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May 1, 2000

Ms. Magalie Roman Salas
Secretary, Federal Communications Commission
445 12th Street, SW
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Washington, D.C. 20554

Re: Applications of America Online, Inc., and Time Warner Inc. for Transfers of Control (CS Docket No. 00-30)

This letter and its attachments (summary of comments and paper) is submitted on behalf of a group of students from MIT and Harvard University who carried out research on the issue of Open Access as part of a final project for the Harvard/MIT/Tufts University class – "Internet Commerce and the Information Economy." This course was jointly taught by Professors Lee McKnight of the Fletcher School of Law and Diplomacy at Tufts University, and Jean Camp of the Kennedy School of Government at Harvard University.

We have greatly appreciated their advice and guidance during the course of our research, but would like to make it clear that the views expressed are our own and not necessarily those of our faculty advisers, MIT, Tufts University, Harvard University, or the ITC.

Regards,

Emy Tseng (MIT)
Kamal Latham (Harvard)
Chen Hao (MIT)
Armand Ciccarelli (MIT)

Summary of Comments concerning the applications of America Online, Inc., and Time Warner Inc. for Transfers of Control (CS Docket No. 00-30)

Advocates of open access to broadband are calling upon cable service providers to open the cable platform to multiple Internet Service. Our research examined the capital costs of two possible technical implementations for upgrading existing cable modem architectures in order to support an open access cable environment:

- Point to Point Protocol over Ethernet (PPPoE), and
- Layer 2 Tunneling Protocol (L2TP).

Results of Research

- Our research indicates that open access deployment within a cable infrastructure is technically feasible using products currently offered by multiple major vendors.
- Moreover, we found that the incremental capital cost (per homes passed) of upgrading to an open access system by the end of the year 2000 would only cost $1.54 for a bridged network (PPPoE) and $9.99 for a routed network (L2TP). The total cost over 5 years (2000E-2004E) is estimated to be $3.89 for a bridged network and $25.20 for a routed network.

Conclusions

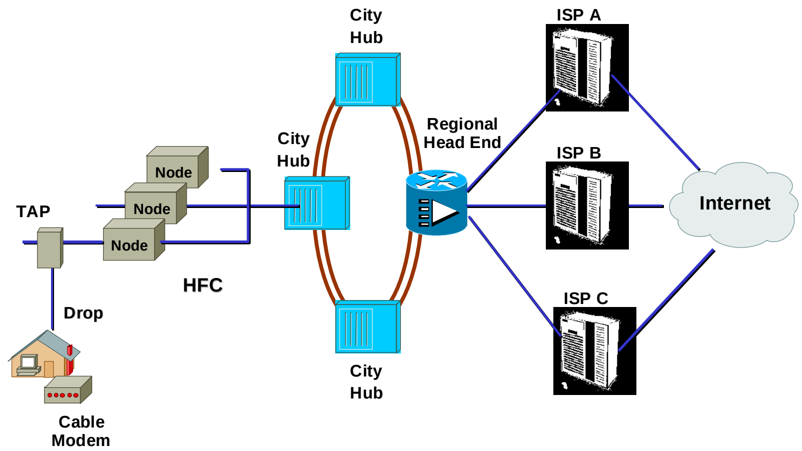
A significant portion of the policy debate focuses on the issue of competitiveness and monopoly, and whether or not open access will stifle future investment in broadband infrastructure. As our analysis is of technical/cost metrics rather than economic in nature, we have nothing additional to add to this aspect of the debate. Rather, as alluded to previously, our analysis has led us to conclude the following:

1. Open Access cable architectures can be implemented without the prohibitive costs or technical barriers that some opponents have claimed make it unfeasible. Moreover, we believe that open access over cable would be beneficial for everyone involved. Not only would it offer consumers a larger number of alternatives in selecting an ISP, but it would also make the cable network architecture more competitive with broadband over DSL, which is currently regulated to operate under the principle of open access.
2. As a condition of the merger, AOL/Time Warner should commit to implementing open access. As our results demonstrate, open access is cost effective and technically feasible. It should lead to

more competition in the market for broadband delivery over cable and result in better quality of service and lower costs for consumers.

3. The FCC should consider re-examining the issue of whether cable service providers should be required by law or administrative action to provide open access over their cable networks, as has already occurred with DSL.
4. Great care must be taken in crafting regulation to insure that such a requirement does not result in a hodgepodge of state regulations for pricing broadband access over cable, as previously occurred with TELRIC pricing. Excessive regulation will yield inefficiency in a market governed by Internet economics. Free market principles must guide the formation of public policy concerning open access over cable, however, a complete laissez-faire approach might unnecessarily allow market failure to occur.

Open Access Cable Network:



Technical Feasibility and Capital Cost

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May 8, 2000

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Section 1. Introduction

Advocates of open access are calling upon cable service providers to open the cable platform to multiple Internet Service Providers (ISPs), in order to allow these ISPs to access the "last mile" of the cable network. For our purposes, the last mile is defined as the segment of the cable network between the home and the cable network head end. Currently, broadband subscribers over cable can only utilize the ISP that has an exclusive contract with the cable service provider. Implementation of an open access cable platform would allow subscribers to access the ISP of their choice

This paper presents two possible technical implementations for an open access cable network:

- Point to Point Protocol over Ethernet (PPPoE), and
- Layer 2 Tunneling Protocol (L2TP).

