

## A Clear Path to 100Gigabit Ethernet on the Alcatel-Lucent Service Router Portfolio

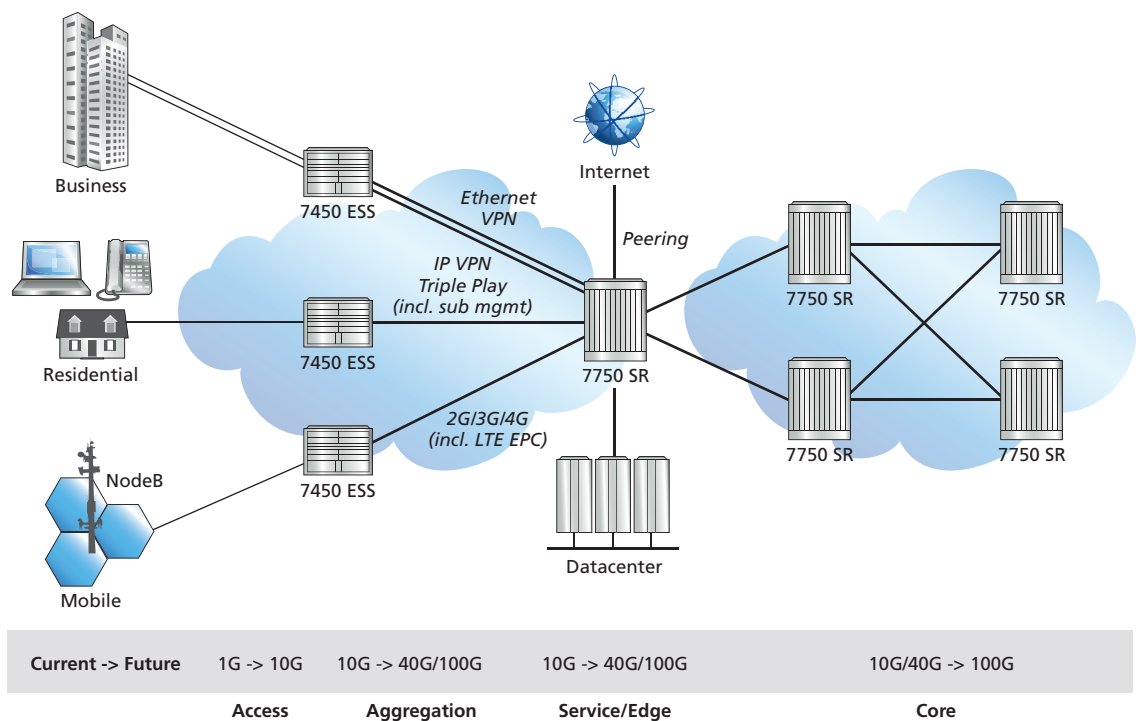
In helping service providers profitably meet the massive bandwidth demands driven by explosive growth in video traffic and sophisticated consumer and business IP services, Alcatel-Lucent is the first to deliver 100 Gigabit interfaces that combine speed, services and industry-leading power efficiency. Leveraging the power and flexibility of innovative FP2 silicon, the service router portfolio goes far beyond faster transport: unleashing powerful 100GigE interfaces that support the full scope and scale of broadband services such as IPTV, Internet access, IP and Ethernet VPNs, Internet peering and LTE mobile broadband — speed, services and scalability with no compromise.

Driven by video, internet traffic continues to grow at an astonishing pace. Broadening interest in Video on Demand (VoD) and walled-garden programming, as well as user-generated multimedia content, will only extend the demands on the service provider network infrastructure as innovative IPTV services and interactive business applications mature. Within a typical day of the Beijing Olympics coverage last year, NBC is estimated to have generated 128 Terabytes (TB) of Internet traffic between streaming video and VoD, accessed by over 3 million live streams and 4 million VoD sessions of various resolutions. By comparison, on a typical day in the same timeframe, YouTube generated over 1100 TB of traffic, serving over 5 billion streams to over 91 million viewers.<sup>1</sup>

In order to profitably keep up with demand, service providers continually seek ways to optimize network infrastructure and reduce the cost per transported bit while extending the service offerings delivered by the network. Higher-speed Ethernet is one solution. With many carriers already running multiple 10GigE links between their routers at large points of presence, and with 10GigE adoption at the aggregation points becoming increasingly prevalent, service providers are eagerly anticipating 40GigE and 100GigE connectivity options. Many are contemplating a direct move to 100GigE, while others are keen to evaluate the economics and availability of both 40GigE and 100GigE in order to optimize their approach.

