

# Integrated Edge Services: The TCO Advantage



by Jennifer Pigg | April 2009

## Executive Summary

In April 2006, Yankee Group published the report “Integration of Ethernet Aggregation, Subscriber Management and Edge Routing Yields TCO Advantages.” In this report, we examined the unique networking needs at the service provider edge and evaluated the ability of existing solutions to meet those needs effectively and economically. In 2006, service providers were likely to be using two or three separate hardware platforms for Ethernet aggregation, subscriber management and edge routing. Our analysis of the cost benefits of using an integrated solution, versus two or more separate boxes, yielded a compelling total cost of ownership (TCO) analysis that favored the integrated solution from both a capex and opex perspective. Now, three years later, we revisit the solutions available to service providers at the edge and examine:

- How has the role of the edge router changed?
- What should service providers be looking for from an integrated edge router?
- Are solution vendors more adept at integrated solutions, or is integration still a differentiator?
- What is the TCO of today’s solutions?

## Table of Contents

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I. A Climate of Change	2
More Traffic	2
A Greater Mix of Traffic	3
Less Revenue per Bit of Traffic	3
Constraints on Headcount	4
Lower or Frozen Capital Budgets	4
II. TCO Analysis: Who Pays the (Biggest) Bill?	5
TCO Results	6
NPR and IRR Results	7
Analysis of the Results	7
III. Conclusions	8

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## I. A Climate of Change

Yankee Group developed our Service Provider Scorecard during the past 12 months. In this scorecard, we evaluate the competitive position of service providers from six key perspectives—from financial stability to partner ecosystem to core and access infrastructure. Our research reveals that the relentless pressure on service provider profitability has caused them overall to finally accelerate their corporate strategies in two key areas. The first is organizational integration. The walls between the voice, or transport, organization and the data organization have prevented service providers from optimizing their resources from a wide range of perspectives: support personnel, operational and business support systems (OSS/BSS), service creation and introduction, and network infrastructure. The second area where we see increased momentum from the service providers is the flip side of the integration coin—that is, optimizing network infrastructure to lower capital costs, increase the speed of service creation/ deployment and improve operational costs. We first saw triple-play bundles introduced eight years ago. It is only in the past three to five years, however, that we have seen service providers move to back them up with an integrated network.

What does this mean to the network edge? When we look at the challenges facing the service provider at the edge of the network, we note five areas where the market has changed significantly since 2006 and our initial TCO analysis. These areas are:

- More traffic
- A greater mix of traffic
- Less revenue per bit of traffic
- Constraints on headcount
- Frozen or lowered capital budgets

We define each of these challenges below, and discuss their impact on the multiservice edge. We also offer our recommendations to service providers regarding what they should look for from a solution vendor to help them meet these challenges.

### More Traffic

Data from IP traffic watchdogs such as Akamai, Arbor Networks and Cisco paint a challenging picture for the service provider. Global IP traffic is growing at more than 45 percent per year through 2012 (i.e., doubling every two years).

**Impact on the edge:** Service providers cannot afford to depreciate equipment this quickly. Today's solution must scale, in terms of chassis, processing speed and line cards, to handle three times the traffic in 2012 that it handles today. Three years ago, broadband aggregation platforms required an aggregate throughput of 80 Gbps, supporting 1 to 10 Gbps slots. Today they must be able to scale to more than 400 Gbps of throughput with slots capable of 1 to 20 Gbps. Three years from now, service providers will be looking for a terabyte of aggregate throughput. Forty-gigabit-per-second interfaces will be the norm, and Tier 1 carriers will demand 100 Gbps interfaces.

**What service providers should watch for:** A multiprocessor architecture. A key indicator of a device's ability to scale, apart from its backplane switching capacity, is its processing architecture and speed. The majority of the devices examined by Yankee Group had single processors for the forwarding plane and, in most cases, a second for the control plane. Some solutions, however, boast a multi-core processing architecture that balances network tasks across four processors. The design challenge for today's integrated edge device is to incorporate just enough processing power to handle all ingress and egress traffic, and also to act on the traffic without imposing delay (e.g., for security, traffic management or subscriber management functions). Too few application-specific integrated circuits (ASICs) and you impose delay because the processors cannot act on the traffic fast enough. Too many ASICs and you impose delay if the ASICs constantly need to communicate with each other.

