STRATEGIC WHITE PAPER

A CLEAR PATH TO 100GIGABIT ETHERNET USING THE ALCATEL-LUCENT SERVICE ROUTER PORTFOLIO

Abstract— Network bandwidth demand continues to grow within U.S. Government Agencies due to the use of collaboration, sophisticated IP services, and multimedia applications. Agencies can meet this demand by offering 100G IP/MPLS networking services at the WAN edge. Alcatel-Lucent was the first to deliver 100 Gigabit interfaces for IP/MPLS Edge Services, doing so with the development of the innovative FP2 chipset, the industry's first 100G network processor (NPU) silicon. Alcatel-Lucent raised the performance bar again with the introduction of the FP3 chipset this year. Each generation of the FP chipset provides advances in power efficiency, supplied bandwidth, scalability, and innovative network services. This whitepaper discusses these FP chipset advances and the resulting benefits to Federal Government agencies.

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I. INTRODUCTION

With a heavy focus on science and research in today's Federal Government landscape, data networks are feeling the pressure of an increased demand on resources. To help meet this demand, LGS Innovations and Alcatel-Lucent have taken a leadership position in the industry as the only supplier to offer deployable 100G solutions in both the IP and optics domains. Not only is 100G next generation technology an innovative and economically viable solution for new deployments, but the power of 100 Gigabit Ethernet (100GE) supports speed, services, and scalability with no compromise.

LGS Innovations and the U.S. Department of Energy's (DOE) Energy Science Network (ESnet) are teaming to build a nationwide 100 Gigabit per second Ethernet (100GE) network that will accommodate ESnet's anticipated tenfold increase in science data traffic volume over the next four years and beyond.

Managed by Lawrence Berkeley National Laboratory (Berkeley Lab) and funded by the DOE Office of Science, ESnet is building a new 100GE network through the Department of Energy's Advanced Networking Initiative (ANI). Under the agreement, LGS Innovations will provide the 7750 Service Router (SR) from Alcatel-Lucent for ten points of presence across ESnet's national backbone as well as directly at select laboratory sites. LGS is providing this solution through a competitively awarded subcontract with Synchronized Networking Solutions, LLC

The new network will first be built as a prototype connecting the DOE Office of Science's three leading computing facilities — the National Energy Research Scientific Computing Center (NERSC) in Berkeley, California, the Argonne Leadership Computing Facility near Chicago, Illinois, the Oak Ridge Leadership Computing Facility in Oak Ridge, Tennessee, and the MAN LAN international exchange point in New York. By the end of 2012, ESnet will transition the network to production, deploying 100GE connections across its entire footprint to provide these enhanced capabilities to researchers across the country.

II. EVALUATING THE NETWORK

In helping government agencies meet the massive bandwidth demands driven by explosive growth in collaboration, sophisticated IP services and multimedia applications, 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 and FP3 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 voice, data and multimedia services, and the proliferation of IPv6 addressed end devices, government traffic continues to grow at an astonishing pace. Broadening use of such services as Video on Demand (VoD), collaborative/interactive applications, Virtual Reality, multimedia content, supercomputing applications, E-Gov, Web Services, the Semantic Web and Unified Communications continues to put further demands on the government network infrastructure.

In order to keep up with this demand, government agencies must continually seek ways to optimize their WAN infrastructure and reduce the cost per transported bit while extending the service offerings supported by their network. Higher-speed Ethernet is one solution. With many agencies already running multiple 10GigE links between their routers and with 10GigE adoption at the aggregation points becoming increasingly prevalent, 40GigE and 100GigE connectivity options will be required to stay ahead of the bandwidth demand curve. Agencies will need to consider moving to 100GigE, which will require evaluating the economics and availability of both 40GigE and 100GigE in order to optimize their approach.

