WHITE PAPER

Business Case for 10 GbE Ethernet-based Triple Play for Rural Service Providers

MANAGEMENT CONSULTANTS TO THE NETWORKING INDUSTRY

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Network Strategy Partners, LLC (NSP)

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Executive Summary

The wireline services market is in transition. Market forces are driving service providers to consider investments in Triple Play services. The U.S. Broadband Stimulus program and the FCC's National Broadband Plan also provide Triple Play investment incentives in the form of grants, loans, and promotion of broadband use. This is especially true for rural service providers.

Though rural service providers are predisposed to invest in Triple Play infrastructure they have many architectural options and vendors to choose from. This causes marketplace confusion and presents the risk that a poor choice of infrastructure will result in a failed service launch.

A 10 GbE backbone and multiservice Ethernet infrastructure can flexibly meet current and future Triple Play performance objectives and provide a low cost service delivery platform. This whitepaper presents the business case for upgrading legacy and first generation IP/Ethernet infrastructure to a 10GE backbone with multiservice Ethernet capabilities.

A representative rural service area containing 32,250 households is used to evaluate the Net Present Value (NPV) and Return On Investment (ROI) for an upgrade to a 10 GbE backbone under two initial conditions.

1. Legacy infrastructure – The network service delivery platform consists of circuit switching for voice and IP over ATM for data but lacks video delivery capabilities

2. First generation IP/Ethernet – An IP/Ethernet infrastructure exists but relies upon a 1GE backbone and lacks the capability and capacity to deliver modern Triple Play service offerings

The ROI, payback interval and NPV for the entire capital investment—10 GbE equipment and other required capital—are shown in Table 1 for each initial condition.

Financial Metric	Legacy Infrastructure	First Generation IP/Ethernet
ROI (%)	359%	87%
NPV ($ millions)	$8.1	$3.2
Payback (Years)	<2	<3

Table 1. Summary of Business Case Results

The upgrade to a 10 GbE backbone yields high return on investment and rapid payback regardless of the legacy network's starting position. Broadcast and on-demand video services contribute the majority of new revenue, consume the majority of network bandwidth, and sustain growth in revenue and cash flow throughout the five year study period. However, the initial year investment in 10 GbE backbone equipment is modest as are subsequent years' incremental capital requirements. The 10 GbE backbone, consequently, is shown to provide a highly scalable foundation for the Triple Play business case.

Introduction

The wireline services market is in transition. Market forces are driving service providers to consider investments in Triple Play services. Voice revenues are declining as subscribers move to mobile services and switch to bundled offerings of Internet and cable TV. First-generation broadband solutions require refreshing to deliver the increased data rates necessary to support video. Opportunities are emerging to offer new video services—HDTV, DVR, VoD, and interactive TV—and leverage multimedia services that go beyond single-service niches. Triple Play holds the potential to create the cash flow needed to upgrade the network and position service providers for future revenue growth.

The U.S. Broadband Stimulus program and the FCC's National Broadband Plan also provide Triple Play investment incentives in the form of grants, loans and promotion of broadband use.

Though rural service providers are predisposed to invest in Triple Play infrastructure they have many architectural options and vendors to choose from. This causes marketplace confusion and presents the risk that a poor choice of infrastructure will result in a failed service launch.

A business case analysis is needed to better define the Triple Play business opportunity and show how deployment of 10GE and multiservice Ethernet switching delivers a flexible and low cost service delivery capability.

Rural service providers are likely to be in one of two current positions:

1. Legacy infrastructure – The network service delivery platform consists of circuit switching for voice and IP over ATM for data but lacks video delivery capabilities

2. First generation IP/Ethernet – An IP/Ethernet infrastructure exists but relies upon a 1GE backbone and lacks the capability and capacity to deliver modern Triple Play service offerings

While legacy infrastructure possesses the capability to provide Internet access service, it is not capable of providing video services using IP. In addition, legacy infrastructure delivers Internet access service with data rates below 1 Mbps. This is well below the FCC's new definition for broadband which calls for a minimum download speed of 4 Mbps and far from the FCC goal of a residential download speed of 100 Mbps[1].

First generation IP/Ethernet that uses a 1 GE backbone can meet the FCC's current broadband data rate minimum requirement but it cannot support forward looking High Speed Internet (HSI) data rate objectives, nor can it reliably deliver IP video services.

A 10 GbE backbone and multiservice Ethernet infrastructure can flexibly meet current and future Triple Play performance objectives and provide a low cost service delivery platform. This whitepaper presents the business case for upgrading legacy and first generation IP/Ethernet infrastructure to a 10GE backbone with multiservice Ethernet capabilities.

