

The Financial Benefits of Managing Peer-to-Peer (P2P) Traffic at the IP Service Edge



MANAGEMENT CONSULTANTS TO THE
NETWORKING INDUSTRY

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Network Strategy Partners, LLC (NSP)

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Executive Summary

Over the last decade, Peer-to-Peer (P2P) traffic has emerged as one of the main consumers of Internet bandwidth. P2P protocols are used for many applications, including MP3 file transfers, video file transfers, VoIP (Skype), and other emerging web applications. P2P is a major driver in residential broadband Internet, and it is also emerging as an important driver of traffic in 3G wireless networks (Figure 1).

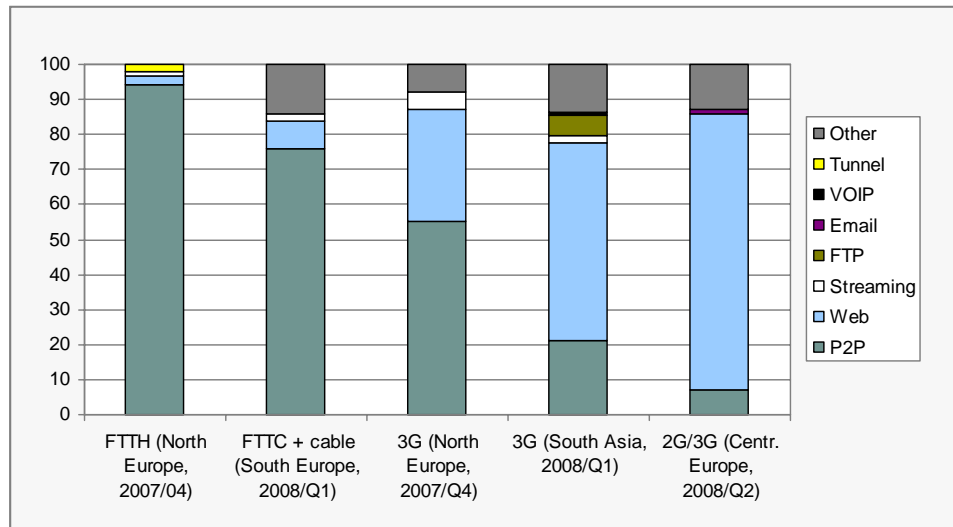


Figure 1. Application traffic distributions (source Ericsson).

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.

The magnitude, bidirectional nature, and unpredictability of P2P are causing problems for many service providers, resulting in expensive upgrades of network capacity. While proponents of net neutrality argue that Internet access and bandwidth should be unlimited, there are always fundamental limits to bandwidth availability and allocation based on network capacity. Furthermore, there is a strong argument to be made that application layer traffic management technology can increase network fairness and therefore improve the experience for the majority of users. As such, some service providers have started to implement application layer traffic management to monitor

and control P2P and other application traffic to ensure network fairness and manage busy-hour traffic congestion. Application layer traffic management has the additional benefit of allowing service providers to implement tiered services and usage-based billing to generate additional service revenue. Effective management of P2P traffic has the benefits of:

- Ensuring fair network bandwidth allocations to subscribers
- Effectively managing network capacity and upgrade expenses
- Providing additional sources of incremental service revenue

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; it only increases the time necessary to perform a file transfer.

The purpose of this study is to 1) calculate the Return-on-Investment (ROI) on Intelligent Traffic Management technology investments necessary for managing P2P traffic 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 P2P traffic management. Specifically, we have used an ROI/TCO model to compare three alternative scenarios:

1. Integrated P2P Intelligent Traffic Management with Deep Packet Inspection (DPI) and heuristic traffic control 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 DPI 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 DPI solution results in a significant reduction in network traffic 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 DPI 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 DPI on the SmartEdge 1200. The payback of the investment in Intelligent Traffic Management DPI equipment is less than one year, the total five-year Return-on-Investment (ROI) is 3142%, the Internal Rate of Return (IRR) over the five-year period is 443%, and the Net Present Value of the Investment is \$14,294,923. Clearly, a strong business case can be made for investing in Intelligent Traffic Management DPI.