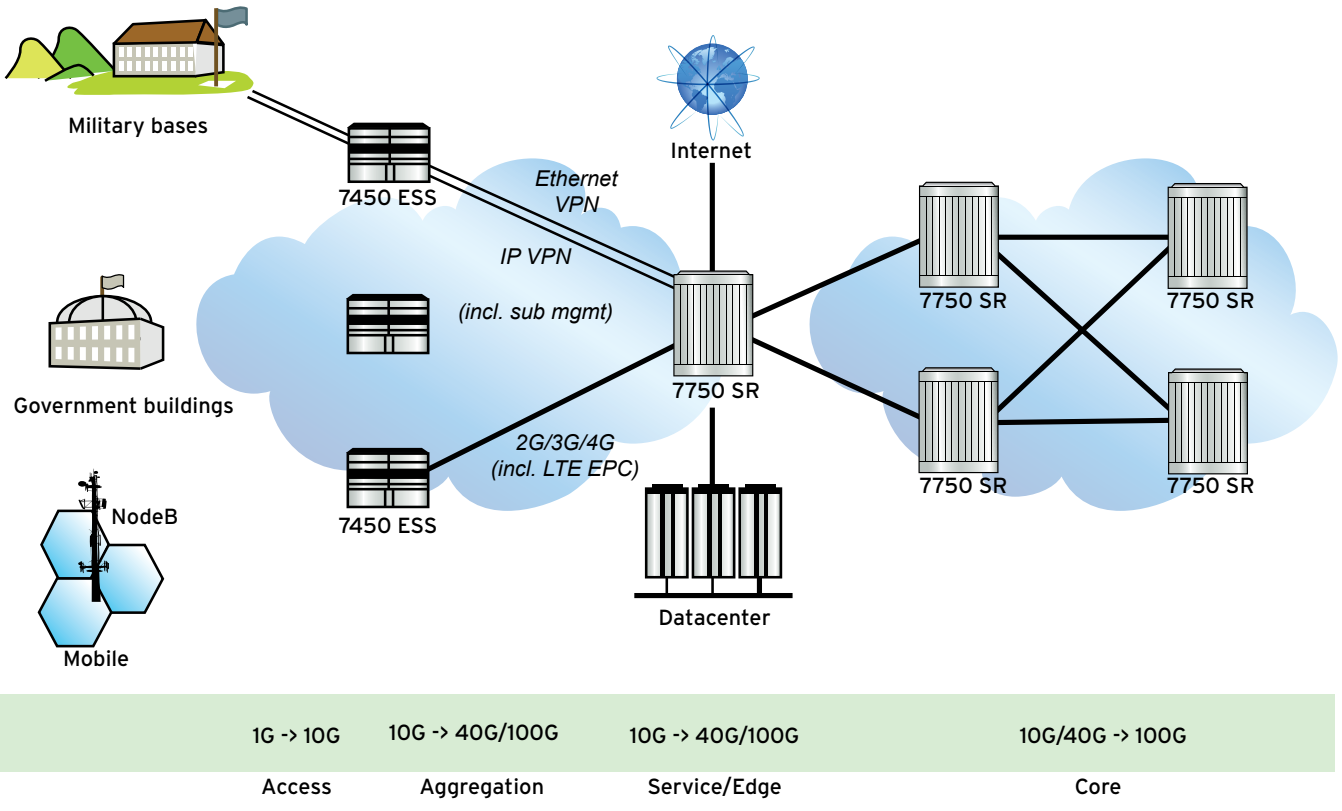

FIGURE 1

The powerful combination of 100GigE speed along with the full suite of edge routing services

The introduction of 100GigE links within the WAN core network is a necessary step, but proves far from sufficient. While core WAN routers must support the highest speeds in order to optimize the cost of IP transport, the benefits and impact of 100GigE ripple quickly outward to the WAN edge. After all, the services that are at the heart of driving increased traffic emanate from the edge. It is at the network edge where a diverse array of government application services originate. 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 points of the network.

Higher-speed Ethernet is critical at the edge because it enables agencies to simultaneously achieve least cost-bit transport and sophisticated handling of important, mission critical services such as collaboration, IPTV, and business Virtual Private Network (VPN). The challenge at the edge is to simultaneously deliver speed and services. What has become rapidly clear, however, is that most of the current generation of edge routers will have difficulty in elegantly supporting 100GigE while supporting edge services.

III. SERVICE ROUTING PLATFORMS FOR SERVICE AND NETWORK NEEDS

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/LTE mobile transport — speed, services and scalability with no compromise.

