Business Case for Deploying Cisco CRS-1 at the Network Core

Network Strategy Partners, LLC

MANAGEMENT CONSULTANTS TO THE NETWORKING INDUSTRY

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Introduction

This paper presents the business case for deploying the Cisco® CRS-1 Carrier Routing System at the network core of a typical service provider. The business case compares deployment of the Cisco CRS-1 in a core point of presence (POP) with the continued use of traditional core routers[1] over a 5-year study interval. The analysis includes comparisons of total cost of ownership (TCO), cash flow, increased network availability, and investment protection.

The Cisco CRS-1 is a fully modular and distributed routing system that features very high availability and system scalability. Its scalability is achieved through use of an application-specific integrated circuit (ASIC)-based 40-Gbps Silicon Packet Processor (SPP) and highly distributed and modular Cisco IOS® XR Software that supports capacity scaling up to 92 Tbps and up to 1152 40-Gbps line cards. It also supports OC-768c/STM-256c IP interfaces, making a significant contribution to reducing transport expense within the backbone network. High network availability is achieved through use of Cisco IOS XR Software. Its microkernel-based design provides granular process independence, fault containment, and isolation, enabling the Cisco CRS-1 to be maintained, upgraded, enhanced, and scaled while minimizing service interruptions. Two Cisco CRS-1 configurations are analyzed—the Cisco CRS-1 16-Slot Single-Shelf System (Cisco CRS-1 16-Slot) and the Cisco CRS-1 MultiShelf System (Cisco CRS-1 MS)[2]. (The section titled *Investment Protection* in this report also includes consideration of the Cisco CRS-1 4-Slot and Cisco CRS-1 8-Slot Single-Shelf Systems.)

Deployment of the Cisco CRS-1 in a core POP is compared to the continued use of existing core router systems—traditional core routers. These routers are single-chassis systems using traditional routing software—software that lacks microkernel design and is not fully modular. Traditional core routers, furthermore, are defined as supporting interface speeds of OC-192 (10 Gbps) or lower. At least two traditional routers must be deployed within the POP so as to improve network availability. Additionally, traditional routers are grouped into clusters when needed to scale to high capacity.

The decision to replace existing routers—assuming current performance and reliability requirements are being met—involves analysis of the trade-off of the benefits of the new routers versus the costs of making the transition. The primary benefits of deploying Cisco CRS-1 routers in the core are reduced TCO derived from the better scaling economics of the Cisco CRS-1, much lower transport cost on the backbone links through use of the OC-768c/STM-256c IP interface[3], and the benefits of higher availability derived primarily from Cisco IOS XR Software.

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[1] Traditional core routers in this document refer to systems with a single control-plane CPU using monolithic kernel-based operating systems supporting interface speeds of OC-192 or lower.
[2] For further information about these products, refer to http://www.cisco.com/go/crs.
[3] Transport cost is treated as part of a separate cash flow analysis. Many large service providers use a transfer pricing system to account for the SONET/SDH, coarse wavelength-division multiplexing (CWDM), dense wavelength-division multiplexing (DWDM), and optical fiber systems used for backbone

The cost of transition to the Cisco CRS-1 includes the cost to incorporate a new product into the service provider's operations support system (OSS), construction of a testing facility, additions to the network operations center (NOC), and increased training expense. Capital expenditures (CapEx) also are increased in the first year, compared to continued use of the existing routers, because the initial Cisco CRS-1 installation must accommodate the current traffic capacity, whereas this cost is a sunk cost for the existing router installation. Premature retirement of the existing routers need not be considered because they can be redeployed easily at the network aggregation or distribution layer[4].

The benefits of deploying Cisco CRS-1 at the core also include "soft-dollar" benefits—benefits not directly captured in the TCO analysis. These benefits include:

- Increased maturity of network operations through the reduction of staff time used for troubleshooting and, therefore, more time used to proactively manage the network
- Reduction of exposure to service-level agreement (SLA) credits
- Increased margins and higher average revenue per user (ARPU) due to improved customer satisfaction and a corresponding reduction in customer turnover; sources include:
  - – Higher lifetime customer value
  - – Higher service take-up rates
  - – The ability to sell larger service bundles
- Faster and lower cost turn-up of new services—for example, by supporting testing with a virtual router

The economic trade-off between the scaling and architectural benefits of deploying the Cisco CRS-1 in the core versus the cost to make the transition from traditional routers is analyzed by studying the TCO and cash flow effects of a single core POP for a 5-year period under nominal, low, and high traffic growth assumptions. The economic effects of reduced network downtime and investment protection are studied in separate analyses.

Cisco CRS-1 Core POP Replacement Study

TCO and cash flow are estimated for a representative core POP over a 5-year study interval for three architectural configurations. They are as follows:

1. Continue using existing routers—Single chassis routers that do not use modular routing software (traditional routers) are deployed at the POP. A minimum of two routers are deployed so as to meet network availability requirements.

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transport. These costs are recognized as monthly recurring charges and are derived from service providers' private-line price schedules, but are heavily discounted.

[4] The investment protection benefits associated with the Cisco CRS-1 are detailed in the concluding section.

2. Deploy Cisco CRS-1 16-Slot Systems—Cisco CRS-1 Single-Shelf Systems replace the existing routers at the core POP. These single-shelf systems are also deployed using at least two routers, as is the case for traditional router deployment.[5]

3. Deploy a Cisco CRS-1 MultiShelf System—A Cisco CRS-1 MultiShelf System that does not use redundant routers to achieve the required availability levels is deployed.

The benefits of replacing existing routers with the Cisco CRS-1 are due primarily to the scale of the POP—the larger the POP capacity and the higher the traffic growth rate the greater will be the benefits of the Cisco CRS-1. This fact is illustrated by comparing the economic results of the three architectural configurations under three traffic growth assumptions. They are shown in Table 1.

Table 1 Annual Growth Rates for Customer-Facing Bandwidth

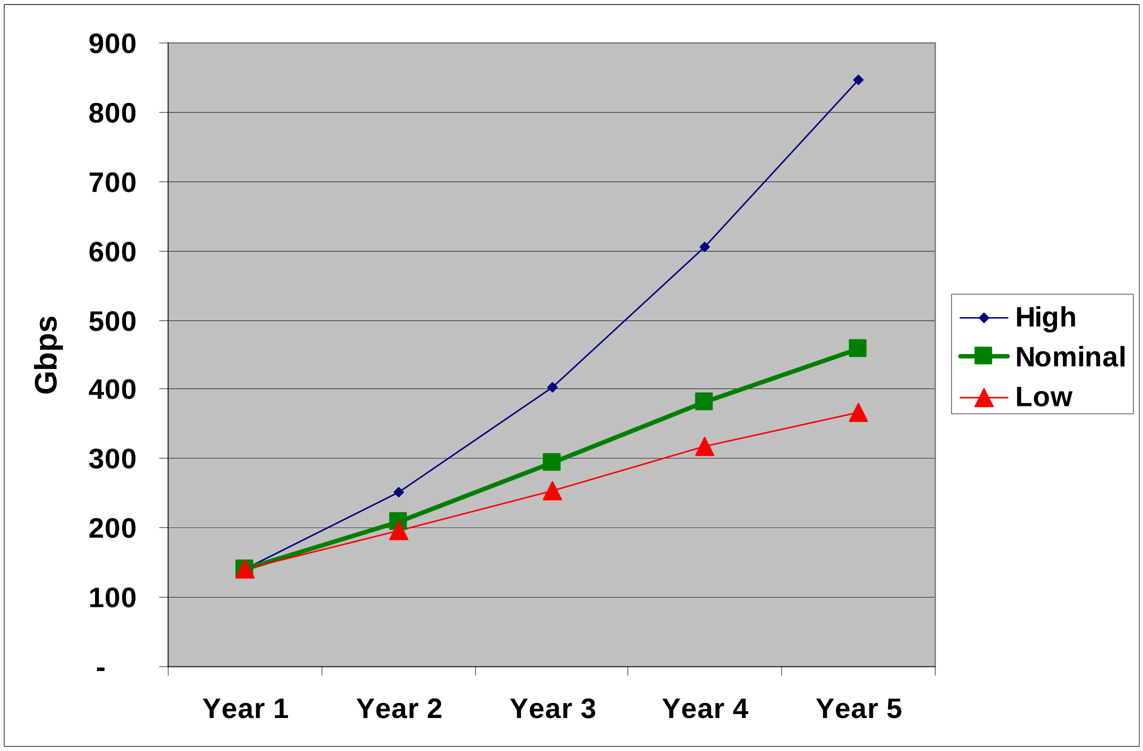
Scenario	Year 1	Year 2	Year 3	Year 4	Year 5
Low	–	40%	30%	25%	15%
Nominal	–	50%	40%	30%	20%
High	–	80%	60%	50%	40%

The total customer-facing bandwidth in year 1 is 140 Gbps[6], a typical level for a large core network.

