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PAPER

The Business Case for Fair Network Access: Intelligent Traffic Management for Fixed Broadband Networks

NETWORK STRATEGY PARTNERS

MANAGEMENT CONSULTANTS TO THE NETWORKING INDUSTRY

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Network Strategy Partners, LLC (NSP)

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Executive Summary

A key consideration in providing open Internet access is ensuring fairness to all subscribers in fixed broadband networks, regardless of their application usage profile. Since data transport resources on the Internet are limited, it is essential to ensure that some users do not monopolize network resources.

Providing fair network access to all users is non-trivial. Network capacity and resources are limited and bandwidth utilization and burstiness are highly variable for different applications and services. Service providers cannot continue to add network capacity for a small set of bandwidth hungry applications because:

- Applications and users will continue to consume large amounts of bandwidth unfairly regardless of how much capacity is supplied
- Service providers must be able to effectively control CapEx and OpEx in order to make money

Clearly the right solution to this problem is to control network applications and traffic such that:

- Subscribers are treated fairly and have equal access to all network applications and services
- All network applications are accessible and work at acceptable levels of performance
- Subscribers have the option to purchase higher grades of service that provide additional performance above and beyond what is allocated to general Internet users

Achieving the goals stated above is non-trivial because of the diversity of network applications and subscribers. In order to provide fair, acceptable levels of service to all users it is therefore necessary to implement Intelligent Traffic Management at the IP service edge of the Internet. Intelligent Traffic Management allows service providers to monitor network application usage and use flow control techniques to ensure fairness to all users while maintaining acceptable levels of performance for all network applications. Flow control techniques have been used widely for many years as a mechanism for fair bandwidth allocation and, in fact, flow control is an integral part of the TCP protocol used by network clients for many Internet applications. Flow control can also be effectively used to intelligently control applications at the service edge of the IP network to ensure fairness to all users.

A good example of how network resources have been unfairly allocated is presented in Figure 1. This is application usage data for real networks in north and south Europe. It shows that P2P traffic is the primary consumer of network resources, and that the majority of subscribers using web and other Internet services are currently getting an unfair allocation of network bandwidth.

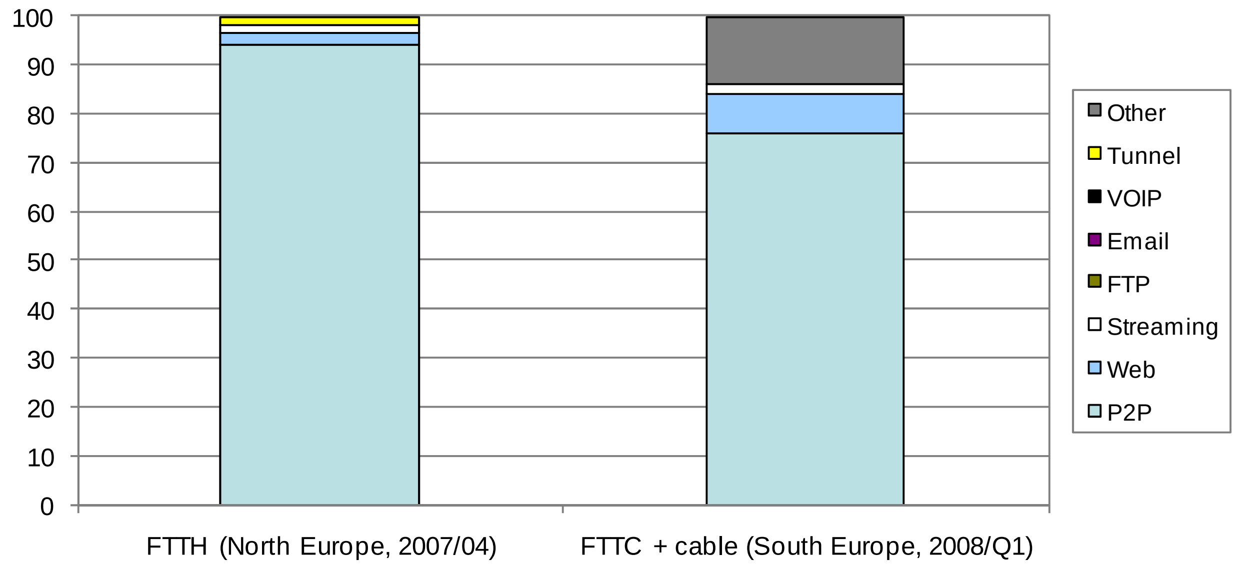

Figure 1. Application traffic distributions (source Ericsson).

P2P traffic is generated when network users are sharing files such as music, video, or pictures. As such, P2P traffic has the following characteristics:

- It is randomly distributed and the sources for file transfers are individual computers, as opposed to large servers in data centers.
- P2P is symmetric—upstream bandwidth can be as large as downstream bandwidth since individual computers are sharing files.
- A major component of P2P traffic is file transfer, which makes it far less sensitive to network delays.
- P2P transfers large files (approximately 700 Mbytes are required for 1 hour of Standard Definition video, and 4 Gbytes are required for 1 hour of HD video).
- The volume of P2P traffic is expected to increase as video traffic (or sharing) becomes more predominant.

Since the lion's share of P2P traffic consists of file transfers that are not delay sensitive, implementing effective flow control mechanisms on P2P does not preclude subscribers from using P2P; in fact flow control maintains fairness so that all users have good network performance. In this study we use Intelligent Traffic Management flow control to limit an individual P2P file transfer to maximum rate of 500Kbps. At this data rate users can expect good performance for P2P applications and network resources will be allocated fairly to all users.

Intelligent Traffic Management (ITM) is networking technology that operates at layers 2-7 in the OSI protocol stack. ITM allows network operators to monitor and shape network traffic at the application layer. ITM implementations may use a combination of Deep-Packet Inspection technology, sophisticated heuristics, and potentially other methodologies to monitor and control traffic at layers 2-7.

