alcatel-Lucent 7950 Extensible Routing System (XRS) is an excellent solution for this. However, a new approach with some very compelling benefits is to introduce a metro core into the metro aggregation network (Figure 5).

**Figure 5. Introducing a metro core**




Introducing a dedicated metro core addresses the backbone scaling issue by offloading this growing intra-metro traffic from the backbone nodes, which can then focus only on switching inter-metro and backbone transit traffic. This creates a natural and logical division of labor with metro core nodes focusing on metro connectivity and intra-metro switching and IP/MPLS backbone nodes dedicating most of their capacity to scaling core-facing network ports and switching transit traffic.

As the majority of metro traffic stays within the metro and most backbone traffic is transit traffic, each core routing platform only needs to dedicate a limited amount of switching capacity to interworking the metro core with the backbone for inter-metro traffic.

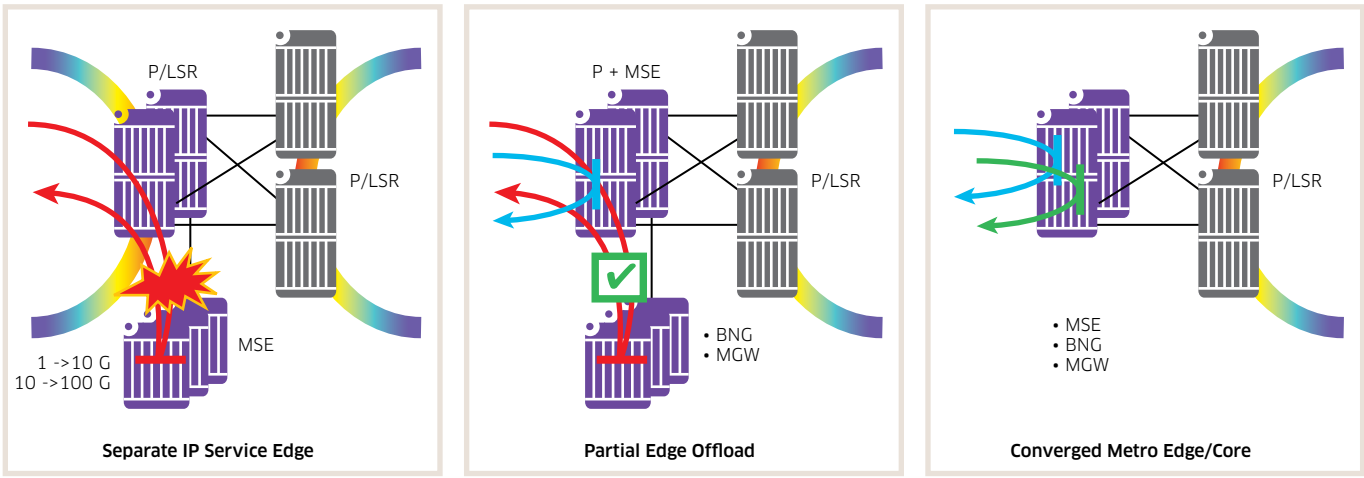
A single 7950 XRS-20 system provides the equivalent capacity of six to ten metro aggregation routers and offloads intra-metro traffic from the backbone nodes. That enables service providers to reduce cost and complexity by collapsing an entire metro aggregation layer in a few metro core nodes and save even more costs by freeing up ports and switching capacity on their existing backbone nodes. Each metro core node is dual-homed to the IP/MPLS backbone nodes for redundancy, which allows scaling metro core and backbone nodes independently to accommodate the fact that metro and backbone traffic grow at different speeds. Introducing a metro core can significantly reduce cost and complexity and open avenues for further cost consolidation at the edge.

## Convergence around the metro core

At present, most metro networks deploy separate IP multiservice edges: a Broadband Network Gateway (BNG) for residential services, Multi-Service Edge (MSE) equipment for virtual leased line (VLL)/VPN business services and a Mobile Gateway (MGW) for mobility services (Figure 6, left).

This scales for low bandwidth services but the average VLL and VPN access capacities for business and wholesale use are experiencing dramatic growth due to increased use of multimedia business content, cloud-based applications, small cells and mobile broadband. Where a decade ago these access speeds were measured in terms of megabits per second, there is now growing demand for access capacity in the order of 10 Gb/s to 100 Gb/s rates. For residential access services, it is not uncommon to see download speeds for services increase to over 100 Mb/s. Since the capacity of the average IP edge router lies in the order of 1 Tb/s, the present mode of operation will quickly exhaust the available capacity and scale poorly.

