

PROFITING FROM NETWORK EFFICIENCY

Achieving Operational Efficiencies with
Juniper Networks Infrastructure

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Executive Summary

In the past year, discussions about environmental responsibility in the business world have reached fever pitch. The telecommunications and networking industries have been no exception. Where previously, energy efficiency was little more than an afterthought in marketing, sales, and engineering activities, it has now become a critical component of all three.

However, in the networking industry at least, little has been done to look at the big picture: namely, how to create an environmentally responsible—and profitable—network-based business. Point products have been evangelized for their energy saving capabilities (though often calculated without any standardized metric), but energy efficiency of network elements is only a small part of a network operator's total environmental footprint. Network reliability, management systems and processes, and even geographic location all have an impact—positive or negative—on a business's social responsibility.

This paper seeks to elevate the corporate responsibility discussion in the networking industry beyond oversimplified product energy consumption comparisons. We will examine the role that hidden costs due to operational inefficiency play in evaluating a corporation's environmental footprint.

Decision makers will learn how Juniper Networks' vision for a next-generation network (NGN) can help them build a profitable, efficient business—and not just by reducing the power consumption of routers (although that's a part of it), but rather by enabling efficient operations as a whole.

Introduction

The telecommunications industry, like most businesses, faces pressure on both profits and margins, as well as increasing pressure to be socially conscious about environmental issues—something now called Corporate Social Responsibility (CSR). At times, CSR initiatives have been more form than substance, in many instances because there is a perception that CSR goals have to be balanced against market goals and shareholder interests.

At Juniper Networks®, we believe that corporate needs for profitable operation and societal needs for responsibility and stewardship of the environment need not be opposing forces. Rather, the starting point for this new and meaningful solution must be in recognizing that both goals can be achieved by pursuing a single focus: efficient operations.

The transformation of materials, ideas, and manpower into goods and services is the foundation for all economic activity. If any aspect of that transformation is inefficient, it consumes resources that impact profitability (at a micro level) and (at the macro level) deplete the global store and pollute land, oceans, and air. To address business, social/ethical, and environmental needs all at the same time, companies must relentlessly pursue operations efficiency. That is true in every industry, and particularly in telecommunications.

In the telecommunications industry, inefficiency can take many forms: from the transformation of electricity to power equipment that processes and transports the bits; to the use of ideas and manpower to manage the networks and services.

Juniper has been building efficient products long before terms such as "green networking" or CSR were ever coined—not because we foresaw how fashionable these terms would become, but because efficiency is an aspect of good engineering. Our model for operations efficiency encompasses the whole of the product life cycle, not just the out-of-the-box energy consumption rating, but the impact of factors that are less easily quantified, but just as real, such as reliability and operational simplicity.

Juniper's model for optimal network efficiency creates business benefits for the builders and operators of networks, which consequently have a positive impact on the environment that surrounds us all. It's a model that is based on fact, sound engineering principles, and a long-term vision of where the network is headed. Thus, it's a model that can be implemented to improve profits (rather than the other way around), and is a model that can be sustained and expanded in the real world.

A Realistic Look at Operations Efficiency

A sustainable drive for “green technology” has to be a part of a business transformation process that generates direct benefits to the bottom line. Operations efficiency can save operations costs, power consumption, fuel consumption, and greenhouse gas generation. If all of these goals are accomplished, then efficiency pays for itself—and more.

The challenge for service provider planners is figuring out just what operations issues have the greatest impact on efficiency, and how to target them. Furthermore, transformational planning must consider the benefits—and costs—of improving efficiency overall. For service providers, that means looking at operations from the top down, and looking at operations cost elements in a realistic and consistent way.

A Starting Point

A good starting point for any discussion about improving efficiency is the power consumption of the network equipment itself. Much has been written recently about how much power the Internet consumes. Estimates typically hold the Internet infrastructure responsible for 1-2% of the world’s carbon emissions—approximately the same as the much more environmentally maligned airline industry.