[1] Residential 100 Mbps download speeds are being delivered now to millions of customers in Japan, South Korea, are other countries that are the U.S.'s marketplace competitors.

Methodology

The business case is supported by modeling the Net Present Value (NPV) and Return on Investment (ROI) for a representative rural service provider that is upgrading either legacy infrastructure or first generation IP/Ethernet to a 10GE backbone with multiservice Ethernet capabilities. Figure 1 provides a schematic overview of the modeling process.

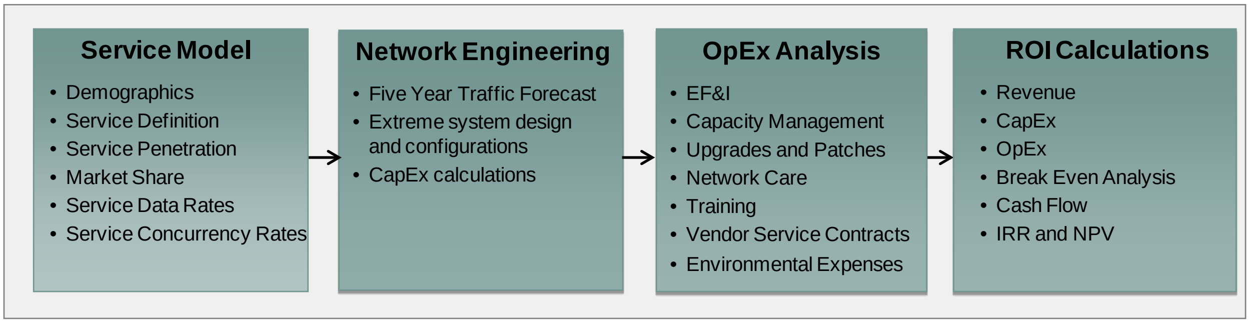


Figure 1. Modeling Process

The modeling process begins by characterizing the service area in terms of the number of households, services offered, service penetration and service traffic characteristics. Using this characterization a traffic forecast is made and then used to configure the Ethernet equipment. Once configured the equipment is priced out to determine the capital expense (CapEx). The operations expense of operating the Ethernet equipment is calculated by using expense factors that are applied to the equipment configurations. Estimates of other capital and operating expenses not associated with the Ethernet equipment are also made by using expense ratio analysis for typical rural service providers.

Incremental revenue, capital and operating expenses associated with the 10GE investment project then are estimated. The estimates are used to calculate financial metrics such as ROI, NPV and the breakeven point.

Rural Service Territory

The business case analysis is performed on a representative rural service territory subdivided into three serving areas. Each serving area contains six Central Offices (CO) classified by size as Large, Medium, and Small according to the total number of households within the COs geographic boundaries. Table 2 shows the number of households and the distribution of COs by size within each of the three serving areas.

Type	Households	Number per Serving Area
Small	750	3
Medium	1,500	1
Large	3,000	2

Table 2. Number and Size of COs per Serving Area

A Hub CO is used to connect the COs in each serving area to backbone services such as a VoIP Gateway and the Internet. The Hub CO also terminates local services. 3,000 households are within its serving area—the same as a large CO. Therefore, the potential market for Triple Play services consists of 32,250 households.

Service Penetration

The number of households that subscribe to each Triple Play service offering are projected by applying penetration rates to the number of households within each CO's service boundaries. Figure 2 shows the assumed service penetration rates for each service.