[5] Though a single Cisco CRS-1 and its associated Cisco IOS XR Software operates at network availability in excess of that achieved by redundant traditional core routers, the conservative assumption is made to deploy redundant core routers to assure high network availability.
[6] The network configurations, bandwidth levels, and growth rates are based on Cisco's experience with large U.S. service providers as well as industry studies—principally those of network strategy partners, vertical systems, and current analysis.

Figure 1 shows the range of traffic capacities modeled by these three growth scenarios.

Figure 1 Customer-Facing Bandwidth



The economic analysis of deploying the Cisco CRS-1 covers a very wide range of possible outcomes by using the three bandwidth growth scenarios. These bandwidth projections are used to compute requirements for customer-facing ports within the core POP.

Table 2 shows the distribution of port types and speeds used in the analysis.

Table 2 Distribution of Customer-Facing Bandwidth

Port Type	Percent of Customer-Facing Bandwidth
Gigabit Ethernet	50%
10 Gigabit Ethernet	20%
OC-12/STM-4	10%
OC-48/STM-16	20%

The model assumes that these ports are dual-homed to the core. It also is assumed that the core network contains 20 POPs—typical for a large U.S. service provider. This assumption is made because some costs are independent of the number of POPs—the cost to add equipment in the NOC, for example—and must be allocated on a per-POP basis.

The analysis includes a cash flow computation to illustrate the benefit of the support of the Cisco CRS-1 for the OC-768c/STM-256c IP interface. The cash flow comparison imputes a portion of total service revenue—referred to as pseudo revenue—to each customer-facing port. Transport cost across the core network is recognized as a monthly recurring charge for transport. It is treated in this way because many large service providers use a transfer pricing system to account for the SONET/SDH, CWDM, DWDM, and optical fiber systems used for backbone transport. The resulting cash flow—also referred to as net revenue—is equal to pseudo revenue less backbone transport cost.

This cash flow computation is treated as a separate analysis because the economic benefit of the OC-768/STM-256 interface compared to the use of multiple OC-192/STM-64 interfaces by the traditional core router is much greater than other economic benefits. The amount of revenue supported by the core POP is estimated by imputing revenue to each customer-facing port by type. It is calculated by estimating the number of end-user services supported by each port on the core and the average monthly recurring charge per associated service type. The estimates are derived from several industry samples of U.S. private-line prices and revenue projected to 2007[7]. Industry samples also are used to estimate the cost of transport over the backbone links of the core. The low unit cost of OC-768c transport as compared to the OC-192c transport used by traditional core routers provides an overwhelming cash flow advantage. The monthly fixed cost per port for OC-768c is $900,000, whereas that for OC-192c is $300,000. (Pricing is lower for services delivered through DWDM but the relative relationships are much the same.) Therefore, four OC-192c ports cost $1,200,000 per month versus the $900,000 for a single OC-768c port. The per-kilometer charge is $1,600 per month for the OC-768c service versus $800 per month per kilometer for a single OC-192c service. Therefore, four OC-192c circuits cost $3,200 per month per kilometer versus $1,600 for a single OC-768c circuit. Assuming the need exists to use this much bandwidth, transport cost considerations overwhelm other elements of the economic comparison.

Note that this cost difference is reflected solely in the cash flow analysis and is not part of the accompanying TCO analysis. (Transport expense is used to calculate net revenue rather than being treated as part of operating expenses [OpEx].)

POP Configurations

The capacity model computes the number of router systems (routers), chassis, and ports of each type required to meet the capacity requirements projected for the three growth scenarios. Under the nominal growth scenario four traditional, two Cisco CRS-1 16-Slot,

[7] All prices for very high-speed transport services are negotiated rates (ICB – Individual Custom Bid). There are no reliable published sources for these types of services.

and one Cisco CRS-1 MS routers are required in the first year of the study to meet the capacity requirements.   Figure 2, 3, and 4 show the configurations for the three router scenarios within the core POP for this initial study year.