And network and computer equipment power is certainly a factor in operations efficiency. A single rack of network equipment consumes about 10 kWh of power directly, and when HVAC and power conversion and storage costs are included, the number jumps to 24 kWh. Server systems actually consume more—about 13 kWh/rack in direct power or about 31 kWh with HVAC and power conversion considered. The cost of this power averages about 9 cents per kWh, and each kWh consumed creates 1.3 pounds of carbon dioxide.

Since it is an important goal in the operations efficiency spectrum, network and computer power consumption has already begun to receive much attention. Equipment vendors—Juniper included—rarely launch products that do not make some reference to improved power consumption statistics, either in relation to competitors, or to previous generations, or to both.¹

In addition to the issues associated with reliably reporting energy consumption of network equipment, total network and computer equipment power consumption is even more difficult to calculate because a significant majority of a network’s total power consumption is based on the overall network architecture. Regardless of how energy efficient each network element is, the network as a whole cannot be efficient if resources are inefficiently utilized. Unlike other types of equipment, the power consumption of today’s network equipment is not load-dependent: a lightly utilized router consumes nearly the same amount of electricity (and HVAC and space) as a fully loaded router.

In short, any discussion of network power consumption should consider architectural efficiency, as well as elemental efficiency.

The Other Side of Inefficiency

While direct network power consumption should be a critical element of any campaign to improve operations efficiency, it should be seen as only one piece of the puzzle. An efficient service provider operation serves customers with more efficient network and IT technology, but just as importantly, an efficient operation serves customers with fewer truck rolls, fewer service calls, and more streamlined management systems and processes.

It will come as no surprise to most readers that service providers spend about 55% of their direct network budgets on the management and support of the network, as compared to only 45% on network equipment. Within this 55%, operations costs can be categorized in three major groups accounting for 30%, 40%, and 30%², respectively, of total operations costs:

- Service creation/provisioning
- Fault and problem management
- Upgrading and integration of services and components, including with partners

¹For more information on Juniper’s power efficiency in T Series routers, see www.juniper.net/us/en/local/pdf/whitepapers/2000284-en.pdf.

²“Market-Area Focus”, Netwatcher Volume 26.7 July 2008, CIMI Corporation

Clearly improving the efficiency of operations—with a focus on these three areas—has the ability to have a significant impact on a business's bottom line. Likewise, reducing support and operations costs can have an enormous impact on the carbon footprint and energy use of the service provider as well.

As an example, consider an average truck roll for a service provider. Assuming it requires 5.5 miles of incremental driving, this one call consumes enough fuel to be the equivalent of 13 kWh of electricity. The truck roll also produces about 14 pounds of carbon dioxide and the call center staff about 3 pounds.

If a single truck roll is generated by a given customer relationship every three years, that's about 900 truck rolls per day per million customers. To support a customer base of 5 million broadband users, about 400 vehicles and technicians would be required. Obviously, this seemingly modest level of interaction would have an enormous cost and an enormous environmental impact.

Even tasks that happen within the network operations center (NOC) have an environmental impact. The average worker in a call center or office environment consumes about 2.3 kWh in power for HVAC, communications, and computer equipment. If every customer generates a single support call per year, that equates to 2,740 calls per day per million customers. To support a customer base of 5 million broadband users, the call rate given here would require a call center of 200 agents.

These two examples help highlight how one aspect of operations can have a dramatic effect on the efficiency of a service provider as a whole. Simply by improving network reliability, service providers can reduce the costs—environmental and fiscal—of the 40% of operations budget that goes to fault and problem management by reducing the need for truck rolls and call center resources. Similarly, the other two areas of operations costs—service creation/provisioning and upgrading/integration—can bring similar gains if providers can improve the efficiency of these two tasks, reducing the number of employees and truck rolls required.

To summarize, thus far we have learned that service providers can drive efficiency by focusing on two major improvement areas—the power consumption of the network and the efficiency of operational tasks. Taking this a step further, the table below breaks out these two major categories into a total of five focus areas, and outlines what can be done from a network perspective to drive improvement.