In anticipating the need for higher bandwidth interfaces, Alcatel-Lucent invested in the development of the innovative FP2 chipset, the industry's first 100G network processor (NPU) silicon. The FP2 chipset has been commercially shipping in the 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 was 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 100Gb/s Integrated Media Modules (IMM) in 48-port GigE and 12, 8 or 5-port 10GigE variants. This translates to an industry-leading 10GigE capacity of 360 ports per rack today.

In initial implementations, a single 100G FP2 chipset has been utilized in the layout of 50G IMMs, with the chipset being used bi-directionally. 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 interface modules can clearly be supported using this layout.

To enable support for 100GigE interfaces and deliver even higher densities of 10GigE, no new silicon was 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, i.e. the FP1 and FP2 chipsets.

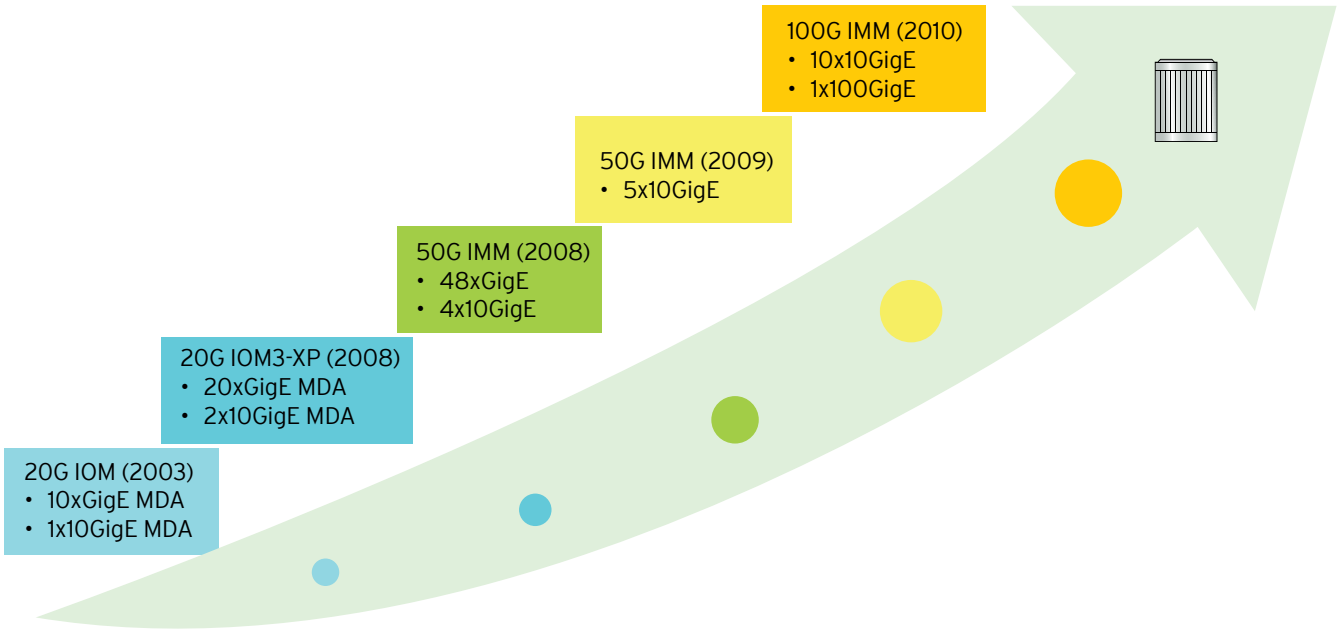

FIGURE 2

Evolution of line cards leveraging two generations of breakthrough silicon innovation