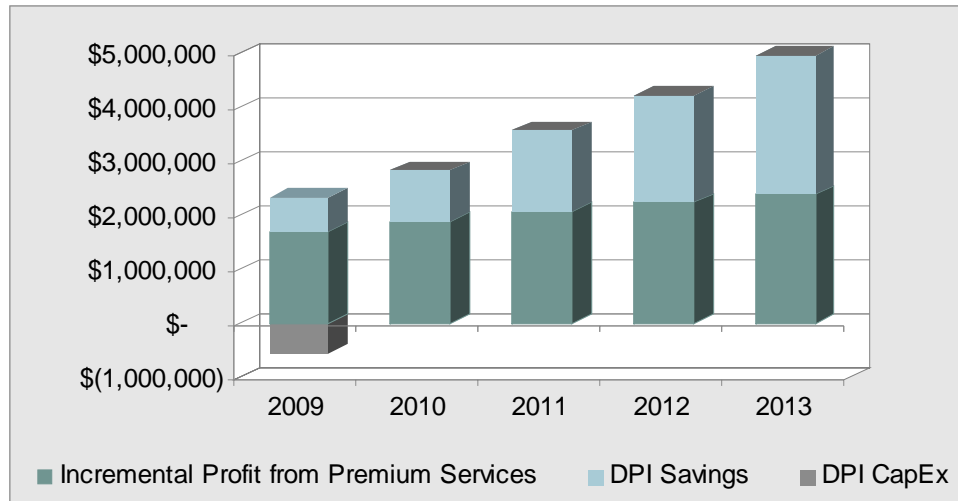


Figure 2. A comparison of DPI capital expenses and network expense savings.

Our results also show that the Total Cost of Ownership (TCO) of the SmartEdge 1200 integrated solution is 49% less than the TCO of the solution using separate DPI. The five-year cumulative TCO of the IP service edge network equipment¹ 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 DPI, 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 traffic management (DPI). Separate platforms lead to more chassis and interfaces, resulting in higher CapEx and OpEx.

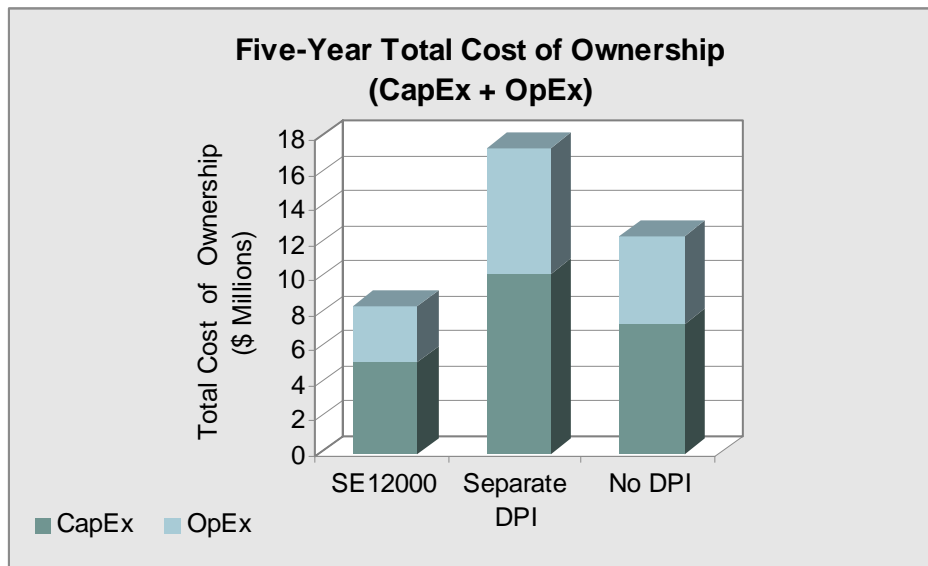


Figure 3. Comparison of the five-year cumulative TCO for the three alternative solutions.

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.

The key advantages of the SmartEdge 1200 integrated solution are:

- Integrated BRAS, MPLS VPN, Intelligent Traffic Management DPI, and subscriber management in a single edge device
- All forward and reverse flows traverse the same router, making complex synchronization algorithms between separate DPI systems unnecessary

In the standalone DPI 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 DPI network element. Also, in standalone DPI systems with multiple network elements, it is possible that the forward and reverse flows could traverse separate DPI systems. Therefore, it is necessary to synchronize state information between multiple DPI 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.

Introduction

Most service providers agree that P2P traffic is a major consumer of network bandwidth and, therefore, an expensive application to support. For this reason, there has been widespread interest in using Intelligent Traffic Management DPI 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 DPI equipment.
2. Intelligent Traffic Management with DPI allows for the generation of incremental revenue for premium service offerings.
3. The Ericsson SmartEdge 1200 integrated multi-service edge router and DPI solution is the most cost-effective approach to service edge routing and P2P traffic management.

Our analysis models a hypothetical Tier 1 service provider network that supports residential triple-play, business, and mobile 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, business, and mobile subscribers 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 management of P2P network traffic. Configuration of IP service edge equipment and calculation of CapEx and OpEx is based on the service assumptions and traffic engineering. We also consider incremental revenue and profits from premium services offered using Intelligent Traffic Management DPI. The Payback of the SmartEdge DPI investment is calculated, and the TCO of the alternative solutions is compared.

