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The Total Economic Impact of Juniper Networks EX4200 Ethernet Switches

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Executive Summary

In October 2009, Juniper Networks commissioned Forrester Consulting to examine the total economic impact and potential return on investment (ROI) enterprises may realize by deploying EX4200 Ethernet switches. The EX4200 line of Ethernet switches are stackable form-factor data network switches offering up to 48 10/100/1000BASE-T interfaces in a single rack-unit switch, or up to 480 interfaces in a Virtual Chassis configuration in which up to 10 inter-connected EX4200 switches behave as a single, logical device. This study illustrates the financial impact of deploying these switches in data center and wiring closet applications.

In conducting in-depth interviews with four existing customers, Forrester found that these companies achieved a 63 percent reduction in network operations costs for tasks associated with switch management, maintenance and recovery times.

Purpose

The purpose of this study is to provide readers with a framework to evaluate the potential financial impact of EX4200 Ethernet switches on their organizations. Forrester's aim is to clearly show all calculations and assumptions used in the analysis. Readers should use this study to better understand and communicate a business case for investing in Juniper Networks and the EX4200 Ethernet switches.

Methodology

Juniper Networks selected Forrester for this project because of its industry expertise in enterprise networking and Forrester's Total Economic Impact™ (TEI) methodology. TEI not only measures costs and cost reduction – areas that are typically accounted for within IT– but also weighs the enabling value of a technology in increasing the effectiveness of overall business processes.

For this study, Forrester employed four fundamental elements of TEI in modeling EX4200 Ethernet switches:

1. Costs and cost reduction
2. Benefits to the entire organization
3. Flexibility
4. Risk

Given the increasing sophistication that enterprises have regarding cost analyses related to IT investments, Forrester's TEI methodology serves an extremely useful purpose by providing a complete picture of the total economic impact of purchase decisions. Please see Appendix B for additional information on the TEI methodology.

Approach

Forrester used a five-step approach for this study:

1. Forrester examined data from existing Forrester research relative to Juniper Networks, EX4200 Ethernet switches and the Ethernet switch market in general.
2. Forrester interviewed Juniper Networks' marketing and sales personnel to fully understand the potential value propositions of the EX4200 line of Ethernet switches.
3. Forrester conducted a series of in-depth interviews with four organizations currently using Juniper Networks and the EX4200 Ethernet switches.
4. Forrester constructed a financial model representative of the organizations interviewed. This model can be found in the TEI Framework section below.
5. Forrester created a composite organization based on the interviews and populated the framework using data from the interviews as applied to the composite organization.

Key Findings

Forrester's study yielded three key findings:

- **ROI.** Based on the interviews with the four existing customers, Forrester constructed a TEI framework for a composite organization (see Appendix A), and the associated ROI analysis illustrating the financial impact areas. As seen in Table 1, the ROI for our composite company is 79 percent with a breakeven point (payback period) of 1.2 months after deployment.
- **Benefits.** Benefits identified by the interviewed organizations included a range of operational and capital costs savings, and simplified network architectures. The composite organization modeled in this study assumes the following benefits:
 - **Simplified network architecture.** In the data center, the composite organization eliminated a network layer between the server farm and the network core. This was achieved by leveraging specific features of the EX4200 switches, including aggregating 10 gigabit Ethernet (GbE) uplinks and using Virtual Chassis technology to deploy and manage logical switches across multiple data center racks.
 - **Lower operations burden due to Virtual Chassis technology.** In wiring closet applications, Virtual Chassis technology reduced the number of managed devices from 120 to 15. The reduction in the number of managed devices resulted in improvements in switch configuration times, making them two to three times faster. In the data center, the time required to reboot a Virtual Chassis configuration was three to four times faster compared to the

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prior solution. The combined cost savings associated with these tasks is 63 percent.

- **Reduced number of uplinks.** Virtual Chassis technology reduced the amount of traffic flowing between the server farm and the network core, by keeping server-server traffic confined to the Virtual Chassis. This reduced the number of uplinks needed by 33 percent.
- **Decreased power requirements of 25 percent in user access aggregation applications.** This benefit was achieved when fiber was run from the EX4200 switch to the access switch in the office. Fiber interfaces typically have lower power consumption than copper interfaces, and fixed switches are typically more power efficient than modular switches that are used to support fiber interfaces. The EX4200 switches support both fiber and copper interfaces, offering flexible cabling infrastructure choices with increased power efficiency.
- **Increased ability to meet end-user and availability service-level agreements.** By using redundant Virtual Chassis configurations and redundant links from the server farm to the network core, end-user service outages resulting from rebooting network switches were substantially reduced. The time to recover the Virtual Chassis configuration was four times faster when compared to the prior chassis-based solution.
- **Avoided structured wiring costs in server farms.** Using "top-of-rack" network designs in server farms avoided the structured wiring costs typically associated with the "end-of-row" chassis solutions previously used.
- **Costs.** Costs to deploy and maintain the EX4200 line of Ethernet switches, include network administrator training, hardware and software maintenance and support costs, and professional services fees. This amounts to \$131,336 over the three-year analysis period.