Table 1: Focus Areas For Overall Network Efficiency

	OPERATIONAL FOCUS	OVERVIEW	WHAT TO CONSIDER
Power Consumption	Element efficiency	Power consumption of individual network elements	Efficiency of network elements, using standardized metrics where possible
	Architectural efficiency	Power consumption of network as a whole	Element utilization levels and design of the network as a whole
Operations Improvements	Service creation and provisioning	The turn up and creation of new services and associated staff costs	Service delivery speed; automation vs. manual provisioning
	Fault and problem management	Resolving customer service issues (accounts for 40% of operations costs)	Reliability of network to reduce needs for service calls
	Upgrading and integration	Software upgrades and installation/compatibility testing of new hardware	Network operating system

In broad terms, operations efficiency can be improved by reducing power consumption, reducing network problems that generate service outages and customer complaints, and improving the reliability, availability, and serviceability of the infrastructure that delivers service features and content.

Technology Choices to Optimize Operations

Through our portfolio of service provider routing, control plane, and policy management solutions, Juniper Networks can help service providers optimize their operations in all five areas referenced above—driving profitability while at the same time meeting, improving, and reducing environmental impacts to accomplish CSR and environmental objectives.

Reducing Network and Element Power Consumption

Following the structure outlined above, and starting with the most obvious and simplest, Juniper’s first initiative is to reduce network element power and resource consumption. Traditionally, the growth in the number of routing elements directly corresponds to the growth in traffic as a whole, so as the Internet has grown, so too has the power consumption of routers. Over time, the efficiency of routers has improved on capacity-to-power consumption, but there is still work to be done here.

On a platform-by-platform comparison, Juniper routers use as much as 40% less power than comparable products from competitors, creating a savings of an average of 4 kWh per rack of equipment. This can be as much as 10 kWh when HVAC and power conversion efficiencies are factored in. That 10 kWh represents 13 pounds of carbon dioxide per hour, per platform. Multiplied over hundreds or even thousands of network elements, these savings can be considerable.

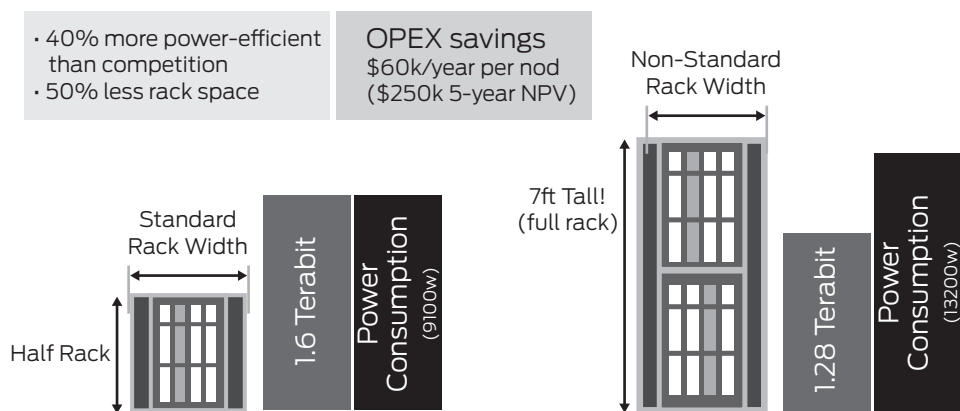


Figure 1: Example product energy consumption comparison

Improving Architectural Efficiency

With Juniper’s unique ability to virtualize core routers—enabled by the Juniper Networks JCS1200 Control System and Juniper Networks T Series Core Routers—Juniper is also helping service providers address architectural efficiency. Virtualization enables network operators to converge multiple networks onto a single physical routing system, enabling them to achieve far more efficient levels of utilization (while keeping organizational boundaries intact). Because routers use essentially the same amount of energy regardless of their utilization levels (much like idle PCs before “sleep mode” was invented), using virtualization to converge networks can lead to dramatic gains in energy efficiency beyond the immediate advantages offered at the systems level.

