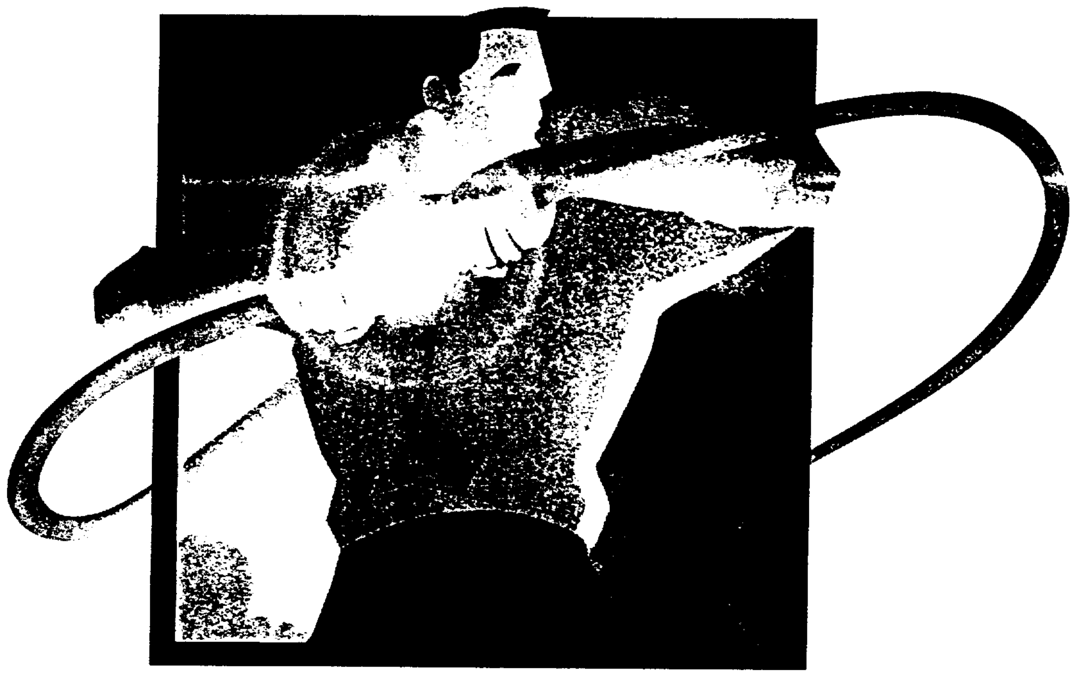
Business Case



A Business Case for Two-Way Service Deployment over HFC Networks

Cisco Systems

Two-Way Business Case **Table of Contents**

A Business Case for Two-Way Service Deployment over HFC Networks

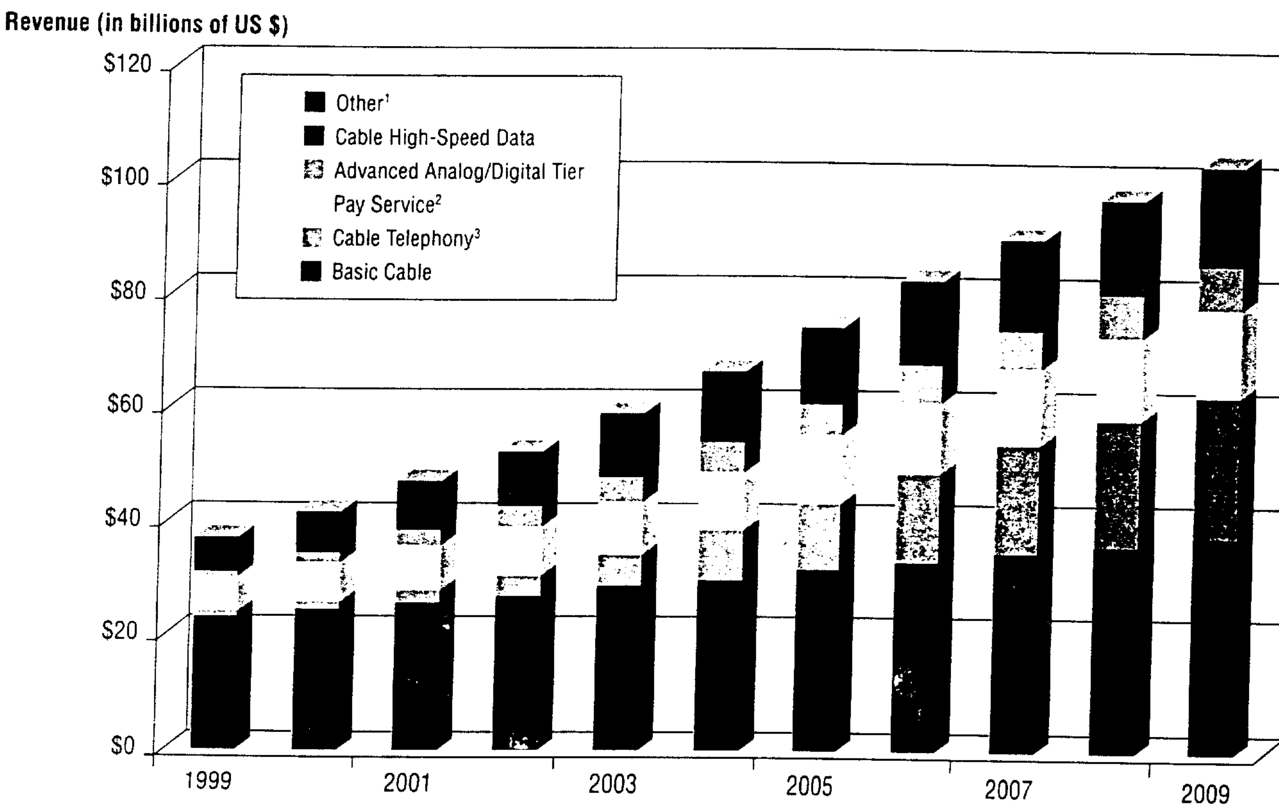
Abstract

Cable service providers are faced with current market conditions that include compelling new opportunities, but can involve substantial risks. To help companies make fact-based, plant-specific decisions about deploying new services, Cisco Systems provides numerous strategic analysis services using a suite of business analysis tools developed for the cable industry. These tools allow Cisco to deliver powerful insights into the economic framework associated with the two-way opportunity. With a solid understanding of the economic drivers, Cisco has helped cable executives make decisions that minimize risk while fully exploiting market opportunities. This paper provides a financial analysis for the two-way opportunity and shares some insights on the forces at work in the cable industry.

Market Conditions

The outlook for the cable market is better than ever. Industry analysts expect the market to enjoy attractive growth rates (Figure 1). The unprecedented usage of the Internet and need for high-bandwidth applications have created an exploding demand for broadband two-way services. While this presents service providers with opportunities for expansion and increased revenue, it also creates risk because they need to make large investments, understand new businesses, and learn to execute efficiently in a different operating environment. Multiple system operators (MSOs) who are able to move quickly will be rewarded with the lower acquisition costs and the positive brand equity associated with providing these new, highly desirable services before competitive alternatives are available.

Figure 1 Cable Revenue Projections by Segment



¹ Other includes local advertising, home shopping, additional services, equipment, and install.
² Pay service includes Pay, PPV/NVoD/VoD, and cable-delivered video game revenue.
³ Cable telephony revenue includes both residential and business.

Source: Paul Kagan and Associates' estimates.

High-Growth Market Segments

Emerging services are expected to account for the greatest growth rates in the cable market—more than three times the growth rate for traditional cable services. In fact, revenue generated from emerging cable services is expected to surpass that of basic cable offerings in the next five years. Technological advancements have made it practical to deliver all these services over common, existing hybrid fiber coaxial (HFC) infrastructures. With Internet Protocol (IP) serving as the accepted standard, service providers are able to deploy an integrated service strategy and offer bundled services through an extremely cost-efficient infrastructure. The position that cable enjoys as a low-cost provider for high-growth services creates the positive outlook and strong valuations present in the industry today.

Consumers will demand a growing array of services in the coming years, including:

Data Services

- Two-way Internet access service (via a PC or a TV)
- E-mail
- Telecommuter network access (virtual private networks [VPNs])
- Web hosting (offsite)
- Commerce transactions
- Targeted advertising, interactive advertising (ads tied to instant transactions)
- Customized news packaging
- Audio programs
- CD-ROM servers
- Home management (utility management and home security)
- Real-time account viewing and bill payment

Voice Services

- Residential and commercial telephone service with custom local area signaling services (CLASS) calling features such as caller ID and redial
- Advanced calling features such as unified messaging (integrated voice mail, fax, paging, and e-mail)
- Phone number directory with automatic dialing

Video and Entertainment Services

- Digital program delivery (video on demand [VoD], pay per view [PPV], etc.)
- Interactive videoconferencing
- Alternative video services (indexed, searchable video libraries; distance learning; TV pause/rewind; schedule shifting; local video content)
- Multiuser, interactive gaming
- Distance learning (multimedia data)

Competing Technologies

Table 1 summarizes the competing technologies that are currently involved in the race to introduce two-way services to consumers. Cable is in a strong position to deliver two-way services over alternative technologies, as illustrated in the technology score card in Table 2.