The service providers should task the solution provider for the cost and configuration of upgrades to the initial solution. What is the capex today and how much will it cost the service provider to scale the solution two, three and five years down the road? How scalable is the chassis? Can the line cards be used in multiple chassis? How costly and difficult is it to add new services to the configuration?

## A Greater Mix of Traffic

YouTube was introduced two months before we published our initial TCO report in 2006. At that time, 2 percent of all Internet traffic was video. Today, YouTube alone accounts for 6 percent of all Internet traffic. Internet video will account for 35 percent of Internet traffic in 2009. This figure does not include peer-to-peer (P2P) file sharing traffic, which accounted for 60 to 70 percent of all Web traffic at the beginning of 2006 and, Yankee Group estimates, will account for 35 percent of Web traffic in 2009. P2P traffic has tripled in volume during this time, but overall traffic growth has outpaced it. Although video is the cause of the rapid growth in traffic, the service providers cannot allow video and P2P traffic to impact the performance of voice and data sessions.

Similarly, while carriers may be migrating services to IP, they continue to support TDM, ATM and even frame relay. They have not been as aggressive in migrating services away from these deterministic services as we expected them to be three years ago. Service providers are cautious about disrupting services that have service-level agreements (SLAs) written into them and that benefit from a highly deterministic network. Service providers are supporting a wide range of traffic types: voice, video and data traffic. Each traffic type has a widely diverging traffic profile in terms of bit rate, average packet size, maximum delay, maximum jitter and susceptibility to buffering. The traffic is supported over a variety of fixed and mobile access technologies—Ethernet, ATM, packet over SONET (POS), TDM, WiMAX, 3G, long-term evolution (LTE)—and is implemented to provide connectivity to a wide range of carrier services: IPTV, high-speed Internet (HSI), voice over IP (VoIP), VDSL, mobile backhaul and VPNs.

**Impact on the edge:** The service provider must protect existing revenue streams with a solution that supports all access methods currently in use on the SP's network. Equally important, subscriber and traffic management are critical. The service provider may support tens or even hundreds of thousands of triple-play subscribers on an integrated edge router. The service provider must define, track and report on a wide range of SLAs. It must identify and apply the appropriate quality of service (QoS) for each type of traffic. For example, the provider must be able to deliver a high QoS to the subscriber paying for gold- or platinum-tiered HSI service and using it moderately at four p.m. when their neighbor, paying for a flat-rate service, is downloading and seeding bandwidth-intensive P2P files. Security must also play a part in subscriber management. The network overall, as well as business users and consumers, needs to be protected from the panoply of security threats.

**What service providers should watch for:** Does the solution support all types of network access needed? If the service provider is using encapsulating traffic via Point-to-Point Protocol over X (PPPoX), does the solution require separate hardware to handle these connections? Similarly, if the service provider's OSS supports and expects the full range of radius attributes for AAA functions but the integrated edge router does not, changes will have to be made to the OSS—which service providers struggle to avoid at all costs.

## Less Revenue per Bit of Traffic

As we mentioned above, traffic on the Internet is doubling every two years. However, the average revenue per user (ARPU) is stagnating. For example, ARPU for triple-play services in the United States in 2006 was slightly more than \$110 per month and remains there today, despite the fact that the average bit rate of broadband connection continues to climb. In addition, with over-the-top video from service providers such as Joost, video becomes essentially free—just another application. Services providers must charge more, lower their own costs or develop alternate revenue channels (e.g., from advertising, content provider and/or over-the-top providers). They will, most certainly, implement a combination of all three strategies.

**Impact on the edge:** If revenue per bit of traffic is declining, two changes must occur at the edge. Firstly, cost per bit of traffic must also decline—both capital and operational cost. A 20 Gbps or 40 Gbps interface cannot be a concatenation of the equivalent number of 10 Gbps interfaces with virtually no savings in capex, rack space, power draw or heating, ventilation and air conditioning (HVAC) expense. Scalability does not just mean handling more traffic. It means handling more traffic at less cost. Secondly, the service provider must be able to capture revenue more granularly and flexibly and at lower cost. This means having robust subscriber management and traffic management tools. The subscriber should be able to modify his or her own service online—resulting in lower service provider costs and improved customer satisfaction. The service provider should be able to monitor usage by subscriber and flag power users—automatically sending them offers for higher bandwidth packages, and at the same time, ensuring that their traffic does not impact the QoS of other online users. Finally, these capabilities must be tied into the service provider's billing system.