Table 1 illustrates the risk-adjusted cash flow for the composite organization, based on data and characteristics obtained during the interview process. Forrester risk-adjusts these values to take into account the potential uncertainty that exists in estimating the costs and benefits of a technology investment. The risk-adjusted value is meant to provide a conservative estimate, incorporating any potential risk factors that may later impact the original cost and benefit estimates. For a more in-depth explanation of risk and risk adjustments used in this study, please see the "Risk" section.

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Table 1: Composite Company ROI, Risk-Adjusted

Summary Financial Results	Original Estimate	Risk-Adjusted
ROI	100%	79%
Payback period (years)	0.09	0.10
Total costs (PV)	(\$131,336)	(\$130,978)
Total benefits (PV)	\$262,996	\$234,730
Total (NPV)	\$131,659	\$103,751

Source: Forrester Research, Inc.

Forrester found that higher ROIs are achieved in networks that deploy larger numbers of EX4200 Ethernet switches.

Disclosures

The reader should be aware of the following:

- The study is commissioned by Juniper Networks and delivered by the Forrester Consulting group.
- Juniper Networks reviewed and provided feedback to Forrester, but Forrester maintains editorial control over the study and its findings and does not accept changes to the study that contradict Forrester's findings or obscure the meaning of the study.
- Juniper Networks provided the organization contacts for the interviews.
- Forrester makes no assumptions as to the potential return on investment that other organizations will receive. Forrester strongly advises that readers should use their own estimates within the framework provided in the report to determine the appropriateness of an investment in the Juniper Networks EX4200 line of Ethernet switches.
- This study is not meant to be used as a competitive product analysis.

Juniper Networks EX4200 Ethernet Switches: Overview

The EX4200 line of Ethernet switches are single rack-unit switches that support either 24 or 48 10/100/1000BASE-T copper or 100/1000BASE-X fiber ports. The switches can be deployed in applications ranging from high-performance server farms to end-user access in wiring closets. Specific features and benefits include:

- Virtual Chassis technology that allows up to 10 switches to be inter-connected and managed as a single logical device. The switches are inter-connected via a 128

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Gbps virtual backplane. Virtual Chassis technology allows users to expand port densities on an as-needed basis and separates physical topology from logical groupings of endpoints. Extended Virtual Chassis topologies can be created using optional front-panel gigabit Ethernet (GbE) or 10 GbE ports to span distances of up to 50 km between multiple wiring closets, floors or buildings.

- The front panel uplink modules offer either four GbE or two 10 GbE ports for high-speed backbone or link aggregation connections.
- High-availability hardware features commonly associated with chassis-based switches including redundant control plane processors, redundant power supplies and redundant cooling fans.
- High-availability software includes support for redundant trunk groups, cross-member link aggregation for devices in Virtual Chassis configurations, and the JUNOS Software operating system that is used in other EX Series switches as well as Juniper Networks carrier-class routers.

Analysis

As stated in the Executive Summary, Forrester took a multistep approach to evaluate the impact that implementing EX4200 Ethernet switches can have on an organization:

- Interviews with Juniper Networks marketing and sales executives.
- In-depth interviews with representatives from four organizations currently using EX4200 Ethernet switches.
- Construction of a common financial framework for the implementation of EX4200 Ethernet switches.
- Construction of a composite organization based on characteristics of the interviewed organizations.

Interview Highlights

A total of four interviews were conducted for this study, involving representatives from the following organizations:

- A North American restaurant management company that operates more than 1,500 full service restaurants. The network supports 1,400 end users located at headquarters and 10 divisional offices, and provides network services to all its restaurants. The company rebuilt its data center, which was part of a larger project to rebuild the company's headquarters campus and office buildings. In redesigning the data center network, the company wished to eliminate end-of-row chassis switches in its server farm, as well as a network layer between the server farm and network core. Secondary design objectives included lowering power and cooling costs, and preparing the network to support voice and video.
- A European university with 35,000 students and approximately 6,000 academic and support staff. The network supports 23,000 data ports and 7,000 voice ports. The university was building a second major data center for redundancy purposes. As part of upgrading end-user network access and enabling end-user network access in new buildings, the university wanted small-form-factor switches that could support high densities of both copper and fiber ports, because they decided to run fiber to the office. Port-level security was important in order to comply with legal requirements (the university acts as an Internet service provider and provides "open access" on some ports). It also wanted switches that had a lower operations burden compared to its installed wiring closet switches.
- A North American company that markets and distributes a broad range of energy-related products for consumer, commercial and health care applications. The company's data network supports more than 1,000 users located in three corporate offices and 80 remote locations. As part of a data center rebuild, the company redesigned its data center network with the goal of collapsing the network from three to two tiers to reduce operating costs. The company also

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wanted to diversify the network vendors that it uses. In the server farm, they wanted to move from an “end-of-row” to “top-of-rack” access network design.