Table 1 Competitive Access Technologies

Technology	Bandwidth	Standards	Estimated CPE Cost (in US $)	Estimated Monthly Access Fee (in US $)
ISDN	64 – 128 kbps	ITU-T I.411, I.412, I.430, I.431	< $250	$30 – $100
Analog Modems	14.4 – 56 kbps	V.32/V.34/V.90	< $150	$10 – $30
xDSL	1.5 – 8 Mbps[1]	G-lite	< $300	$30 – $500
Satellite	*Uplink: PSTN* Downlink: 200 - 400 kbps	*Limited*	*$300 – $800*	*$20 – $130*
Cable	5 – 10 Mbps	MCNS/DOCSIS	< $300	$30 – $60

1. Transmission rates possibly may be higher with improved proximity to central office.

Source: Gartner Group, Forrester Group, IDC, and Cisco Systems estimates.

Table 2 Remote Access Score Card

Technology	Bandwidth	Standards	Availability	Price
ISDN	◔	◕	◕	◕
Analog Modems	○	●	●	●
xDSL	◑	◑	◑	◔
Satellite	◑	○	○	○
Cable	●	◕	◑	◑

Excellent ● ◕ ◑ ◔ ○ Poor

Source: Gartner Group, Forrester Group, IDC, and Cisco Systems estimates.

Cable: Positioned to Win the Two-Way Battle

Technological Advantages

Cable companies are well positioned to offer two-way services. Current cable technology is a strong contender compared to alternate delivery platforms because it offers excellent performance (high bandwidth) and interactivity at low cost. In addition, with upgrades for digital TV already in progress, two-way services offer an additional revenue stream to offset costs. The cable companies that are positioned for success are those that can minimize the time to market for new services. This improved time to market will help cable companies build the positive brand equity associated with offering high-technology services to a receptive market. It will also enable them to acquire customers before the competition increases acquisition costs. Bundling of services is another ingredient for success: the service providers that can deliver combinations of services (data, voice, video, and gaming) can improve their profit margins (and cash flow) by lowering churn, decreasing service provision costs, and increasing revenue.

A Strong Standards Foundation

The emergence of a standards-based platform further positions cable as a premier platform for two-way services. Standards give network operators more flexibility in building their networks by allowing them to choose the best product (technically and economically) for each function in their network. Standards also increase the rate of innovation by fostering competition among vendors to further differentiate their products through value-added features.

As an open systems vendor, Cisco has been playing a lead role in the development of standards-based cable modems for customer premises equipment (CPE) and cable modem termination shelf (CMTS) platforms for the headend. Currently, North American markets are embracing the Data Over Cable Service Interface Specification (DOCSIS). European markets are choosing between DOCSIS and the Digital Audio Visual Council (DAVIC) cable modem specification, which was developed in a manner similar with DOCSIS. A feature-rich standard, DOCSIS, makes it easy to add capabilities to your network and differentiate your services from the competition. DOCSIS features include:

- *Performance*—DOCSIS-compliant cable modems and CMTS products feature excellent transmission rates (now about 10-times faster than the earliest DOCSIS products) with improved upstream/downstream transmission. These characteristics are important for two-way services such as telephony and videoconferencing.
- *Affordability*—Consistent interfaces and support features reduce installation, maintenance, service, and equipment costs.
  - *Installation*—Cisco products such as Cisco Subscriber Registration Center (CSRC) allow users to provision themselves without assistance from the service provider and are driving the industry toward a retail model.
  - *Equipment costs*—DOCSIS has allowed the industry to move toward an internal form factor (a modem card with its own memory), resulting in further reductions in cost and lessening the risks for the service.

Deployment Risks and Risk Management

Of course, there are risks associated with deploying any new service. Since service providers will most likely be required to make substantial investments in plant upgrades and new equipment, it becomes increasingly important to understand the financial structure and profit drivers for the services. Understandably, cable operators have voiced the need to accurately predict the expected returns on their investments so that they can make the best decisions and be well-informed when planning their two-way service deployments.

The Cisco Contribution to Risk Management

Cisco can help operators ensure success as they deploy two-way services. Cisco can help operators ensure success as they deploy two-way services by offering:

- *Proven experience*—Cisco has worked closely with service providers to help them evaluate the economics of their network architecture and the economics associated with the ability of their network to adapt to emerging standards and upcoming product requirements.
- *Economic modeling*—Cisco provides a complementary model that can be used to analyze the business case for the services being considered for an operator's target markets. The business perspective gained from the model and the analysis improves the visibility in the economic levers of the operator's business.

With a solid technology platform, architecture guidelines for your network, and a well-balanced perspective on the economics of the deployment, a cable operator can speed the introduction of a new service while minimizing the risks.

The Cisco Track Record

Cisco strategic business modeling tools have been used successfully by many existing cable operators. Many customers have shared feedback that illustrates how Cisco strives to facilitate a broad range of service deployments over cable and then teams up with customers to ensure mutual success. The following are examples of comments that Cisco has received from a wide range of customers with small to large cable operations, spanning from domestic to international markets:

"Most companies talk about providing excellent service, but Cisco actually delivers. This financial model for cable-based n rigorous look at my business and constructed a robust, credible, and highly flexible tool for me to understand the magnitude of the opportunity and the timing of investment required. This tool helps provide me with certainty in a highly uncertain environment. Developing and sharing this tool demonstrates that Cisco truly wants to be a partner in my business."

—Jeff Turner, Director of IP Telephony, MediaOne

"I would like to thank Cisco for its assistance with our business plan. Big Sky is the first company to execute a contract to commercially deploy cable Internet access in China. Cisco's technical and business acumen has been much appreciated, given the historic importance of our project. This type of joint effort has been the hallmark of the relationship between our companies and a contributor to our continued success."

—Matthew Heysel, Chairman, Big Sky Network Canada Ltd.

Analysts are projecting cable industry revenue to double by 2005, thanks to the growth of emerging two-way services. The selection of services is the first critical step to formulating a successful business model because this selection determines the pricing and revenue as well as the network infrastructure and capital expenditures. The different services and their associated market segments offer diverse business advantages but present varying technical challenges.

Data Services

The data segment of the two-way services market is projected to experience a 10-year compound annual growth rate (CAGR) of approximately 42 percent, as seen previously in Figure 1, increasing from annual revenue of US $0.5 billion in 1999 to US $4.8 billion in 2009. Consumers have already exhibited interest in the Web, online shopping, and access to real-time information services such as stock quotes and travel information. In addition, many new data applications are leveraging the additional bandwidth provided by cable broadband networks.

Technical Challenges for Data Services

Most technical challenges, such as security and bandwidth availability, have been overcome at the industry level. Therefore, data deployments are normally the first two-way service offered by MSOs. While solutions to these common issues are widely understood and easily resolved, activities such as provisioning, billing, customer service, and initial network deployment are normally encountered during the data rollout.

Competition

Internet service providers (ISPs) are already established in this segment, but have problems delivering broadband services over low-performance modem connections. Cable has an opportunity to bring high-bandwidth connections to the home and office and enable better access and real-time streaming. Digital subscriber line (DSL) technology promises to provide a higher competitive benchmark. However, the shared nature of the infrastructure of cable provides cost and performance advantages in nearly all residential situations.

Voice Services

Significant opportunities exist for service providers in the voice market. In 1998, the market for telephone services was approximately eight times the size of the cable market. In other words, if MSOs could achieve a 10- to 15-percent market share in this larger arena, revenue is likely to double. Some industry analysts project that revenue for telephony services is likely to decline in the coming year. However, the market for ancillary services such as voice mail, call waiting, caller ID, and call forwarding should create higher margins for service providers. New services such as unified messaging promise improving incremental revenue over time.

Technical Challenges for Voice Services

The release of DOCSIS 1.1 should provide quality of service (QoS), real-time performance, and extremely high reliability required for toll-quality voice communications. Voice networks need to scale as market penetration and call traffic (for multiple telephone lines, dedicated fax, Internet, and cellular phone connections) increase. Another challenge for voice infrastructures is integrating operations support system (OSS) functions for billing and provisioning and including network monitoring tools for ensuring continuous real-time operation.

Competition

Traditional telephony players, the independent local exchange carriers (ILECs), competitive local exchange carriers (CLECs), and interexchange carriers (IXCs) remain the main source of competition for voice-over-IP (VoIP) telephony via cable. Global deregulation has increased the numbers of these competitors and resulted in many new players with flexible infrastructures geared for two-way services.

Video Services

Two characteristics among consumers are driving the emerging video services market. The proven consumer interest in video rentals lends itself to new forms of video delivery such as pay-per-view and video-on-demand (users download or stream a desired selection at the time they choose). The need for people to stay connected and be productive regardless of geography is driving new communications options such as videoconferencing. Video can also be an effective medium for various forms of distance learning, both video-on-demand courses as well as interactive video classroom services.

Because of the brand association between the current product offering of cable and future video services, market penetration should be relatively high for these applications when they are available. Analysis has shown that profit margins improve as product bundles become larger, suggesting that two-way video capabilities should not only complement the service offering and help to maximize customer retention, but also create additional shareholder value.