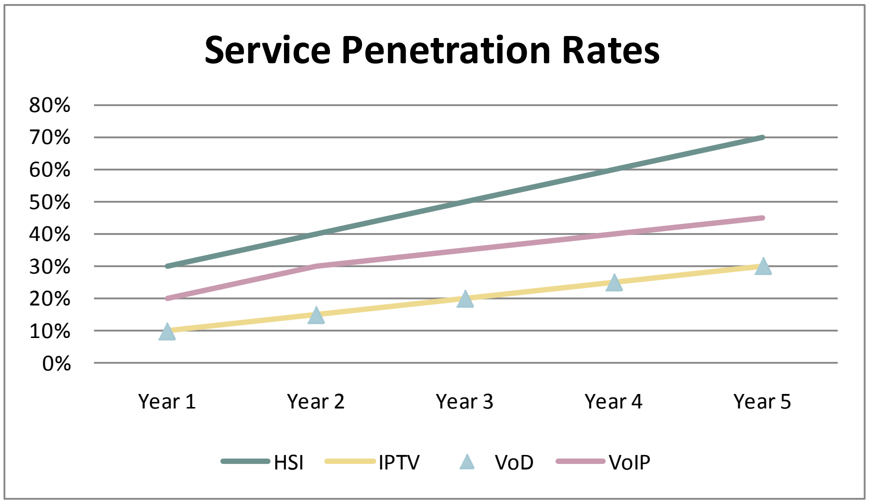


Figure 2. Service Penetration Rates

The service penetration rate assumptions used in this study are based upon industry trends and the results of recent FCC sponsored studies[2]. All services are expected to increase penetration over each year of the study. Video on Demand is typically bundled with IPTV service offerings so its penetration rate is identical to that of IPTV. High Speed Internet service is projected to be the most widely accepted service with VoIP in second place and slowly gaining share over time.

Table 3 shows the resulting number of subscribers for each service over the entire service territory.

[2] See for example, *Next Generation Connectivity: A review of broadband Internet transitions and policy from around the world*, The Berkman Center for Internet & Society at Harvard University, Cambridge, MA, October 2009

Number of Subscribers in Service Territory						
Service	**Year 0**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
High Speed Internet	9,675	9,675	12,900	16,125	19,350	22,575
IPTV	3,225	3,225	4,838	6,450	8,063	9,675
Video on Demand	3,225	3,225	4,838	6,450	8,063	9,675
VoIP	6,450	6,450	9,675	11,288	12,900	14,513

Table 3. Number of Subscribers by Service in Entire Service Territory

Revenue Projections

The business case uses an incremental analysis. Revenue benefits, investment and operations expenses are estimated relative to that prior to the upgrade project. For example, if First Generation High Speed Internet service is already being offered at a price of $25 per month and the upgrade introduces Second Generation High Speed Internet service at a price of $35 per month then the incremental revenue benefit is $10 per month. Consequently the incremental effects are relative to the service provider's initial position. Table 5 shows the revenue recognition for each initial position.

Service	Legacy Infrastructure	First Generation IP/Ethernet
High Speed Internet	$10	$0
Broadcast TV	$65	$65
VoD	$10	$10
VoIP	$0	$0

Table 4. Monthly ARPU per Service Versus Initial Position of Infrastructure

There are several revenue categories where no incremental revenue is recognized. There is no HSI incremental revenue when upgrading from first generation IP/Ethernet because the existing infrastructure already supports the service. The full ARPU of Broadcast TV and VoD are recognized for the Legacy Infrastructure and First Generation IP/Ethernet initial positions because neither of these architectures can support IPTV. There is never a benefit associated with VoIP because it cannibalizes circuit switched voice service.

There are none-the-less service retention and churn reduction benefits derived from offering these services even when there is no incremental revenue benefit. For example, the VoIP service offer helps retard the loss of voice service business to competitors by giving the customer the opportunity to stay with his current service provider. Furthermore, the Triple Play service bundle itself provides strong customer retention and churn reduction incentives. There is substantial market research that shows that customers are more loyal when they subscribe to multiple services. The upgrade to 10GE also protects HSI subscriptions even though incremental revenue is not recognized. The 10GE infrastructure provides a great deal of bandwidth headroom that will be needed as customer expectations increase from the current expectation of at least 4 Mbps of download speed to at least 100 Mbps of download speed in the future.

Figure 3 compares the total incremental revenue produced versus the network's initial position.