Alcatel-Lucent is raising the performance bar again with the introduction of the FP3 chipset in 2012. The FP3 is the third generation Alcatel-Lucent network processor design. Each generation of FP chips has built on the features of the previous generation, providing feature continuity and consistency, while increasing speed and adding functionality. This feature continuity allows the SR portfolio to seamlessly support all generations FP processors while benefiting from the latest performance improvements. Figure 3 summarizes the chip technology and computational specifications of each FP generation. Alcatel-Lucent is the first to market with a 400 Gb/s network processor array optimized for the delivery of 400 Gb/s Ethernet services. The FP3 network processor delivers 4x the performance of the nearest competitor, i.e. Alcatel-Lucent's own 100 Gb/s FP2 network processor, while reducing power consumption per packet by >50%. As the third generation of in-house designed network processors, FP3 is the new foundation for the continuing evolution of Alcatel-Lucent's Service Router portfolio. Alcatel-Lucent has announced a new family of high-performance, high-density service line cards for the 7750 SR and 7450 ESS based on the new FP3 network processor. The Alcatel-Lucent 2-port 100G and 20-port 10GigE Integrated Media Modules are supported with the FP3 chipsets. This translates to an industry-leading 100G capacity of 60 ports per rack and 10GigE capacity of 600 ports per rack