- A private U.S. higher education organization with 6,000 students. Its network is distributed across 22 buildings on the main campus and ties in 40 other buildings that are located across two different states. As part of a network upgrade, the university wanted to eliminate network layers to simplify the network design and lower operating costs. The network used equipment from four different vendors and the university wanted to migrate to a single-vendor solution for all routing and switching.

Lower network equipment acquisition costs was a major product selection criterion for all the organizations we interviewed. From these four interviews we created the composite organization that is used in this analysis.

The four in-depth interviews yielded the following insights:

- The EX4200 switches with Virtual Chassis technology allowed users to simplify their network architecture, reduce the network operations burden and increase the flexibility of the network. In wiring closet applications, customers were able to extend the Virtual Chassis configurations across different buildings and manage the switches in the Virtual Chassis as a single logical device. In data center applications, users observed similar operational benefits by extending the Virtual Chassis configuration across multiple racks within the data center infrastructure. One network operations manager noted that Virtual Chassis deployments were “more flexible and modular” compared to chassis-based solutions.
- JUNOS Software, Juniper Networks’ network operating system, reduced overall network operating costs. All users mentioned the stability and ease of use associated with JUNOS Software, as well as the predictability of software updates. This benefit was maximized in networks where Juniper Networks devices (routers, switches and security gear) were pervasive.

TEI Framework

Introduction

From the information provided in the in-depth interviews, Forrester has constructed a TEI framework for those organizations considering implementation of EX4200 Ethernet switches. The objective of the framework is to identify the cost, benefit, flexibility and risk factors that impact the investment decision.

Composite Organization

Based on the interviews with the four existing customers provided by Juniper Networks, Forrester constructed a TEI framework, a composite company, and an associated ROI analysis that illustrates the areas impacted financially. The composite organization that Forrester synthesized from these results represents a \$4 billion manufacturing company headquartered in Europe, with sales and distribution offices in 10 countries and manufacturing facilities in Asia and Europe. The company has 10,000 employees worldwide. See Appendix A for more details on the composite organization.

Framework Assumptions

Table 2 lists the discount rate used in the PV and NPV calculations and time horizon used for the financial modeling.

Table 2: General Assumptions

Ref.	General assumptions	Value
	Discount rate	10%
	Length of analysis	Three years

Source: Forrester Research, Inc.

Organizations typically use discount rates between 8 and 16 percent based on their current environment. Readers are urged to consult with Finance to determine the most appropriate discount rate to use within their own organizations.

In addition to the financial assumptions used to construct the cash flow analysis, Table 3 provides salary and network configuration assumptions used within this analysis.

Table 3: Salary Assumptions

Ref.	Metric	Value
A1	Number of network engineers	2
A2	Network engineer annual fully loaded salary (\$)	\$85,000
A3	Salary overhead multiplier	1.25
A4	Hours worked per year	2,080
A5	Network engineer hourly rate	\$51
A6	Hourly cost of downtime	\$10,000
A7	Number of 24-port wiring closet switches	73
A8	Number of 48-port wiring closet switches	47
A9	Total wiring closet switches	120
A10	Number of wiring closet Virtual Chassis configurations	15
A11	Number of data center server racks	24
A12	Number of data center switches	42
A13	Number of data center Virtual Chassis configurations	8

Source: Forrester Research, Inc.

Costs

The costs of deploying, maintaining and operating the EX4200 Ethernet switches include training costs for network administrators and engineers, professional services costs incurred when initially deploying Juniper hardware, and ongoing maintenance costs.

Excluded from the cost analysis are network hardware acquisition costs. While the interviews found some differences in hardware costs between Juniper and alternate vendors, this analysis focuses on the opex and capex savings that result from network designs that use the EX4200 Ethernet switches when compared to the prior state or alternate designs. We exclude network administrators' and engineers' salaries as these were already incurred to support their current networks.

Network Engineer Juniper EX Series Switch Training

To ensure that the composite organization's network engineers can proficiently provision, operate and maintain the EX4200 Ethernet switches, Forrester assumes that network engineers will undergo relevant training required to support hardware and switches. We assume that two engineers will take training classes during the initial deployment period, and any additional training will be provided in-house. Using a list price of \$2,700 per class, the initial training costs are \$5,400 (see Table 4).

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Table 4: Network Engineer Training Costs

Ref.	Metric	Calculation	Per Period
B1	Number of network support engineers		2
B2	Cost Per Person		\$2,700
Bt	Network engineer Juniper EX Series switch training	B1*B2	\$5,400

Source: Forrester Research, Inc.