The purpose of this study is to 1) calculate the Return-on-Investment (ROI) on Intelligent Traffic Management technology investments necessary for P2P traffic flow control and 2) demonstrate that an integrated Intelligent Traffic Management solution using the Ericsson SmartEdge 1200 service edge router is the most cost-effective approach to Intelligent Traffic Management. Specifically, we have used an ROI/TCO model to compare three alternative scenarios:

1. Integrated Intelligent Traffic Management at the IP Service Edge using the SmartEdge 1200 IP service edge router
2. An IP service edge with no Intelligent Traffic Management
3. A standalone Intelligent Traffic Management solution at the IP service edge with a separate Broadband Remote Access Server (BRAS) and IP edge router for IP service control

Our results show that the SmartEdge 1200 integrated Intelligent Traffic Management solution results in a significant reduction in network traffic growth in a service provider's access and aggregation networks and core IP networks—the reduction in traffic directly translates to annual cost savings. The Intelligent Traffic Management solution also allows service providers to offer premium services such as tiered services, bandwidth-on-demand, and premium video services to generate incremental revenue and profits. Figure 2 shows network cost savings and incremental profits from premium service as compared to the CapEx required for Intelligent Traffic Management on the SmartEdge 1200. The payback of the investment in Intelligent Traffic Management equipment is less than one year, the total five-year Return-on-Investment (ROI) is 1700%, the Internal Rate of Return (IRR) over the five-year period is 272%, and the Net Present Value of the Investment is $7,714,536. Clearly, a strong business case can be made for investing in Intelligent Traffic Management.

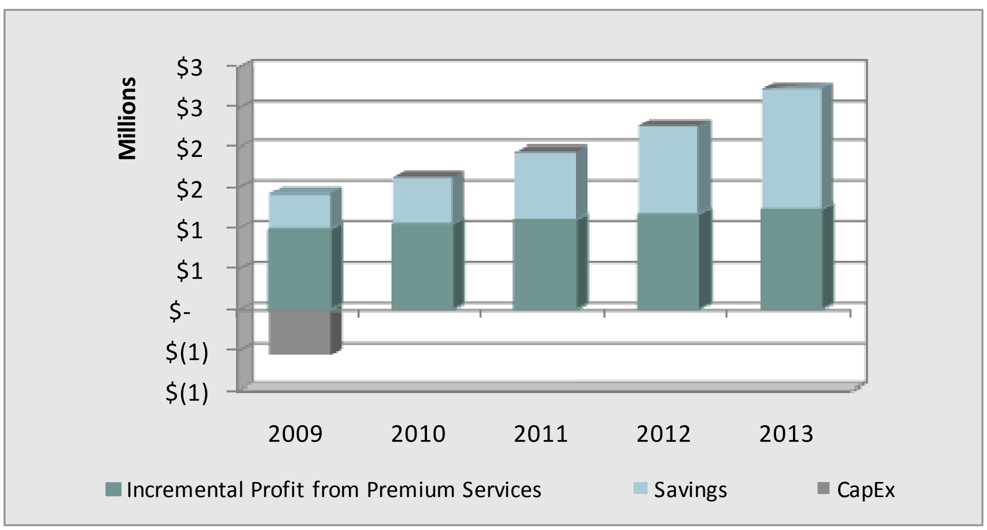

Figure 2. A comparison of capital expenses and network expense savings.

Our results also show that the Total Cost of Ownership (TCO) of the SmartEdge 1200 integrated solution is 54% less than the TCO of the solution using separate Intelligent Traffic Management.

The five-year cumulative TCO of the IP service edge network equipment[1] for each of the three alternatives is depicted in Figure 3. This TCO advantage is due to the integrated SmartEdge 1200 solution providing all edge functions, including Intelligent Traffic Management (ITM), in a single, scalable chassis. The other solutions use separate network elements for the residential IP service edge (BRAS), the business IP service edge (MPLS VPN), and Intelligent Traffic Management. Separate platforms lead to more chassis and interfaces, resulting in higher CapEx and OpEx.

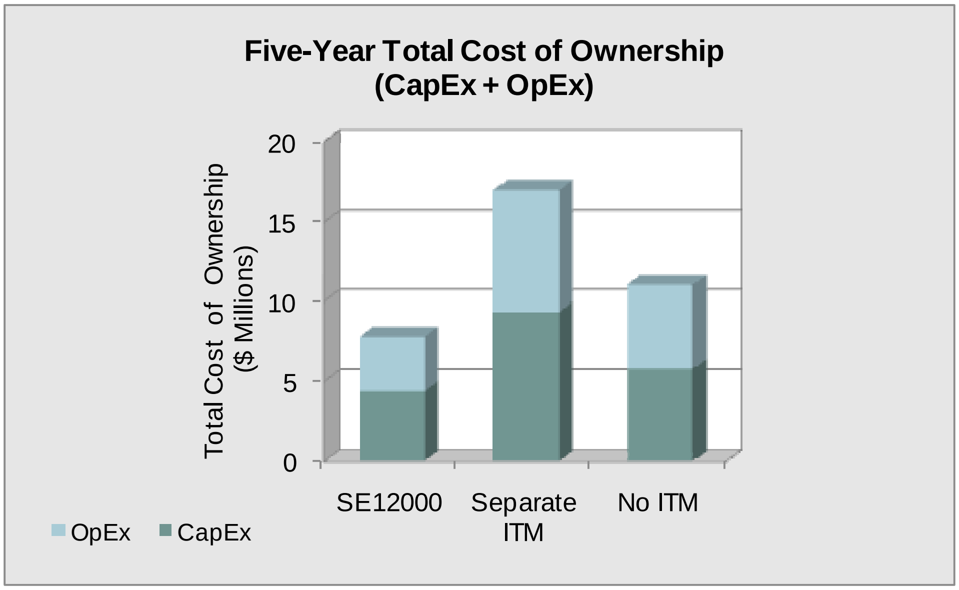

Figure 3. Comparison of the five-year cumulative TCO for the three alternative solutions.

The key advantages of the SmartEdge 1200 integrated solution are:

- Integrated IP/MPLS Edge Routing, BRAS, MPLS L2/L3VPN, and Intelligent Traffic Management in a single edge device
- All forward and reverse flows traverse the same router, making complex synchronization algorithms between separate Intelligent Traffic Management systems unnecessary

In the standalone ITM solution, subscriber management is handled by the BRAS; therefore, system integration and synchronization of subscriber policy in the BRAS must be integrated with subscriber policies in the ITM network element. Also, in standalone ITM systems with multiple network elements, it is possible that the forward and reverse flows could traverse separate ITM systems. Therefore, it is necessary to synchronize state information between multiple ITM systems which leads to system complexity and, consequently, potential reliability problems.

The body of this paper presents the details of the assumptions used in this analysis with additional detailed results on the capital and operating expense breakdown.

[1] These numbers do not include the Intelligent Traffic Management cost savings coming from network traffic reduction and incremental service revenues. This is strictly a comparison of the TCO of the SmartEdge integrated solution and the two nonintegrated solutions.