Figure 2 Traditional Router Configuration

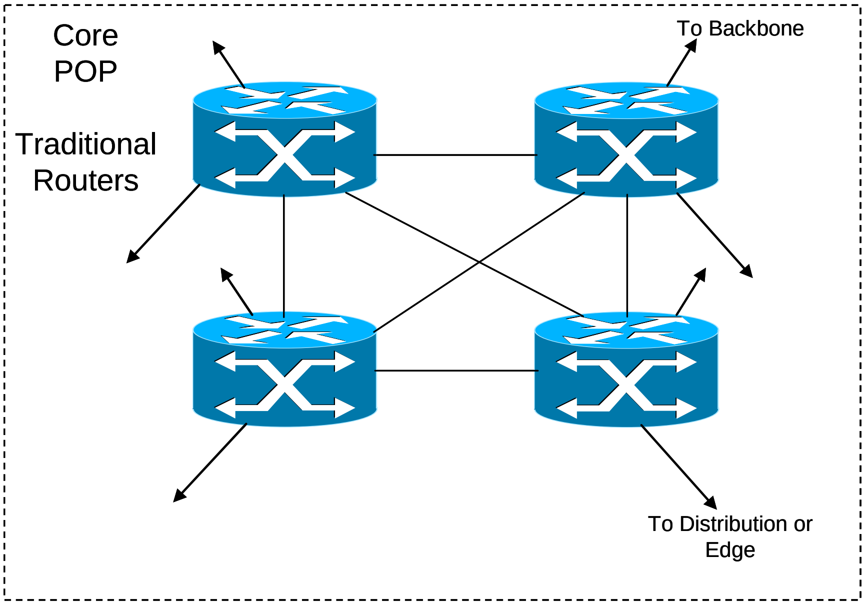


Figure 3 Cisco CRS-1 16-Slot Router Configuration

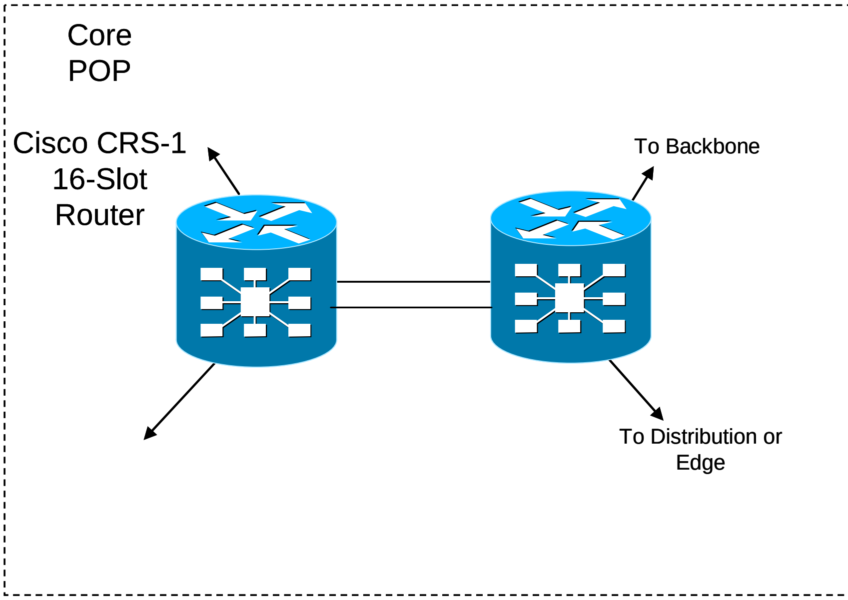
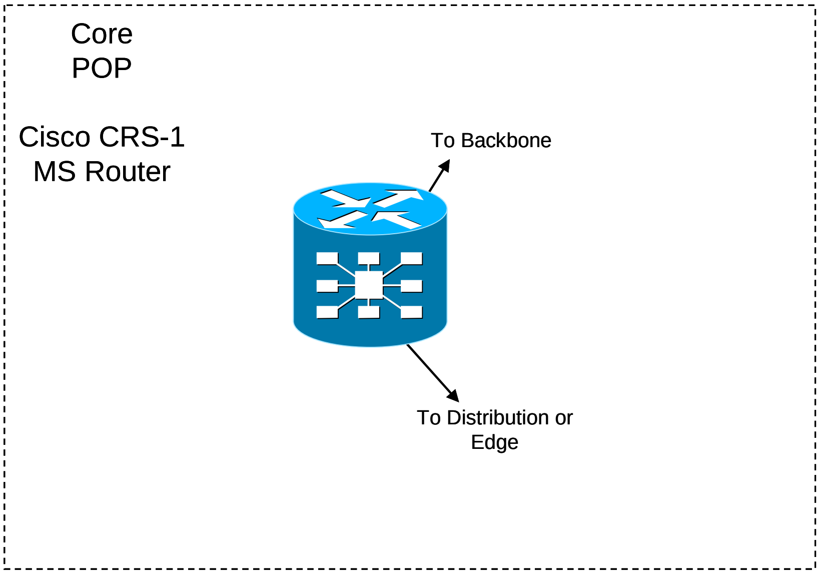
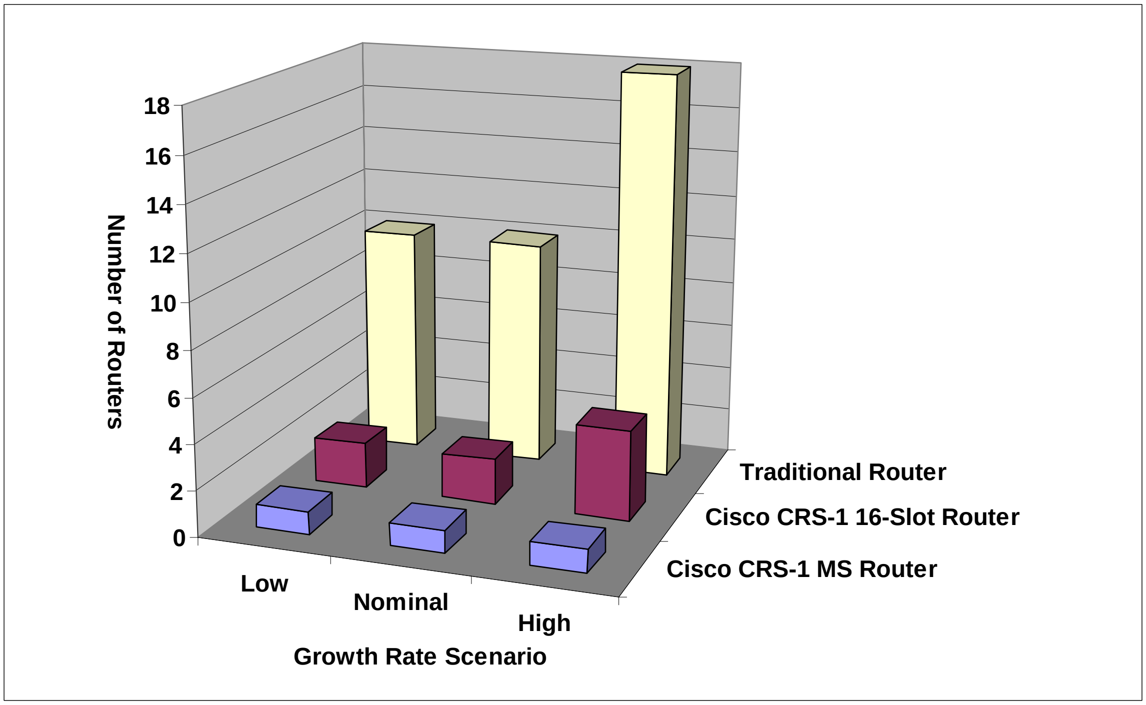


Figure 4 Cisco CRS-1 MS Router Configuration



The initial 140-Gbps customer-facing bandwidth requirement delivered through Gigabit Ethernet, 10 Gigabit Ethernet, OC-12/STM-4, and OC-48/STM-16 ports require a cluster of four traditional routers, as shown in Figure 2. In contrast, only two Cisco CRS-1 16-Slot Routers are required to meet these requirements. In fact the capacity is met by a single Cisco CRS-1 16-Slot Router, but they are deployed in tandem to increase network availability. Finally, a single multishelf Cisco CRS-1 is used (Figure 4) because multishelf and multiple virtual routers are operated within a single multishelf router system. Figure 5 shows the aggregate number of routers in the fifth year of the study required for each of the three router types for each 5-year growth rate scenario.

Figure 5 Number of Installed Routers (Year 5)

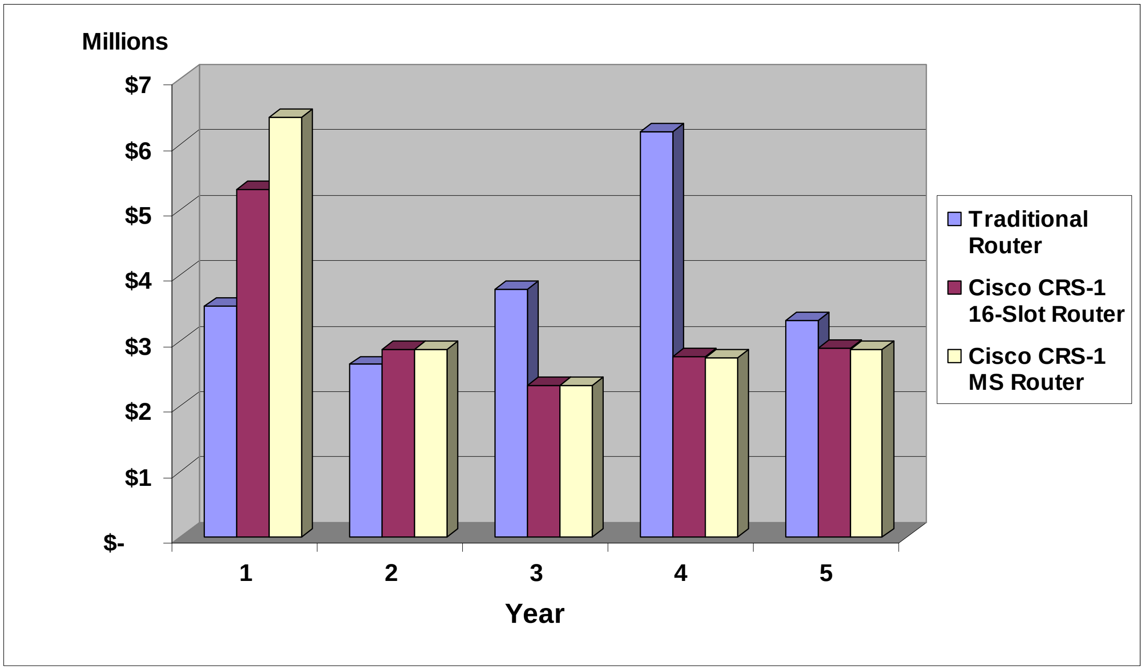


Even the low growth assumption requires 10 traditional routers by the fifth study year. Under the high growth assumption, 18 traditional routers are required. In contrast, only one Cisco CRS-1 MS system is required regardless of the growth assumption, and the Cisco CRS-1 16-slot configuration never requires more than four routers. The number of required routers affects, in turn, the CapEx estimates, and many OpEx components as well. For example, the move from dual routers to a 4-router cluster causes an explosion in the number of ports because each router must be connected to each router port at a downstream distribution or aggregation router as well as upstream to at least two other backbone POPs. In addition, additional router ports are required to form a full mesh among the routers within the core POP. The addition of ports in turn may require additional transport links between the core POP and edge or aggregation POPs. Each line card and chassis added within the POP, furthermore, incurs OpEx for such items as maintenance contracts, environmental expense, spares, and engineer, furnish, and installation (EF&I) expenses. Unit cost ($/Gbps) also increases with the addition of router systems because common costs scale up with the number of systems. Consequently, when a threshold level of customer-facing capacity is reached, the Cisco CRS-1 MS becomes the most efficient system because only one system is required despite the capacity level because external interconnects are avoided as a result of the multishelf fabric. The next section analyses the TCO results for the three system configurations.