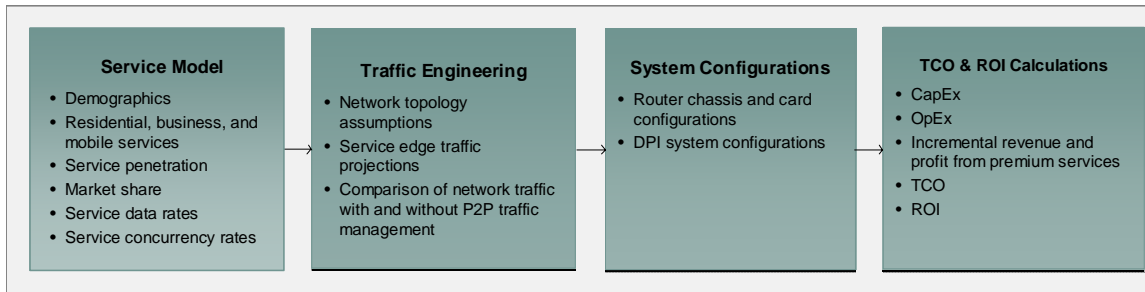


Figure 4. TCO/ROI model framework.

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, business, and mobile data services in a metro area served by a single IP service edge. Key assumptions used in this analysis are presented in Table 1. Four 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)
- Mobile customers

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
Mobile Population	126,960	130,134	133,387	136,722	140,140
Mobile Penetration Rates	8%	9%	10%	11%	12%
Mobile Subscribers	10,157	12,076	13,616	15,073	16,222

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 nonactivity 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, Businesses, and Mobile Subscribers

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
Mobile Subscriber Average Data Rate (Mbps)	0.1	0.3	0.7	0.9	1.1

These assumptions are used to create traffic forecasts for the hypothetical network over the five-year study period (see Figure 5 through Figure 7). Three scenarios are presented for residential, business, and mobile traffic growth. The residential forecast splits traffic into application categories consisting of web, P2P, gaming, VoIP, internet video, and 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. Mobile data traffic is divided by P2P applications and all other non-P2P applications. The growth projections are based on Network Strategy Partners’ traffic studies.

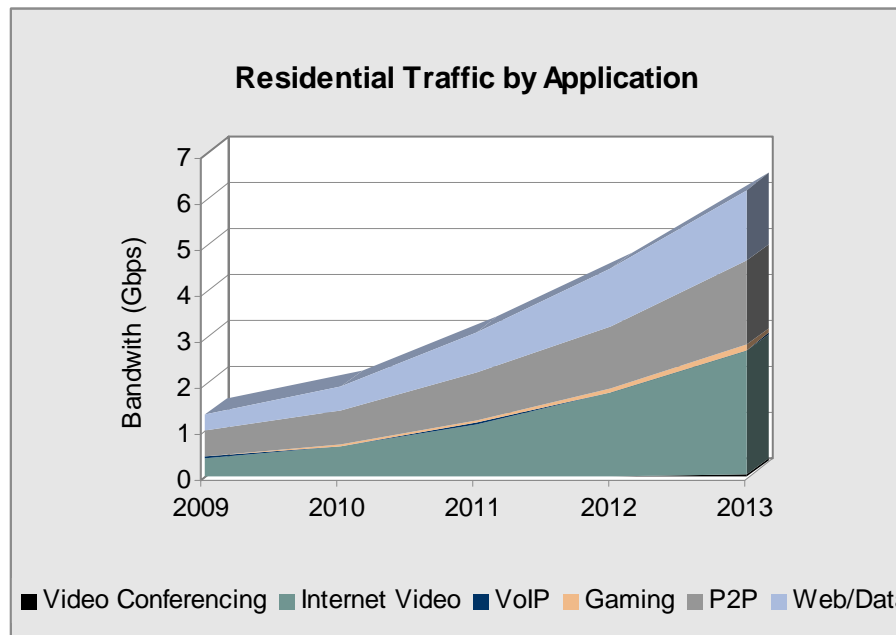


Figure 5. Service edge residential traffic projections in the hypothetical network.