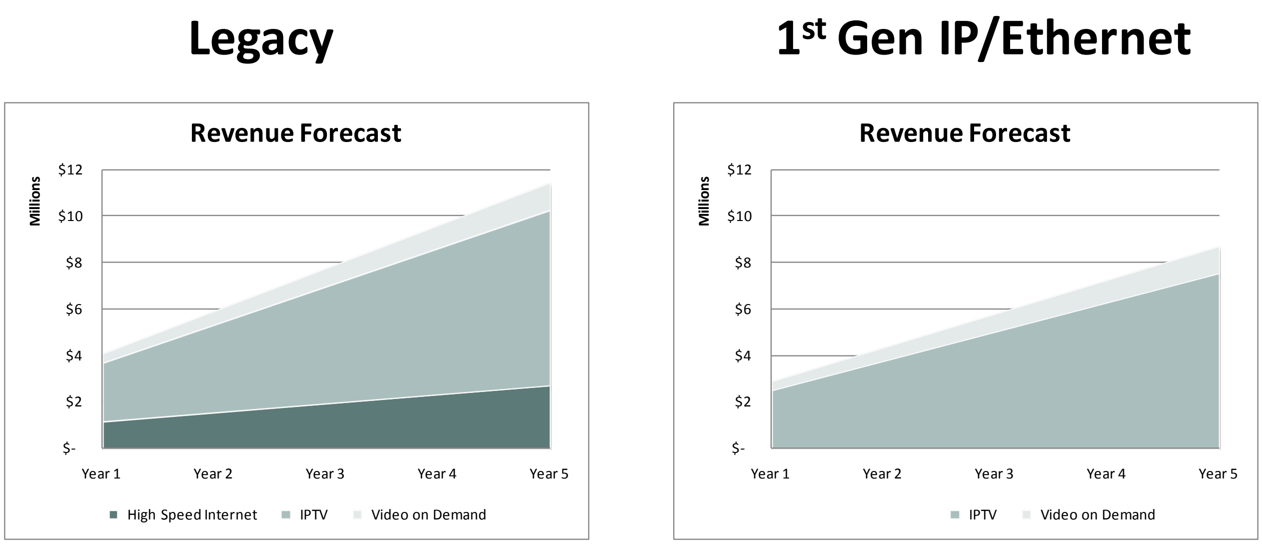


Figure 3. Incremental Revenue for Entire Service Territory versus Network Initial Position

Traffic Forecast

It is necessary to make a traffic forecast in order to size and configure the equipment used for the 10 GbE Ethernet-based Triple Play solution. The traffic forecast depends upon the network topology. Figure 4 shows the network topology for the service territory.

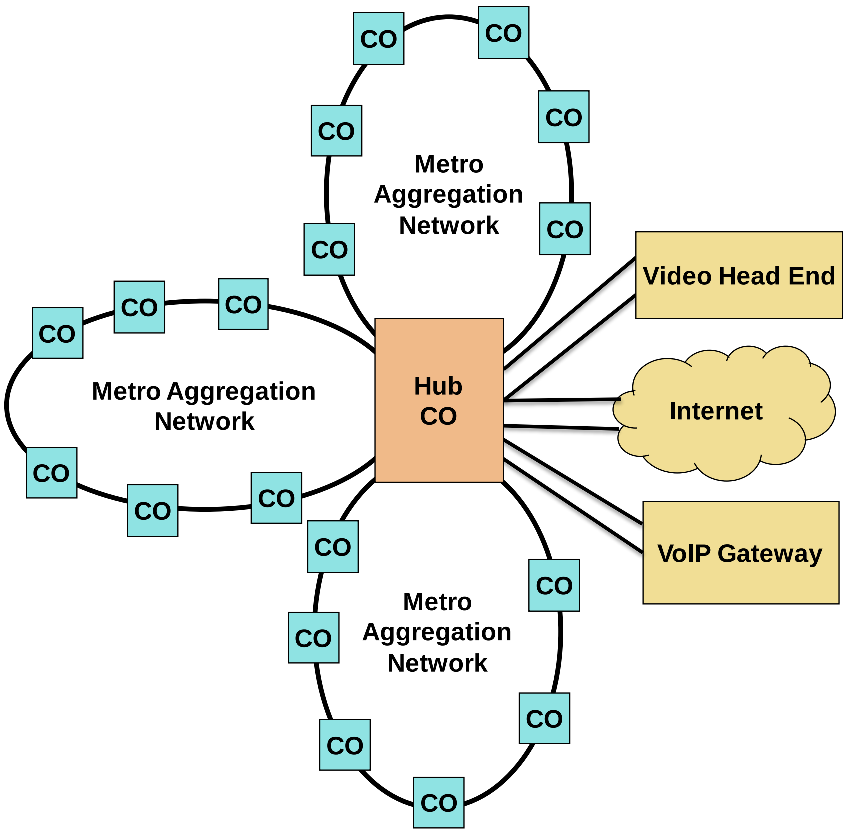


Figure 4. Network Topology for Representative Rural Service Territory

The network consists of three metro aggregation rings each of which connects to six Central Offices (CO). Each aggregation ring in turn is connected to a Hub CO. The Hub CO provides connections to a Video Head End, Internet backbone and a VoIP Gateway.

Data Rates and Concurrency

Residential services include High Speed Internet (HSI), VoIP, broadcast video and video on demand (VoD). Broadcast video and VoD are offered in High Definition (HD) and Standard Definition (SD) formats. Table 5 shows the data rate and concurrency[3] for each service per TV or telephone for VoIP and video services.

[3] Concurrency is the percent of end-user devices (telephones or TVs) that are active during the busy period.