Introduction

Clearly P2P traffic is a major consumer of network bandwidth leading to an unfair allocation of network resources among users. Furthermore, service providers need to continue to provision network bandwidth to keep the network operational while many users still experience poor service due to the unfair allocation of network resources. For these reasons, there has been widespread interest in using Intelligent Traffic Management technology at the IP service edge to manage P2P traffic. This study is an ROI analysis with three primary results:

1. The savings in network bandwidth expenses due to reduced P2P busy-hour loads generate a favorable ROI on Ericsson's Intelligent Traffic Management equipment.
2. Intelligent Traffic Management allows for the generation of incremental revenue for premium service offerings.
3. The Ericsson SmartEdge 1200 integrated multi-service edge router with Intelligent Traffic Management is the most cost-effective approach among those studied.

Our analysis models a hypothetical Tier 1 service provider network that supports residential triple-play and business data services. The framework of the TCO/ROI model used in this study is depicted in Figure 4. The model characterizes network traffic, system configurations, and incremental service revenue, capital, and operations expenses over a five-year period. U.S. Census data is used to characterize the demographics of residential and business customers in a major metro area. Assumptions are made for service penetration rates, service provider market share, and average data rates for network services. These assumptions are used in a network traffic engineering model to estimate network traffic at the IP service edge with and without Intelligent Traffic Management. Configuration of IP service edge equipment and calculation of CapEx and OpEx is based on service assumptions and traffic engineering. We also consider incremental revenue and profits from premium services offered using Intelligent Traffic Management. The Payback of the SmartEdge 1200 investment is calculated, and the TCO of the alternative solutions is compared.

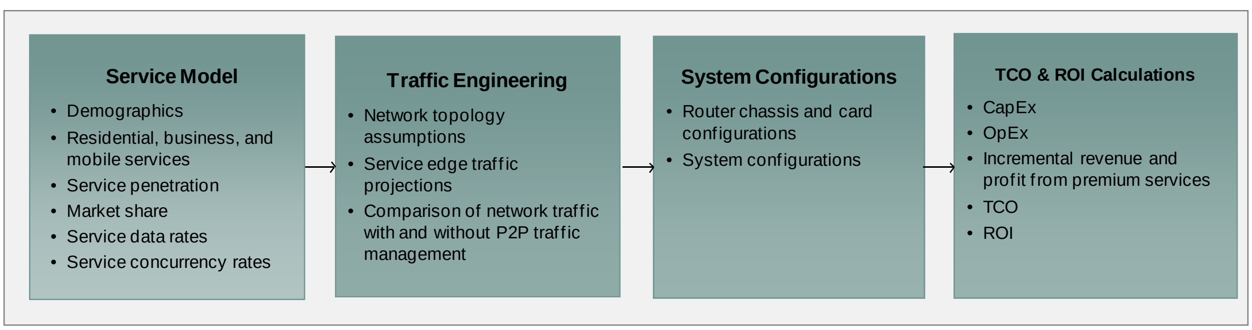

Figure 4. TCO/ROI model framework.

The body of this paper reviews our assumptions for service demand models and network architecture and presents the detailed results of the analysis.

Service Demand Assumptions and Traffic Forecasts

Traffic forecasts are made for residential and business services in a metro area served in a single IP service edge. Key assumptions used in this analysis are presented in Table 1. Three categories of customers are considered:

- Residential consumer households
- Small business establishments
- Enterprise establishments (these are typically enterprise branch offices as opposed to large offices or headquarters)

Information from U.S. Census data was used to estimate the total number of potential customers in each category, and assumptions were made regarding service provider penetration rates to estimate the number of subscribers served by the IP service edge.

Table 1. Demographic Assumptions for a Metro Area Served by an IP Service Edge

Metro Area Customers	2009	2010	2011	2012	2013
Consumer Households	46,000	47,150	48,329	49,537	50,775
Consumer Penetration Rates	30%	31%	32%	33%	34%
Consumer Subscribers	**13,800**	**14,617**	**15,465**	**16,347**	**17,264**
Small Business Establishments	2,760	2,829	2,900	2,972	3,047
Small Business Penetration Rates	70%	70%	70%	70%	70%
Small Business Establishments Served	**1,932**	**1,980**	**2,030**	**2,081**	**2,133**
Enterprise Establishments	2,300	2,358	2,416	2,477	2,539
Enterprise Penetration Rates	30%	31%	32%	33%	34%
Enterprise Establishments Served	**690**	**731**	**773**	**817**	**863**

Another important aspect of traffic forecasting is assumptions for average Internet data rates for each class of customer—these assumptions are presented in Table 2. It should be noted that these are average data rates as opposed to peak burst rates. The average rates are much lower than peak rates because they account for a large amount of non-activity time when users are reading web pages or making decisions before requesting web data. The increase in average data rates is primarily due to the increased video streaming traffic which is fundamentally less bursty in nature than web-based traffic.

Table 2. Average Data Rates for Households and Businesses

Average Internet Data Rates	2009	2010	2011	2012	2013
Consumer Household Average Data Rate (Mbps)	0.4	0.5	0.7	0.9	1.1
Small Business Average Data Rate (Mbps)	0.4	0.5	0.6	0.7	0.8
Enterprise Establishment Average Data Rate (Mbps)	1.0	1.2	1.8	2.6	3.6

These assumptions are used to create traffic forecasts for the hypothetical network over the five-year study period (see Figure 5 through Figure 6). Two scenarios are presented for residential and business traffic growth. The residential forecast splits traffic into application categories consisting of web, P2P, gaming, VoIP, Internet video, and web cam based video conferencing. Business traffic is divided by enterprise MPLS VPN traffic, enterprise Internet traffic, and small business Internet traffic. Since most small businesses consist of a single establishment, they do not have an MPLS VPN. Alternatively, enterprises that have many independent divisions (or satellite offices) are often interconnected with an MPLS VPN private network. The growth projections are based on Network Strategy Partners' traffic studies.

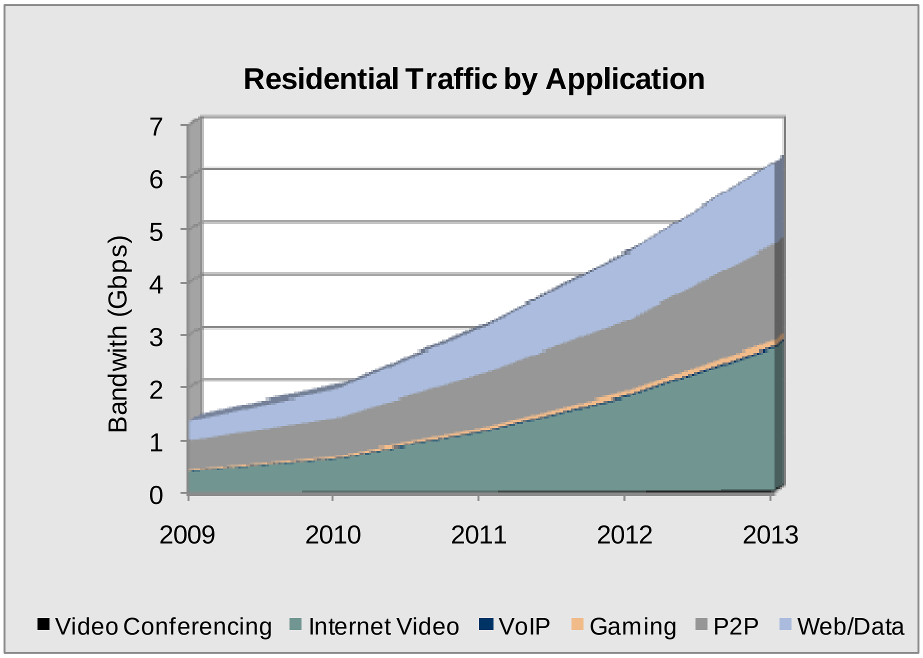

Figure 5. Service edge residential traffic projections in the hypothetical network.