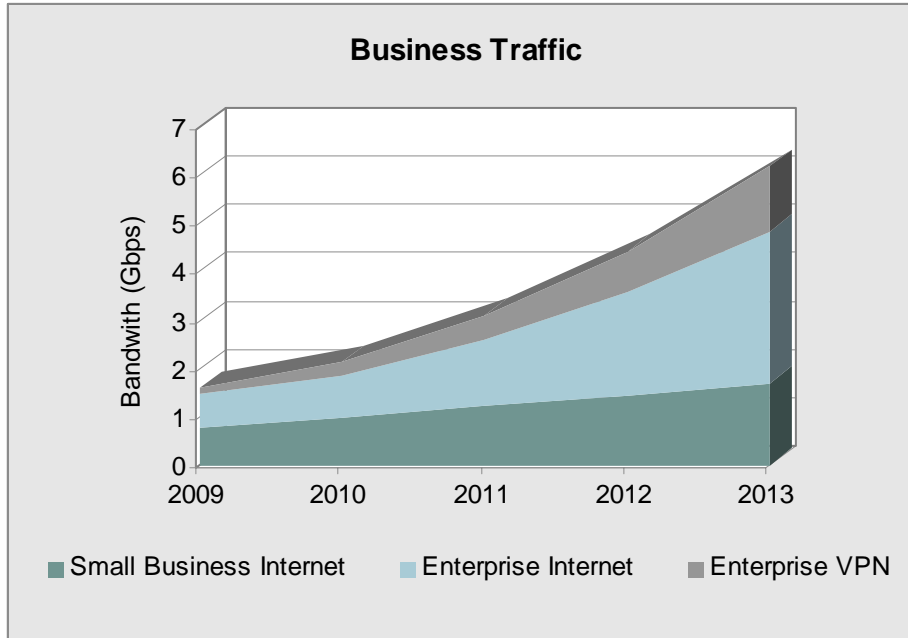


Figure 6. Service edge business traffic projections in the hypothetical network.

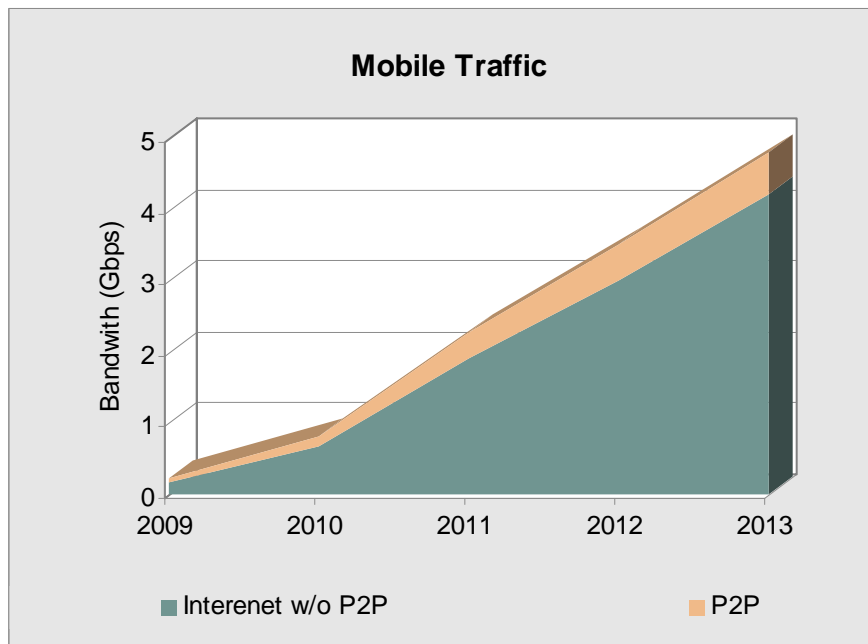


Figure 7. Service edge mobile traffic projections in the hypothetical network.

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

- For DSL traffic, it is assumed that P2P bursts to 1.34 Mbps².
- For mobile traffic, it is assumed that P2P bursts to 2 Mbps.
- If DPI flow control is implemented, it is assumed that all bursts are smoothed to a rate of 250 kbps.

This translates to an 81% reduction in DSL P2P traffic and an 88% reduction in mobile wireless P2P traffic across the IP service edge and the core IP network. Figure 8 presents the traffic at the IP service edge with and without DPI. The impact of DPI flow control on both the residential and mobile components of traffic are presented as well as the flow control impact of total network traffic to the core. The total traffic to the core consists of residential, mobile, and business traffic.