**Figure 6. Metro edge consolidation**




The solution is to offload the bulk of this traffic from the IP service edge by enabling L2/L3 VPN services for wholesale consumers and businesses on the metro core platform (Figure 6, middle). Rather than backhauling all VPN traffic to separate Provider Edge (PE) routers, the metro core will handle this VPN traffic directly, thereby reducing the cost and complexity of backhauling this traffic to separate IP edge equipment.

The Alcatel-Lucent 7950 XRS runs the same operating system — the Alcatel-Lucent Service Router Operating System (SR OS) — as the 7750 Service Router (SR) with the same comprehensive service features and is managed by the same management system — the Alcatel-Lucent 5620 Service Aware Manager (SAM). VPN services can be enabled on the 7950 XRS through a system-level software license upgrade and do not require any hardware upgrades. Service scalability is more than adequate for access wholesale and business use with up to 192,000 L2 VLLs or ePipes, up to 40,000 VPLS instances and over 10,000 L3 VPNs. Although this scenario provides a partial service offload of the IP edge, it provides a far more cost-efficient growth path for access wholesale and premium business services without changing or introducing any additional hardware.

Alternatively the Alcatel-Lucent 7750 SR-12e provides a convergence option (Figure 6, right) for smaller scale core/edge deployments. The 7750 SR-12e offers comprehensive IP edge features for residential, business and mobile services, as well as a full core routing feature set. Its 7.2 Tb/s switching capacity is sufficient to handle all but the largest metro core deployments. Levering the Alcatel-Lucent 7950 XRS family and the Alcatel-Lucent 7750 SR-12e provides service providers with scalable and flexible options for cost-efficient metro core deployment.

The rate and extent at which operators can adapt their existing operational procedures and support systems to more converged future modes of operation will vary due to operational dependencies. While few operators may be ready to adopt a full convergence strategy on Day 1, over time they must be able to progressively consolidate and converge their network infrastructures as economies evolve. To do so requires the deployment of modular product solutions that support a path to convergence from Day 1 and enable this path in a manner that protects and leverages investments done over the course of this evolution.

## Customer deployment examples

The Alcatel-Lucent 7950 XRS has been deployed in a variety of metro scenarios. Here are some examples:

- An MSO in Europe selected the 7950 XRS for its metro core deployment as it is experiencing rapid growth in its popular triple play service offerings and is implementing an aggressive eco-friendly agenda to reduce its carbon footprint. Through the introduction of the 7950 XRS, they are able to cost-efficiently scale their broadband delivery networks for years to come, and cater to the growth of VoD, broadband Internet and cloud services. A similar use case exists in North America.
- A Tier 1 telecom service provider in Europe that has decided to deploy the 7950 XRS as an outer core, where it is replacing up to six backbone aggregation routers and efficiently interconnecting with an inner-core network from another vendor. This deployment enables the service provider to rationalize their aggregation networks and better scale their backbone infrastructure.
- A Tier 1 full service provider in the US has been experiencing tremendous demand for high capacity Switched Ethernet Services, which was leading to a rapid proliferation of Ethernet Aggregation switches. It decided to deploy the 7950 XRS in the metro core, but also leverages it to deliver Switched Ethernet Services (PBB VPLS) for business and wholesale users. Because this customer had already operationalized the 5620 SAM as well as other Alcatel-Lucent IP products, it was able to introduce the XRS in its existing network infrastructure with a minimal amount of effort. In this new network design, the XRS is handling metro aggregation core and service traffic and interconnects to a separate MPLS backbone for inter-regional traffic.
- A North American carrier is planning to deploy the 7950 XRS as a metro core router with IP edge services support. Because this carrier sees a lot of demand for wholesale connectivity services, the ability of the 7950 XRS to scale capacity with services was exactly what they were looking for.

Besides these metro-centric examples, there are many additional deployments with the 7950 XRS in the IP/MPLS backbone, for data center interconnect, Internet peering and Internet Exchange. This level of platform versatility is essential for a non-disruptive network evolution and for opening up further convergence opportunities to achieve better returns on network investments. Please refer to the 7950 XRS press releases for further detail.

# ALCATEL-LUCENT 7950 XRS

The Alcatel-Lucent 7950 XRS is purpose-built to deliver scalable routing capacity in a dramatically smaller space and power footprint, with the versatility to accommodate multiple roles and requirements in the metro core and the scalability to address current and future core network needs. The 7950 XRS leverages the same industry-leading, in-house developed 400 G FP3 programmable network processor silicon used in the Alcatel-Lucent 7450 and 7750 product families, which enables scale, flexibility and efficiency without compromise.