Technical Challenges for Video Services

Currently, digital video applications require significant bandwidth, creating the need for improved density in networking gear and relatively large amounts of downstream Radio Frequency (RF) spectrum. As technologies such as Motion Picture Expert Group (MPEG-4) lower the bandwidth requirements of streaming video applications and as equipment density improves over time, streaming video services are likely to become increasingly attractive to MSOs. Storage and digital encoding prices also present challenges in the video business model.

Competition

The two-way properties of the HFC plant improve the positioning of cable technology against the satellite threat. The multicast capabilities of the infrastructure of cable give it significant cost advantages over DSL in many video applications. Once these technologies are proven, the cable industry should be very well positioned to capture significant market share.

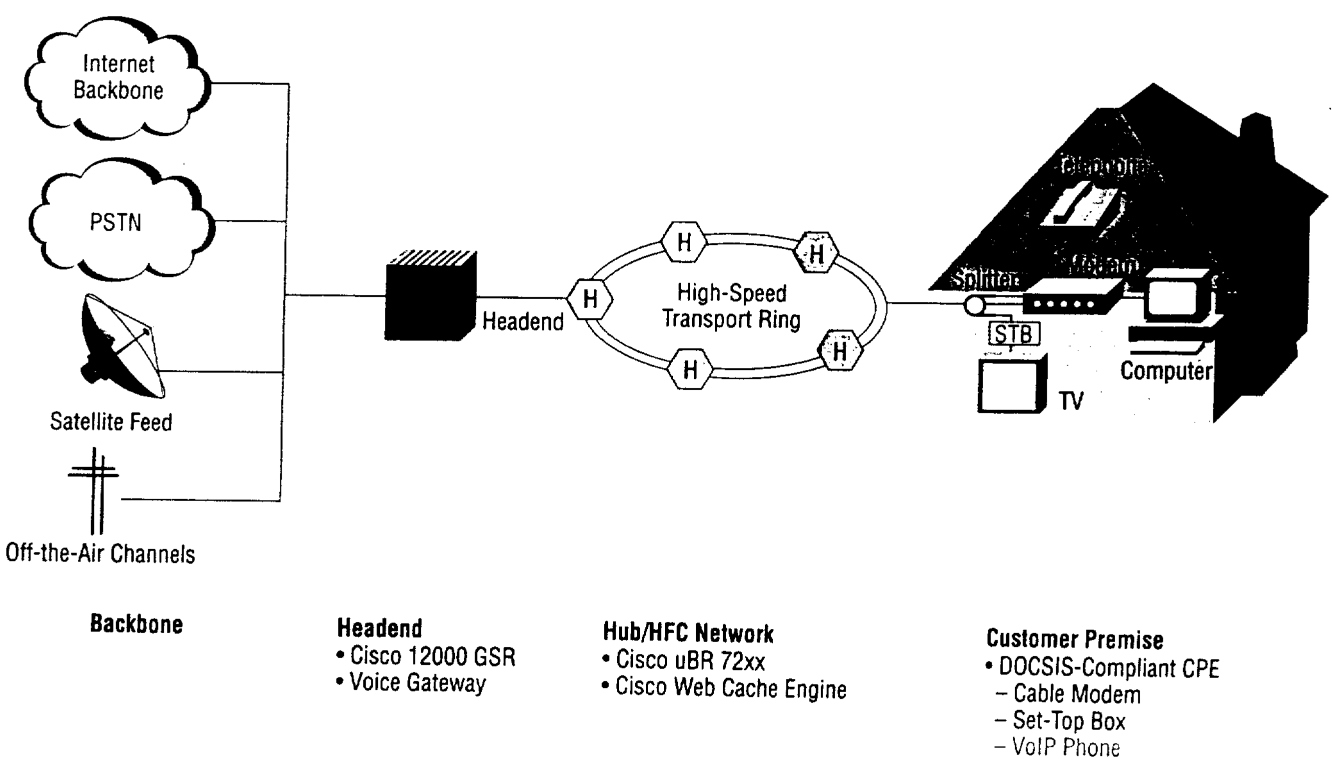
This section overviews the basic cable access architecture associated with each of the main service types (data, voice, and video) and discusses Cisco products used in the deployment of these services. Cisco solutions make it possible for cable operators to augment existing HFC access infrastructures and introduce the ability to offer two-way data, voice, and video services over the resulting network. Since all the services employ an IP-based backbone, much of the investment required can be leveraged among multiple services. Your local Cisco representative can provide more details and product information pertaining to the topics covered in this section.

Basic Broadband Access Architecture: Components and Solutions

To evolve an existing HFC network for two-way services, the architecture for the cable network needs to have the following components (Figure 2):

- The high-speed network backbone transports data, voice, and video to external networks, which support these applications.
- The headends pass data, voice, and video between the backbone and hub/HFC network. Centralized equipment such as provisioning servers, OSS servers, and billing support system (BSS) servers typically reside in the headend. If an MSO provides voice services, call gateways and call agent software are required in the headend.
- The hubs/HFC network connect the subscriber premises to the headend/backbone infrastructure. They convert the traditional digital packets (seen in the headends and on the backbone) into the RF format used to transmit the information through the fiber coaxial portions of the plant.
- The DOCSIS-compliant CPE resides at the customer's premises and converts the RF data streams generated at the hub and carried over the HFC network into the usable data, voice, and video information supplied to the end user. Examples of CPE include cable modems, set-top boxes, and VoIP phones.

Figure 2 Basic Cable Plant Architecture



High-Speed Network Backbone

A high-speed digital backbone network connects the network of the MSO to the rest of the world (in very large MSO networks, backbones also are used to carry data between different regions of the MSO network). The backbone connects to other networks such as the Public Switched Telephone Network (PSTN), other cable system backbones, and Internet connection points. Figure 3 illustrates the components in a cable multiservice network.

Headend

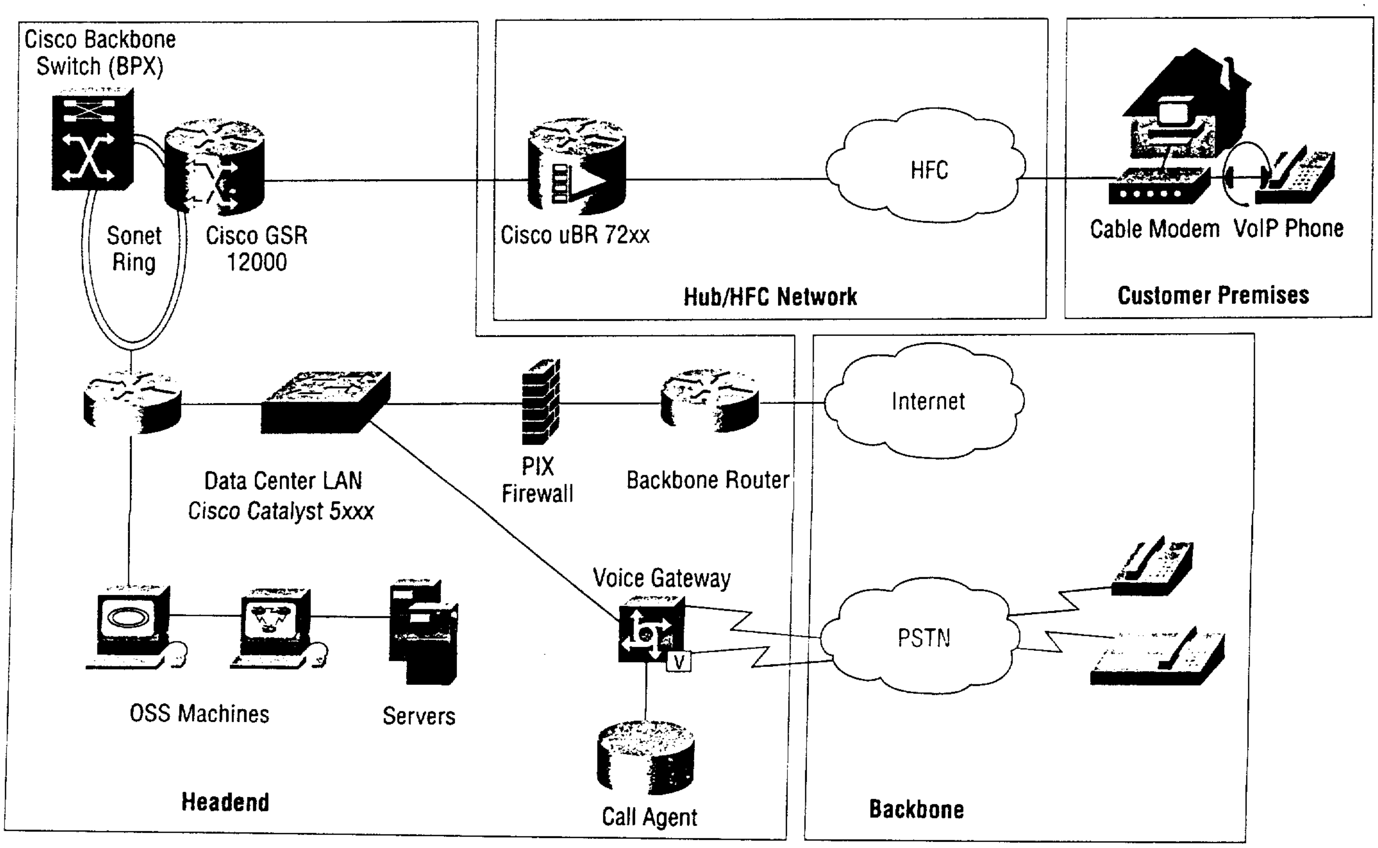
The principal role of the headend is to bring external services—satellite video, off-the-air video, Internet data, and voice—into the cable operator's access network. In some cases, several headends will be used in each region, each with somewhat different roles in voice, video content, and Internet connectivity. Typically, headends contain a gigabit switch router (GSR) to pass traffic between external sources and the internal network. Frequently, Cisco Catalyst® switches are used to route local traffic between the GSR and the servers (OSS, BSS, provisioning, and so on) located in the headend. If an MSO chooses to offer voice services, a key component of the headend is the telephony gateway. This component gives the broadband network the ability to interoperate with the PSTN. Other elements in the headend include: IP/MPEG remuxes, MPEG compressors, analog receivers, satellite receivers/scramblers, and descramblers.