EX Series Switch Annual Maintenance Costs

Annual hardware and software maintenance charges are based on the number and configuration of the EX4200 switches. Maintenance costs are included in the analysis because these costs are necessary to ensure reliable long-term equipment operations, regardless of the network vendors that are used. Forrester recognizes that maintenance costs will vary with the services included in the maintenance contract, the type of equipment under maintenance, and with the provider of the maintenance services. For the composite organization, we assumed different support levels for the wiring closet and data center switches. The data center switches receive a higher level of support because of their critical nature. The maintenance costs are based on Juniper's service-level description, which provides for 7x24 technical assistance and next-day hardware replacement for the data center switches and 7x24 technical assistance and return-to-factory hardware replacement for the wiring closet switches. The maintenance costs are \$47,424, as shown in Table 5.

Table 5: Annual Hardware And Software Maintenance Fees

Ref.	Metric	Calculation	Per Period
C1	48-port data center switches: 7x24 phone support and NBD HW replacement, 42 switches @ \$425 each		\$17,850
C2	24-port wiring closet switches: 7x24 phone support and Return-to Factory HW replacement, 31 switches @ \$153 each		\$4,743
C3	48-port wiring closet switches: 7x24 phone support and Return-to Factory HW replacement, 89 switches @ \$279 each		\$24,831
Ct	EX Series switch annual maintenance costs	C1+C2+C3	\$47,424

Source: Forrester Research, Inc.

Professional Services Fees

When performing a major network upgrade that involves a significant network redesign, we assume that the composite organization will use services from a third party to assist in

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optimizing the network design; planning the migration; solve any interoperability issues; and to fill in any skill gaps that the composite organization may have. For the composite company, we assume a professional services fee of \$8,000 (see Table 6).

Table 6: Professional Services Fees

Ref.	Metric	Calculation	Per period
D1	Professional services fees (\$/day)		\$2,000
D2	Number of days		4
Dt	Professional services fees	D1*D2	\$8,000
Dto	Total (Original)		(\$8,000)

Source: Forrester Research, Inc.

Total Costs

The total incremental costs for deploying, operating and maintaining the EX4200 Ethernet switches are \$155,672 (see Table 7).

Table 7: Total Costs

Costs	Initial	Year 1	Year 2	Year 3	Total
Network engineer Juniper EX Series switch training	(\$5,400)				(\$5,400)
EX Series switch annual maintenance costs		(\$47,424)	(\$47,424)	(\$47,424)	(\$142,272)
Professional services fees	(\$8,000)				(\$8,000)
Total	(\$13,400)	(\$47,424)	(\$47,424)	(\$47,424)	(\$155,672)

Source: Forrester Research, Inc.

Benefits

The Juniper EX4200 Ethernet switch customers interviewed for this study experienced a broad range of benefits including reduced operating costs, savings on specific pieces of hardware and reduced power consumption.

Cost Avoided For Server Farm Structured Cabling

The companies we interviewed noted that by moving from an “end-of-row” to a “top-of-rack” network topology for their data center server farms, they avoided the structure cabling costs associated with “end-of-row” designs. Structured cabling solutions include racks, cabling, cable management systems, termination points and labor to install the solution. Interviewees also noted that “top-of-rack” cabling makes physically moving the network gear to a new room or building far easier. The interviewees mentioned that the

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cost of structured cabling for their installations ranged from \$80,000 to \$120,000. For the composite organization, we assume avoided costs of \$100,000 (see Table 8).

Table 8: Cost Avoided For Server Farm Structured Cabling

Ref.	Metric	Calculation	Per Period
E1	Cost of server farm structured cabling		\$100,000
Et	Cost avoided for server farm structured cabling	E1	\$100,000

Source: Forrester Research, Inc.

Reduction In Wiring Closet Switch Management Effort

By using EX4200 Ethernet switches with Virtual Chassis technology to group multiple physical wiring closet switches into fewer logical devices, interviewees were able to reduce the number of devices that required active management. For the composite organization, 120 wiring closet switches were grouped together into 15 logical devices, reducing the number of devices that need to be managed by 105, an 87.5 percent reduction. Interviewees also said that the number of engineers required to manage these devices was reduced from three to one (network engineers), yielding a savings of two engineers. In calculating the savings, we assume that each device is “touched” or managed four times per year for one hour. This yields savings of \$42,909 (see Table 9).

Table 9: Reduction In Wiring Closet Switch Management Effort

Ref.	Metric	Calculation	Per Period
F1	Number of network engineers		2
F2	Network engineer hourly rate		\$51
F3	Number of hours saved		1.0
F4	Reduction in number of managed devices		105
F5	Task frequency per year		4
Ft	Reduction in wiring closet switch management effort	$F1 * F2 * F3 * F4 * F5$	\$42,909

Source: Forrester Research, Inc.

Reduction In Effort To Recover From Server Farm Switch Failure

Many features of the EX4200 Ethernet switches contribute to these savings. The composite organization’s server farm network design enabled eight redundant Virtual Chassis configurations connected in a fully meshed manner. This ensured that the overall network will continue to operate if a single switch or a Virtual Chassis configuration is taken out of service or fails. In comparison to the previous network, the EX4200 switches’

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fast reboot time and the stability of the underlying network operating system allowed the composite organization to recover from outages rapidly.