TCO Results

The next several paragraphs examine the TCO results for the nominal growth scenario. Figure 6 shows the annual TCO for each of the three configurations.

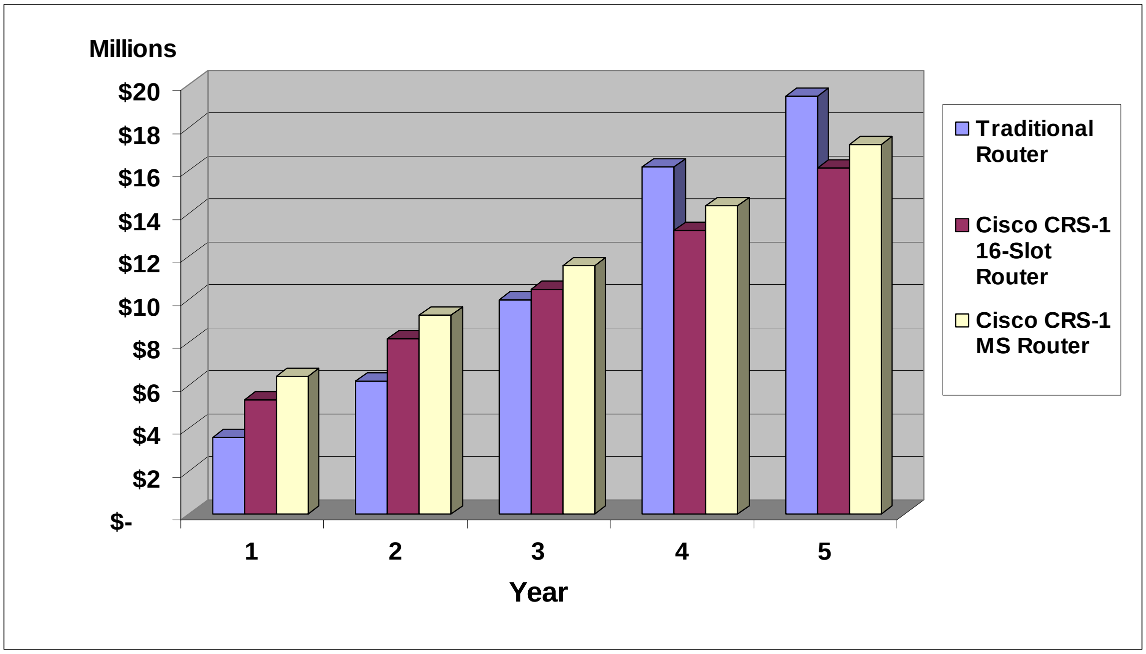
Figure 6 Total Cost of Ownership



The figure shows that the traditional router configuration is the least costly in the first year, whereas the Cisco CRS-1 MS configuration is the most costly. This scenario is to be expected because the cost of the installed base of equipment for the traditional router is a sunk cost and not part of the study. Traditional router expenditures are related only to year-1 system additions to accommodate growth and ongoing OpEx. The two Cisco CRS-1 systems, in contrast, must bear transition expenses such as modifying OSSs to support a new product and the equipment cost to meet the base-level capacity requirement. The traditional configuration is much more expensive than the other two designs in years 3 and 4 because of the better scaling properties of the Cisco CRS-1 discussed previously.

Figure 7 shows cumulative TCO over the 5-year study.

Figure 7 Cumulative Total Cost of Ownership



The traditional router configuration becomes more expensive than the two Cisco CRS-1 configurations between the third and forth years. The Cisco CRS-1 16-slot configuration is the lowest total cost alternative over the full 5-year study period. If bandwidth growth rates were higher or a longer study period was used, the Cisco CRS-1 MS would produce lower cumulative TCO. Such trade-offs are addressed in the “Sensitivity” section later in this paper.

Figure 8 and 9 show cumulative CapEx and OpEx over the 5-year study.

Figure 8 Cumulative CapEx

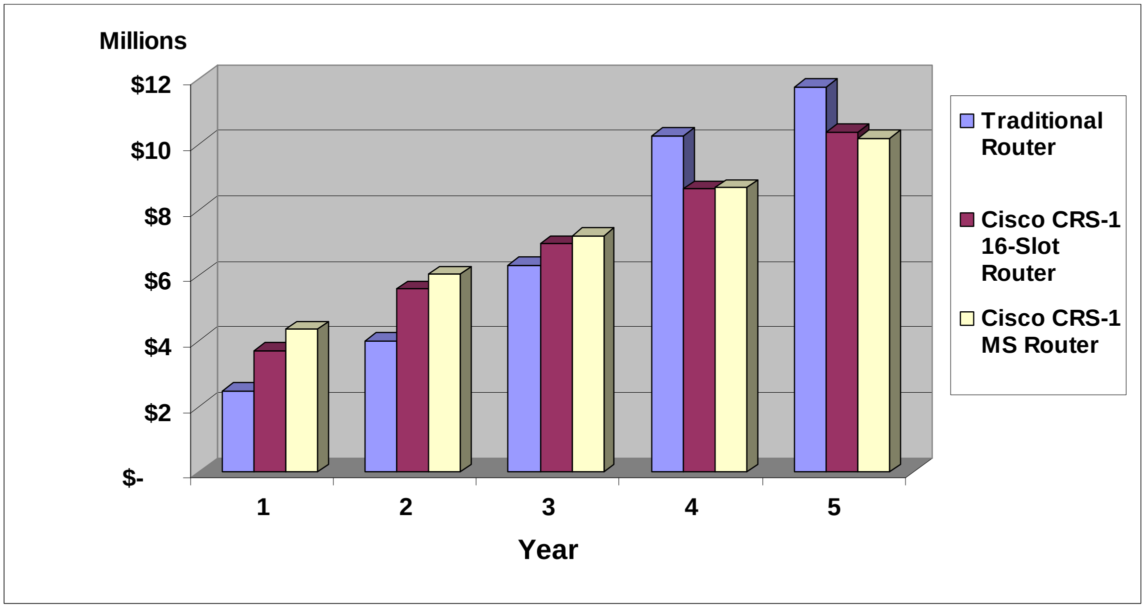
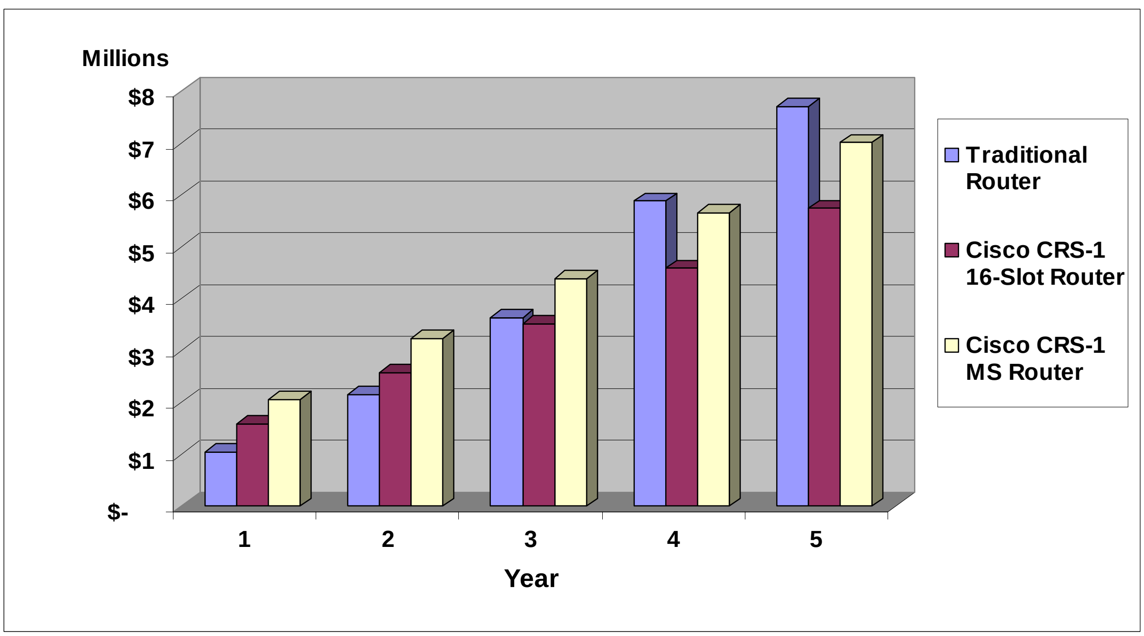