Service	Data Rate (Mbps)	Concurrency (%)
VoIP	0.032	25%
Standard Definition Broadcast Video	2.0	50%
High Definition Broadcast Video	9.0	50%
Standard Definition VoD	2.0	20%
High Definition VoD	9.0	20%

Table 5. Data Rate and Concurrency per TV or telephone

HSI service has a 25% concurrency rate per household. Its average data rate during the busy period steadily increases with time as more multi-media services—especially video—are delivered over the Internet. Figure 5 shows the projection of HSI average data rate over the busy period.

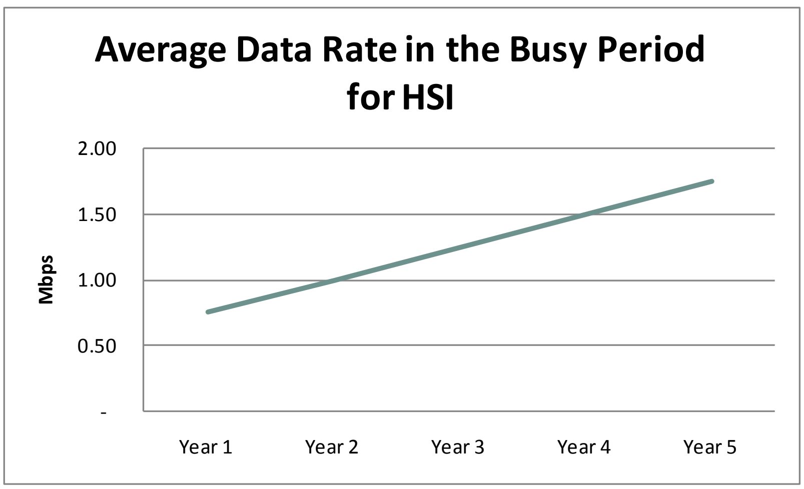


Figure 5. Average Data Rate in the Busy Period for High Speed Internet Service per Household

Note that the average data rate over the busy period is much lower than the service's maximum download speed because each user may not be active throughout the entire busy period and that average speed includes the time that the user is typing commands or reading the screen—these are periods when no traffic is being generated.

Network Traffic Forecast

The network traffic forecast is made by for each service by applying the concurrency rates, average data rates, and whether the service is unicast or multicast to the number of subscribers served at each CO. These results are then combined to obtain traffic on each access ring, at the Hub switch and that flowing between the network core and the Hub switch.

Figure 6 shows the total traffic on a single access ring.

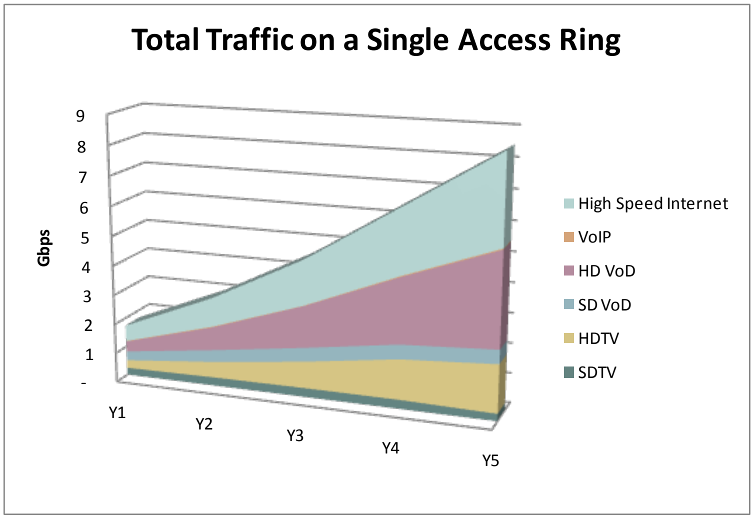


Figure 6. Total Traffic on a Single Access Ring

More than half of the total traffic is video. High Definition video accounts for the majority of bandwidth for two reasons. The High Definition video stream requires 4.5 times as much bandwidth as Standard Definition video and the rapid conversion of households to HDTV means that an ever increasing share of viewing will be in High Definition. High Speed Internet service is the next most important traffic source. The increasing use of streaming video over the Internet is the primary driver for High Speed Internet's increasing bandwidth requirement. Bandwidth requirements for VoIP are negligible.

Figure 6 also shows that total traffic on each access ring is in excess of 8 Gbps by Year 5. Once traffic engineering rules are applied—discussed in the next section—more than one 10 GbE data stream will be required to serve the traffic load within each of the three service areas.

Network Configuration

The network topology shown in Figure 4 is configured with Extreme Networks Summit X480 aggregation switches in each Central Office and an Extreme Networks BlackDiamond 20804 at the aggregation network hub. Three 10 Gbps optical rings link the aggregation switches to the hub switch. A second set of three 10 Gbps optical rings is required in Year 5 to service the traffic load within each access area. Once the port requirements for each aggregation switch and the network hub switch are determined their CAPEX is calculated by applying system prices including a industry average price discount rate.