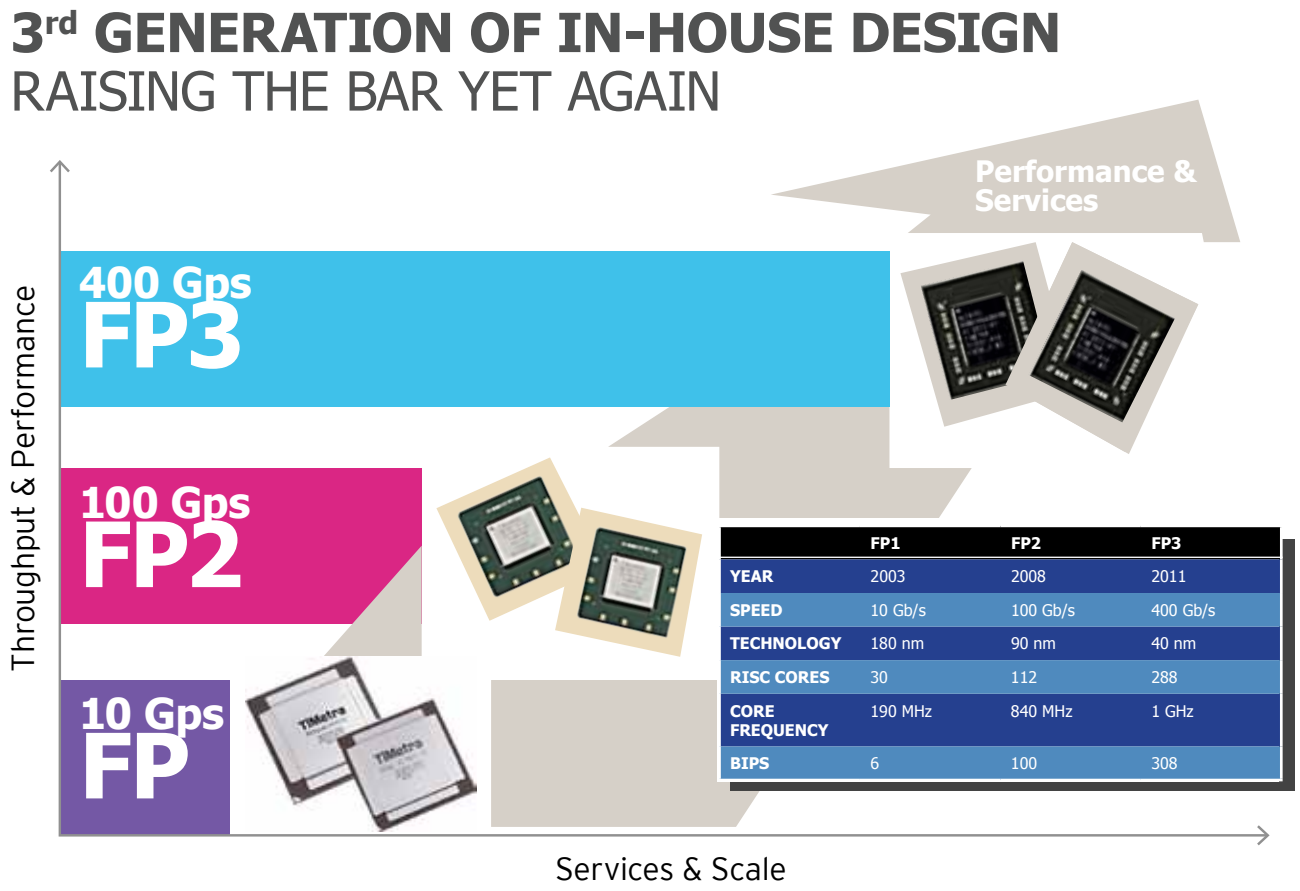

FIGURE 3

Evolution of Alcatel-Lucent Service Router Network Processor Unit

IV. INCREASING NETWORK EFFICIENCY

Optimization of space and power remain key vectors for cost containment with government agencies. Over the past five years, Alcatel-Lucent has significantly and effectively reduced power consumption per Gigabit of traffic (Figure 4), and continues to strive for further improvements in power and thermal efficiency. 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. Line cards based on the FP2 chipset operate at approximately 6 W/Gb. Alcatel-Lucent optimizes 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. Alcatel-Lucent FP network processors have active power management built into the chip design. The network processor is able to turn off portions of the chip where features are not being used, to ensure optimal energy efficiency when being used for different applications. FP3 chipset implementation reduces the power consumption per packet processed even further. The FP3 based 400 Gb/s line card operate at approximately 2W/Gb. The 400 Gb/s design translates into power efficiency improvements for line cards, common equipment, and overall network operations. At the card level, with 400 Gb/s of processing capacity available through a single network processing chipset, fewer power-hungry network processors are required to deliver the same amount of bandwidth, reducing the watts consumed per Gigabit of traffic delivered. As cards increase in port density, fewer cards are required to meet bandwidth demand, thereby reducing the amount of common equipment required. Higher performance network processors also support the trend towards the convergence of multiple overlay IP edge networks onto a common platform, reducing the number of distinct nodes in the network, and hence reducing the overall power required to offer a full range of IP services.