Hub/HFC Network

Hubs contain equipment that converts between the backbone format and the format required for a particular data, voice, or video access network. Internal components of the hub include modulators, receivers, scramblers/descramblers, remuxes, codecs, and cache servers. Hubs may additionally receive local off-the-air video streams in analog format or digital video from satellite feeds.

At the center of the Cisco two-way hub architecture is the Cisco universal broadband router (uBR) 72xx. The uBR 72xx acts as the aggregation point, connecting subscribers on the HFC plant to the backbone network through both LAN and WAN interfaces. The uBR 72xx is the first CMTS to be a DOCSIS-qualified device that guarantees interoperability with a variety of DOCSIS-certified devices. If traffic demands on a particular hub are relatively high, more than one uBR 72xx may be required. In this case, a GSR 12000 is typically used to aggregate traffic before it is passed to the headend.

Figure 3 Cable Multiservice Network

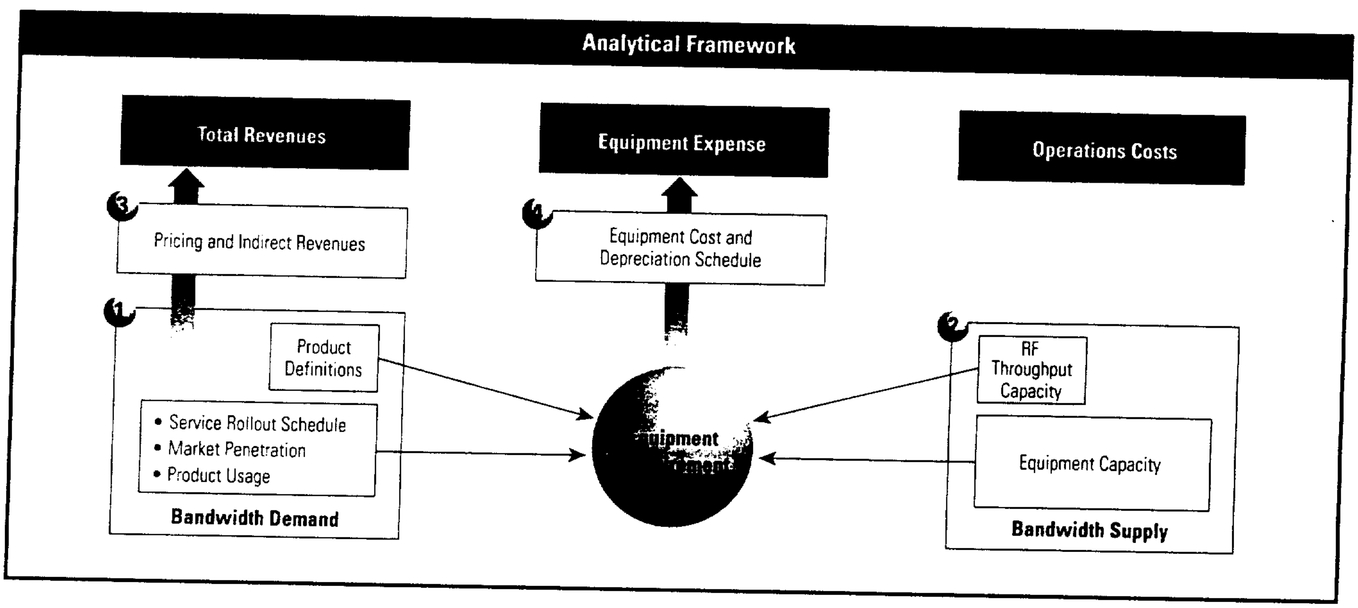


This section describes the information and variables that the cable operator needs to consider when evaluating the two-way services business proposition. Once the assumptions for the framework have been established, the Cisco Network Analysis tool or tops-down analysis tool is used to compile meaningful financial results. The next section "The Base-Case Assumptions and Analyzing Results" highlights the results of this economic analysis to give a better understanding of the magnitude of the business opportunity and the timing of the investments required to deploy the desired services.

The Shift to a New Business Paradigm

The financial picture surrounding two-way services cannot be viewed in the same way as the traditional cable business. Basic cable services are delivered to every home in the operator's customer base, and subscribers pay for the service regardless of actual usage. There is very little correlation between the service provider's costs and subscriber usage/revenue generated. In contrast, network traffic creates varying loads on the infrastructure based on actual usage. Bursts of traffic will be generated at peak periods. For example, very little network traffic is expected at 4 a.m., while peak periods such as 9 p.m. drive expected equipment expenditures. Revenue and operations costs—in fact, almost every financial parameter—are influenced by the network profile. Figure 4 illustrates the analytical framework used in the tops-down analysis tool to evaluate these relationships.

Figure 4 Analytical Framework For Tops-Down Tool



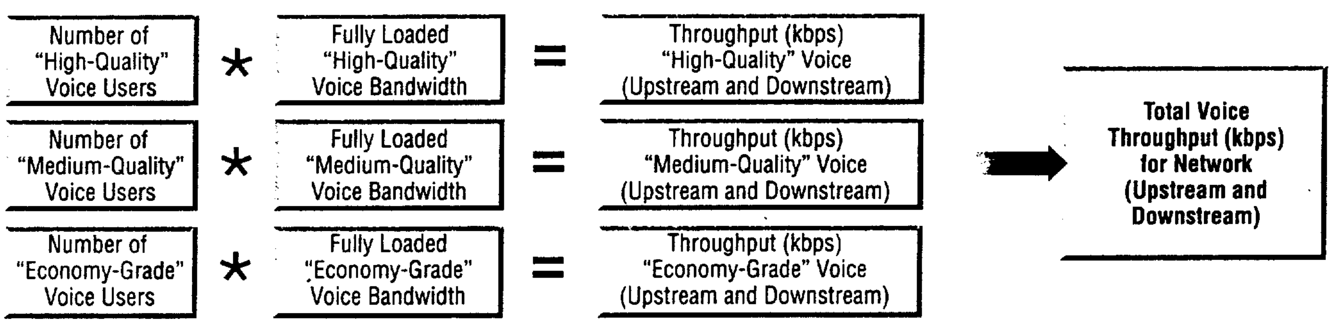
- For voice services: The calculations are more complex—there are several quality levels (as specified by the different voice codecs) to be considered as well as the number of overhead bits that are consumed to ensure adequate QoS for the transmission. Overhead can change, based on a number of criteria, such as the ability to compress protocol overhead, the degree of robustness of forward error correction, the minimum acceptable timeframe to ensure high-quality sound, and numerous other variables. Table 3 summarizes typical throughput requirements for individual voice calls at different quality levels.

Table 3 Voice Throughput

Voice Codec	Quality Level	Base-Level Bandwidth (kbps)	Approximate Fully Loaded Bandwidth (kbps)
G.711	Toll/High	64	90
G.728	Medium	16	40
G.729	Economy	8	25

Operators new to this market may find it difficult to establish these inputs, but can take advantage of industry statistics available from Cisco and outside sources such as the Federal Communications Commission (FCC). These statistics are included in the model. *Market penetration times peak subscriber usage at each voice service level equals peak bandwidth requirement on the network (Figure 9).*

Figure 9 Voice Bandwidth Requirement



Bandwidth Supply

RF Throughput Capacity

Once bandwidth demand has been established, operators need to analyze issues related to the transmission medium that will be used to deliver services to the customer. Plant cleanliness typically drives the amount of bandwidth that can be delivered through a single channel of RF spectrum (an upstream channel of RF spectrum is normally 1.2 MHz, while a downstream channel occupies 6 MHz of RF spectrum). These plant cleanliness assumptions help establish two key network properties:

- *Maximum number of nodes per port*—This parameter describes the number of nodes that can be combined into a single upstream port on a line card. Typical combination ranges are from three to nine nodes per port, depending upon the relative noise levels in the plant. For example, exceptionally clean plants have lower ingress and can support more nodes combined into each upstream port.
- *Bandwidth capabilities*—The operator must consider the upstream and downstream bit rates required for the planned services. The DOCSIS specification states the typical bit rates that can be used for this step of the analysis. Normally, operators are able to modulate at Quadrature Phase-Shift Keying (QPSK) in the upstream, achieving a throughput of 2.5 Mbps. In the downstream, operators are able to modulate at 64 or 256 Quadrature Amplitude Modulation (QAM), achieving a throughput of 30 to 40 Mbps.