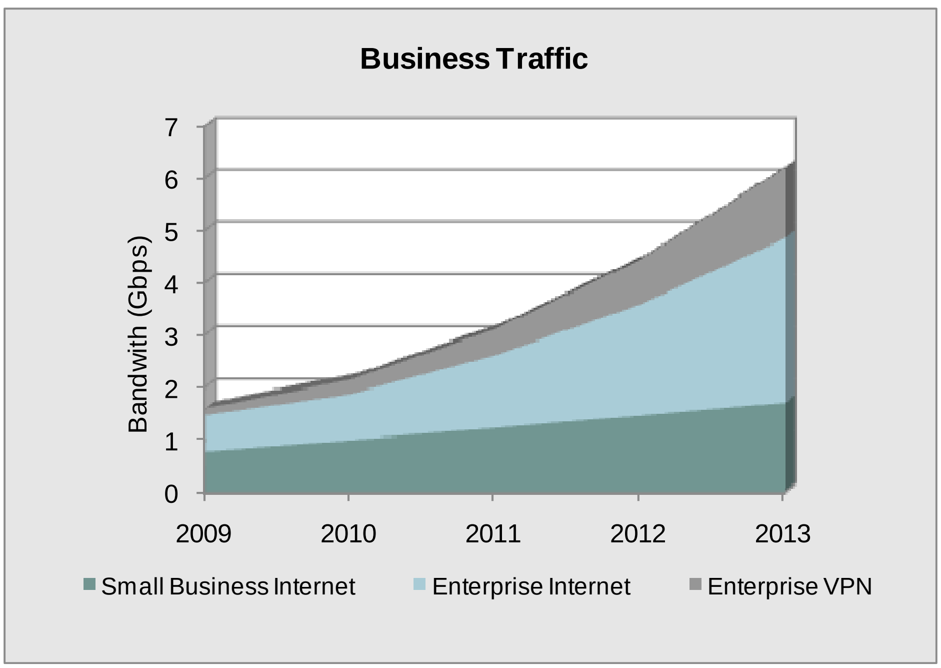

Figure 6. Service edge business traffic projections in the hypothetical network.

P2P traffic is, and will continue to be, a major consumer of network bandwidth. In order to determine ITM cost savings, we first determined the reductions in total busy-hour traffic due to

ITM P2P flow control. P2P traffic consists of large file transfers that are sent in bursts across the Internet. The bursty nature of P2P drives the need for bandwidth in the network. By smoothing out the bursty traffic using ITM flow control on P2P file transfers, the need for increased network capacity is reduced and allocation of network bandwidth between all users is done fairly. The following assumptions are used to calculate P2P bandwidth requirements with and without ITM flow control:

- For DSL traffic, it is assumed that P2P bursts to 1.34 Mbps[2].
- If P2P flow control is implemented, it is assumed that all bursts are smoothed to a rate of 500 kbps.

This translates to an 63% reduction in DSL P2P traffic across the IP service edge and the core IP network. Figure 7 presents the total residential and business traffic at the IP service edge with and without ITM. Since only DPI traffic is limited the total reduction in network traffic is fairly modest. However, even with these modest traffic decreases we will show that there are significant network TCO savings and a positive ROI on the SE1200 capital investment.

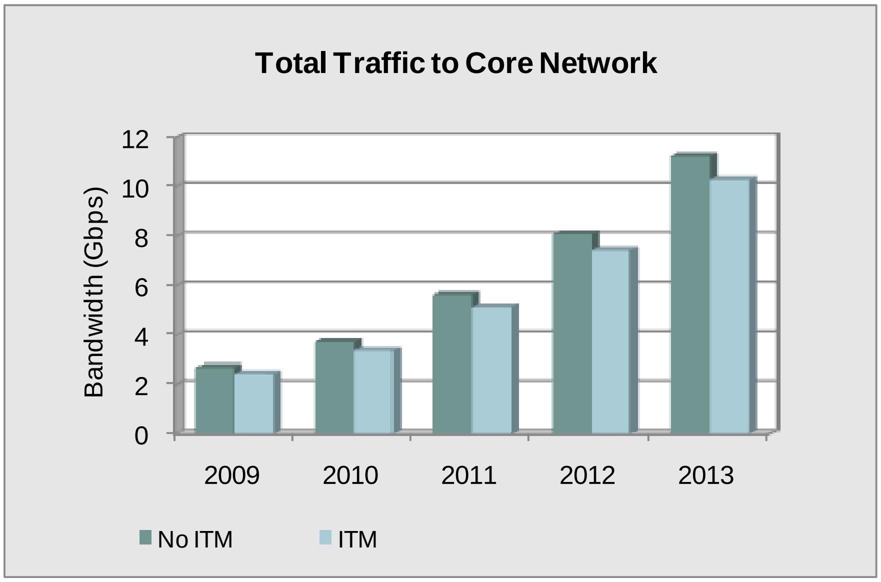

Figure 7. Service edge to core network traffic with and without ITM.

Network Architecture Assumptions

This study compares three architecture alternatives for the IP service edge:

1. Integrated Intelligent Traffic Management at the IP service edge using the SmartEdge 1200 IP Multi-Service Edge Router
2. An IP service edge with no Intelligent Traffic Management
3. A standalone Intelligent Traffic Management solution at the IP service edge with a separate BRAS and IP edge router for IP service control

[2] This result is based on statistics available at http://www.speedtest.net/.

Also in this analysis we assume that the hypothetical network has ten IP Service Edge Points-of-Presence (POPs). The details of each of these alternatives are presented to help the reader understand the results of the TCO and ROI analysis.