Network operators can virtualize their entire network, including all network equipment and all of the Session Description Protocols (SDPs) and servers creating service features or managing services processes, as a single resource pool. Applications and features can be hosted on that pool in an optimum way, securing the largest possible base for resource economies of scale and reducing the total number of servers needed. That reduces the power and emission load. According to a study by Network Strategies Partners, service providers can gain an additional 40% reduction in power requirements at the network level when implementing a core virtualization solution.³

Taking this a step further, cloud computing can also be used to move network/service assets to locations where power costs are lower, where HVAC is less a factor, and where worker commuting adds fewer miles of vehicle operation. A recent article in MIT’s Technology Review⁴ suggested that Internet companies could save as much as 40% of their energy costs by dynamically routing traffic to areas with lower power costs.

³See Business Case for Core IP Network Virtualization at www.juniper.net/us/en/local/pdf/whitepapers/bus_case_core_virtualization.pdf.

⁴Energy Aware Internet Routing, MIT Technology Review, August 17, 2009.

Driving Efficiency Through Operations

At the operations level, Juniper solutions enable operational improvements in all three areas identified above—service provisioning and creation, fault and problem management, and upgrading/integration. Starting with service provisioning and creation, Juniper has several initiatives which help service providers introduce services more quickly, using less manpower and fewer truck rolls.

Service Management

The first such initiative is to improve service-to-network integration to facilitate service management. Juniper recognized from the start that services were a combination of a set of management processes and a set of control plane functions. Switching/transport is a data plane function. By separating the control and data planes of hardware both at the device level and in the design of Juniper Networks JUNOS® Software, Juniper created a structure where control plane handling had no effect on the performance of the data plane, enabling much more robust service handling capabilities. With the introduction of the JCS1200 Control System, Juniper took this a step further—enabling, for the first time, control plane resources to be scaled in a way that was independent of forwarding capacity, and supporting virtualization of a single network into any number of service overlays.

This virtualization enables more efficient network utilization as noted above, but the power of independent control plane expansion power can also be used to add service features to the network. These independent control plane features can then be effectively managed to provision and sustain customer experiences more efficiently.

In addition, the Partner Solution Development Program (PSDP) allows third-party developers and integrators to customize the open, separate control plane of JUNOS and Juniper hardware to create a very tight bond between services and packet forwarding. Both service providers and developers/integrators are already using PSDP to create service-specific traffic handling and monitoring.

Complementing all of these capabilities is Juniper Networks C Series Controllers, which host the Juniper Networks Session and Resource Control (SRC) Modules. Together, the C Series and SRC applications can create coordinated service behavior across multiple devices and are easily integrated with service layer technology using XML templates. By taking a “service layer” request and translating it into device commands, the SRC reduces the operational complexity of service setup, assurance, modification, and termination. In fact, SRC support a completely abstract service-to-resource connection and can even be used with non-Juniper hardware to increase the scope of service layer/network layer integration.

The Open IP Service Creation Program (OSCP) is a developer/integrator program built around the open interfaces of the SRC. OSCP applications can leverage not only the SRC but also, through it, all of Juniper’s devices, all JUNOS Software features, and even applications and services built using control plane separation, JCS1200, and the PSDP. The OSCP is also Juniper’s flagship in the emerging area of service componentization, and supports TeleManagement Forum (TMF) management standards that Juniper pioneered through its IPsphere Forum leadership.

The PSDP and OSCP programs provide operators with the ability to customize management and control plane behavior and add service/network control applications that meet their specific needs. These applications can not only control and monitor resources, they can also secure the network and network interconnect points, a capability that adds significantly to network reliability and stability—again, improving operations efficiency.

Availability and Reliability

Network reliability and stability brings us to the second item on the operations portion of our discussion—driving operations efficiency improvements in fault and problem management. Clearly the most effective way to improve efficiency of fault resolution is to strive to avoid faults in the first place, meaning any discussion of this area must start with improvements in network reliability, availability, and resiliency.