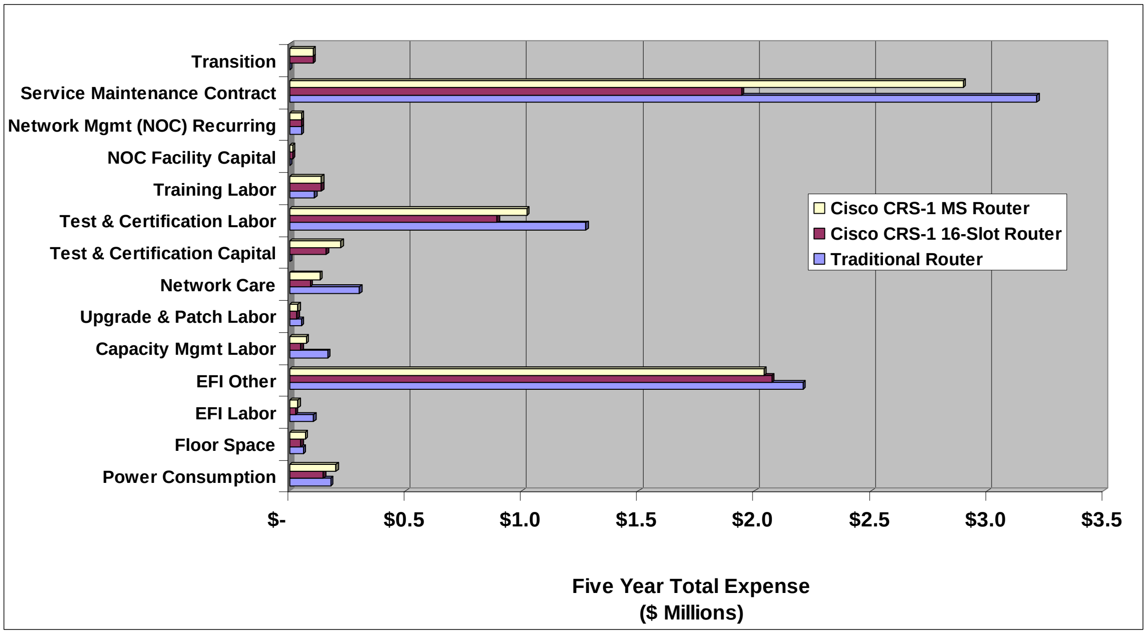
Figure 9 Cumulative OpEx



The traditional configuration has the lowest CapEx in the first year because the cost of its initial configuration is a sunk cost and the Cisco CRS-1 configurations must incur the initial capital cost to replace that capacity. However, sometime after the third year, total CapEx for traditional routers is greater than for either Cisco CRS-1 alternative. The same pattern is seen in operations expense due to the initial transition expenses incurred by the Cisco CRS-1 configurations. However, the Cisco CRS-1 16-Slot configuration overcomes its initial operating expenses (OpEx) disadvantage between the second and third years.

Figure 10 shows a breakdown of operations expenses over the 5-year study period.

Figure 10 Operations Expense Breakdown



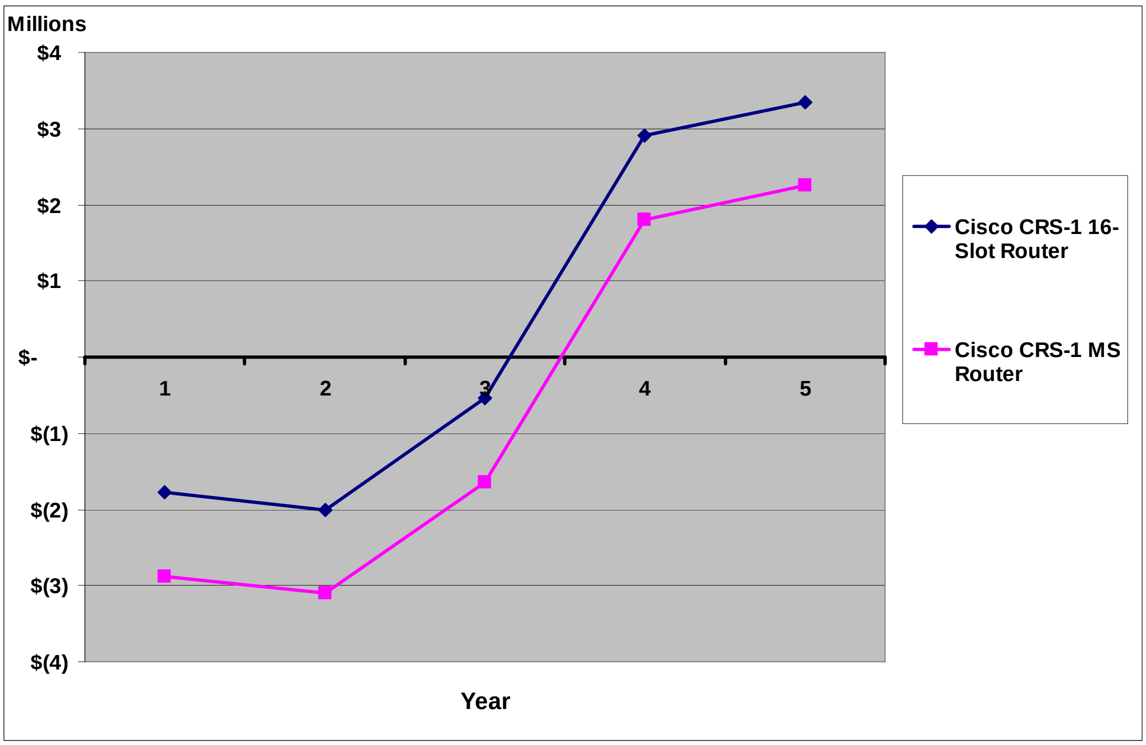
Service maintenance contracts, EF&I, and test and certification expenses are the largest elements of OpEx. The 5-year cost for each of these elements is higher for traditional routers than for the Cisco CRS-1 configurations. These expenses are directly related to the amount of new router equipment that is installed. Therefore, the large number of routers that are required for the traditional configuration puts this configuration at an OpEx disadvantage. Large service providers often cite the cost of modifying their OSSs to accommodate a new product as the reason that they chose not to move to a new system. This study uses a $2 million charge for OSS transition[8]—a number in the midrange for such projects. Such costs are spread across all POPs because this cost is a common cost. With a 20-POP core network—typical for a large service provider—this amounts to $100,000 per POP and, as Figure 10 shows, this cost is easily recovered by other operations cost savings.