SmartEdge 1200 Integrated IP Edge Solution

Figure 8 depicts the SmartEdge 1200 Integrated solution—an IP service router providing an intelligent edge for residential and business networks. The IP edge is the boundary between the access, aggregation, and core IP networks. Legacy ATM DSL and Frame Relay networks use ATM transport in the aggregation network. Newer Ethernet DSL, PON, and business Carrier Ethernet services run on top of Carrier Ethernet access and aggregation networks. Therefore, the edge router needs to terminate legacy ATM interfaces as well as Ethernet interfaces. It is assumed that all ATM interfaces are OC3 and Ethernet interfaces to both the aggregation and core networks are 10 GbE.

Following are some of the SmartEdge 1200 functions:

- BRAS (service control and subscriber management for the residential networks Internet access)
- MPLS VPN (private IP network service for enterprises with distributed locations)
- Intelligent Traffic Management

Essentially, all the key IP service edge functions are integrated in a single, scalable platform supporting up to 256,000 subscribers and multiple 10 GbE interfaces.

Intelligent Traffic Management on the SmartEdge 1200 is delivered by the Advanced Services Engine (ASE) card. A SmartEdge system can be populated with ASE cards supporting millions of flows and scaling to process multi-gigabit application traffic. Only designated Internet traffic traverses the ASE. All multicast and private network traffic bypasses the ASE.

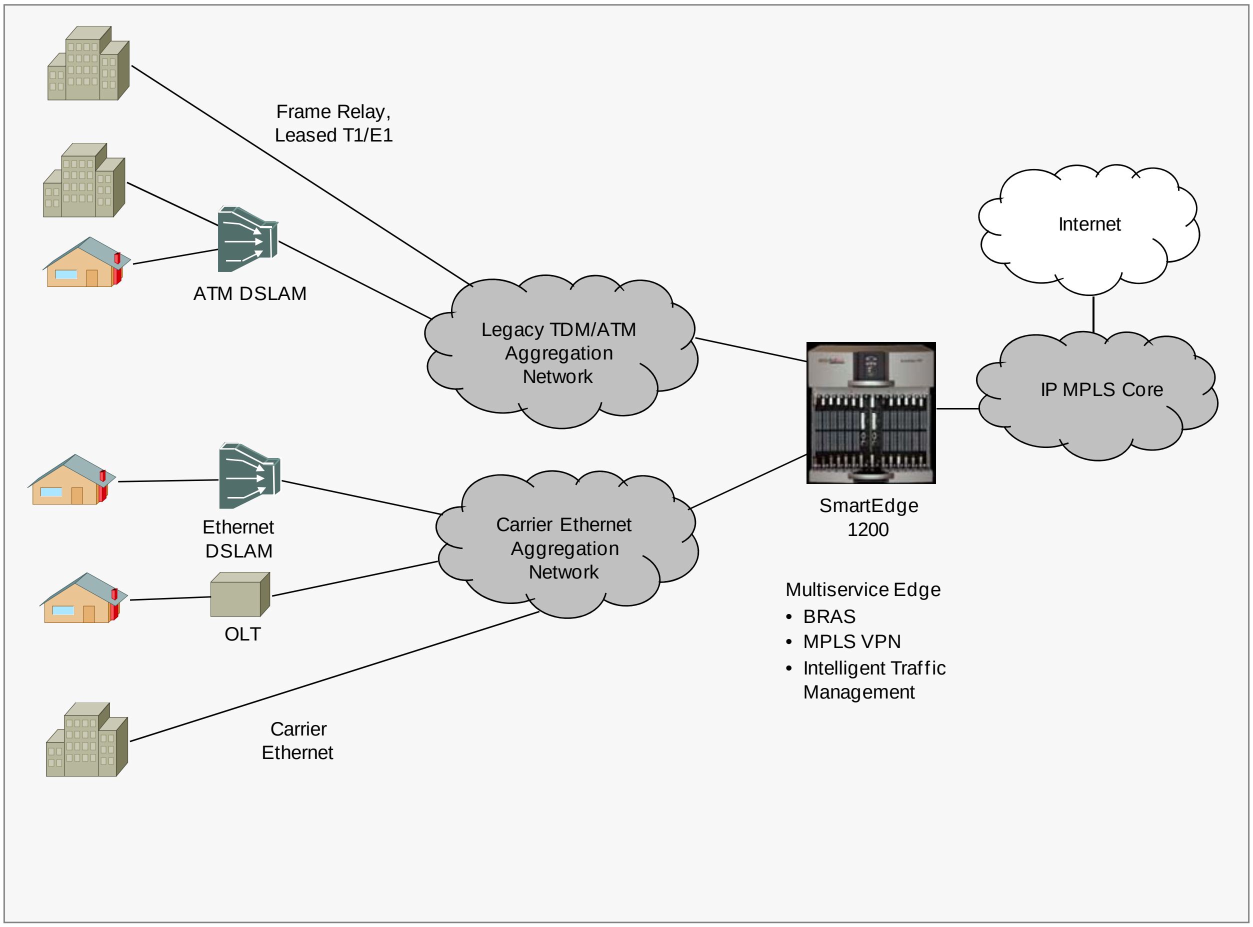

Figure 8. SmartEdge 1200 Integrated IP Service Edge.

IP Service Edge with no Intelligent Traffic Management Capability

One of the key objectives of this study is to show that P2P traffic shaping using Intelligent Traffic Management saves money. Therefore, we consider a second network architecture with no Intelligent Traffic Management capability as depicted in Figure 9. This solution uses separate platforms for the BRAS (residential and business DSL Internet service) and MPLS VPN (business VPN) functions. Both edge routers terminate legacy ATM OC3 and next-generation Ethernet traffic. OC3 ATM ports are used to connect to the ATM aggregation network, and 10 GbE ports are used to connect to the Ethernet aggregation and core networks.