Access devices such as IP DSLAMs and set top boxes, the Core network and other capital items are not modeled explicitly. These items, however, are included in the ROI analysis using a ratio analysis modeling method.

Business Case for 10 GbE

Table 6 shows the ROI, Net Present Value (NPV) and Payback time for the upgrade to a 10 GbE aggregation network for networks with an initial starting point of legacy ATM or first generation Ethernet starting points.

Financial Metric	Legacy ATM Infrastructure	First Generation IP/Ethernet
ROI (%)	359%	87%
NPV ($ millions)	$8.1	$3.2
Payback (Years)	<2	<3

Table 6. Financial Metrics vs. Initial Starting Point

The upgrade to a 10 GbE solution yields high return on investment and rapid payback regardless of the legacy network's initial starting position. The return on investment is higher if the existing network is currently using ATM-based DSLAMs rather than first generation IP/Ethernet technology. No additional revenue for HSI service is recognized for the upgrade if first generation IP/Ethernet infrastructure is already in place. First generation IP/Ethernet infrastructure can support current U.S. Internet access requirements of 4 Mbps download speeds, however, consumer download speed expectations will rise rapidly over the next decade. First generation IP/Ethernet infrastructure will not be able to meet those requirements. 10 GbE solutions, on-the-other-hand, are already delivering download speeds in excess of 50 Mbps in other countries.

Figure 7 shows annual revenue versus annual CAPEX for each starting point.

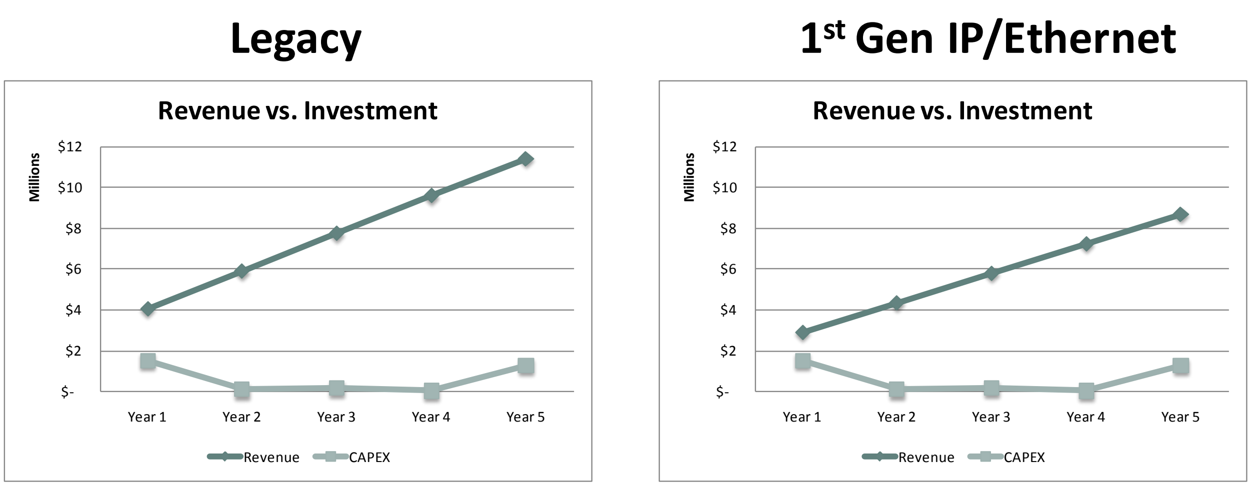
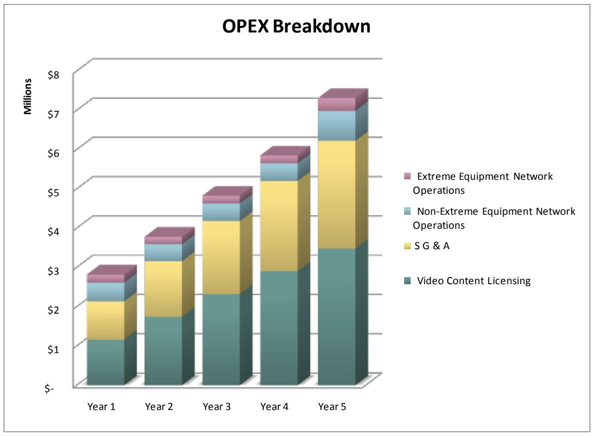


Figure 7. Annual Revenue and CAPEX

The chart shows that very little additional CAPEX is needed after Year 1 to support strong annual growth in revenue. This demonstrates the strong scalability of the 10 GbE solution.