With bandwidth demand established and bandwidth supply defined, the Cisco Network Analysis tool uses equipment capability information and user-defined pricing to determine how much equipment needs to be purchased and how much it costs.

Understanding Revenue

With knowledge of the capital expenditure requirements of the network, the next step is to explore the revenue opportunities available to the operator. The goal of revenue analysis is to determine the cost to the subscriber for each service as well as any expected ancillary revenues. To accurately estimate the pricing, each operator must decide between offering a service for a flat per-month rate or pricing the service to vary depending on actual usage.

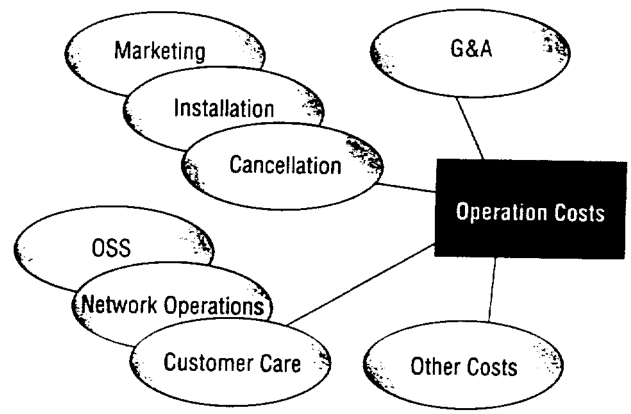
Flat rates are simpler to administer, more easily understood by the customer, and require a smaller investment in OSS/BSS systems. Unfortunately, they do not allow the operator to charge more to users that impose greater loads on the network. Metered billing approaches more accurately correlate to the operator's incurred costs, but tend to result in higher operations costs, systems expense, and lower customer satisfaction since bills can vary significantly from month to month.

Since market penetration and usage were already considered as part of the analysis to determine capital expenditures, we have enough information, given additional pricing assumptions, to calculate total revenue independent of the billing approach chosen by the MSO. Ancillary revenues can be determined through a similar approach.

Outlining Operating Expenses

The final key step in performing an economic analysis is to estimate operations costs. Although this information is difficult to obtain, a thorough assessment of operations costs is important to obtaining an accurate financial profile. If this information is not readily available, the Cisco analysis team can provide guidance based on market data and real-world deployments in which it has been actively involved. Although details of specific installations cannot be disclosed, Cisco can provide guidelines that are representative of industry averages.

Figure 10 Activity-Based Costing for Operating Expenses



By analyzing many customer scenarios, Cisco has found that activity-based costing (ABC) is the most accurate and flexible method for detailing operating expenses. ABC provides a more effective and thorough cost analysis for the operator because it organizes the cost structure into individual activities, allowing costs to scale as the operating parameters (market penetration, pricing scheme, network infrastructure, operating efficiency, and so on) change (Figure 10). Under the Cisco ABC approach, costs are divided into the following categories:

- *Customer acquisitions*—The costs for expanding the customer base include various activities such as direct mail campaigns, outbound telemarketing, mall tours, kiosks, infomercials, sales lead qualifications, direct sales calls, and—for commercial two-way services—customers' site surveys.
- *Installations*—For each new subscriber, the cable operator incurs the costs of coordinating an appointment at the customer site, provisioning, the truck roll, and the plant build-out (for approximately one-third of all business customers, the operator must run wire from the curb to the actual installation site).
- *Customer service*—Any reported customer problem results in the costs of a phone call and the time and resources required to resolve the problem and, if necessary, the costs of escalating the problem to an engineer or to a site visit by a senior engineer.

- *Cancellations*—For any subscriber cancellations, the operator costs include the notification process (taking the customer's phone call), deprovisioning, and the truck roll (if the operator needs to retrieve the CPE).
- *Other fixed costs*—Operators also incur the costs associated with a network operations center (support and maintenance of the infrastructure), executive overhead, and general and administrative (G&A) expenses.

Running the Model

Once the revenue, capital expenditure, and operating expense information has been collected, the relevant data is considered in the network analysis tool to deliver an economic profile and run a number of "what-if" scenarios.

The following sections provide an economic overview and answer many basic questions:

- What happens if usage patterns change?
- What is the cost of adding services?
- What are the effects of varying bandwidth requirements?
- What are the financial implications of operations costs and marketing costs for an operator?

This section explains the basic assumptions about a base case or a typical scenario for a cable operator in today's market. Some guidelines for the analysis process are also reviewed.

Base-Case Assumptions

Demand-Side Assumptions

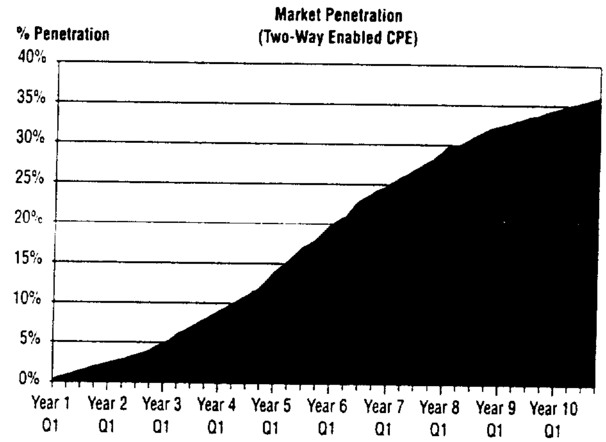
The base case includes the *network topology* parameters for a typical network rollout in the case of a mid-tier MSO. It is assumed that the topology spans 10 systems of various sizes (Table 4): two systems each with 400,000; 200,000; 100,000; 50,000; and 25,000 homes passed, for a total of 1.55 million homes. By blending five different system sizes, the base case represents an average cable network and gives the model the ability to accurately depict the network connectivity and aggregation properties of the equipment in locations with varying sizes, and explore the impact of plant density.

Table 4 Network Topology

	Large	Medium Large	Medium	Small/ Medium	Small
No. of Headends (per city)	1	1	1	1	1
No. of Hubs (per headend)	1	1	1	1	1
No. of Nodes (per hub)	400	200	100	50	25
No. of Individual Homes (per node)	1000	1000	1000	1000	1000
Individual Homes (per city)	400,000	200,000	100,000	50,000	25,000

It is challenging to quantify *market penetration* since it is a function of several variables. Market penetration ultimately depends on a host of different factors such as product awareness, price, perceived quality, purchase timing, competitive pressures, installation or cancellation barriers, and customer switching preferences. Historical data is used to build a reliable starting point, and then statistical methodology can be used to forecast future growth rates. Figure 11 illustrates the market penetration profile that is assumed for two-way-enabled CPE. Appendix A.1 gives further details regarding these assumptions for market penetration.

Figure 11 Market Penetration



The base case assumes that two services are offered: residential high-speed data (Internet access) and voice services (cable telephony). It is assumed that the data service will provide up to 512 kbps of downstream throughput and 256 kbps of upstream throughput, on a "best-effort" basis. Telephony service includes both local and long-distance service, with a peak usage of 0.25 Erlangs per household, or 0.16 Erlangs across 1.5 lines per household. In other words, we expect 25 percent of households to be on the telephone during peak hours.

Supply-Side Assumptions

Regarding plant geography, the base case assumes that telephone calls will be uniformly distributed throughout the calling area. The probability that the call will terminate in the network of the MSO is equal to the likelihood that the call will terminate within the MSO geographic footprint times the likelihood that the user will answer the phone and subscribe to the service of the MSO. For example, assuming that local geographic coverage is 60 percent and that the voice penetration rate is 10 percent, then the likelihood of a call terminating in the geographic footprint of the MSO is equal to 10 percent * 60 percent = 6 percent. Transport efficiency is assumed to be 90 percent for both upstream and downstream transmission.

Economics

We have included assumptions for equipment pricing based on observations of price trends in the industry. Refer to Appendix A.2 for more specific pricing information on network equipment. From data that was collected from several MSOs, the base case also assumes that installation will be 15 percent of equipment cost, with a monthly maintenance cost of one percent of the equipment cost.

The base case assumes typical market values for long-distance rates and local calling charges. In addition, termination charges (as well as revenue from termination) are included in the analysis. Note that with 50 percent of the calls originating from each voice subscriber and 50 percent of the calls terminating to that voice subscriber, the net impact of these charges is zero dollars.

The base case assumes a flat monthly fee and advertising/transaction revenue to be generated for high-speed data service.

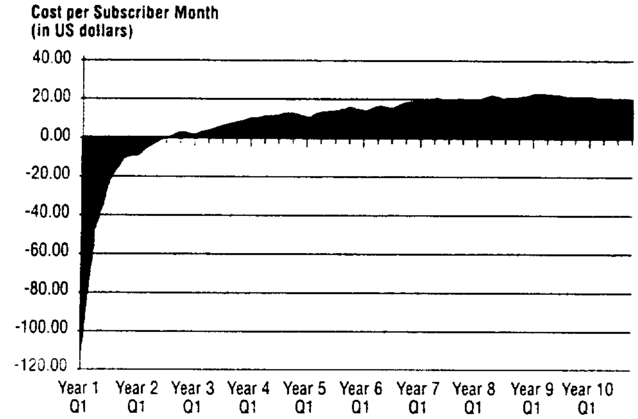
Again, detailed assumptions regarding revenue for the product services are listed in Appendix A.3. In summary, initial revenue is approximately US $22.50 for voice and US $40 for data services. Various assumptions are made to derive base-case operational costs. Refer to Appendix A.4 for a list of the assumed operations costs.