Furthermore, the paper presents an analysis of the incremental capital costs (incurred by a cable company) associated with upgrading the existing cable modem network architecture to support open access.

The debate concerning open access over cable is multi-faceted in nature. It has economic, technical and financial dimensions. Many groups involved in the debate have focused on the economic side of the issue, specifically whether or not issues of monopoly power exist that require government intervention. Due to the plethora of research on the economic considerations of open access, we have opted not to treat it in our analysis. We felt that value could be added to the overall debate by carefully examining the feasibility of implementing open access, both from a technical and capital cost perspective.

Based on our analysis, we have made a few conclusions regarding open access and recommend a course of action the FCC should take concerning regulation of this architecture. A limitation of this report is that it does not examine all possible architectures enabling open access. Furthermore, it does not examine the operational costs and potential capital financing requirements of deploying an open access system. As pertaining to the latter, we have made an effort to indicate the variables that would have to be taken into consideration in order for a full accounting of the total financial cost of upgrading to open access to be done.

Section 2. U.S. Public Policy Debate

Section 2.1. Open Access

A significant part of the open access debate has focused on the dominant positions that a small number of companies have been able to acquire in the Broadband over cable market. AT&T's acquisition of both TCI and MediaOne, (and the AOL/Time-Warner merger if it is approved) would provide them with control over a significant portion of the existing broadband over cable network in the United States. Although both AT&T and AOL/Time-Warner have recently stated that they are "in principle" willing to permit unaffiliated ISPs to utilize their cable networks, the time frame for when this will actually occur remains unclear. Moreover, some proponents of open access fear that even when these lines are finally opened up for use by independent ISPs, such access will be provided at a higher cost and/or with inferior service than that provided to those ISPs already affiliated with the cable service provider.

This leads to a number of questions regarding the provision of Broadband Internet Access over cable, including: 1) How can the government, specifically the FCC guarantee fair competition in this area if only a small number of companies control most of the access? and 2) How can we ensure that cable service providers set a price for access to their networks that will allow independent ISPs to remain competitive, while still encouraging these network providers to invest in the upkeep and expansion of their architectures?

Section 2.2. The FCC

Throughout the course of this debate, the FCC has maintained that it is the marketplace, not the government that should ultimately decide how the open access issue is resolved. They believe that the competition from other Broadband technologies such as DSL and wireless will in and of itself create the competition necessary to drive cable providers to open their networks, at a reasonable cost, to independent ISPs. Still, despite coming out time and again in favor of open access without regulation, FCC Chairman William Kennard recently stated that open access is what consumers want and that he "wants to be able to point to lots of activity in the marketplace driving toward a marketplace solution."[1] As explained by Chairman Kennard, such "activity" should be composed of "open protocols, open boundaries, and open pricing," which create market-based solutions for the provision of Broadband over cable to all Americans (including those with disabilities and lower incomes).[2]

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[1] From address of Chairman of FCC William Kennard at the WESTERN SHOW, California Cable Television Association, December 16, 1999.

[2] From address of Chairman of FCC William Kennard at the WESTERN SHOW, California Cable Television Association, December 16, 1999.

Section 2.3. Pro-Open Access Groups

While the FCC continues to maintain its open access without regulation position, numerous municipalities and interest groups have indicated that due to the risk of market failure, some form of regulation is needed to insure that fair competition plays out in this arena. These advocates of open access via regulation claim that the growth of the Internet has occurred primarily due to competition in price, service, and content, all of which resulted from open access to the "last mile" of the telephone companies' networks. They argue that without open access to Broadband over cable, competition will fall and that cable service providers and those ISPs having exclusive contracts with them will fail to innovate, thereby injuring consumers.[3]

Both AT&T and Time Warner/AOL have agreed, at least in principle, to provide open access on their Broadband cable networks to non-affiliated ISPs. Even so, some pro open access groups have stated that though these agreements sound good, there remain a number of questions that the "investment community, the Federal Communications Commission and others must ask in order to ensure that this is a real step forward." Finally, supporters of open access have argued that the two year head start provided to AT&T and @Home under their MOUs gives them an unfair competitive advantage. They believe that by the time AT&T implements open access in 2002, many independent ISPs are likely to have already gone bankrupt.

Section 2.4. The Cable Industry: A Traditional Opponent to Open Access

The cable industry has traditionally claimed that it was "not technically feasible for cable operators to unbundle their networks and allow multiple ISPs to provide their own independent data services to subscribers over cable facilities" and that the cost of providing such service was prohibitively expensive. Recently, a major cable provider (Time Warner) has come to accept open access "in principle."[4] They claim that open access is their ultimate goal, but as stated by FCC Chairman Kennard, it should occur as dictated by the marketplace rather than via government regulation. They argue that over-regulation of the industry is likely to stifle future investment in the cable backbone, as well as other Broadband networks (i.e. Wireless).