The introduction of 100GigE links within the core is a necessary step, but proves far from sufficient. While core routers must support the highest speeds in order to optimize the cost of IP transport, the benefits and impact of 100GigE ripple quickly outward. After all, the services that are at the heart of driving increased traffic emanate from the edge. It is at the network edge that a diverse array of residential, business and mobile services meet the network. Figure 1 illustrates the breadth of services that converge on the service edge. The efficient classification and aggregation of traffic streams, application of subscriber management, Quality of Service (QoS) and policy, as well as all value-added processing of flows, occurs in the service routing and aggregation tiers of the network.

**Figure 1. The powerful combination of 100GigE speed along with the full suite of edge routing services**



<sup>1</sup> Nemertes Research, Internet Interrupted, Nov 2008

Higher-speed Ethernet is critical at the edge because it enables operators to simultaneously achieve least cost-bit transport and sophisticated handling of high value revenue generating services such as IPTV, business Virtual Private Network (VPN) and mobile LTE services. Unlike the core, where the proposition is to simply push bits as fast as possible, the challenge at the edge is to simultaneously deliver speed and services. What has become rapidly clear to service providers, however, is that most of their existing edge routers will have difficulty in elegantly supporting 100GigE in their current instantiations.

The Alcatel-Lucent Service Routing platform, on the other hand, is the first in the industry to deliver 100GigE at the edge, where services meet the network. The portfolio is readily extensible to 100GigE, delivering speed without compromising the full scope and scale of broadband services such as IPTV, Internet access, IP VPNs, Ethernet VPNs, Internet peering and 2G/3G/4G mobile transport — speed, services and scalability with no compromise.

In anticipating the need for higher bandwidth interfaces, Alcatel-Lucent invested in the development of an innovative FP2 chipset, the industry's first 100G network processor (NPU) silicon. The FP2 chipset has been commercially shipping in service router (SR) platforms since mid-2008, and remains the only 100G NPU chipset in the marketplace today. The FP2 chipset is fully programmable, delivering massive queuing and classification capabilities and enabling unprecedented service flexibility and scale.

Leveraging FP2 silicon innovation, Alcatel-Lucent offers industry-leading density for GigE and 10GigE, and is the first to announce support for 100G line cards on existing edge routing platforms. In the spirit of service routing, Alcatel-Lucent ensures that interface speeds and densities can scale without compromising services. The full scope of rich layer 2 and layer 3 services supported by the existing platforms will continue to be delivered over the high-speed Ethernet interfaces, and logical scaling of queues and buffers is likewise enhanced. Unlike other implementations where the forwarding plane comprises a combination of lower-speed complexes, the FP2 NPU uniquely positions Alcatel-Lucent for handling 100GigE within a single forwarding complex.