Analysis of the Outputs

Profitability and Cash Flow

In the base-case scenario, two-way services show an operating profit fairly quickly—typically in fewer than four quarters. Figure 12 illustrates that an MSO incurs an initial net loss of $105 per subscriber per month, but net income breaks even by the end of year two. In year five, the network is generating a fairly steady profit level of approximately US $10 to US $15 per subscriber per month.

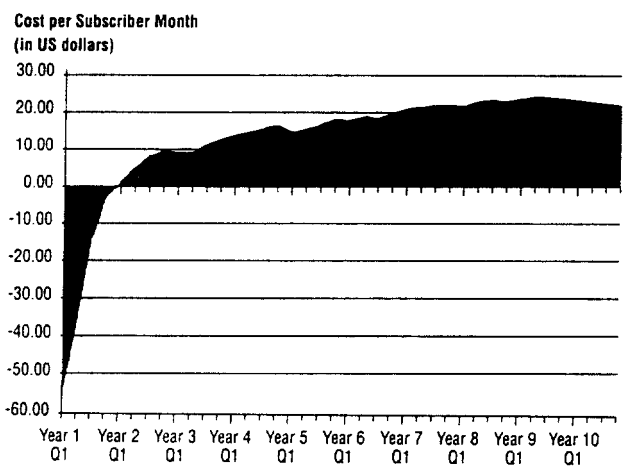
Figure 12 Net Income



The net present value (NPV) of the net income stream for the base-case scenario is approximately US $296 million. Any additional equipment required to support higher penetration levels when the network is not operating at its economically efficient state contributes to the bumpiness shown in the profitability profile.

Compared to traditional cable offerings, two-way services can add significantly to cash flow. As reflected in Figure 13, operating cash flow is negative US $55 per subscriber per month, but then starts turning positive by the end of year one, and finally approaches a level of US $15 per subscriber each month by year five. The NPV of the operating cash flow for the base-case scenario is approximately US $264 million.

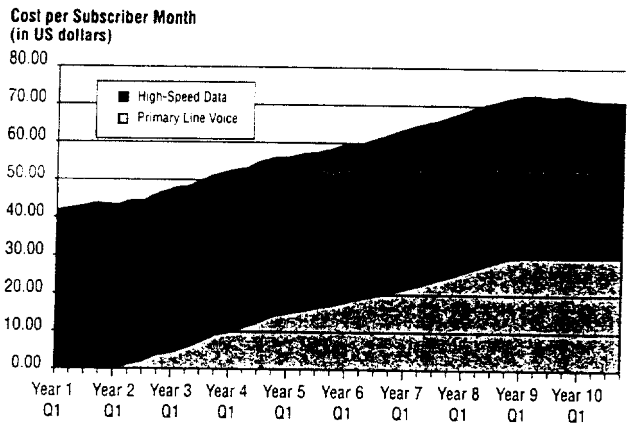
Figure 13 Operating Cash Flow



Revenue and Profit Breakdown

Because voice services rollout is assumed to occur in year two, high-speed data will account for most of the revenue (Figure 14). Eventually, voice will become a significant contributor to revenue.

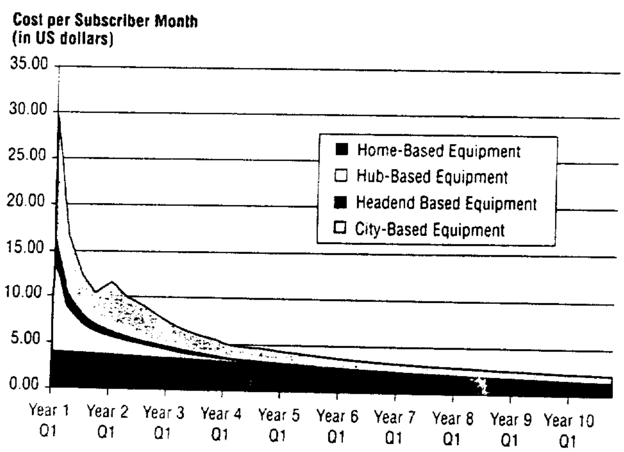
Figure 14 Revenue Breakdown



Cost Breakdown

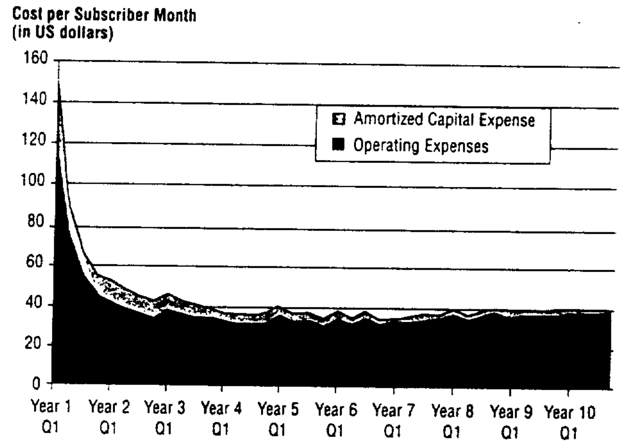
Some valuable insights into the base-case scenario can be obtained from a cost analysis. As illustrated in Figure 15, most of the capital equipment costs are concentrated around the CPE. The relatively high percentage of capital equipment costs concentrated around the hub and headend equipment (versus the CPE) in the early years illustrates the fact that the network has not reached an efficient utilization state. Once the user requirements have scaled the network to reasonable levels, the CPE costs dominate the capital expense profile.

Figure 15 Capital Expenditure



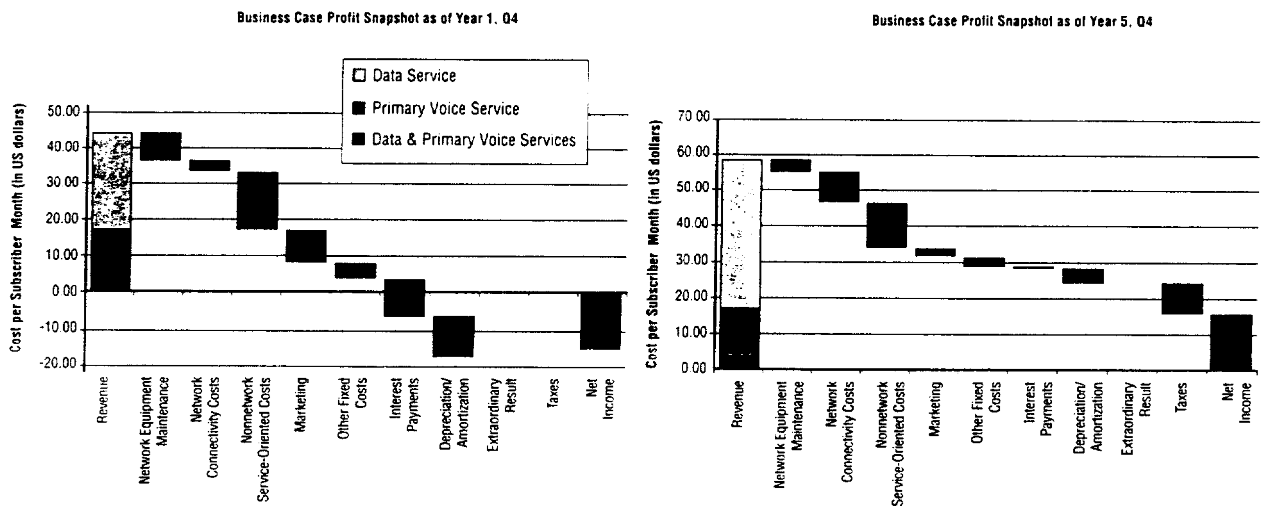
Capital costs are about US $30 per subscriber per month in year one and then moderate to US $4 per subscriber per month in year five. On the other hand, operations costs are US $113 per subscriber per month in year one, and then decline to US $30 per subscriber per month in year five. Once scale is achieved, capital costs are fairly small compared with operations costs (see Figure 16).

Figure 16 Cost per Subscriber per Month



Note that operating costs include various other costs such as installation and marketing. For the base-case scenario, customer care and Internet connectivity costs represent the bulk of the operations costs (Figure 17). While installation costs are high initially, they are not a factor for the ongoing cost picture. Marketing costs also come into play, with customer acquisition costs factoring into the overall cost breakdown. As expected, the marketing and acquisition costs become a less-prominent element in operations costs once the subscriber base matures, while customer care and Internet connectivity become the more important factors in operations costs over time.

Figure 17 Profit Snapshots



Operations costs contain elements that grow with the subscriber base, whereas equipment costs, with the exception of the CPE, tend to experience greater economies of scale. On an amortized basis, it is interesting to note that equipment costs comprise a small percentage of providing service. For example, once the data backbone is built, the incremental cost of adding a new subscriber is small. However, a customer call center needs to be staffed proportionately with the subscriber base, just as Internet connectivity costs scale proportionately with the subscriber base.