**What service providers should watch for:** Service providers are rigorous and methodical in evaluating hardware in terms of speeds, feeds and port density. There are two additional areas where today's solutions warrant close inspection. Solution providers in 2009 are emphasizing their "green" initiatives much more so than three years ago. We expect to see more industry and government guidelines and mandates for power usage similar to the European Union's "Code of Conduct on Energy Consumption of Broadband Equipment," the third version of which was published last November. Service providers should expect the vendor to demonstrate the power requirements of their solution as a measure of how much power it takes to deliver a service to a consumer. Traditional methods such as overall power draw, watts per port or per Mbps, and the amount of heat dissipated, expressed in British Thermal Units (BTUs), are a good start as service providers begin to manage power consumption on a per-subscriber basis. What's good for the environment is good for the balance sheet.

The second area that will benefit from closer inspection is the system software. One of the benefits of the integrated edge router is that the SP Ethernet aggregation, edge routing and subscriber management are all under one management system. Combine this with DPI and firewall functionality and that's a lot of software to evaluate. Yankee Group recommends service providers compare solutions in terms of ease of configuration; updating protocols; In-Service Software Upgrade (ISSU), not just for new software versions, but for patches; DPI filtering capability (can it identify encrypted P2P traffic?) and the scalability of the system in terms of the number of active triple-play subscribers, IP router MAC addresses, etc. Finally, service providers should ask themselves whether the solution supports all broadband access protocol needed and a full range of RADIUS attributes.

## Constraints on Headcount

Between telco consolidations and a depressed global economy, Yankee Group is surprised when we find a service provider that has not reduced its force in the past 12 months, particularly among wireline carriers in established markets. This is not just a temporary mandate to "do more with less." Service providers know that to compete in a triple- or quadruple-play arena, they must finally bite the bullet and combine their data and transport organizations, and ideally their mobile organizations as well. Verizon, BT, AT&T, Telstra and France Telecom are all combining organizations and looking for the economies that these reorganizations bring in terms of staffing and network infrastructure.

**Impact on the edge:** The network must be simpler. The number of management systems must be reduced, the number of platforms consolidated. In defining an edge infrastructure in 2009, the issue is not what services the customer will need—voice, HSI or IPTV—it is what flavor of each service does the customer need? Triple play

is assumed—how to deliver it rapidly, securely, at low cost to the carrier and with greater flexibility to the end user is the issue. To make the best use of available resources, service providers are looking to remove complexity from network end points and user sites, thereby reducing access device costs and the number of truck rolls, and enabling remote configuration and management. The edge of the network is where service providers are looking to focus resources.

**What service providers should watch for:** How many management systems can the operations staff afford to master? The days when network management integration meant a chair with wheels are long gone. Service providers should evaluate systems based on the cost of training and the number of operations staff required to maintain the system or systems.

## Lower or Frozen Capital Budgets

AT&T announced in January that it would cut capital spending 10 to 15 percent, or by \$2 billion to \$3 billion from 2008 levels. Yankee Group has seen similar announcements from carriers worldwide. MTS, the largest mobile phone operator in Russia, cut its capital expenditure forecast to \$2 billion from \$2.5 billion. Sprint announced in December it was holding off on its network expansion. The Nordic operator TeliaSonera announced in January that its capital spending would stay the same or decrease in 2009.

Quarterly results from telco equipment vendors and integrators are similarly depressed. The majority are posting lower-than-expected sales at the end of 2008. An exception is Ericsson, which exceeded analysts' expectation by increasing sales in networks by 22 percent in the fourth quarter of 2008.

**Impact on the edge:** More than ever, service providers are looking to future-proof their networks. They need solutions that not only scale, but are flexible. They cannot predict exactly how the access network is evolving, and they need a solution that can meet their access needs today with, for example, ATM access support and tomorrow with IP. Service providers grapple with numerous complex wholesale and tariffing schedules, regulatory environments and broadband availability constraints. They are looking for solutions that meet their service and connectivity needs, which can change on a daily basis.

**What service providers should watch for:** Service providers require flexibility and scalability under one management system, with the ability to leverage only the specific functionality needed. The ideal solution will result in a substantially lower TCO—with multifunction capabilities, a modest capital cost and a low power profile and footprint. Can today's integrated edge routers deliver on this promise? This is the question we answer in our TCO analysis in the next section.