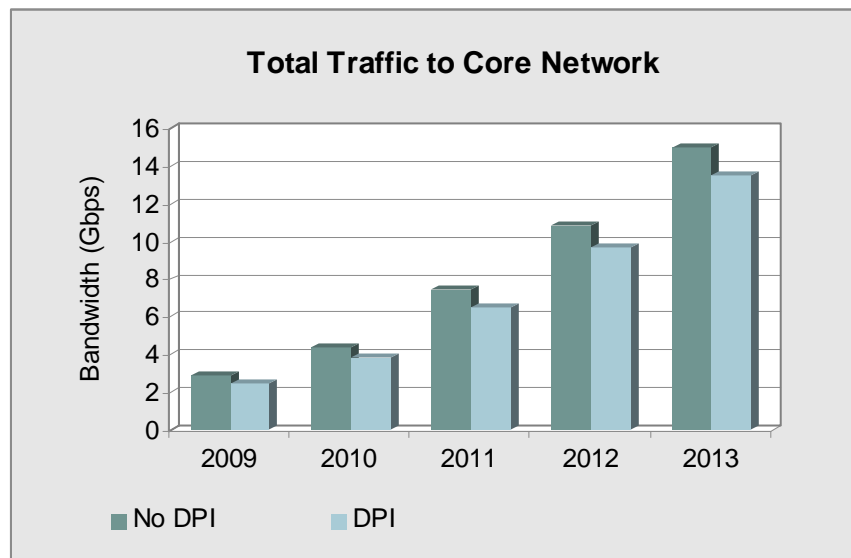


Figure 8. Service edge to core network traffic with and without DPI.

Network Architecture Assumptions

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

1. Integrated P2P DPI traffic control at the IP service edge using the SmartEdge 1200 IP Multi-Service Edge Router
2. An IP service edge with no DPI traffic control capability
3. A standalone DPI 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 9 depicts the SmartEdge 1200 Integrated solution—an IP service router providing an intelligent edge for residential, business, and mobile networks. The IP edge is the boundary between the access, aggregation, and core IP networks. Legacy ATM DSL, Frame Relay, and UMTS mobile networks use ATM transport in the aggregation network. Newer Ethernet DSL, PON, mobile, 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)
- DPI (deep packet inspection and heuristics technology for P2P 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. Edge services and DPI traffic control is performed for residential, business, and mobile networks and traffic.

DPI services on the SmartEdge 1200 are 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.

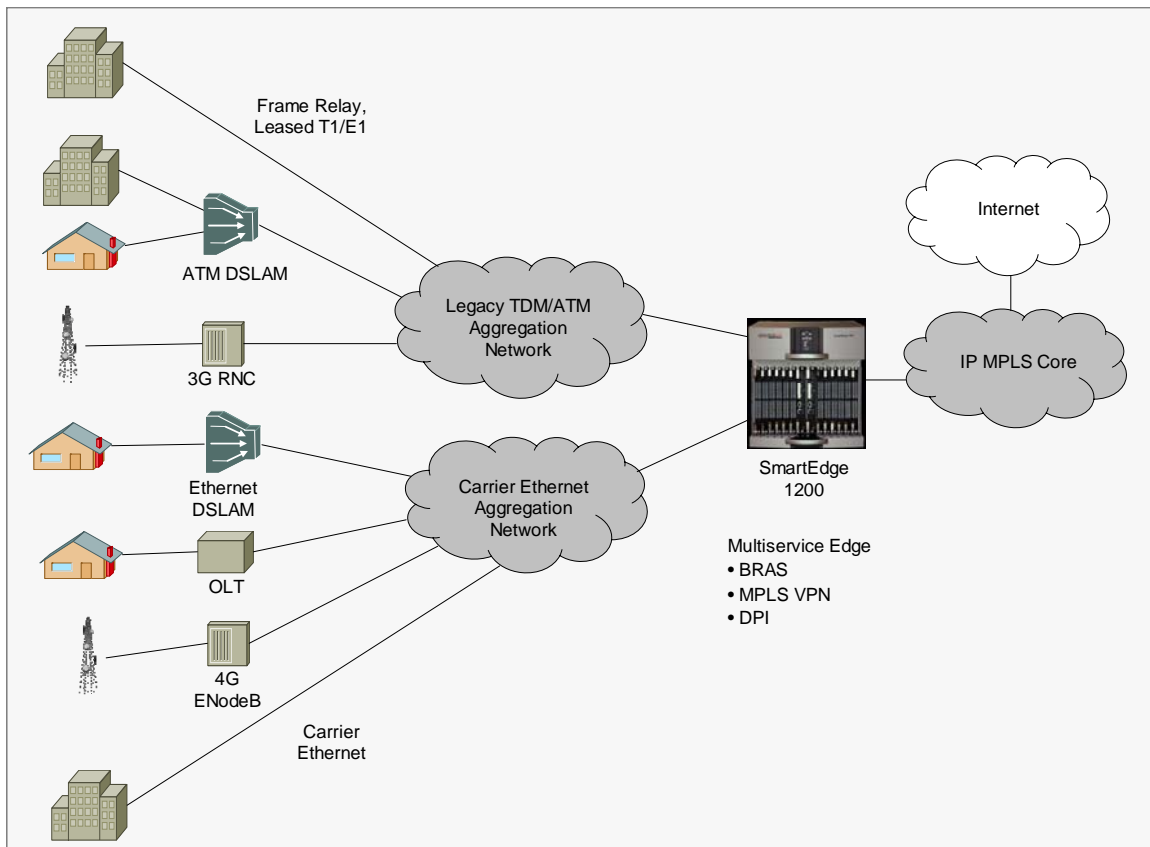


Figure 9. SmartEdge 1200 Integrated IP Service Edge with DPI.