Juniper calls its approach to high availability “continuous systems,” reflecting the company’s overall goal to provide systems that do not disrupt or degrade service. At Juniper Networks, continuous systems is a culture—not a single feature, protocol, or product. Continuous systems means addressing all of the potential areas that can cause service degradation and outages. It’s about a complete, all-around approach that looks at potential causes of problems and finds ways to mitigate them to maintain service-level agreements (SLAs). Some of the specific Juniper Networks continuous systems components include nonstop active routing (NSR), which relies on the modular, fault-tolerant JUNOS Software network operating system to provide:

- Uninterrupted routing and forwarding
- Unified in-service software upgrade (ISSU), which makes it possible to replace an entire operating system without an interruption in routing
- JUNOScript Automation, a powerful set of scripts for on-box problem detection and resolution
- Advanced Insight Solutions (AIS), a suite of tools that embeds Juniper engineering expertise directly into routers and other network devices

Further capabilities are contained in the key strategic Juniper initiative of orchestration, which we define as software tools to perform service-specific tasks automatically in response to conditions, or manually on demand, with interfaces that are customized to the management systems or operations practices in use. The goal of this initiative is to eliminate the increase in network support incidents now associated with higher level services, and thus to control operations cost growth as new service opportunities multiply. We believe that this initiative will result in substantial reductions in overall operations costs for all next-generation packet-based services—Ethernet or IP.

Beyond the capital and power/environmental savings outlined above, virtualization can create significant benefits operationally. There are many initiatives for componentizing service and service management software to promote reuse of elements, support syndication of components of services across multiple provider partners, and create a set of service interfaces that can be exposed to developers. These initiatives need a stable computing infrastructure on which to run, or they threaten to generate another burst of operations cost escalation.

Virtualization and cloud computing provide this infrastructure. Their ability to assign, and reassign applications to resources ad hoc reduces failures by improving the performance and availability of server/SDP assets used in the creation of NGN features and services.

Every service outage generates customer complaints, and every customer complaint must be handled by a call center. In many cases, complaints will result in field service personnel being dispatched, simply because it may be impossible to determine the root cause of the problem. By making service layer infrastructure more reliable, complaints are reduced, and the efficiency of the service provider as a whole is increased. Customer loyalty is also enhanced, reducing churn and customer acquisition costs.

Upgrading and Integration

The final piece—which is implicit in all of the points above but which we call out specifically here—is Juniper’s support for a single JUNOS operating system software version across all major service provider products. This creates an operational unity that is literally unparalleled in the industry. Because all network elements are running the same software and even the same software version, the chance of creating unstable network behavior by mixing software elements that are not fully compatible is virtually eliminated.

A study from Forrester Research shows that the single JUNOS Software code base can reduce operations problems associated with network upgrades and enhancements by between 33% and 50%⁵. In addition, we’d point out that the most publicized packet network service failures of the past, and the ones with the widest impact on customers and the greatest total cost, were associated with problems created during an upgrade to software or hardware, or created by versioning problems in the software itself.

⁵Refer report by Forrester Consulting: The Total Economic Impact™ Of Juniper Networks’ JUNOS Network Operating System

Total Operational and Economic Impact

The total operations impact of Juniper's products and initiatives can be profound. Since the distribution of infrastructure and the nature of services vary by the type of service provider involved, it's essential to look at both access providers and non-access service providers ("interior" providers) separately. We also believe that it's important to separate power savings from operational savings, because the former depends on equipment deployment and the latter on human resources. Additionally, we have followed the structure of the above sections and have identified the three areas of operations focus—service creation and provisioning, customer support, and integrating and sustaining the infrastructure—so operators can see how each area of their operations is affected.

Figures 2 and 3 summarize the savings associated with the application of the five Juniper initiatives. To make the numbers immediately relevant, we express them all as a percentage of revenue. In both of these figures, the first column shows the addressable cost as a percentage of revenue, and the following columns show the savings available for each applicable operations efficiency initiative. Note that the percentages shown as costs and savings are both percentages of revenue, so a savings of "10%" means the provider could save an amount equal to 10% of revenue. Also note that these numbers are based on the assumption that optimum practices are applied to achieve the most savings. Actual savings will depend on the exact nature of services and infrastructure.