[8] The largest U.S. regional Bell operating companies (RBOCs) estimate that IT project costs to revise the interfaces to their OSSs are from $2 to $3 million, with an upper limit of $5 million. This cost is independent of the number of core POPs. However, larger networks are likely to require larger IT projects. On the other hand, service providers unencumbered by the need to support large older IT operations and fewer POPs can make the same transition for $300,000 to $500,000.

Investment Analysis

The decision to make the transition from an existing backbone network using traditional routers to one using the Cisco CRS-1 can be analyzed as a classic investment decision where money is invested in the initial years so as to realize a return on the investment in the future. Figure 11 charts the transition to Cisco CRS-1 in just this way.

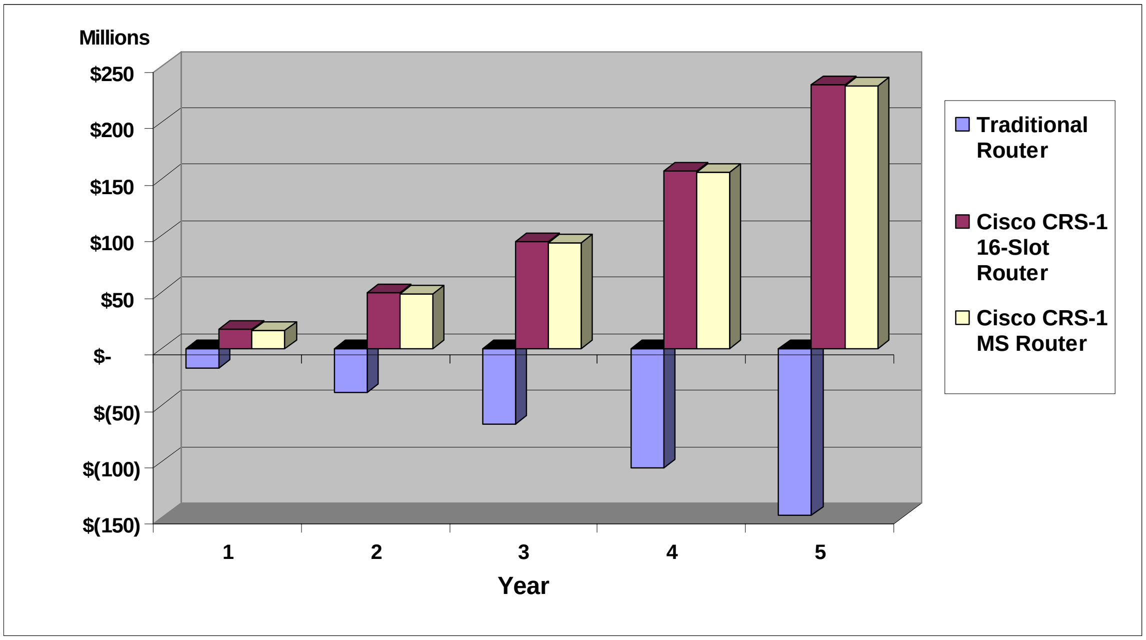
Figure 11 Cumulative Cisco CRS-1 TCO Advantage



The TCO of the traditional router configuration is subtracted from that of the Cisco CRS-1 16-Slot and Cisco CRS-1 MS configurations. This plot is shown in Figure 11, and because the traditional configuration costs less initially, the curves begin negatively and turn positive (break even) in a little more than three years for the Cisco CRS-1 16-Slot and 3.5 years for the Cisco CRS-1 MS configurations. The performance of such an investment can be measured by computing the internal rate of return (IRR)—a discount rate at which the discounted future returns exactly equal the discounted investment costs (negative values). The IRR for transition to the Cisco CRS-1 16-Slot Router is 45 percent per year, whereas that of the Cisco CRS-1 MS Router is 22 percent. These returns will meet hurdle rate requirements at many large carriers.

A second way of assessing an investment is to estimate its operating cash flow. Operating cash flow is revenue less investments and operating expenditures. Figure 12 compares the operating cash flow of the three router configurations.

Figure 12 Cumulative Cash Flow



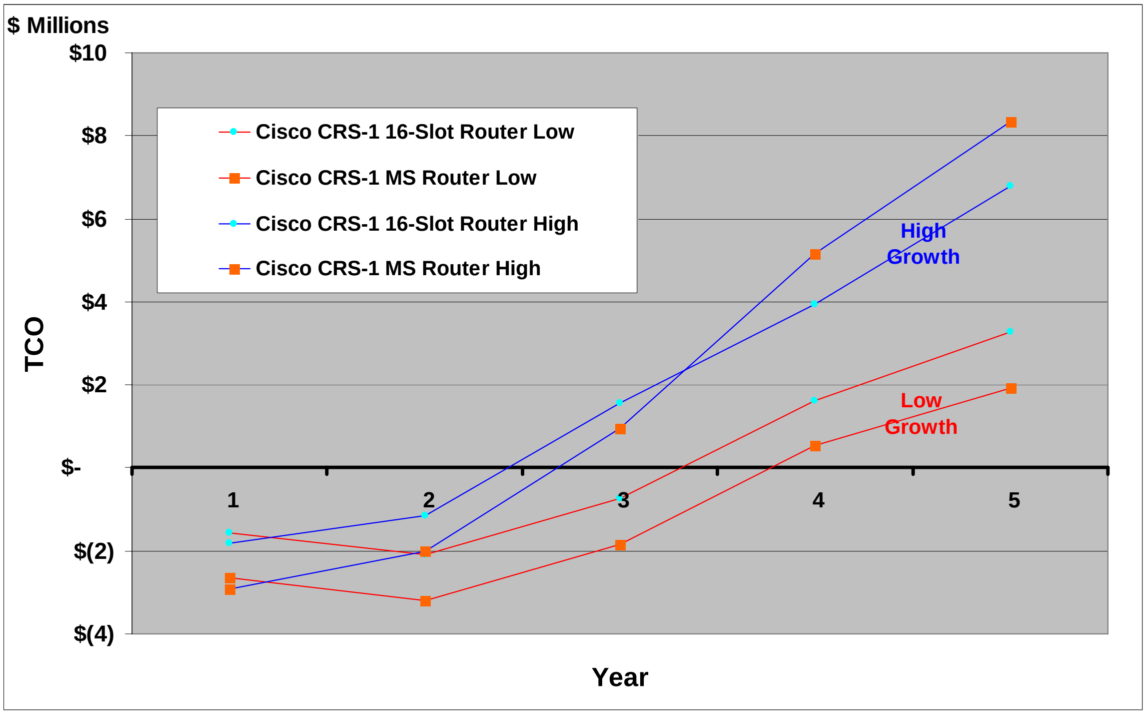
The operating cash flow of the Cisco CRS-1 projects is positive for every year of the study, whereas the traditional router configuration never achieves positive cash flow because of the use of an OC-768c/STM-256c IP interface onto the backbone network links. Traditional core routers do not support this high-speed interface[9]. As discussed previously, the very low unit cost of OC-768c/STM-256c transport service as compared to OC-192/STM-64 transport service overwhelms other financial considerations in the study and produces these results favorable to transition to the Cisco CRS-1.

Sensitivity Analysis

The results in the preceding sections used the nominal growth scenario. In general, low growth rates will favor the traditional router configurations, whereas high growth rates favor making a transition to the Cisco CRS-1 MS. Also, the single-shelf Cisco CRS-1 16-Slot Router will produce higher return on investment at lower growth rates, whereas the multishelf Cisco CRS-1 will be more attractive at higher growth rates. Figure 13 compares the low and high growth scenarios using the TCO advantage analysis of the previous section.

[9] The traditional core router definition used in this study limits I/O interface speeds to OC-192 or less.