IP Service Edge with no DPI Capability

One of the key objectives of this study is to show that P2P traffic shaping using DPI saves money. Therefore, we consider a second network architecture with no DPI capability as depicted in Figure 10. 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.

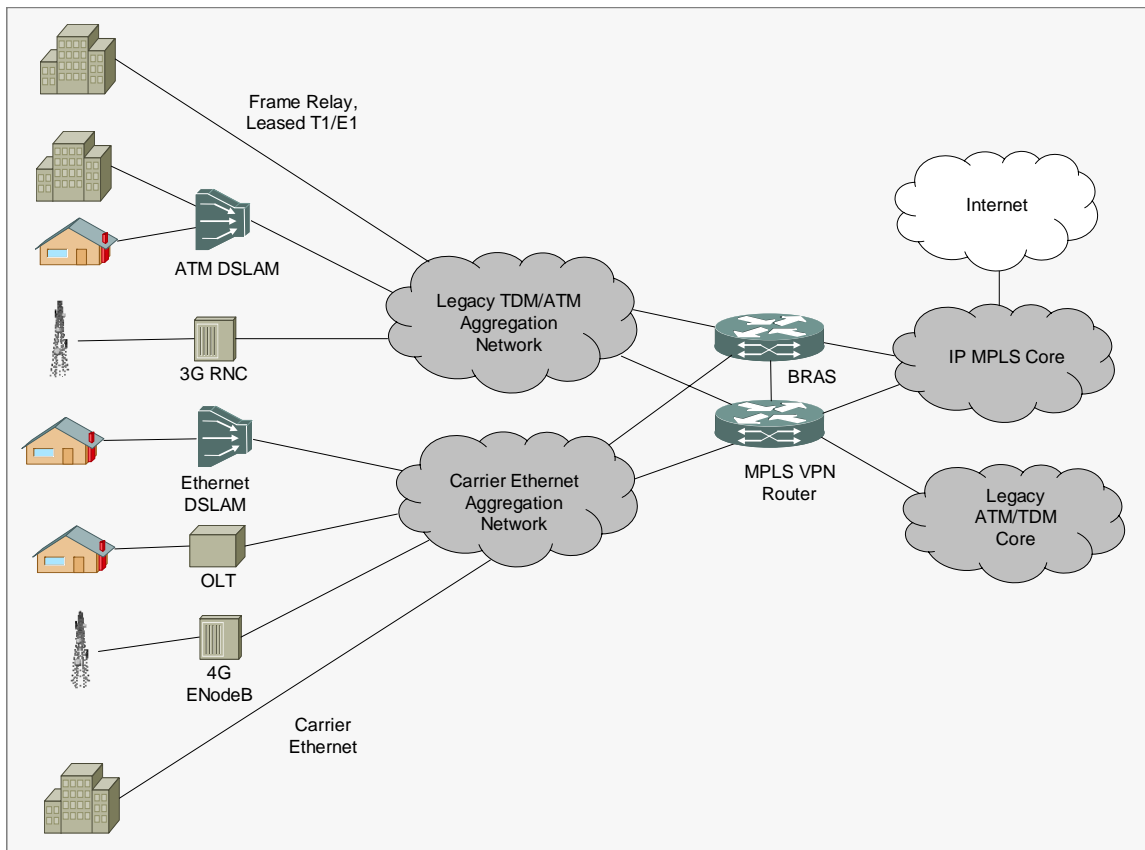


Figure 10. IP service edge with separate BRAS and MPLS VPN routers—no DPI.

Standalone DPI Architecture

A second result of this study shows that the integrated Ericsson SmartEdge 1200 solution is more cost-effective than a standalone DPI solution. These results are based on a comparison of the SmartEdge 1200 architecture with the standalone DPI architecture depicted in Figure 11. The standalone DPI architecture uses separate platforms for the BRAS and MPLS VPN functions as well as a separate DPI network element 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 DPI network element uses 10 GbE interfaces for all packet forwarding. Also at least two DPI network elements are used for redundancy.