The 7950 XRS family consists of three products, each addressing the broad range of core routing needs (Table 1).

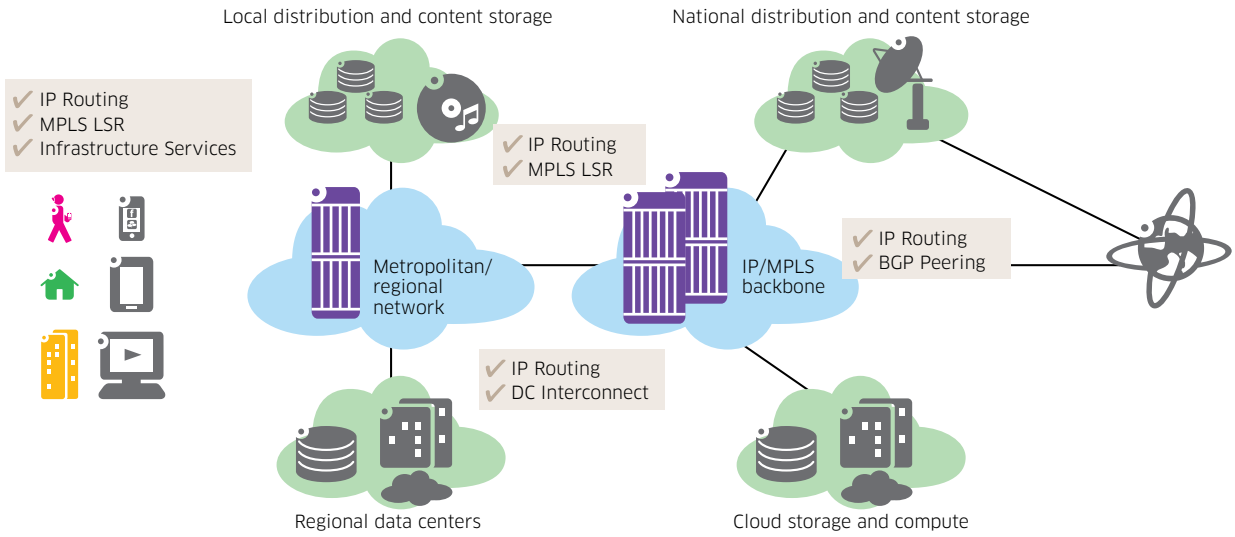
**Table 1. Alcatel-Lucent 7950 XRS[2] product overview**

| SYSTEM MODEL | SYSTEM CAPACITY | INTERFACE SLOTS | 100 GIGE CAPACITY | 40 GIGE CAPACITY | 10 GIGE CAPACITY | EXPANSION OPTIONS | SPACE REQUIREMENT |
|---|---|---|---|---|---|---|---|
| XRS-40 | 32 Tb/s | 40 | 160 | 240 | 1600 | Multi-chassis | 2 racks (19 in) |
| XRS-20 | 16 Tb/s | 20 | 80 | 120 | 800 | XRS-40/multi-chassis | 1 rack (19 in) |
| XRS-16c | 6.4 Tb/s | 16 | 32 | 96 | 320 | Stand-alone | 1 rack (19 in) |

The 7950 XRS has been designed to scale to 1 + Tb/s slot capacity and will scale substantially higher than these initial capacity numbers. The versatility of the 7950 XRS platform offers an economically attractive approach to service providers who need to balance routing (L3) and MPLS switching (L2.5) requirements within the metro or backbone network. From a power, space and operational perspective it is far more compelling to leverage a common versatile platform, than adding dedicated and incremental network elements. XRS platform features are enabled through software licensing based on actual network needs, thus providing a versatile and flexible solution to a variety of core networking requirements in a cost effective, pay-for-use licensing model.

Software licenses are defined at system level and at individual line card levels. Line card licenses allow service providers to enable basic MPLS Label Switch Routing (LSR) and/or full IP routing on related interface ports on those cards. Advanced functionality licenses can enable additional service capabilities including granular QoS capabilities, Layer 2 and Layer 3 infrastructure services, advanced Border Gateway Protocol (BGP) peering, and so on, without requiring any hardware upgrades or changes (Figure 7).