Figure 2 shows the impact of the operations cost savings on both access providers and other service providers. Addressable operations costs amount to 23.8% of revenue for the access providers and 17.5% for non-access providers⁶. Applying all of the efficiency measures to their operation, access providers could save 34% of this cost and non-access providers 66%.

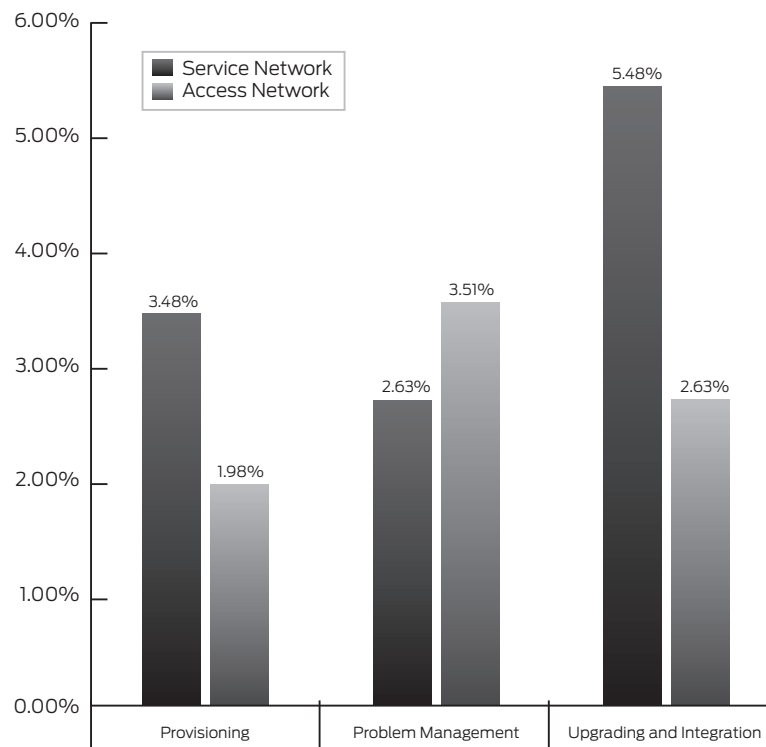


Figure 2: Impact of operations savings, expressed as a percent of revenue

In Figure 3, we outline the savings associated with power efficiency. This includes both the direct savings in power associated with Juniper's higher efficiency, and the power savings in servers and storage associated with higher layer services, improved as a part of virtualization/cloud computing efficiency. These savings are modest (about 1%) for access providers whose power consumption tends to be focused on edge office subscriber broadband technology rather than the points of presence (POPs) where routers factor heavily, but count for a 10% savings in operations costs for non-access carriers such as content providers and backbone providers, including content delivery network (CDN) providers.