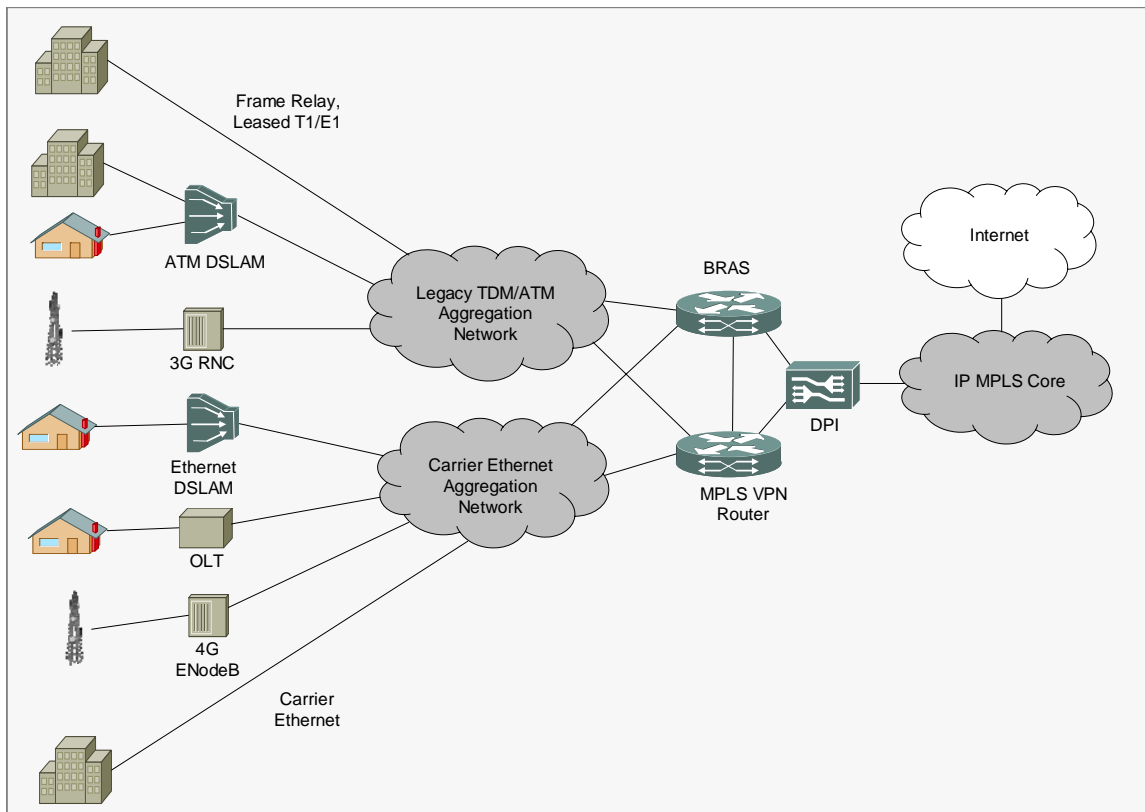


Figure 11. IP service edge with separate BRAS, MPLS VPN routers, and DPI.

Premium Services and Incremental Revenue

Another major benefit of Intelligent Traffic Management DPI 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.

Today, many broadband networks are limited to L2/L3 technologies, which have minimal 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 DPI 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 DPI, 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 DPI P2P flow control on the SmartEdge 1200 reduces network expenses and has a payback of less than one year.
- Intelligent Traffic Management DPI 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 DPI network element

The payback on the DPI capital investment is presented in Figure 12. 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 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 and mobile 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
Number of Mobile Subscribers	101,568	120,764	136,161	150,731	162,224
Additional Monthly Revenue per Subscriber for Premium Services	\$ 5	\$ 5	\$ 5	\$ 5	\$ 5
Penetration Rate for Premium Services	20%	20%	20%	20%	20%
Total Incremental Revenue for Premium Services	\$2,874,816	\$3,203,152	\$3,489,771	\$3,770,438	\$4,018,311
Gross Margin	60%	60%	60%	60%	60%
Gross Profit for Incremental Services	\$1,724,890	\$1,921,891	\$2,093,863	\$2,262,263	\$2,410,987

Intelligent Traffic Management DPI also reduces the transport cost of the aggregation and core networks. 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 DPI solution is calculated by combining the cost of aggregation and core network bandwidth with the results of the traffic analysis presented in Figure 8.

The combination of network savings and premium service profits results in a payback of ASE CapEx of less than one year, a total five-year Return-on-Investment (ROI) of 3142%, a five-year Internal Rate of Return (IRR) of 443%, and a Net Present Value (ASE Investment) of \$14,294,923. Clearly, there is a strong business case for Intelligent Traffic Management DPI.