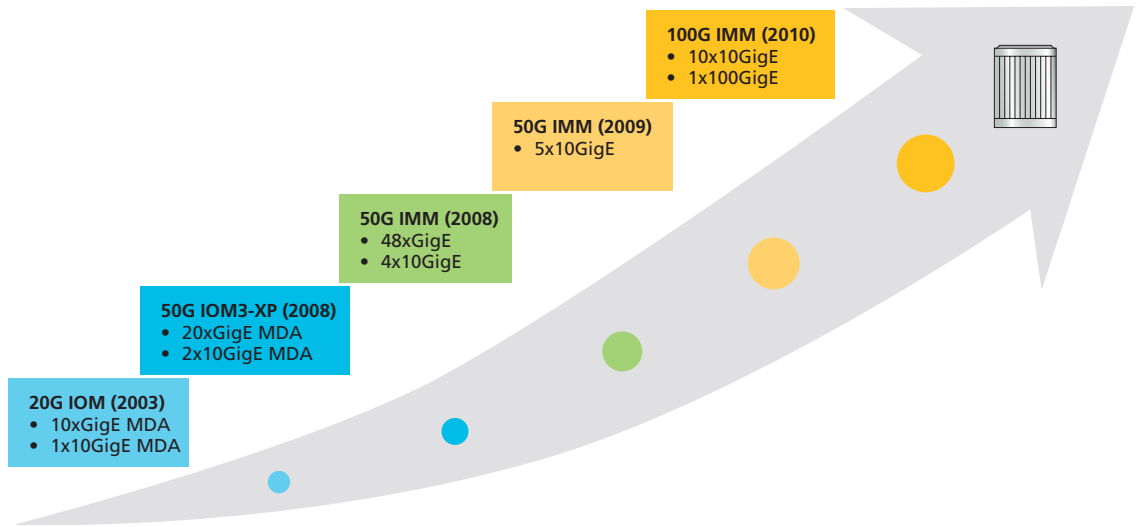
Every chip that is required to support 100GigE interfaces on SR platforms is already in production today. The FP2 silicon has been shipping since mid-2008 and serves as the engine for the Alcatel-Lucent 50Gb/s Integrated Media Modules (IMM) in 48-port GigE and 5-port 10GigE variants. This translates to an industry-leading 10GigE capacity of 150 ports per rack today, extensible to 300 ports per rack in future releases.

In initial implementations, a single 100G FP2 chipset has been utilized in the layout of 50G IMMs, with the chipset being used bidirectionally. In other words, traffic traverses the chipset on ingress as well as egress. In this layout, a line-rate bidirectional throughput of 50G is achieved. The 40GigE interface modules can clearly be supported using this layout, and will be added to the SR portfolio pending customer demand and ratification of the P802.3ba specification by the IEEE.<sup>2</sup>

To enable support for 100GigE interfaces and deliver even higher densities of 10GigE, no new silicon is needed. With the foresight of investing in 100G silicon, the 100G-capacity line cards are derived from a simple layout change. By employing the FP2 unidirectionally and using two chipsets, one dedicated to ingress and another to egress traffic, full line-rate 100G throughput is achieved on any slot within the chassis. In this manner, Alcatel-Lucent customers can leverage the power and flexibility of FP2 silicon to achieve a clear evolution path to 100G interface support on existing systems. Figure 2 summarizes the evolution of Alcatel-Lucent's industry-leading Ethernet density from inception to support for 100G line-cards, leveraging two generations of breakthrough silicon innovation.

<sup>2</sup> The IEEE organized a task force in 2006 to address standardization for higher speeds of Ethernet. The 802.3ba task force has recently published a Working Group ballot. After a sponsor ballot late this year, final approval of the specification is expected in June of 2010.

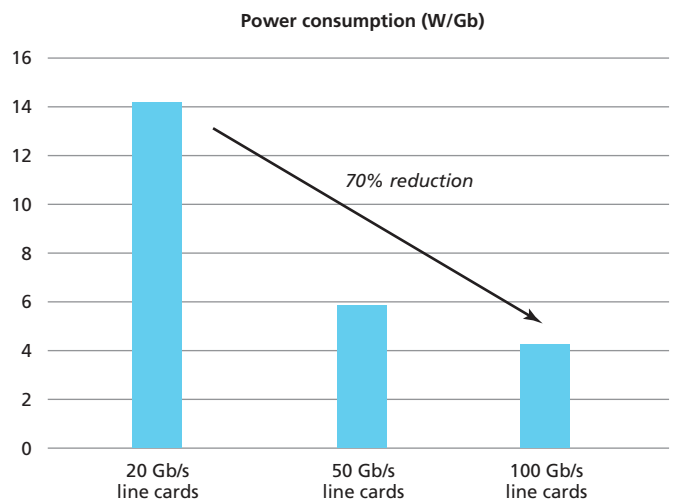
**Figure 2. Evolution of line cards leveraging two generations of breakthrough silicon innovation**