## II. TCO Analysis: Who Pays the (Biggest) Bill?

The assumption behind triple-play services is that subscribers require all three services: voice, video and HSI. Service providers that bundle these services into one offering provide “stickiness” to their service portfolio, discouraging users from switching carriers. Service providers have been aggressive in marketing their triple-play bundles. However, on the network side, triple-play services may be anything but integrated, with multiple overlapping lines, equipment and management systems. Going into our TCO analysis in 2006, we assumed that an integrated service portfolio on the subscriber side would benefit from integration on the network side and, specifically, an integrated edge router. The results of the analysis strongly supported our assumption. However, do these advantages still hold true in 2009?

Much has changed for the solution providers in the intervening three years. Some have integrated Ethernet aggregation and subscriber management, some have integrated Ethernet aggregation and IP services, and all have scaled their platforms to support more subscribers and more throughput. However, a majority of vendors still require at least two separate platforms to offer all three services. We are revisiting our TCO analysis to test whether the cost benefit still lies with the integrated platform.

To evaluate TCO and ROI, Yankee Group used a hypothetical service provider (HSP) that is rolling out triple-play services using two separate edge architectures: one that integrates edge routing, Ethernet aggregation and subscriber management on one platform, and one that uses two separate platforms to offer these services. For the purpose of this report, TCO is considered the sum of capital and operational costs of deploying broadband aggregation infrastructure. ROI is measured in terms of net present value and internal rate of return—two widely applied discounted cash flow (DCF) metrics.

Before we calculate TCO and ROI, we must establish the market and network conditions in which the HSP plans to deliver residential IP-based voice, video and data services. The following assumptions apply to the HSP’s triple-play service offering:

- **The primary bundle includes VoIP, HSI and IPTV services.** IPTV includes multicast channels and unicast services, such as video on demand (VOD) and network-based DVR service.

- **The metro-area subscriber forecast spans four years.** Given a large metropolitan area market with a population of eight million to 10 million people, we expect 100,000 subscribers to the bundle in Year 1 (2009), growing to 703,000 by the end of 2012 (see Exhibit 1). Yankee Group research shows that a new triple-play entrant to a competitive market can expect to command 10 percent of that market within 18 months, based on user demand for competitive offerings. However, in a large metropolitan market, the logistics of turning up that number of users persuaded us to expand the time window to four years.
- **Average revenue per user (ARPU) remains steady during the four-year period.** ARPU starts at \$110 per month and maintains this through 2012. However, service providers will be providing higher speeds for this monthly rate. Those subscribers that maintain their existing connection speeds are likely to see their monthly fee decrease during the survey period. The ARPU growth trend is based on Yankee Group research.

Our HSP’s network planners rely on the subscriber, ARPU and revenue forecasts to invest in next-generation infrastructure. The following assumptions apply to the HSP’s decisions regarding broadband aggregation network planning and design:

- **Requires flexible ATM-to-Ethernet migration plan:** We assumed that the HSP maintains a large HSI subscriber base supported in part by ATM-based aggregation. To realize the projected growth in triple-play subscribers, the HSP will migrate ATM aggregation links to Ethernet during the four-year time frame.
- **Supports full suite of triple-play services over ATM and Ethernet access:** Although HSP will migrate subscribers to Ethernet during the long term, the option to deliver the full triple-play bundle over either ATM or Ethernet provides the flexibility needed to migrate gradually with minimal disruption to the network or subscribers.
- **Uses PPP- or DHCP-based subscriber management:** HSP’s existing infrastructure and operational processes are designed for Point-to-Point Protocol over Ethernet (PPPoE)-based DSL connections interfacing with RADIUS servers. HSP will continue to use PPP, but will deploy an aggregation solution that can migrate easily to IP over Ethernet using DHCP authentication.

- **Requires high availability:** HSP will only install broadband aggregation platforms that maintain high availability, including features such as non-stop forwarding and ISSU. Solutions must also support session-level reliability and common link failover mechanisms.
- **Requires hierarchical QOS:** HSP plans to use hierarchical QOS to assign as many as eight queues per subscriber, and to rate-limit and schedule traffic on a per-service basis. HSP also relies on hierarchical QOS for preventing security attacks to the control plane and reporting subscriber accounting data to the OSS layer.
- **Embraces Ethernet and ATM aggregation:** HSP must support both ATM and Ethernet uplinks from the installed base of DSLAMs. We assumed that HSP will use 10-Gigabit Ethernet for network-side uplinks to the IP/MPLS core.