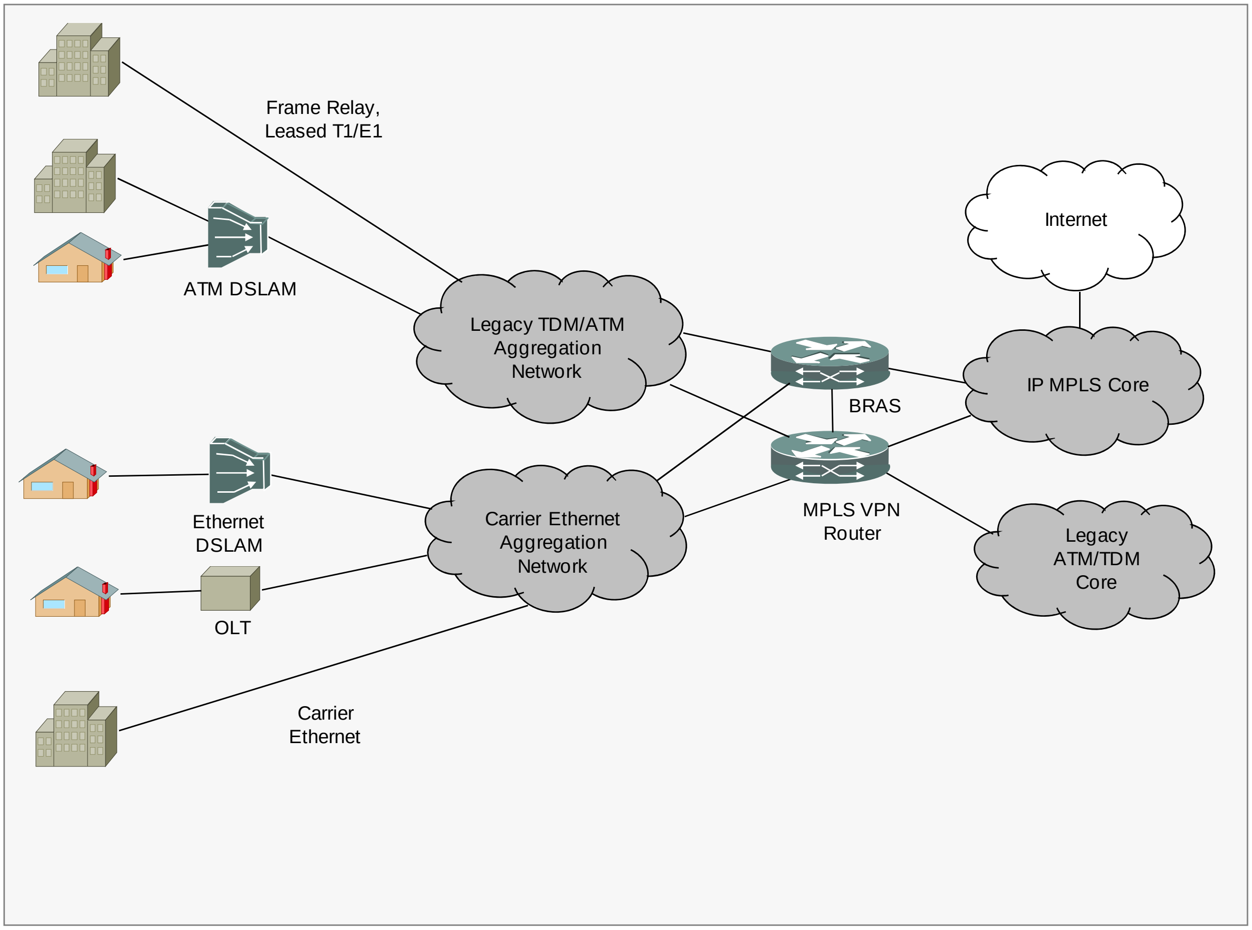

Figure 9. IP service edge with separate BRAS and MPLS VPN routers—no ITM.

Standalone Appliance for Intelligent Traffic Management

A second result of this study shows that the integrated Ericsson SmartEdge 1200 solution is more cost-effective than a standalone Intelligent Traffic Management solution. These results are based on a comparison of the SmartEdge 1200 architecture with the standalone Intelligent Traffic Management architecture depicted in Figure 10. The standalone Intelligent Traffic Management architecture uses separate platforms for the BRAS and MPLS VPN functions as well as a separate Intelligent Traffic Management appliance for application layer traffic management. The BRAS and MPLS VPN edge routers use ATM OC3 interfaces to connect to the ATM aggregation network and 10 GbE interfaces to connect to the Ethernet aggregation and core networks. The Intelligent Traffic Management appliance uses 10 GbE interfaces for all packet forwarding. Also at least two appliances are used for redundancy. If redundancy is used for other systems as well, which is a necessary requirement in many deployments, the complexity of the network may increase exponentially when such factors as inter-system connectivity is considered. The case for the SmartEdge 1200, however, is straightforward as a redundant deployment simply interconnects two systems not multiple.

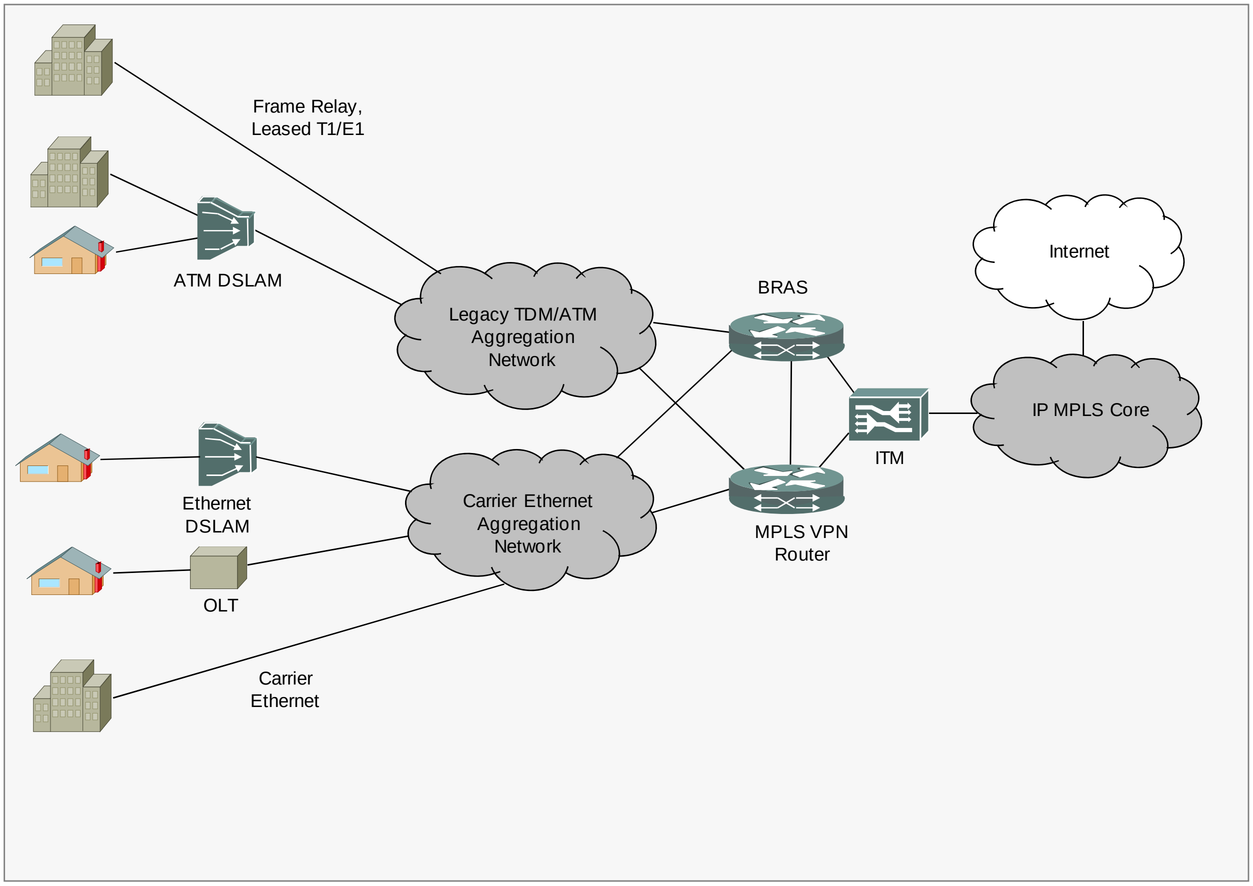

Figure 10. IP service edge with separate BRAS, MPLS VPN, and Intelligent Traffic Management.