In service providers' minds, optimization of space and power remain key vectors for cost containment. In tune with their needs, higher density 10GigE line cards can also be achieved in this manner. A 10-port 10GigE IMM with SFP+ pluggable optics is planned for the 2010 timeframe, further increasing the 10GigE density advantage of the SR portfolio. Further, Alcatel-Lucent continues to make strides in minimizing the power utilization across the portfolio. By investing in home-grown silicon and optimizing line card designs, effective power utilization (measured in Watts/Gigabit) continues to decline. The current generation of line cards based on the FP2 chipset operate at approximately 6 W/Gb, which is significantly lower than other routers deployed in service provider networks today. With the 100G line cards, Alcatel-Lucent strives to approach power consumption levels approaching levels as low as 4 W/Gb. To this end, Alcatel-Lucent is optimizing thermal efficiency through linear modulation of fans, which reduces power consumption as well as noise. Innovations in silicon optimization such as NPU clock gating techniques to enable clock shut down for areas of silicon not in use are also expected to contribute to enhancements in power efficiency. Over the past five years, Alcatel-Lucent has effectively reduced power consumption per Gigabit of traffic by over seventy percent (Figure 3), and continues to strive for further improvements in power and thermal efficiency.

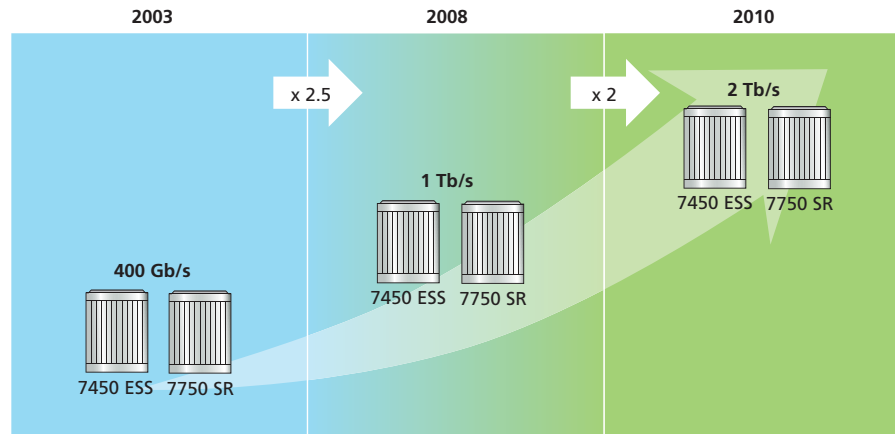
The 40GigE and 100GigE interfaces will give service providers a full range of high-speed Ethernet connectivity options, over time yielding a simpler and more cost-effective infrastructure. The good news is that existing Alcatel-Lucent service routers will support the move to 100G using currently available network processor and traffic manager silicon that was developed with this evolution in mind.

**Figure 3. Continuous reduction in line card power consumption on the SR portfolio**



With consistent silicon innovation and future-proof platform design, and a commitment to continuous capacity enhancement leveraging existing platforms, Alcatel-Lucent delivers scale without compromising full range of service capabilities, resulting in operational consistency and investment protection (see Figure 4).

**Fig 4. The Alcatel-Lucent SR portfolio offers proven investment protection**



This design mentality has enabled the SR platforms to scale from 400 Gb/s at inception to 1 Tb/s, while and will ensuring that the same systems will scale to 2 Tb/s with 100GigE ports capable on each slot.

Since 2003, Alcatel-Lucent has shipped more than 35,000 IP/MPLS service router portfolio systems, deployed by over 270 service providers in over 100 countries. Earlier this year, Alcatel-Lucent took over the #1 position in IP Edge Routing in the Europe, Middle East and Africa regions according to Infonetics and reinforced its #2 global position in edge routing. Innovations such as the seamless introduction of 100GigE interfaces on existing systems result in continued investment protection for our service provider customers as they profitably expand their services and networks.

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