**Exhibit 1. Hypothetical Service Provider Triple-Play Subscriber, ARPU and Revenue Forecasts**

Source: Yankee Group, 2009

	Subscribers	ARPU per Month	Triple-Play Revenue
2009	100,000	\$110	\$132,000,000
2010	185,000	\$110	\$244,200,000
2011	351,000	\$110	\$463,320,000
2012	703,000	\$110	\$927,960,000

**TCO Results**

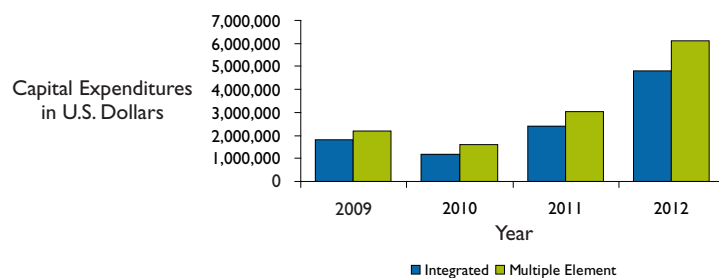
The TCO calculation combines the capital and operational costs of each alternative during a four-year period. Capital expenditure (capex) includes all system costs—chassis, line cards, power supplies and fans. The capex calculation applies the appropriate number of systems and components to the triple-play subscriber forecast shown in Exhibit 2. Operational expenditure (opex) includes all HVAC costs, power consumption, rack space, security

and engineering labor. Exhibits 2, 3 and 4 (on the next page) show the results of the capex, opex and TCO calculations. The integrated solution yields significant cost of ownership advantages over the multiple element model:

- Capex advantage: 21 percent
- Opex advantage: 52.6 percent
- TCO advantage: 22.1 percent

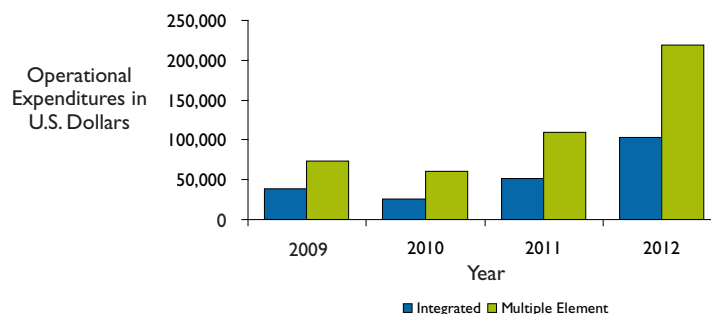
**Exhibit 2. Capital Expenditure: Integrated vs. Multiple Element Model**

Source: Yankee Group, 2009



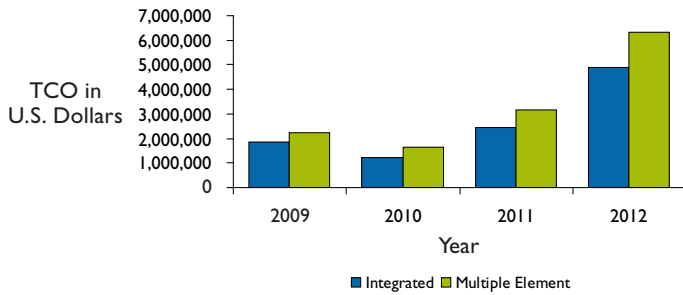
**Exhibit 3. Operational Expenditure: Integrated vs. Multiple Element Model**