The prior chassis-based solution took one hour to reboot, and required four levels of expertise to perform the reboot. The required expertise includes engineers from networking, applications, server infrastructure and storage. For the Virtual Chassis solution, the time needed to reboot the server farm switches was reduced from one hour to 15 minutes, avoiding three-quarters of an hour of network downtime. The reboot required the expertise of one network engineer, reducing the number of engineers required from four to one. The savings total for this task is \$10,115 (see Table 10).

Table 10: Reduction In Effort To Recover From Server Farm Switch Failure

Ref.	Metric	Calculation	Per Period
G1	Layers of expertise not required to perform a reboot (engineers saved)		3
G2	Network engineer hourly rate		\$51
G3	Hours saved to perform a reboot		0.75
G4	Event frequency (annual)		1
G5	Downtime avoided (hours)		1
G6	Cost of downtime (\$/hour)		\$10,000
Gt	Reduced effort to recover from switch failure in the server farm	$G1 \cdot G2 \cdot G3 \cdot G4 + (G5 \cdot G6)$	\$10,115

Source: Forrester Research, Inc.

Reduction In User Access Aggregation Switch Power Requirements

In this case, fiber rather than copper is run from the aggregation switch to the access switch in the office. Interviewees who used this reported a 25 percent reduction in power consumption. Based on the power consumption of the EX4200 line of switches and assuming power costs of \$0.13/kWh, the composite organization achieves a total saving of \$3,563 (see Table 11). Note that the electricity cost is an average for industrialized European countries. While not reported by the companies we interviewed, we note that savings on cooling can run as high as two times the power savings.

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Table 11: Reduction In Wiring Closet Power Requirements

Ref.	Metric	Calculation	Per Period
H1	Number of 24-port switches		89
H2	Number of 48-port switches		31
H3	Power consumption for 24-port switches (watts)		600
H4	Power consumption for 48-port switches (watts)		930
H5	Operating hours per year		8,736
H6	Total wiring closet switch power consumption (watts)		82,230
H7	Energy cost (\$/KWh)		\$0.13
H8	Average reduction in power consumption		25%
Ht	Reduction in wiring closet power requirements	$(H6/(1-H8)-H6)*H7$	\$3.563

Source: Forrester Research, Inc.

Reduction in Equipment Sparing Costs

In this case, interviewees note that carrying spare EX4200 switches was less expensive than carrying and maintaining spare blades for a chassis. We note that it is difficult to make a direct comparison between the components of a chassis and those of a stand-alone Ethernet switch. Forrester believes that the spares that an organization may need to carry for a chassis solution would include at least a line card and a controller card, and may include fans, optics and power supplies. We also believe that cost savings offered by the Juniper solution may result from the fact that the chassis, line card and controller are integrated into a single unit. We encourage readers to examine the sparing costs of each solution in order to make a fair comparison. For the composite organization, we assume a savings equivalent to two blades for a total savings of \$12,000 (see Table 12).

Table 12: Reduction In Data Center Switch Sparing Costs

Ref.	Metric	Calculation	Per Period
I1	Number of blades (saved)		2
I2	Cost saving per blade		\$6,000
It	Reduction in data center equipment sparing costs	$I1*I2$	\$12,000

Source: Forrester Research, Inc.

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Cost Avoided For Server Farm Data Network Uplinks

A variety of EX4200 switch features contribute to this savings, including the fact that the Virtual Chassis technology uses an “out-of-band” 128 Gbps backplane over which rack-to-rack network traffic travels. This avoids the need to send rack-to-rack traffic up to the network core and back down to the access layer, therefore reducing the bandwidth consumed on the uplinks. Interviewees reported uplink reduction of one-third. Based on the cost of 10 GbE uplinks, this amounts to a savings of \$22,500 (see Table 13).

Table 13: Cost Avoided For Server Farm Data Network Uplinks

Ref.	Metric	Calculation	Per Period
J1	Number of uplinks in new design		18
J2	Cost per uplink		\$2,500
J3	Percent reduction in number of uplinks		33%
J4	Number of uplinks saved		9
Jt	Cost avoided: reduction in uplinks	J2*J4	\$22,500

Source: Forrester Research, Inc.

Total Benefits

For the composite organization, the total three-year benefits are \$304,261 (see Table 14).

Table 14: Total Benefits

Benefits	Initial	Year 1	Year 2	Year 3	Total
Cost avoided for server farm structured cabling		\$100,000			\$100,000
Reduction in wiring closet switch management effort		\$42,909	\$42,909	\$42,909	\$128,726
Reduced effort to recover from switch failure in the server farm		\$10,115	\$10,115	\$10,115	\$30,345
Reduction in wiring closet power requirements		\$3,563	\$3,563	\$3,563	\$10,690
Reduction in data center equipment sparing costs		\$12,000			\$12,000
Cost avoided: reduction in uplinks		\$22,500			\$22,500
Total		\$191,087	\$56,587	\$56,587	\$304,261

Source: Forrester Research, Inc.