⁶Source: CIMI Corporation, for all information in Figures 2 and 3

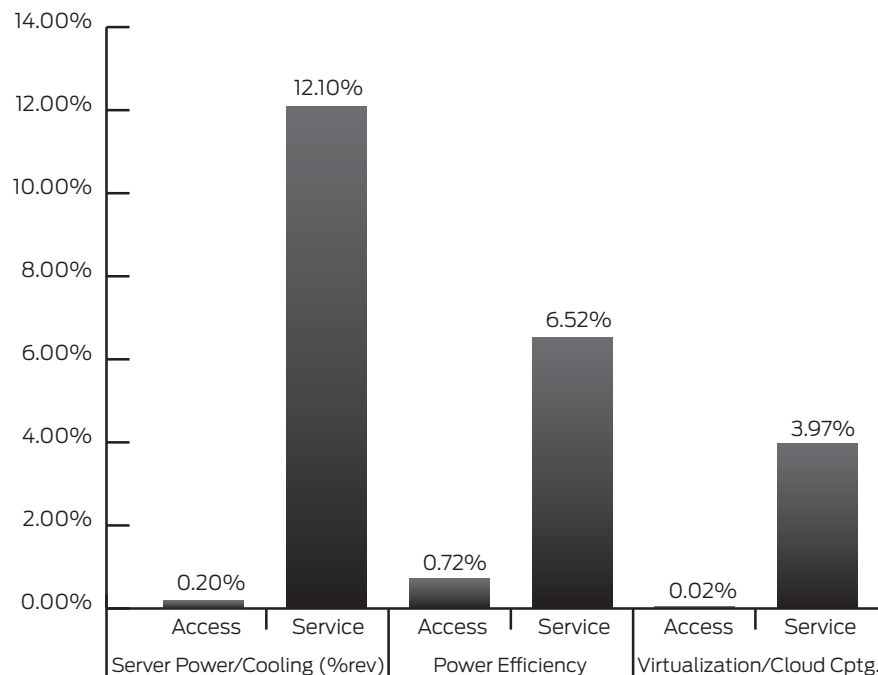


Figure 3: Savings as a result of power consumption reductions, shown as a percent of revenue.

The total savings that could be achieved if operations were made optimally efficient is considerable—8.9% of revenue for access providers and 22.1% for interior or non-access providers. Since service provider gross profits range from 15% to 25% of revenue, this could add significantly to profitability. And since CapEx budgets are typically 14% to 27% of revenue, a provider could enhance its capital spending by a considerable amount and still have a net increase in gross profit. In addition, the savings would have a major environmental impact, reducing power requirements and carbon dioxide emissions. The latter, in a mandatory cap-and-trade framework, could add further to the savings.

In addition to the direct savings shown here, there are also vehicle operating costs and capital costs that could be reduced when truck rolls are reduced with improved fault management practices, and customer retention and acquisition costs are reduced by improved customer service. All of these reductions can pave the way for a new set of more personalized and profitable services that achieve their personal touch without a corresponding explosion in operations costs.

Conclusion: Securing the Future

The increased number of devices, the dynamic network behavior, the growth in network-based content and data applications, and the new age of converged and personalized services have all contributed to steadily increasing demands on service providers. They've also contributed to the industry's increased environmental impact—not just through the electrical requirements of the network equipment, but in indirect ways such as the consumption of power by support vehicles and staff.

Juniper has long engineered products that were as operationally efficient as possible—this is what prompted our vision for the single JUNOS Software. Never has efficiency been more important than now. And nowhere but at Juniper will one find a portfolio of networking infrastructure solutions that address all aspects of efficiency: from power consumption to operations as a whole.

With the industry's most energy efficient routers, Juniper helps drive efficiency of network elements, and with virtualization, Juniper improves efficiency of the network as a whole. Tools such as our PSDP, OSCP, virtualization (again), and of course JUNOS enable Juniper's service provider customers to improve the efficiency of service management, problem resolution, and upgrades and integration.

Today, it's good PR for a corporation to be socially and environmentally conscious. But reputation need not be the only reason for service providers to pursue efficiency. Rather, operational efficiency can result in real savings—both economically and environmentally. The savings can be used to increase network investment to address new opportunities or respond to competition, and to improve the company's bottom line. Since the total savings are a very significant percentage of revenue, there is a strong business incentive to secure them and their related benefits.

Bibliographic Citation

Forrester Consulting: *The Total Economic Impact™ Of Juniper Networks' JUNOS Network Operating System*
www.juniper.net/us/en/reports/junos_tei.pdf

NSP: *Business Case for Core IP Network Virtualization*
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Energy Efficiency for Network Equipment: *Two Steps Beyond Greenwashing*
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Virtualization in the Core of the Network
www.juniper.net/us/en/local/pdf/whitepapers/2000299-en.pdf

About Juniper Networks

Juniper Networks, Inc. is the leader in high-performance networking. Juniper offers a high-performance network infrastructure that creates a responsive and trusted environment for accelerating the deployment of services and applications over a single network. This fuels high-performance businesses. Additional information can be found at www.juniper.net.

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