Premium Services and Incremental Revenue

Another major benefit of Intelligent Traffic Management is the capability to provide premium services that generate incremental revenue. Examples of premium services are tiered service offerings (for example: gold, silver, bronze, and best effort), bandwidth-on-demand services, and premium video services. To be clear, the concept of premium services does not conflict with the goal of providing an open Internet. All Internet users have access to all Internet applications with good levels of performance with basic Internet service. However, users who choose premium services can get additional levels of performance for increasing file download times, providing better HD video performance, and enhancing the Internet experience by paying for premium service.

Today, many broadband networks have limited application monitoring and service control capabilities. As a result, broadband network service providers are at risk of losing a significant percentage of their subscribers' service budgets to other emerging service providers. For example, if a service provider sells a "dumb broadband pipe" at a commodity price, it is likely that subscribers will buy higher margin services (such as VoIP, IPTV, VoD, Email, Internet gaming, and other emerging services) from other Internet content service providers. This is a serious problem for network service providers that have made significant investments in their broadband infrastructure, only to see revenues funneled away to Internet-based content providers.

The solution is a "smart broadband pipe," which offers service providers visibility into how subscribers and applications use the network, allowing them to implement service monitoring and control and to participate in the service value chain. A service-aware network infrastructure enables high-margin service offerings such as tiered services, high-speed gaming, bandwidth-on-demand, and Internet video-on-demand services. Ericsson's Intelligent Traffic Management affords network operators complete visibility of network applications, flexible traffic control, and the economies of one device-many applications to convert "dumb broadband pipes" into a service- aware network. By using a "smart broadband pipe" enabled by Ericsson's Intelligent Traffic Management, service providers can efficiently deliver high-margin services and partner with content providers to retain a larger percentage of the subscriber's service budget.

TCO and ROI Results

The results of this study demonstrate that:

- Implementing Intelligent Traffic Management and P2P flow control on the SmartEdge 1200 reduces network expenses and has a payback of less than one year.
- Intelligent Traffic Management allows service providers to offer premium services generating incremental revenue and profits.
- The SmartEdge 1200 is a more cost-effective solution than an architecture that uses a separate Intelligent Traffic Management network appliance

Payback Analysis

The payback on the Intelligent Traffic Management capital investment is presented in Figure 11. This chart compares the capital expense of the ASE cards that must be installed on the SmartEdge 1200 to the operations cost savings in the aggregation and core IP networks and the incremental premium service revenue over a five-year period.

The payback of the investment in Intelligent Traffic Management equipment is less than one year, the total five-year Return-on-Investment (ROI) is 1700%, the Internal Rate of Return (IRR) over the five-year period is 272%, and the Net Present Value of the Investment is $7,714,536. Clearly, a strong business case can be made for investing in Intelligent Traffic Management.

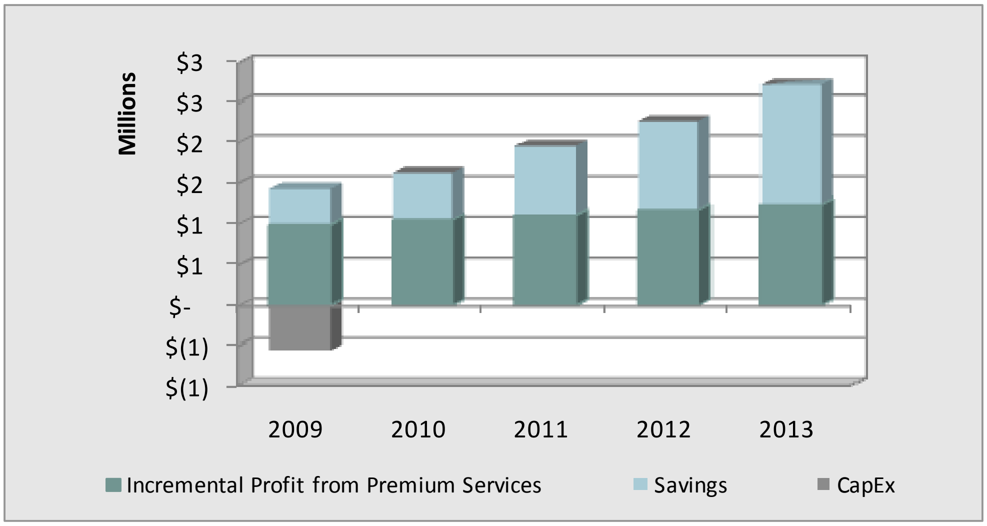

Figure 11. Payback on investment in ASE cards on the SmartEdge 1200.

Incremental Revenue Stream

The assumptions used to calculate the incremental service revenue are presented in Table 3. We assume (1) that the penetration rate for premium services is 20%, (2) that, on average, $5 of incremental service revenue is generated per subscriber, and (3) that the Gross Margin for premium services is 60%. Using our projections for the number of residential subscribers in a network served by ten IP service edges, the Gross Profit for incremental services is presented in Table 3.

Table 3. Incremental Profits for Premium Services

	2009	2010	2011	2012	2013
Number of Residential Subscribers	138,000	146,165	154,653	163,472	172,635
Additional Monthly Revenue per Subscriber for Premium Services	$ 5	$ 5	$ 5	$ 5	$ 5
Penetration Rate for Premium Services	20%	20%	20%	20%	20%
Incremental Revenue for Premium Services	$1,656,000	$1,753,980	$1,855,834	$1,961,665	$2,071,620
Gross Margin	60%	60%	60%	60%	60%
Gross Profit for Incremental Services	$993,600	$1,052,388	$1,113,500	$1,176,999	$1,242,972

Cost Effectiveness & TCO Calculations

Intelligent Traffic Management also reduces the transport cost of the aggregation and core networks. Transport costs are reduced as a direct result of P2P flow control. We have estimated a service provider's ongoing operations costs of aggregation networks to be $3000 per Gbps and the costs of core network transport and routing to be $10,500 per Gbps. These estimates are based on numerous Network Strategy Partners economic studies on aggregation and core network transport, switching, and routing. The network savings achieved with the SmartEdge 1200 solution is calculated by combining the cost of aggregation and core network bandwidth with the results of the traffic analysis was presented in Figure 7.