Source: Yankee Group, 2009



**Exhibit 4.**  
**Total Cost of Ownership: Integrated vs. Multiple Element Model**

Source: Yankee Group, 2009

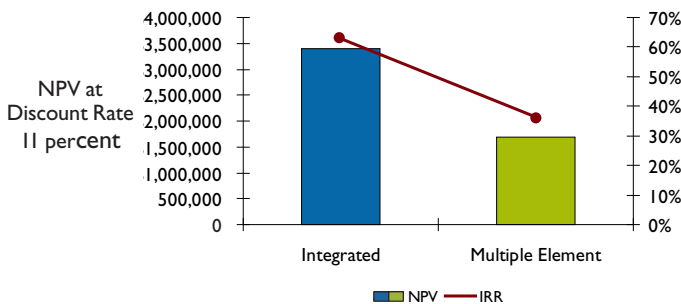


**NPR and IRR Results**

TCO is an important metric to consider. However, the decision to invest in either the integrated solution or multiple element solution depends on the net present value (NPV) of future cash flows associated with each deployment. In addition, decision-makers must be convinced that the internal rate of return compares favorably to similar network infrastructure projects. To calculate cash flows, Yankee Group first used its TCO calculation in Time 0 (year-end 2008) for the initial cash outlay in support of the triple-play service introduction. In years 2009 to 2012, we subtracted cash outflows for new systems and associated opex from the percentage of total triple-play revenue allocated to the broadband aggregation layer. We calculated the cash inflow allocated to each scenario using the activity-based costing method, which assigns revenue to investments based on its cost contribution to a project. For the purpose of this analysis, Yankee Group assumed a risk-adjusted discount rate of 11 percent to calculate NPV. The rate assumes that the service provider is undertaking moderate risk, which is inherent to introducing a new service bundle based on next-generation platforms and new operational processes. The NPV and IRR calculations show that the integrated platform is the better investment (see Exhibit 5).

**Exhibit 5.**  
**TCO Net Present Value and Internal Rate of Return**

Source: Yankee Group, 2009



**Analysis of the Results**

Both the integrated and multiple element models satisfy HSP's requirements. However, the integrated model provides a clear financial advantage:

- The 21 percent capex advantage is a direct result of deploying fewer network elements that are able to meet the service provider's requirements for scalability, QOS, reliability and subscriber management. When we conducted our earlier TCO analysis, the ability for a single broadband aggregation platform to meet all of these criteria had only recently emerged. Today, three years later, the leading network solution providers have all of the elements in their product portfolio. However, in most cases they are not integrated into one product. This is because the demands of each function are quite different and integrating them into one platform while maintaining optimal performance for all processes is far from trivial. Although it is difficult for the hardware vendor to create a fully integrated solution, the product's benefits to the service provider are obvious. The integrated solution enables the service provider to exceed performance thresholds across all functions with fewer elements, spares, fiber interconnects and software licenses.
- The 52.6 percent opex advantage is the result of simplifying the aggregation network, requiring less rack space, power, HVAC, security and labor. While the facilities (rack space, power and HVAC) savings are non-trivial, accounting for 18 percent of the savings, the bulk of opex advantage is derived from the lower cost of managing and maintaining the system. One network management system means easier integration into the OSS, a single service control point for service creation and management, and lower training costs for operations staff.
- The 52.1 percent IRR advantage and 50.6 percent NPV advantage stem from lower TCO, in particular at the outset of the network deployment. Initial capital and operational outlays often determine the success of a particular business model. In fact, the integrated model requires a 22 percent lower TCO at the beginning of the deployment. This advantage contributes significantly to the NPV and IRR results. However, throughout the four-year study period, the integrated model sustains its cost advantage as it supports the same triple-play subscriber base and revenue total. As a result, the NPV and IRR differentials show the integrated model's potential to contribute to a more profitable triple-play business model.

### III. Conclusions

In the 1990s, Yankee Group examined the economics of a variety of integrated solutions—including the so-called “God Box” or “PoP-in-a-Box.” Some of these solutions included functionality that appeared to be integrated merely because it could be integrated, not because it was needed by the service provider. These boxes faced a number of challenges. The service providers had discrete voice and data networks, and the turf wars between the organizations were fueled by rapidly growing revenue and profits. Trying to get these antagonistic organizations to agree on any common network element was an exercise in diplomacy, if not futility. In addition, this was the era of “bandwidth is free.” Network infrastructure was so overprovisioned, many assumed capacity would never run out.

Service provider networks today are very different, for all of the reasons presented earlier in this report. Traffic growth is outpacing network capacity and, more notably, profitability. Service providers are rationalizing their organizations to present a more nimble and lean competitive profile. Users are demanding not just voice, video and data services, but also the ability to modify their services on demand. Integrated solutions are clearly the direction that the industry is taking. Our 2009 TCO analysis, like our analysis in 2006, demonstrates that a solution that provides all of the capabilities required on a single platform offers the service provider the best operational and competitive advantage.

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