Figure 8 shows the breakdown of OPEX for each starting point.

Legacy



1st Gen IP/Ethernet

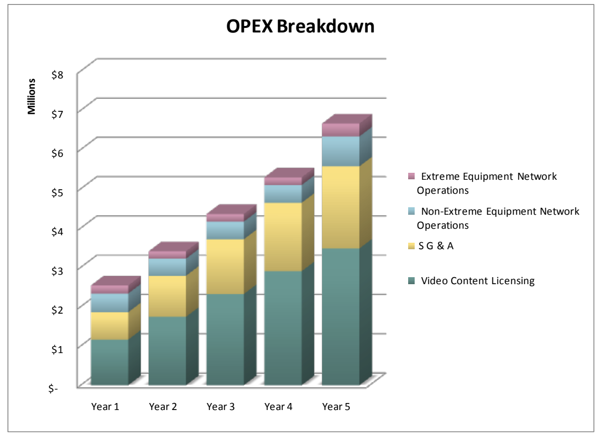


Figure 8. Breakdown of OPEX

The OPEX breakdown is very similar for both starting points. The primary difference is that incremental Internet peering expense is incurred for the Legacy starting point. This expense is incurred by the Legacy starting point because the 10 GbE upgrade creates additional High Speed Internet access revenue of which a portion must be paid out to the peering partner. No incremental High Speed Internet revenue is created by the upgrade when the starting point is first generation IP/Ethernet.

Sales, General, and Administrative expense (SG&A) and Video Content Licensing account for the majority of OPEX. The business case rests fundamentally on acquiring video subscriptions, billing subscribers and sourcing video content. Network operations are highly efficient and add little to OPEX.

Table 7 shows the full cash flow analysis for the Legacy starting point while Table 8 shows the analysis for the first generation IP/Ethernet starting point.

	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Incremental Revenue						
High Speed Internet	$ 1,161,000	$ 1,548,000	$ 1,935,000	$ 2,322,000	$ 2,709,000	$ 9,675,000
IPTV	$ 2,515,500	$ 3,773,250	$ 5,031,000	$ 6,288,750	$ 7,546,500	$ 25,155,000
Video on Demand	$ 387,000	$ 580,500	$ 774,000	$ 967,500	$ 1,161,000	$ 3,870,000
Annual Allocated Revenue	**$ 4,063,500**	**$ 5,901,750**	**$ 7,740,000**	**$ 9,578,250**	**$ 11,416,500**	**$ 38,700,000**
Operations Expenses						
Video Content Licensing	$ 1,161,000	$ 1,741,500	$ 2,322,000	$ 2,902,500	$ 3,483,000	$ 11,610,000
Internet Peering	$ 232,200	$ 309,600	$ 387,000	$ 464,400	$ 541,800	$ 1,935,000
S G & A	$ 975,240	$ 1,416,420	$ 1,857,600	$ 2,298,780	$ 2,739,960	$ 9,288,000
Non-Extreme Equipment Network Operations	$ 477,247	$ 435,894	$ 450,545	$ 452,835	$ 762,478	$ 2,578,998
Extreme Equipment Network Operations	$ 204,535	$ 186,812	$ 193,091	$ 194,072	$ 326,776	$ 1,105,285
Annual Operations Expenses	**$ 3,050,222**	**$ 4,090,225**	**$ 5,210,235**	**$ 6,312,587**	**$ 7,854,014**	**$ 26,517,283**
Capital Expenses						
Non-Extreme Equipment	$ 1,075,887	$ 65,874	$ 136,140	$ 26,350	$ 907,155	$ 2,211,407
Extreme Equipment	$ 461,095	$ 28,232	$ 58,346	$ 11,293	$ 388,781	$ 947,746
Annual CAPEX	**$ 1,536,982**	**$ 94,106**	**$ 194,486**	**$ 37,643**	**$ 1,295,936**	**$ 3,159,153**
Annual Cash Flow	**$ (523,704)**	**$ 1,717,418**	**$ 2,335,279**	**$ 3,228,021**	**$ 2,266,550**	**$ 9,023,564**
Cumulative Cash Flow	**$ (523,704)**	**$ 1,193,715**	**$ 3,528,993**	**$ 6,757,014**	**$ 9,023,564**	
Discounted Cash Flow	**$ (523,704)**	**$ 1,651,364**	**$ 2,159,096**	**$ 2,869,699**	**$ 1,937,456**	**$ 8,093,911**
Cumulative Discounted Cash Flow	**$ (523,704)**	**$ 1,127,660**	**$ 3,286,756**	**$ 6,156,455**	**$ 8,093,911**	