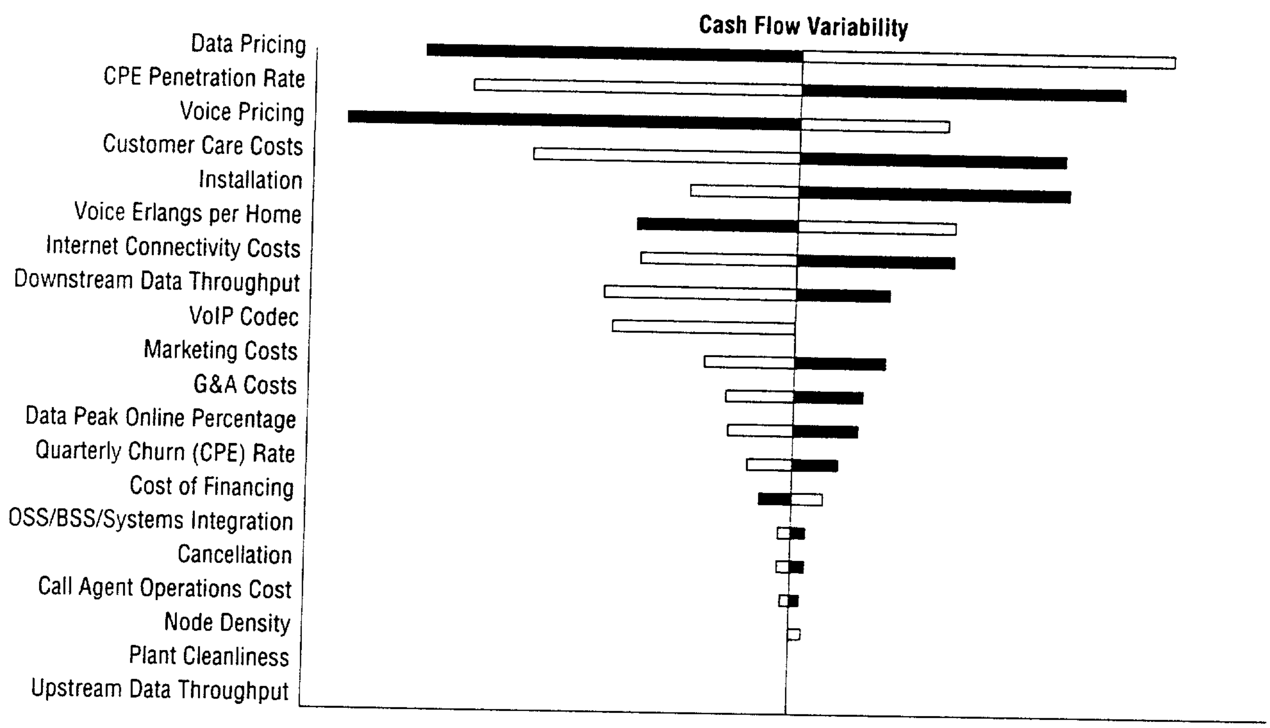
Cisco formulated the base case to clearly define a starting point for your analysis case. As you study a particular service or group of services, you will be changing parameters from the base case to more closely reflect your own unique business conditions and networks. Cisco has evaluated the variables to determine which changes to the base case result in a more significant impact to cash flow. For each variable evaluated, a reasonable range of values was tested, and the corresponding changes to the cash flow were compared to identify those factors that caused the biggest changes in cash flow over time.

The tornado diagram in Figure 18 ranks the importance of input variables in terms of their contribution to cash-flow sensitivity. The "funnel-like" shape of the tornado diagram is highly dependent on the ranges that are selected for the input factors tested. Reasonable ranges for the input factors that represent typical fluctuations based on our observations in the industry were selected. Table 5 illustrates the range of values that were used in running the sensitivity analysis as well as the resulting variation in the output.

Based on the sensitivity analysis, the following variables (listed in order of importance), as expected, significantly affect the output for the base case:

- Pricing for data and voice services
- Market penetration
- Internet connectivity
- Operations costs: customer care, marketing, and installation

Figure 18 Sensitivity Analysis for Generic Tops-Down Base Case



More detailed analyses exploring the marginal impacts (so-called "second-order" effects) between input variables in the sensitivity analysis were performed. The key to this analysis was determining how the variation of a less-sensitive factor affects the more-critical factors (the key swing variables) of the sensitivity analysis. For example, how marketing/customer acquisition cost, a less-sensitive variable, affected CPE market penetration, one of the most critical factors of the sensitivity analysis was studied. Table 5 summarizes the results from the analysis:

Table 5 Sensitivity Analysis Ranges of Inputs/Outputs

Sensitivity Parameters	Input Range			NPV Net Income (in thousands of US $)			NPV Cash Flow (in thousands of US $)		
	Low	Median	High	Low	Median	High	Low	Median	High
Plant Cleanliness	70%	90%	95%	$296,397	$296,426	$296,426	$264,173	$264,213	$264,213
Node Density	4	4	6	$296,426	$296,426	$297,517	$264,213	$264,213	$265,456
Cost of Financing	6%	10%	14%	$293,472	$296,426	$299,320	$261,260	$264,213	$267,107
Quarterly (CPE) Churn Rate	4%	5%	6%	$300,782	$296,426	$292,064	$268,441	$264,213	$259,980
Data Peak Online Percentage	10%	15%	20%	$302,422	$296,426	$290,183	$270,107	$264,213	$258,016
VoIP Codec	G.728	G.728	G.711	$296,426	$296,426	$279,217	$264,213	$264,213	$247,085
Voice Erlangs Per Home	0.20	0.25	0.30	$280,189	$296,426	$312,631	$249,090	$264,213	$279,256
Upstream Data Throughput	128 kbps	256 kbps	512 kbps	$296,426	$296,426	$296,399	$264,213	$264,213	$264,175
Downstream Data Throughput	256 kbps	512 kbps	1,024 kbps	$305,254	$296,426	$278,156	$272,886	$264,213	$246,130

Sensitivity Parameters	% Deviation From Base Case			NPV Net Income (in thousands of US $)			NPV Cash Flow (in thousands of US $)		
	Low	Median	High	Low	Median	High	Low	Median	High
Data Pricing	−10%	0%	+10%	$260,209	$296,426	$332,374	$228,938	$264,213	$299,220
CPE Penetration Rate	−10%	0%	+10%	$262,786	$296,426	$330,069	$233,607	$264,213	$294,768
Voice Pricing	−30%	0%	+10%	$252,635	$296,426	$311,020	$221,964	$264,213	$278,294
Internet Connectivity Costs	−50%	0%	+50%	$311,774	$296,426	$281,050	$278,949	$264,213	$249,449
OSS/BSS/Systems Integration	−20%	0%	+20%	$297,757	$296,426	$295,085	$265,522	$264,213	$262,896
Call Agent Operations Cost	−20%	0%	+20%	$297,309	$296,426	$295,537	$265,079	$264,213	$263,342
G&A Costs	−20%	0%	+20%	$302,774	$296,426	$290,064	$270,561	$264,213	$257,852
Cancellation Costs	−20%	0%	+20%	$297,754	$296,426	$295,097	$265,499	$264,213	$262,928
Customer Care Costs	−30%	0%	+30%	$322,288	$296,426	$270,504	$289,217	$264,213	$239,151
Installation Costs	−50%	0%	+20%	$322,462	$296,426	$285,945	$289,680	$264,213	$253,960
Marketing Costs	−30%	0%	+30%	$304,971	$296,426	$287,826	$272,615	$264,213	$255,758

To maintain cash flow NPV parity, an overall price decrease of 1 percent, can be mitigated by:

- 1.7 percent greater overall market penetration (voice and data services)
- 5.9 percent lower customer care costs
- 17.5 percent lower marketing costs

A 1 percent decline in prices for data services would require a 1.6 percent increase in data subscribers to be economically equivalent, while a 1 percent decline in voice service pricing would require a 2.0 percent increase in voice subscriptions.

Tables 6 and 7 show the economic effects of different levels of throughput provisioned. Table 6 shows, at different downstream data provisioning levels, the change in price or number of data subscribers that are required to be economically equivalent.

Table 6 Bandwidth Sensitivities for Data

Downstream Data Throughput Provisioned	Price Level Required*	Data Subscriptions Required[1]
2,048 kbps	115%	132%
1,024 kbps	105%	109%
512 kbps (base case)	100%	100%
256 kbps	98%	96%

1. Expressed as a percentage of the base-case, assuming no other variables are changed.

Table 7 shows, for voice services, the price levels or penetration that are required to support the various quality levels.

Table 7 Bandwidth Sensitivities for Voice

Voice Codec	Price Level Required	Voice Subscriptions Required*
G.711	112%	135%
G.723	106%	112%
G.728 (base case)	100%	100%
G.729	97%	95%

The value of a subscriber was estimated at US $1,075 based on our observation that the NPV of cash flows is zero if customer acquisition costs are increased to this level. This is a conservative estimate because:

- The NPV calculation does not include a terminal value. With a conservative terminal value assuming zero growth after year 10, the value of a customer increases to US $2,300.
- The base-case model assumes only two services—"basic" high-speed data and voice—and only residential customers. The value per residential customer increases significantly as other services and market segments (for example, small businesses) are factored into the calculation.