Figure 13 TCO Advantage – Sensitivity Analysis



The sensitivity analysis shows the expected results. TCO turns positive more quickly with high growth than low growth. Also, at low growth rates the Cisco CRS-1 16-Slot Chassis maintains a consistent TCO advantage over the Cisco CRS-1 MS. However, whereas the Cisco CRS-1 MS falls below the Cisco CRS-1 16-Slot Chassis in the initial years at high growth rates. Its TCO advantage surpasses the Cisco CRS-1 16-Slot Chassis in the fourth year, reflecting the superior scaling properties of the multishelf configuration at large bandwidth capacities.

Benefits of Improved Availability

Extremely high network availability is required of a core network handling more than 100 Gbps of customer-facing bandwidth. The Cisco CRS-1 achieves the required availability through use of Cisco IOS XR Software. The microkernel-based design of Cisco IOS XR Software provides granular process independence, fault containment, and isolation, enabling the Cisco CRS-1 to be maintained, upgraded, enhanced, and scaled without service interruptions. Core routers with traditional software always are deployed in dual router (or cluster) configurations in order to improve network availability. However, even with this configuration routers with traditional software cannot reach the availability levels delivered by Cisco IOS XR Software.

Network elements that are part of the backbone network are required to meet or exceed a network availability objective with probability 0.99999—five 9s availability, meaning that the maximum total network outage permitted in one year is 5.3 minutes. This standard is very high and differs from the SLAs that service providers enter into with their customers in that no provision is made for scheduled downtime. Therefore, both unscheduled outages caused, for example, by a link failure and scheduled outages caused, for example, by a need to upgrade router software count against the 5.3-minute annual outage limit.

The effect of an outage can be classified as imperceptible, minor, or major, with average downtime, as shown in Table 3.

Table 3 Effect of Outages

Effect of Downtime	Downtime (seconds)
Imperceptible	0.05
Minor	5.00
Major	≥30.00

Imperceptible effects are defined to be those of 50 ms or less—the criteria established for SONET/SDH circuit restoration. Major effects are defined to be of at least 30 seconds. These effects are typically incurred by the need to reboot a router or to rebuild router tables throughout a network, and they can last for many minutes. A 0.99999 availability objective can easily be exceeded by a small number of major downtime effects.

The most common outages that incur major downtime effects when using traditional software are caused by software upgrades and configuration changes, software failure within the control plane, and link failure. The actual network availability realized depends on the frequency of outages as well as the downtime effect—imperceptible, minor, or major. Analysis of these factors predicts availability of 0.9999 for a core node using dual routers with traditional software because of the major downtime effects incurred in recovering from these three most common outages.

A core node using the Cisco CRS-1 with Cisco IOS XR Software achieves availability in excess of 0.99999 when operating under the same conditions. Availability is improved because the Cisco CRS-1 node eliminates major downtime effects while recovering from the most common outage types. The Cisco IOS XR In Service Software Upgrade feature eliminates major downtime effects associated with software upgrades[10]. The self-defending nature of the Cisco CRS-1 system prevents a control-plane failure caused, for example, by a distributed denial-of-service (DDoS) attack, and the Multiprotocol Label Switching MPLS Fast Reroute feature eliminates major downtime effect caused by link failure.

[10] This feature now supports only minor patches not moving between major software revisions.

Business Case Benefits of Improved Availability

Some of the benefits of improved availability are implicit in the TCO analysis of the previous section, whereas other benefits affect customer satisfaction and revenue that are not part of the TCO analysis.

Benefits due to improved availability that are included in the TCO analysis include:

- Reduction in staff time for troubleshooting—Fewer outages require troubleshooting and improved diagnostics decreases the time required to correct problems.

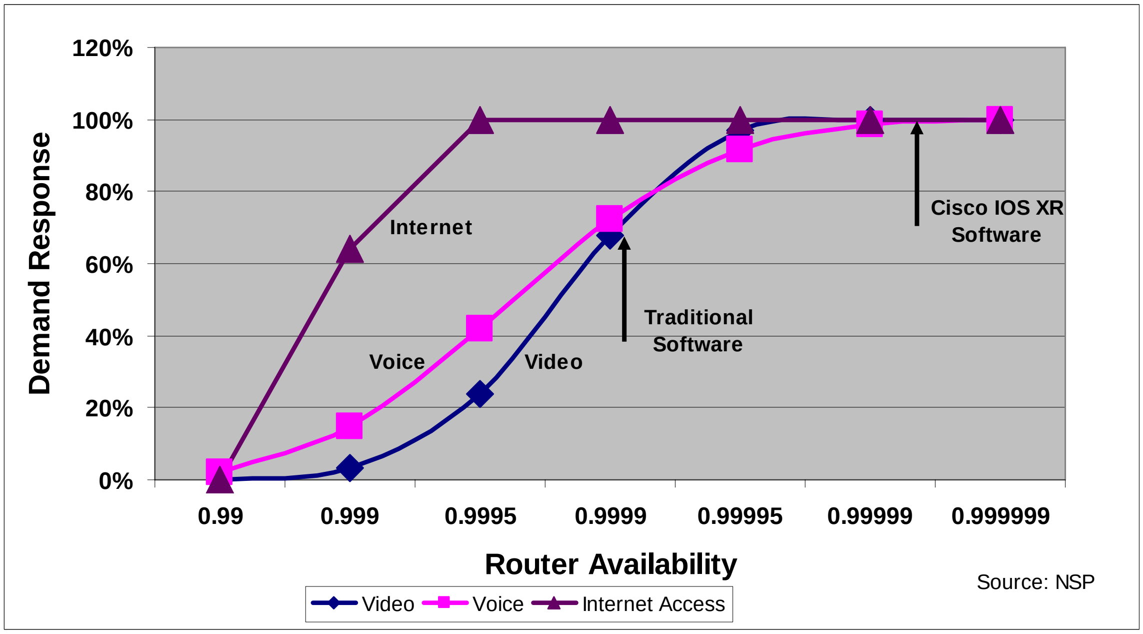
- Lower network operations cost—Beyond direct labor savings, reduction in time spent troubleshooting increases the time technical staff has to proactively manage the network, resulting in more cost-efficient operations, fewer outages, and improved asset use.

Improved network availability also has direct and indirect benefits on revenue, reduction of customer turnover, and increased lifetime customer account value. Reduction in SLA credits has a direct benefit. For example, the service pricing of customer-facing bandwidth per core POP modeled in the business case study was estimated to be $300 million in the first year and $973 million by the fifth year. Typical SLA provisions call for a 1-month credit if the SLA is violated. Therefore, $25 million in the first year up to $81 million in the fifth year is at risk for a single POP-wide SLA violation.

Enterprise customers, however, are unanimous in the view that SLA credits do not nearly compensate them for the cost of a service interruption. Reliable service and quick service restoration if an outage occurs are important elements of enterprise customers' buying criteria, and it is becoming more important as IP networks are being used increasingly for much more than just Internet service.

Figure 14 illustrates this concept.

Figure 14 Subscriber Take-Up vs. Router Availability



The figure relates demand response (take-up rate) to router availability. Customer expectations are formed by their prior experience with similar services. Web browsing on the Internet, for example, occasionally requires more than one attempt to access a Webpage—an academic study showed that the Internet component of a Web browsing transaction has 0.999 reliability. In contrast, the public switched telephone network has been designed with 0.99999 reliability for critical network elements for more than 50 years. Cable television service also delivers highly reliable service. The human factors requirements for services also affect what customers judge to be acceptable service. For example, the need to click a second time to link to a Webpage is no big inconvenience, whereas a screen freeze during the winning goal of a World Cup soccer match would spark an international outcry. The three curves shown in Figure 14, therefore, reflect these customer expectations formed by experience and the human factors requirements for each service.

Traditional router software with associated 0.9999 availability, therefore, provides fully acceptable performance for Internet service but falls short for voice and video services. In contrast, routers with Cisco IOS XR Software meet the availability requirements for Internet, voice, and video services.