Risk

Forrester defines two types of investment risk associated with this analysis: implementation and impact risk. **Implementation risk** is the risk that a proposed technology investment may deviate from the original resource requirements needed to implement and integrate the investment, resulting in higher costs than anticipated. **Impact risk** refers to the risk that the business or technology needs of the organization may not be met by the technology investment, resulting in lower overall total benefits. The greater the uncertainty, the wider the potential range of outcomes for cost and benefit estimates. Quantitatively capturing investment risk, by directly adjusting the financial estimates, results in more meaningful and accurate estimates and a more accurate projection of the ROI. The risk-adjusted numbers should be taken as “realistic” expectations since they represent the expected values considering risk. In general, risks affect costs by raising the original estimates, and they affect benefits by reducing the original estimates.

The following implementation risks are identified as part of this analysis:

- Professional services expenses may vary depending on each firm’s needs and the abilities of its internal network engineering resources.
- Annual maintenance costs, which vary with the level of the support that the customer purchases from Juniper. Maintenance costs will also depend on the configuration of specific network devices. For this analysis, we assumed that the data center switches would be on next-day support. Higher levels of support (i.e. greater expense) are avoided because the composite company maintains its own spares.

The following impact risks are identified as part of the analysis:

- Cost savings associated with avoided hardware, operations and power costs will vary greatly according the network design, the actual EX4200 switch models employed, the skill and experience of the network engineers, and the particulars of an organization’s prior network design and implementation.

For the purpose of this analysis, Forrester risk-adjusts benefit estimates to better reflect the level of uncertainty that exists for each estimate. The TEI model uses a triangular distribution method to calculate risk-adjusted values. To construct the distribution, it is necessary to first estimate the low, most likely and high values that could occur within the current environment. The risk-adjusted value is the mean of the distribution of those points.

Table 15 shows the values used to adjust for uncertainty in the benefit estimates. Different benefits estimates have different levels of risk adjustments. Readers are urged to apply their own risk ranges based on their own degree of confidence in the benefit estimates.

Table 15: Benefit Category Risk Adjustments

Benefits	Low	High	Mean
Cost avoided for server farm structured cabling	80%	120%	100%
Reduction in wiring closet switch management effort	50%	100%	83%
Reduced effort to recover from switch failure in the server farm	50%	100%	83%
Reduction in wiring closet power requirements	40%	100%	80%
Reduction in data center equipment sparing costs	60%	100%	87%
Cost avoided for server farm data network uplinks	60%	100%	87%

Source: Forrester Research, Inc.

Flexibility

Flexibility, as defined by TEI, represents an investment in additional capacity or capability that could be turned into business benefit for some future additional investment. Flexibility would also be quantified when evaluated as part of a specific project (described in more detail in Appendix B).

Flexibility benefits typically increase with the scalability of the technology investment. This provides an organization with the “right” or the ability to engage in future initiatives but not the obligation to do so. In the case of this investment, customers who choose to employ EX4200 switches may achieve some additional operations savings or be able to run new applications over their networks, based on the capabilities of the switches.

While Forrester believes organizations that adopt EX4200 switches can take advantage of these flexibility options, quantification (using the financial industry standard Black-Scholes or the binomial option pricing models) of the additional value associated with these options for this customer would require scenario development and forward-looking analysis that is not available at this time. The value of flexibility is unique to each organization, and the willingness to measure its value varies from company to company.

TEI Framework: Summary

Considering the financial framework constructed above, the results of the costs, benefits, risk and flexibility sections using the representative numbers can be used to determine a return on investment, net present value and payback period. Table 16 shows the consolidation of the numbers for the composite organization.

Table 17 shows the risk-adjusted values, applying the risk adjustment method indicated in the “Risks” section and the values from Tables 15 to the numbers in Tables 7 and 14.

It is important to note that values used throughout the TEI framework are based on in-depth interviews with four organizations and the resulting composite organization built by

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Forrester. Forrester makes no assumptions as to the potential return that other organizations will receive within their own environment. Forrester strongly advises that readers use their own estimates within the framework provided in this study to determine the expected financial impact of implementing EX4200 Ethernet switches.

Table 16: Cash Flow Summary – Non-Risk Adjusted

Cash Flow Analysis - Non-risk Adjusted						
	Initial	Year 1	Year 2	Year 3	Total	Present Value
Benefits		\$191,087	\$56,587	\$56,587	\$304,261	\$262,996
Costs	(\$13,400)	(\$47,424)	(\$47,424)	(\$47,424)	(\$155,672)	(\$131,336)
Total net benefits	(\$13,400)	\$143,663	\$9,163	\$9,163	\$148,589	\$131,659
ROI	100%					
Payback period	0.09					