Finally, the effects of customer churn were studied. A one-percentage-point increase in churn (per quarter) requires a 1.4 percent higher market penetration to be equivalent. In other words, if 10 extra customers are expected to terminate during the quarter, 14 extra customers are needed at the beginning of the quarter to fully compensate for the costs of churn.

A one-percentage-point increase in churn also could be mitigated if:

- Marketing costs were 15 percent lower
- Installation costs were 8 percent lower
- Cancellation costs were 62 percent lower

A 5 percent reduction in costs across all three categories would have the same effect in mitigating churn.

These calculations merely are a sampling of the type of analysis that can be performed once the base-case assumptions are established. Cisco is ready to work with you to understand the key variables affecting your own business and how these variables interrelate.

Model Summary

Based on our findings, Cisco offers the following guidelines for deploying two-way services over HFC networks:

- *Consider strategies other than lowering price to achieve higher market penetration rates*—Because changes in pricing directly affect the bottom line, this is not an effective tool for increasing penetration. Using pricing as a differentiator encourages commoditization of the product. A value-added approach, including bundling of upsell services such as voice mail, preserves margins while offering the user an overall, cost-effective solution. Increasing market penetration is best achieved using alternative strategies that can provide higher return, such as increasing bandwidth or customer care budgets.
- *Bandwidth is cheap*—A key message from our analysis is that it may be very affordable to consider adding more data throughput to your system to increase market penetration before lowering prices of your services.
- *Marketing investments are worthwhile only to a point*—It is important to acquire the right customers because customers who have higher churn are unprofitable. This analysis suggests that additional marketing investments in new customers that are only marginally interested in the service (customers acquired beyond saturation) are unlikely to yield worthwhile returns.
- *Focus on improving operations costs*—Making strong investments from the start to streamline and improve operations might be justified since this expense is a significant, recurring charge throughout the life of the network. For example, call center or autoprovisioning systems should strongly be considered for long-term deployments.

Team Up with Cisco

Your local Cisco representatives are ready to share their expertise with you and help you more fully explore the tools and analyses presented in this paper. Whether you want to request and use one of the modeling tools on your own or have Cisco walk you through the process, please contact a Cisco representative in your area. Cisco can develop a customized solution for your specific goals and existing plant layouts. Involving Cisco in your decision-making process can save you time and significantly reduce your risks. To get started, visit www.cisco.com/go/analysis.

Appendix A.1 Demand Side: Market Penetration

- *Percentage of homes passed with IP-enabled CPE*—A market penetration profile was derived by blending the market penetration rates for cable data services from Paul Kagan and Forrester Research. Typically, initial market penetration is 2 percent at the end of year one, but this variable also depends on the maturity of the market. This assumption was made to model the base-case market penetration profile. It typically takes one to two years to ramp up service. Thereafter, market penetration increases about 1 to 2 percent per quarter, a level of growth that some MSOs have observed. In the future years, we extrapolated market penetration rates based on market research data Cisco obtained. Cisco believes the market penetration profile is valid because it resembles the S-shaped curve that is characteristic of the growth cycle that most services experience: 1) slow start; 2) ramp up; and, 3) finally, saturation.
- *Percent of IP-enabled homes subscribing to voice*—A market penetration profile with statistics presented by Forrester Research was used.
- *Churn for data*—An average churn for data of 14 percent per year, based on moving rates was assumed: typically, one of every seven persons tends to move or switch services per year—the best you can do without giving up a market segment.
- *Churn for voice*—Six percent per quarter for the base case was assumed. Various statistics from Paul Kagan for the smaller operators suggest a churn rate of 3 to 6 percent for cable telephony. It is natural to have rates for voice churn higher than data churn because voice is entering a market that is highly competitive.
- *Percent of households (HH) on phone during peak*—At most, 25 percent of phone customers are placing calls. This assumption helps determine the amount of equipment needed to provide service. A 25-percent estimate corresponds to 0.16 Erlangs across 1.5 lines per home, consistent with conservative industry standards.
- *Percent of subscribers at each quality level*—The model has used a mid-quality assumption in this case—between high-quality and economy-grade—representing the G.728 codec for voice.
- *Percent of calls considered long distance*—23 percent of all calls are projected to be long distance. This statistic has been consistent for the distribution of calls (long distance versus local) that we have derived from the recent statistical telephony trends published by the FCC.
- *Percent of calls considered outgoing*—We have assumed 50 percent because in a typical scenario; the average person receives as many calls as he/she makes (call centers or telemarketing are not accounted for in this statistic).
- *Percent of calls placed during peak hour*—Considering that 20 percent of phone calls are placed during peak hour, there is a high concentration of traffic during the peak hours. Cisco believes that one of every five calls placed during the peak hour is a conservative estimate, which was derived from using the 150 minutes of long distance per month usage statistic obtained from the FCC.
- *Product usage (for basic high-speed data)*—Peak throughput of 6 kbps per subscriber for basic high-speed data was assumed. This is a reasonable estimate based on sponsored field trials with partner MSOs.

Appendix A.2. Equipment Pricing

Equipment	List Price (US $)	Installation Cost (US $)	Initial Discount	Moore's Law Quarterly Discount Rate	Capitalization Years
CPE	$365	–	35%	4%	5
Node	–	–	0%	4%	3
MC-16 Modem Card	$30,250	$4538	30%	4%	3
Cisco uBR 72xx	$53,850	$8078	30%	4%	3
OC-3 Ring	–	–	0%	4%	3
GSR OC-3 Line Card	$33,000	$4950	30%	4%	3
GSR 12xxx	$64,950	$9743	30%	4%	3
OSS/Prov. Systems/Systems	$12,000,000	–	0%	4%	10
AS5300 Voice Gateway	$52,400	$7860	30%	4%	3
Call Agent	$10,000,000	–	0%	0%	8
Internet Connectivity (per DS-3)	–	–	0%	0%	1

Appendix A.3 Pricing and Revenues

Voice Penetration

- *Long distance pricing (per minute)*—Based on statistics from the International Telecommunication Union (ITU), long-distance pricing can range from US $0.05 to US $0.11 per minute. US $0.08 per minute was assumed for the base-case scenario as a reasonable value in between this range. Thereafter, long-distance pricing is expected to continue to decline gradually as a result of increased competition and improved efficiency of service providers.
- *Local calling pricing (flat rate)*—Recent telephony statistics from the FCC indicate that the basic local rate, including taxes, is US $19.52 per month. Excluding taxes and knowing that the average subscriber normally has 1.5 lines, it is assumed that initially, local calling service is about US $22.50 per month. Cisco projects that pricing for local calling services will taper off to US $9 by year 10 because of competition.
- *Long distance PSTN charges*—Long distance PSTN charges of US $0.04 per call were assumed consistent with recent statistics from the FCC.
- *Partner and local termination charges*—Termination charges of US $0.02 were assumed consistent with recent statistics from the FCC. It was also assumed that the termination charges occurring within the local footprint are the same for calls occurring in the partner footprint.

High-Speed Data Penetration

- *Basic Direct Revenues (flat pricing)*—The base case assumes this pricing schedule based on market research results from Paul Kagan and Associates ("Cable Industry Projections: 1997–2008," *The Cable TV Investor,* August 10, 1998). Pricing is assumed to start at US $40 per month during the first year, and then gradually decrease to US $25 per month at year 10 because of increased competition and saturation of service.

Other Assumptions

- *Indirect revenue (advertising)*—The base case assumes that advertising revenue for high-speed data services is increasing as the service rolls out. Advertising revenue starts at US $1.00 per subscriber per month during year 1 and then steadily ramps to US $6.50 per subscriber per month by year 10.
- *Indirect revenues (transaction costs)*—Along with increasing advertising costs, it was assumed that transaction costs for high-speed data services will be increasing as the service adoption rates increase. Transaction costs start at US $1 per subscriber per month and then steadily increase to US $9 per subscriber per month.

Appendix A.4 Operations Costs

Customer Care

Customer care is assumed to cost US $2.03 per month for each subscriber, plus US $2.75 per month for each data subscriber, and US $4.06 per month for each voice subscriber. This cost structure reflects the fact that voice customers typically place more customer service calls than data customers.

Installation

Installation entails a US $100 basic fee, plus a US $15 fee for each additional service. The basic fee represents the cost of a truck roll to come out and provision the home for service; the US $15 represents the cost to coordinate the service. For example, installation costs for a data-only subscriber would be US $115. Installation costs for both voice and data would be US $130.

Cancellation

Cancelling a service will typically cost US $10 per CPE, plus an estimated US $18.27 for each service. For example, cancelling voice services would cost US $28.27, while cancelling voice plus data services would cost US $46.54.

Billing

Direct billing costs are assumed to be US $0.75 per subscriber per month. Note that this does not include the BSS—the IS system to generate bills—since this charge is already included in the equipment costs.

Bad Debt

Bad debt is assumed to be 2 percent of revenue (accepted as typical in the industry).

Customer Acquisition Costs

Customer acquisition costs entail a US $60 basic cost and an additional US $32 for each service. For data, the customer acquisition costs would be US $92; for data and voice, the costs would be US $124.

General and Administrative Expenses (G&A)

Based on the experience of Cisco with several MSOs, the base case conservatively assumes a US $8.00 cost per subscriber in G&A.