Further analysis compared the TCO of the three alternative solutions:

1. Integrated Intelligent Traffic Management P2P flow control at the IP service edge using the SmartEdge 1200 IP multi-service edge router
2. An IP service edge with no Intelligent Traffic Management
3. A standalone Intelligent Traffic Management solution at the IP service edge with a separate BRAS and IP Edge router for IP service control

The objective of the TCO analysis was to compare the CapEx and OpEx of the three alternative architectures presented earlier. Therefore, we only considered the CapEx and OpEx associated with the IP service edge and did not account for the cost savings generated by the reduction in network bandwidth requirements or incremental service revenue. The reason for making this distinction is that the bandwidth cost savings and incremental service revenues associated with Intelligent Traffic Management are far greater in magnitude than the CapEx and OpEx associated with the service edge. Since the business case for using Intelligent Traffic Management has already been established (see Figure 11), the goal of the TCO comparison was to determine the best solution.

The summary of the five-year cumulative TCO for each alternative is presented in Figure 12. The cumulative TCO of the SmartEdge 1200 integrated solution is **54% less expensive** than the standalone Intelligent Traffic Management solution and **30% less expensive** than the solution with no Intelligent Traffic Management. Reasons for the CapEx advantages are as follows:

- The SmartEdge 1200 is an integrated solution with a single chassis as opposed to multiple chassis used in both the standalone no Intelligent Traffic Management architectures (see Figure 8, Figure 9, and Figure 10).
- Fewer physical cards and interfaces are needed in the integrated solution.

An explanation of the OpEx categories is provided in Table 4. The OpEx calculations use a Network Strategy Partners OpEx model that estimates operations costs based on labor costs, person hours, dimension of the network, environmental expenses, and operations expenses that are a function of CapEx. Following are the fundamental reasons why the SmartEdge 1200 integrated solution has lower OpEx than the competing solutions:

- A single-vendor, single-chassis solution is easier to install and operate.
- Less training is required.
- Less power, cooling, and floor space are needed.
- Systems integration efforts to unify subscriber management databases are unnecessary.
- Network management systems costs are lower for an integrated single-vendor solution.

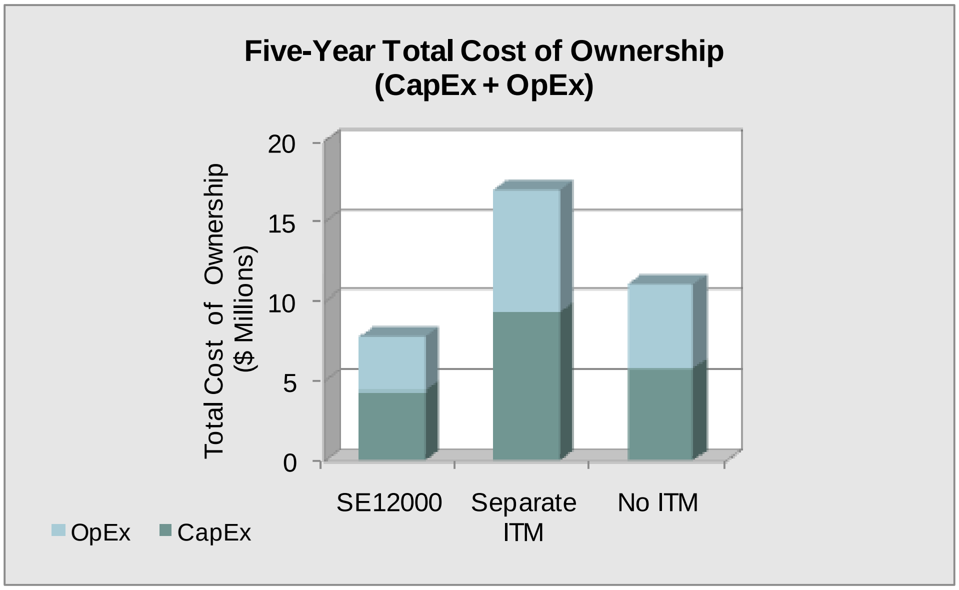

Figure 12. Comparison of the five-year cumulative TCO for the three alternative solutions.

Table 4. OpEx Cost Components

Operations Expense	Definition
Engineering, Facilities, and Installation (EF&I)	Cost of engineering, facilities, and installation of network equipment.
Capacity Management	Engineering function of planning and provisioning additional network capacity.
Network Upgrades & Patches	Hardware and software upgrades to the network.
Network Care	Network provisioning, surveillance, monitoring, data collection, maintenance, and fault isolation.
Testing and Certification Operations	Costs associated with the testing and certification needed for all new hardware and software releases that go into the production network.
Testing and Certification Capital	Capital equipment required for the test lab.
Training	Initial training expenses, as well as ongoing training expenses.
Service Contracts	Vendor service contracts required for ongoing support of network equipment.
Sparing Costs	Costs associated with line card spares.
Floor Space Cost	Costs associated with the floor space cost/square meter in the CO.
Power Cost	Electricity costs to power equipment.
Cooling Cost	Cost of the HVAC system to cool equipment.
Network Management Equipment and Software	All hardware and software required to manage the network.

Conclusion

In recent years the Internet bandwidth has been monopolized by a small group of users using bandwidth intensive P2P file transfers. In this paper we have shown that service providers can use Intelligent Traffic Management technology to provide a fair and open service to all users for all applications. Additionally we have shown that there is a good business case to implement Intelligent Traffic Management. The investment has a payback of less than one year based on cost savings in the aggregation and core networks and incremental service revenue generated by premium services. Furthermore, the SmartEdge 1200 integrated solution has a five-year cumulative TCO that is 54% less than the alternative solution with separate components for BRAS, MPLS VPN, and Intelligent Traffic Management functions. The SmartEdge 1200 solution has both CapEx and OpEx cost advantages over the alternatives. Scalability is one of the key reasons for the SmartEdge 1200 TCO advantage. The SmartEdge 1200 can support up to 256,000 subscribers in a single chassis. The alternative solutions may require multiple chassis and multiple external appliances which significantly increases TCO. As network traffic continues to grow, it is critical for service providers to implement scalable and cost-effective systems at the IP service edge.

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