Source: Forrester Research, Inc

Table 17: Cash Flow Summary – Risk Adjusted

Cash Flow Analysis - Risk Adjusted						
	Initial	Year 1	Year 2	Year 3	Total	Present Value
Benefits		\$176,875	\$46,860	\$46,860	\$270,596	\$234,730
Costs	(\$13,042)	(\$47,424)	(\$47,424)	(\$47,424)	(\$155,314)	(\$130,978)
Total net benefits	(\$13,042)	\$129,451	(\$564)	(\$564)	\$115,282	\$103,751
ROI	79%					
Payback period	0.10					

Source: Forrester Research, Inc

Study Conclusions

Forrester's in-depth interviews with EX4200 Ethernet switch customers yielded several important observations:

- Based on information collected in interviews with current customers of the EX4200 line of Ethernet Switches, Forrester found that organizations can realize benefits in the form of simplified network designs with the associated hardware savings and reduced network operations costs, reduced power requirements.
- Of the customers interviewed, several factors contributed to the differences in ROI. These factors included the scale of the network, specifics of the network design and use of specific features of the EX4200 switches.

The financial analysis provided in this study illustrates the potential ways an organization can evaluate the value proposition of the Juniper Networks EX4200 line of Ethernet switches. Based on information collected in four in-depth customer interviews, Forrester calculated a three-year risk-adjusted ROI of 79 percent for the composite organization with a payback period of 0.1 years. All final estimates are risk-adjusted to incorporate potential uncertainty in the calculation of costs and benefits.

Based on these findings, companies looking to implement the EX4200 line of Ethernet switches can deploy simpler network designs that can scale as needed. Using the TEI framework, many companies may find the potential for a compelling business case to make such an investment.

Appendix A: Composite Organization Description

In this TEI study, Forrester has created a composite organization to illustrate the quantifiable costs and benefits, risk, and flexibility of implementing the Juniper Networks EX4200 line of Ethernet switches. The composite organization was derived from the four interviews conducted as part of this study.

The composite organization is a \$4 billion manufacturing company headquartered in Europe, with sales and distribution offices in 10 countries and manufacturing facilities in Asia and Europe. The company has 10,000 employees worldwide.

Pre-Juniper EX4200 Switch Network Architecture

Prior to deploying EX4200 Ethernet switches, the composite organization's network had:

- 5,000 endpoints at its headquarters campus.
- 100 access switches located in wiring closets and intermediate distribution frames (IDFs) in its main campus, offices and manufacturing facilities. These switches are five to seven years old, had a variety of form factors (stackable and chassis), and were sourced from three different vendors. In the main campus, the wiring closet switches were connected to aggregation switches (chassis form factor) via a mix of 10/100 Gbps and 1 Gbps Ethernet uplinks.
- A server farm in the data center with 480 servers that occupied 24 racks. Each server had dual NICs that are connected via redundant structured copper links to redundant chassis aggregation switches located at the "end-of-row" of the racks. The server farm chassis switches are fully redundant. The server farm was connected to the network core with 10 GbE fiber uplinks.

High-Level Business Goals

As a result of aging network infrastructure, power, space and cooling constraints in their data center, and the desire to reduce overall network complexity, the composite company decided to rebuild its data network. The redesigned network would be rolled out in phases, beginning with a planned data center upgrade and wiring closet upgrade at the corporate headquarters.

In redesigning its network architecture, the composite company had the following goals:

- **Simplify its network architecture** by evolving to a "core-edge" two-tier architecture, and eliminate layers that exist in its current network. The company wanted to implement this architecture both in its data center and end-point access/aggregation layers.
- **Lower the operations burden** associated with its wiring closet switches.
- **Reduce the power and cooling requirements** in the data center while freeing up space for future growth. Some of these savings would be achieved by reducing

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the number of physical servers using server virtualization on 20 percent of the servers. Server virtualization would also be used to support disaster recovery.

- **Position the network to support new services** such as wired and wireless Voice over IP (VoIP) and advanced virtualization features like live motion.
- **Improve failover and reliability capabilities** to improve network uptime and reduce costly outages.

Specific Requirements

The composite organization had the following requirements for its new switches:

- Have a small form factor, especially for the space-constrained data center.
- Support fiber and copper connections.
- Support a mix of GbE and 10 GbE uplinks.
- Support 802.1Q and 802.1X protocols for VLAN tagging, authentication and accounting.
- Be Multiprotocol Label Switching (MPLS)-capable for future routing requirements.
- Provide dire-speed performance, especially for the data center.
- Support redundant power supplies for data center and wiring closet applications.
- Support Power over Ethernet (PoE) for VoIP applications in the wiring closet.
- Offer in-line upgrades for hardware and software so that network downtime could be avoided when performing upgrades.

Re-designed Network Architecture

End user access

The legacy wiring closet switches were replaced with Juniper EX4200 Ethernet switches with Virtual Chassis technology. For the wiring closet upgrade:

- 120 switches were deployed to provide 5,000 terminations for access points at the composite company's headquarter campus. The models deployed had a mix of 24- and 48-ports and varied according to the required port densities in specific wiring closets.

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- The access switches were grouped and connected together into 15 Virtual Chassis configurations.
- Each Virtual Chassis configuration was connected to the network core switches with 10 GbE fiber uplinks.