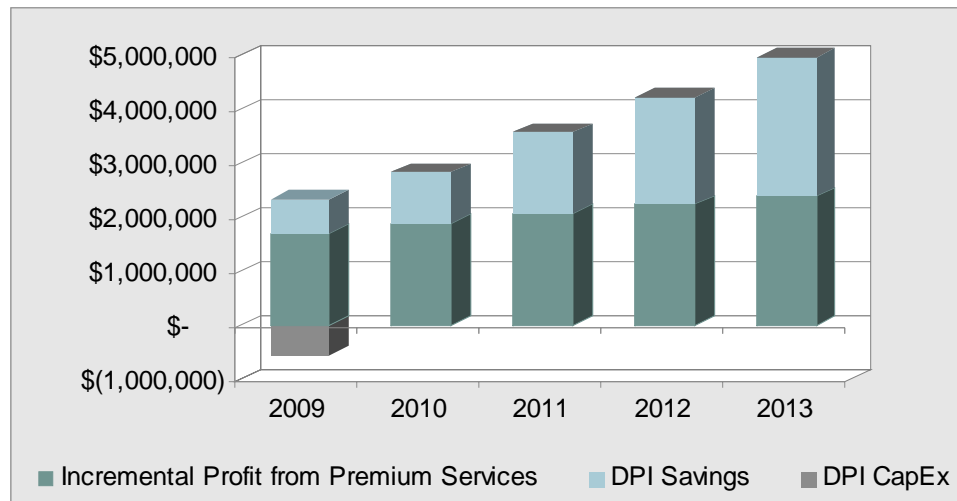


Figure 12. Payback on investment in DPI ASE cards on the SmartEdge 1200.

The second part of this analysis compared the TCO of the three alternative solutions:

1. Integrated P2P DPI traffic control at the IP service edge using the SmartEdge 1200 IP multi-service edge router
2. An IP service edge with no DPI traffic control capability
3. A standalone DPI 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 DPI are far greater in magnitude than the CapEx and OpEx associated with the service edge. Since the business case for using Intelligent Traffic Management DPI has already been established (see Figure 12), 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 13. The cumulative TCO of the SmartEdge 1200 integrated solution is **49% less expensive** than the standalone DPI solution and **29% less expensive** than the solution with no DPI. 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 DPI and no-DPI architectures (see Figure 9, Figure 10, and Figure 11).
- 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.

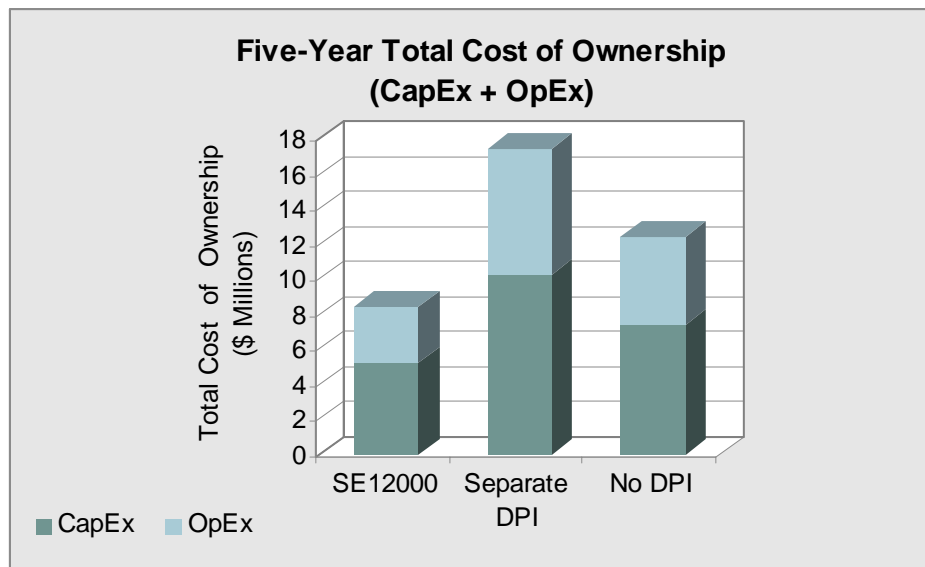


Figure 13. Comparison of the five-year cumulative TCO for the three alternative solutions.

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

Internet traffic is continuing to grow at a rapid rate and P2P traffic is a significant consumer of network bandwidth. This study has used a network engineering and economic model to show that the integrated SmartEdge 1200 DPI solution 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 49% less than the alternative solution with separate components for BRAS, MPLS VPN, and DPI functions. The SmartEdge 1200 solution has both CapEx and OpEx cost advantages over the alternative. As network traffic continues to grow, it is critical for service providers to implement scalable and cost-effective systems at the IP service edge.

Network Strategy Partners, LLC

44 Stone Root Lane

Concord, MA 01742

Tel: 978-287-5084

www.nspllc.com