Investment Protection

The preceding sections have analyzed the TCO, cash flow, and improved network availability benefits of making a transition from traditional core routers to the Cisco CRS-1. This section analyses the additional economic benefit of investment protection that is built in to both the entire Cisco CRS-1 product family as well as more generally across Cisco router platforms, including the Cisco CRS-1, Cisco 12000, Cisco 7600, and Cisco 7300.

Investment protection is achieved by building in interface module and forwarding card compatibility across the Cisco CRS-1 product family from the Cisco CRS-1 4-Slot Chassis to the Cisco CRS-1 Multi-Chassis as well as by providing interface portability across the entire Cisco router platforms listed previously, resulting in increased flexibility of deployment by permitting equipment reuse and common sparing for customers with existing Cisco routers in their network while lowering overall CapEx and OpEx spending. Furthermore, as the core network expands and larger Cisco CRS-1 chassis become necessary, customers can reuse the existing interface and forwarding engines from previous chassis on the newer units as needed. This scenario is in contrast to competing router vendors that provide none or limited portability across their edge or core router product lines, resulting in increased CapEx and OpEx spending for the customer. Overall inventory, training, network management. and field maintenance expenses are all reduced by minimizing the number of separate parts that must be stocked, maintained, and operated.

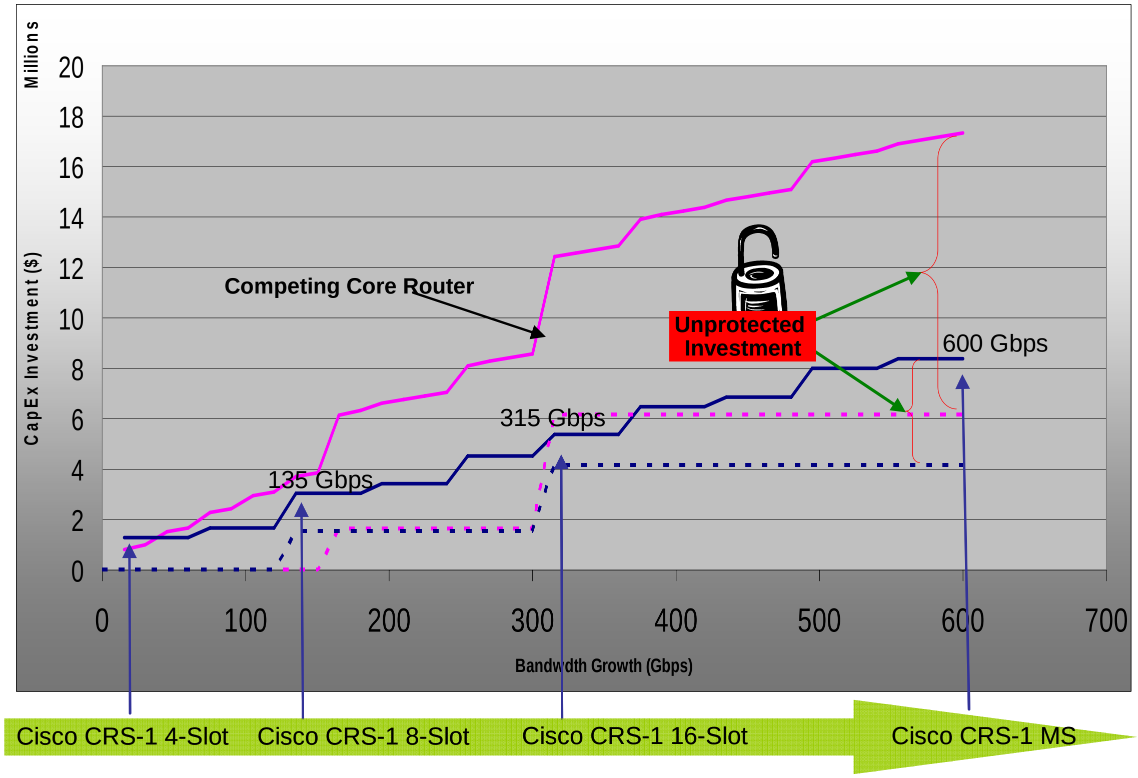
Modules and cards that are common across the Cisco CRS-1 product family include:

- Modular service card (MSC)—The forwarding engine for all interface modules
- Physical layer interface module (PLIM)—Fixed-configuration interface modules
- SPA interface processor (SIP)—A jacket card that takes up to 6 shared port adapters (SPAs)
- SPAs—Individual interface sets that populate the SIP

In addition, a single forwarding engine is used for all interface types ranging from DS-3 through 40 Gbps, while the SPAs are portable across the Cisco CRS-1, Cisco 12000, Cisco 7600, and Cisco 7300 platforms.

Figure 15 compares the CapEx required to support bandwidth growth in a core network for the Cisco CRS-1 product family versus that of another competitive vendor's router.

Figure 15 Cisco CRS-1 Investment Protection



Configuration – 10 Gigabit Ethernet Ingress with OC-192/OC-768 Egress

Source: Cisco Estimates

Total required CapEx to support bandwidth growth are shown as solid lines for the Cisco CRS-1 and for the competing router vendor's product family. The difference in these solid lines is caused by the scaling advantages of the Cisco CRS-1 as was analyzed in the TCO section. Additional benefits, however, are gained through the superior investment protection provided by the Cisco CRS-1 product line. Figure 15 also identifies the actual protected CapEx investment for each product family with a dashed line. The difference between total investment and protected investment is unprotected investment—identified by brackets on the chart. As shown, the competing router has unprotected investment of $11 million as compared to $4 million for Cisco CRS-1 as bandwidth requirements grow. The Cisco CRS-1 has 2.75 times more overall protected investment than the competing router family analyzed.

This investment protection advantage of the Cisco CRS-1 greatly reduces the risk associated with transition to Cisco CRS-1 from existing traditional router-based networks.

Conclusion

A strong business case can be made for making the transition from routers with traditional software to the Cisco CRS-1 with Cisco IOS XR Software. The primary benefit of making the transition is reduced TCO due to the superior scaling properties of the Cisco CRS-1 as compared to traditional routers. The costs of making the transition include the cost of adding a new network product to the service provider's OSS, construction of a testing facility, additions to the NOC, increased training expense, and the cost to replace the existing capacity of the POP. A TCO study using typical POP capacity and nominal growth rates showed that the transition program reaches the break-even point in slightly more than 3 years and has an IRR of 45 percent per year over a 5-year study interval when the Cisco CRS-1 16-Slot Chassis is deployed in a dual-router configuration. A sensitivity study showed that transition to Cisco CRS-1 provides a strong financial return across a very wide range of possible growth scenarios.

A cash flow analysis was performed to measure the contribution of the Cisco CRS-1 OC-768c/STM-256c IP interface used to connect to the backbone interface. Traditional routers lack this interface, requiring them to use much more expensive OC-192/STM-64 transport services to carry the same traffic capacity on the backbone links. The cash flow analysis showed consistent positive cash flow for both Cisco CRS-1 configurations, whereas the traditional routers never produce positive cash flow because of the high cost of OC-192/STM-64 transport services.

The Cisco CRS-1 and Cisco IOS XR Software also produce higher network availability than routers with traditional software. The in service upgrade, self-defending nature, and MPLS Fast Reroute capabilities of the Cisco CRS-1 and Cisco IOS XR Software combination eliminates the major downtime effects caused by network outages, producing an improvement in router availability from 0.9999 for traditional routers to 0.99999 for the Cisco CRS-1 with Cisco IOS XR Software. The business case benefits of improved availability include lower CapEx and OpEx as discussed previously, reduced exposure to SLA credit risks, and improved customer uptake for advanced IP services such as voice and video.

Finally, the cross-platform and cross-family compatibility of Cisco CRS-1 interfaces and forwarding modules provides extensive investment protection that further reduces the investment risks of making the Cisco CRS-1 transition. Compared to its closest competition, the Cisco CRS-1 provides 2.75 times more investment protection for its customers.