Data Center Server Farm

The server farm was completely redesigned and the number of physical servers was reduced from 480 to 413 by running virtualization on 20 percent of the servers. The servers occupied 21 racks arranged in four rows. Juniper EX4200 Ethernet switches were used to connect the servers to the network core as follows:

- Each rack had two EX4200 switches for redundancy — totaling 42 switches; each EX4200 switch is equipped with redundant power supplies.
- Each row had two Virtual Chassis configurations for redundancy — totaling eight Virtual Chassis configurations.
- The Virtual Chassis configurations are meshed together for redundancy.
- Each Virtual Chassis configuration had four 10 GbE fiber links — two to connect to the network core and two to connect to the Virtual Chassis mesh.

Appendix B: Total Economic Impact™ Overview

Total Economic Impact is a methodology developed by Forrester Research that enhances a company's technology decision-making processes and assists vendors in communicating the value proposition of their products and services to clients. The TEI methodology helps companies demonstrate, justify, and realize the tangible value of IT initiatives to both senior management and other key business stakeholders.

The TEI methodology consists of four components to evaluate investment value: benefits, costs, risks, and flexibility. For the purpose of this analysis, the impact of flexibility was not quantified.

Benefits

Benefits represent the value delivered to the user organization — IT and/or business units — by the proposed product or project. Often product or project justification exercises focus just on IT cost and cost reduction, leaving little room to analyze the effect of the technology on the entire organization. The TEI methodology and the resulting financial model place equal weight on the measure of benefits and the measure of costs, allowing for a full examination of the effect of the technology on the entire organization. Calculation of benefit estimates involves a clear dialogue with the user organization to understand the specific value that is created. In addition, Forrester also requires that there be a clear line of accountability established between the measurement and justification of benefit estimates after the project has been completed. This ensures that benefit estimates tie back directly to the bottom line.

Costs

Costs represent the investment necessary to capture the value, or benefits, of the proposed project. IT or the business units may incur costs in the forms of fully burdened labor, subcontractors, or materials. Costs consider all the investments and expenses necessary to deliver the proposed value. In addition, the cost category within TEI captures any incremental costs over the existing environment for ongoing costs associated with the solution. All costs must be tied to the benefits that are created.

Risk

Risk measures the uncertainty of benefit and cost estimates contained within the investment. Uncertainty is measured in two ways: the likelihood that the cost and benefit estimates will meet the original projections and the likelihood that the estimates will be measured and tracked over time. TEI applies a probability density function known as “triangular distribution” to the values entered. At a minimum, three values are calculated to estimate the underlying range around each cost and benefit.

Flexibility

Within the TEI methodology, direct benefits represent one part of the investment value. While direct benefits can typically be the primary way to justify a project, Forrester believes that organizations should be able to measure the strategic value of an investment. Flexibility represents the value that can be obtained for some future additional investment building on top of the initial investment already made. For instance, an investment in an

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enterprisewide upgrade of an office productivity suite can potentially increase standardization (to increase efficiency) and reduce licensing costs. However, an embedded collaboration feature may translate to greater worker productivity if activated. The collaboration can only be used with additional investment in training at some future point in time. However, having the ability to capture that benefit has a present value that can be estimated. The flexibility component of TEI captures that value.

Appendix C: Glossary

Discount rate: The interest rate used in cash flow analysis to take into account the time value of money. Although the Federal Reserve Bank sets a discount rate, companies often set a discount rate based on their business and investment environment. Forrester assumes a yearly discount rate of 10% for this analysis. Organizations typically use discount rates between 8% and 16% based on their current environment. Readers are urged to consult their organization to determine the most appropriate discount rate to use in their own environment.

Net present value (NPV): The present or current value of (discounted) future net cash flows given an interest rate (the discount rate). A positive project NPV normally indicates that the investment should be made, unless other projects have higher NPVs.

Present value (PV): The present or current value of (discounted) cost and benefit estimates given at an interest rate (the discount rate). The PV of costs and benefits feed into the total net present value of cash flows.

Payback period: The breakeven point for an investment. The point in time at which net benefits (benefits minus costs) equal initial investment or cost.

Return on investment (ROI): A measure of a project's expected return in percentage terms. ROI is calculated by dividing net benefits (benefits minus costs) by costs.

A Note On Cash Flow Tables

The following is a note on the cash flow tables used in this study (see the Example Table below). The initial investment column contains costs incurred at "time 0" or at the beginning of Year 1. Those costs are not discounted. All other cash flows in Years 1 through 3 are discounted using the discount rate shown in Table 2 at the end of the year. Present value (PV) calculations are calculated for each total cost and benefit estimate. Net present value (NPV) calculations are not calculated until the summary tables and are the sum of the initial investment and the discounted cash flows in each year.

Example Table

Ref.	Category	Calculation	Initial cost	Year 1	Year 2	Year 3	Total

Source: Forrester Research, Inc.