ROI	**359%**
NPV	**$ 8,093,911**

Table 7. Cash Flow, ROI and NPV Analysis for Legacy Starting Point

	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Incremental Revenue						
High Speed Internet	$ -	$ -	$ -	$ -	$ -	$ -
IPTV	$ 2,515,500	$ 3,773,250	$ 5,031,000	$ 6,288,750	$ 7,546,500	$ 25,155,000
Video on Demand	$ 387,000	$ 580,500	$ 774,000	$ 967,500	$ 1,161,000	$ 3,870,000
Annual Allocated Revenue	**$ 2,902,500**	**$ 4,353,750**	**$ 5,805,000**	**$ 7,256,250**	**$ 8,707,500**	**$ 29,025,000**
Operations Expenses						
Video Content Licensing	$ 1,161,000	$ 1,741,500	$ 2,322,000	$ 2,902,500	$ 3,483,000	$ 11,610,000
Internet Peering	$ -	$ -	$ -	$ -	$ -	$ -
S G & A	$ 696,600	$ 1,044,900	$ 1,393,200	$ 1,741,500	$ 2,089,800	$ 6,966,000
Non-Extreme Equipment Network Operations	$ 477,247	$ 435,894	$ 450,545	$ 452,835	$ 762,478	$ 2,578,998
Extreme Equipment Network Operations	$ 204,535	$ 186,812	$ 193,091	$ 194,072	$ 326,776	$ 1,105,285
Annual Operations Expenses	**$ 2,539,382**	**$ 3,409,105**	**$ 4,358,835**	**$ 5,290,907**	**$ 6,662,054**	**$ 22,260,283**
Capital Expenses						
Non-Extreme Equipment	$ 1,075,887	$ 65,874	$ 136,140	$ 26,350	$ 907,155	$ 2,211,407
Extreme Equipment	$ 461,095	$ 28,232	$ 58,346	$ 11,293	$ 388,781	$ 947,746
Annual CAPEX	**$ 1,536,982**	**$ 94,106**	**$ 194,486**	**$ 37,643**	**$ 1,295,936**	**$ 3,159,153**
Annual Cash Flow	**$ (1,173,864)**	**$ 850,538**	**$ 1,251,679**	**$ 1,927,701**	**$ 749,510**	**$ 3,605,564**
Cumulative Cash Flow	**$ (1,173,864)**	**$ (323,325)**	**$ 928,353**	**$ 2,856,054**	**$ 3,605,564**	
Discounted Cash Flow	**$ (1,173,864)**	**$ 817,825**	**$ 1,157,247**	**$ 1,713,719**	**$ 640,684**	**$ 3,155,612**
Cumulative Discounted Cash Flow	**$ (1,173,864)**	**$ (356,038)**	**$ 801,209**	**$ 2,514,928**	**$ 3,155,612**	

ROI	**87%**
NPV	**$ 3,155,612**

Table 8. Cash Flow, ROI and NPV Analysis for First Generation IP/Ethernet Starting Point

Conclusion

A 10 GbE backbone and multiservice Ethernet infrastructure can flexibly meet current and future Triple Play performance objectives and provide a low cost service delivery platform. A network serving a representative rural service area containing 32,250 households is used to evaluate the NPV and ROI for an upgrade to a 10 GbE backbone under two initial conditions.

1. Legacy infrastructure – The network service delivery platform consists of circuit switching for voice, IP and ATM for data, and lacks video delivery capabilities
2. First generation IP/Ethernet – An IP/Ethernet infrastructure exists but relies upon a 1GE backbone and lacks the capability and capacity to deliver modern Triple Play service offerings

The ROI, Payback interval and NPV for the entire capital investment—10 GbE equipment and other required capital—are shown in Table 9.

Financial Metric	Legacy Infrastructure	First Generation IP/Ethernet
ROI (%)	359%	87%
NPV ($ millions)	$8.1	$3.2
Payback (Years)	<2	<3

Table 9. Summary of Business Case Results

The upgrade to a 10 GbE backbone yields high return on investment and rapid payback regardless of the legacy network's starting position. Broadcast and on-demand video services contribute the majority of new revenue, consume the majority of network bandwidth, and sustain growth in revenue and cash flow throughout the five year study period. However, the initial year investment in 10 GbE backbone equipment is modest as are subsequent years' incremental capital requirements. The 10 GbE backbone, consequently, is shown to provide a highly scalable foundation for the Triple Play business case.

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