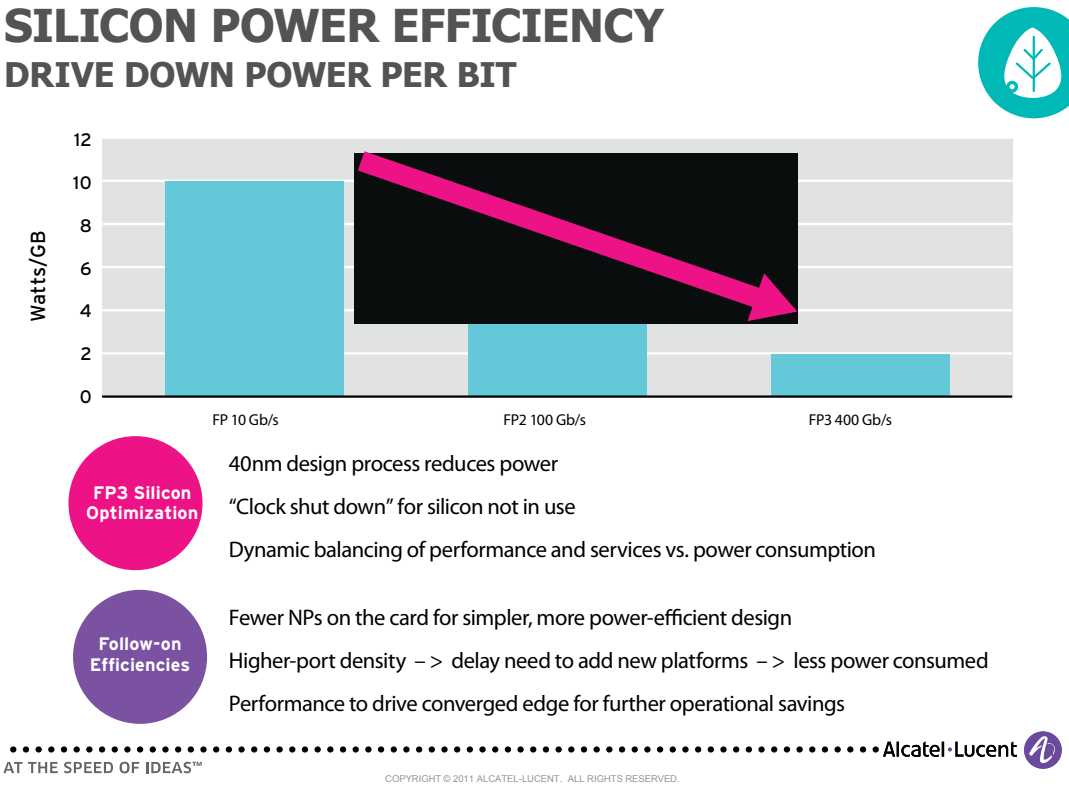

FIGURE 4

Continuous reduction in line card power consumption on the SR portfolio

V. CONCLUSION

The 40GigE and 100GigE interfaces give agencies 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 support the move to 100G using currently available network processor and traffic manager silicon that was developed with this evolution in mind.

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 5).

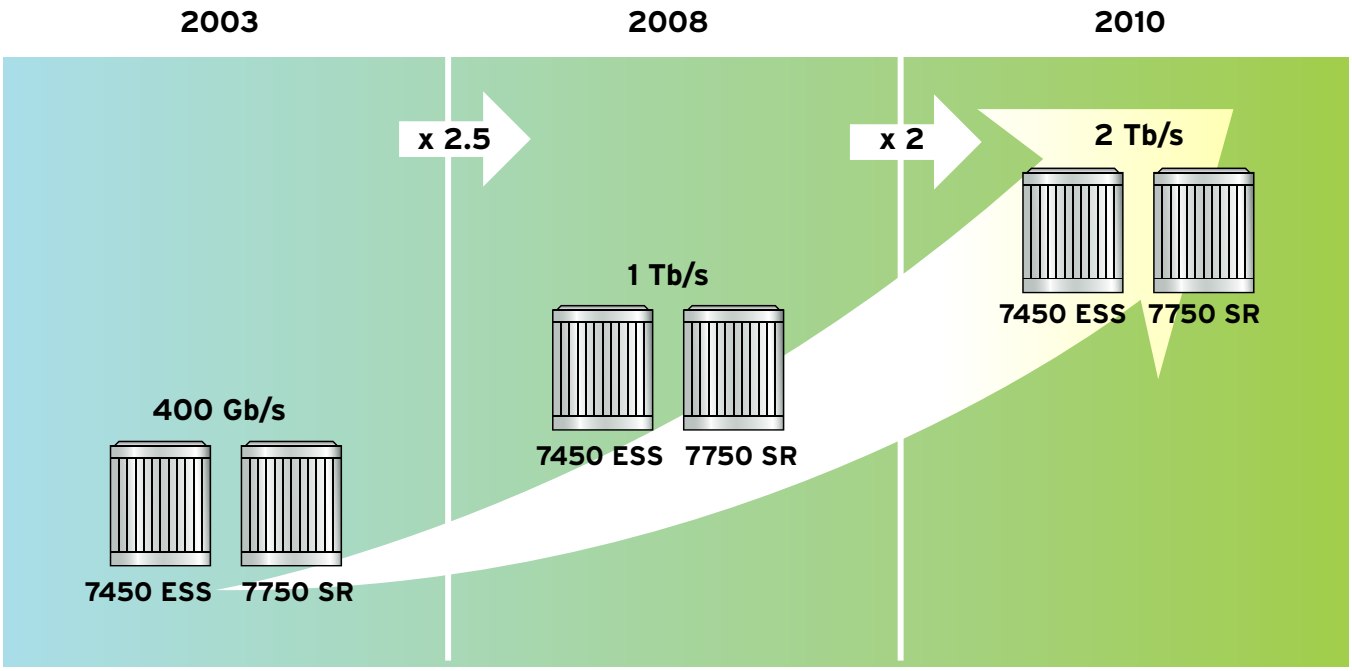

FIGURE 5

The Alcatel-Lucent SR portfolio offers proven investment protection

Since 2003, Alcatel-Lucent has shipped more than 200,000 IP/MPLS service router platforms, deployed by over 440 customers in over 100 countries. Alcatel-Lucent is #2 globally in edge routing. Alcatel-Lucent Service Router Portfolio continues to grow quarter-over-quarter and year-over-year faster than the Service Provider Edge Routing market. Innovations, such as the seamless introduction of 100GigE interfaces on existing systems, result in continued investment protection for our customers as they expand their services and networks to provide value to their users.