**Figure 7. Versatile deployment options for the metro core and IP/MPLS backbone**




2 Product data is subject to change. Please refer to the data sheets for the current release information.

While already highly cost efficient in itself (consuming 1 watt per Gb/s switching capacity), the 7950 XRS offers common hardware to support all features, where many alternative market solutions require different hardware for different feature sets. XRS Media Adapters (XMAs) contain an FP3-based forwarding complex and perform packet lookup, classification, processing, forwarding and physical media. The XRS-20 and 40 slots support both XMA and Compact XMA (C-XMA) line cards, while the XRS-16c supports C-XMA line cards only.

Currently available are:

- 400 G XMAs offering 4 x 100 GigE ports or 40 x 10 GigE ports
- 200 G C-XMAs offering 2 x 100 GigE ports, 6 x 40 GigE ports, and 20 x 10 GigE ports

A Gigabit Ethernet line card is in the planning stages for lower rate edge services and local central office connectivity.

The Alcatel-Lucent 5620 SAM is a management platform that maximizes operational efficiency by addressing the challenges of managing converged metro networks. It delivers end-to-end service provisioning, monitoring and assurance across the metro access, aggregation, edge and core network domains, which allows unified management of the IP and optical transport layers – from wavelengths to IP routes and MPLS paths. With the 5620 SAM, operators gain the flexibility to logically divide and control workflows between IP/MPLS and optical transport technology focused groups, or to manage both technology domains together.

The 5620 SAM supports the full range of IP/MPLS routing products, in combination with IP integrated optical transport, fixed and wireless access systems. A single converged management system reduces the number of touch points across the network and alleviates the need for operators to manually coordinate multiple management systems. The 5620 SAM provides a single, comprehensive north-bound open interface to facilitate custom operations support system (OSS) integration requirements in multivendor environments with support from market-leading third-party OSS applications that are pre-certified.

# CONCLUSION

The metro has become the key area for traffic growth, capacity investments and network innovation. Mobile broadband, VoD, ultra-fast Internet and the introduction of cloud-based services present new revenue opportunities for service providers, but also place more demands on the network.

Network operators can address these opportunities in a profitable manner by investing in a next-generation metro infrastructure that is cost- and performance-optimized for emerging cloud-services, while supporting a non-disruptive migration of legacy services on a common, converged packet-based infrastructure.

The metro core is the natural point of convergence in the metro network and performs a number of roles:

- Aggregation point for the various purpose-built metro aggregation networks already in place
- Attachment point for data center infrastructure and IP service edge infrastructure
- Access point for the metro network with the IP/MPLS backbone(s) and Internet

The metro core is emerging as a focal point for integrating and consolidating various aggregation networks, IP service edge equipment as well as data center storage and compute resources for cloud-based services.

Alcatel-Lucent's approach for transforming the metro enables a gradual investment strategy that progressively consolidates legacy infrastructure and migrates services on a converged metro infrastructure, while offloading or rationalizing existing infrastructure. The Alcatel-Lucent 7950 XRS and 7750 SR-12e provide scalable, flexible and cost-efficient options to cost efficiently aggregate and switch the burgeoning metro traffic on a scalable metro core platform in combination with existing IP/MPLS backbone nodes.

Further convergence and cost rationalization opportunities can be derived from enabling service edge capabilities in a converged metro core/edge deployment, in order to offload the considerable amount of growing service traffic from business and wholesale users from existing IP edge infrastructure. This provides a more scalable and cost-efficient growth path for the future, without changing or introducing additional hardware.

The result is a more agile multiservice deployment model that scales more cost efficiently and better utilizes complementary traffic patterns from the combination of service demand across user segments.

# ACRONYMS

| | |
|---|---|
| BGP | Border Gateway Protocol |
| BNG | Broadband Network Gateway |
| BTS | base transceiver station |
| C-XMA | Compact XMA |
| GigE | Gigabit Ethernet |
| GPON | Gigabit Passive Optical Network |
| MGW | Mobile Gateway |
| MPLS | Multiprotocol Label Switching |
| MSE | Multi-Service Edge |
| MSO | multiple system operator |
| OSS | operations support system |
| P/LSR | Provider/Label Switch Router |
| PBB | Provider Backbone Bridge |
| PE | Provider Edge |
| QoE | Quality of Experience |
| QoS | Quality of Service |
| SAM | Service Aware Manager |
| SR | Service Router |
| SR OS | Service Router Operating System |
| VDSL | very high bit rate digital subscriber line |
| VLL | virtual leased line |
| VoD | video-on-demand |
| VPLS | virtual private LAN service |
| VPN | virtual private network |
| XMA | XRS Media Adapter |
| XRS | Extensible Routing System |

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