The cable industry asserts that the Broadband Internet market should be viewed as being composed of both cable and DSL, and that while cable access to broadband currently maintains a greater market share, projected increases in the number of DSL subscribers makes this a competitive market rather than a monopoly. They argue that due to expected market pressures, they will be compelled to increase service levels and decrease prices whether or not they are regulated to do so.

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[3] openNet coalition – "AT&T'S ACQUISITION OFMEDIAONE,OPEN ACCESS,AND THE PUBLIC INTEREST," CS Docket No. 99-251, September 17, 1999, Pg 23.

[4] The Internet Freedom Act and The Internet Growth and Development Act of 1999, Hearings on H.R. 1685 and H.R. 1686 Before the House Comm. on the Judiciary, June 30, 1999 (Statement of Tim Boggs, Senior Vice President for Public Policy at Time Warner, Inc.)

Section 2.5. Current Status of the Policy Debate

There are two areas in which policy decisions concerning open access are currently being made that could have a profound impact on the future of the open access debate. These areas are:

- The Ninth Circuit Court of Appeals – AT&T vs. The City of Portland
- Congressional discussion of potential legislation

City of Portland vs. AT&T and the Ninth Circuit Court of Appeals

Although the open access debate has been around for some time, the real fireworks did not begin until the City of Portland, and surrounding Multonomah County (Oregon) passed, in response to the proposed AT&T-TCI merger, an ordinance requiring that the franchise "Transferee" (AT&T) provide "non-discriminatory access to Franchisees' (TCI's) cable modem platform for providers of Internet and on-line services, whether or not such providers are affiliated with AT&T or TCI.[5] AT&T refused to provide such service, and in response, during January 1999, the City/County denied AT&T's franchise transfer application. AT&T subsequently brought a federal lawsuit against the City/County, and in June 1999 a federal district judge found for the City/County. AT&T appealed the decision to the Ninth Circuit Court of Appeals (which heard the case in November of 1999) and a decision is pending. AT&T's primary argument in this case is that the imposition of an open access requirement by the local franchising authorities is "contrary to various provisions found in the "Cable Communications" title of the Communications Act. "The FCC has intervened in this suit on behalf of AT&T, arguing that localities are pre-empted by federal statute from requiring open access."[6] (see notes from Amicus Curiae brief below)

Notes from FCC Amicus Curiae Brief submitted to the Ninth District Court of Appeals

The FCC's brief to the court states that:

- "The FCC is the only agency with jurisdiction over all of the current providers of broadband technology -- cable operators, wireline telephone companies, providers of wireless telecommunications service, and satellite communications firms. Local franchising authorities, in contrast, are in no position to implement technologically-neutral policies with respect to all these competitors."[7]

- The FCC has not yet had the opportunity to decide whether cable modem service is a "cable service," within the meaning of the Communications Act, or an "advanced telecommunications service," within the meaning of the 1996 Telecommunications Act. According to the FCC, defining cable modem service as an

[5] AMICUS CURIAE BRIEF OF THE FEDERAL COMMUNICATIONS COMMISSION – from AT&T v. City of Portland. Case No. CV99-65PA, pg.16.
[6] Sanford C. Bernstein & Co., Inc. and McKinsey & Company, Inc., "Broadband!", January 2000, pg 65.
[7] AMICUS CURIAE BRIEF OF THE FEDERAL COMMUNICATIONS COMMISSION – from AT&T v. City of Portland. Case No. CV99-65PA, pg. 29.

"advanced telecommunications service" would enable them to "develop a coherent regulatory policy that took into account the full range of broadband service providers, including cable systems."[8] Furthermore, local authorities would have no opportunity to regulate these services because they have no regulatory authority over broadband service providers other than cable systems.

- Even in the absence of "express statutory preemption, the FCC may preempt local cable regulations that conflict with federal policy, so long as the Commission acts within the scope of its congressionally delegated authority. So even if Internet Access via cable is properly characterized as a "cable service" under the Communications act, the FCC would have authority to preempt local regulation of that service to the extent such regulation conflicted with a permissible federal policy."[9] In this case, the permissible federal policy being that the FCC has "acted affirmatively" by "declining to impose regulation on the developing, nascent broadband market."[10]

<u>Federal Legislation</u>

There are currently several bills under consideration by Congress that could affect the future provision of broadband Internet access. These include:

- **Bill HR 1685, Internet Growth and Development Act (Boucher-Goodlatte)**, and **Bill HR 1686, Internet Freedom Act (Goodlatte-Boucher)** – with regard to the provision of open access via unbundled cable networks, these bills are designed to force broadband Internet providers, (both ILECs with DSL loops and cable companies) to unbundle their networks.

- **Bill HR 2420, Internet Freedom and Broadband Deployment Act (Tauzin-Dingell) -** This bill would amend the Telecomm Act of 1996 to provide that the FCC shall not require an ILEC to "provide unbundled access to any network elements used in the provision of any high speed data service ... or offer for resale at wholesale rates any high speed data service." However, it contains provisions that its backers claim will insure that customers have access to their choice of ISP.

- **Bill HR 2637, Consumer and Community Choice in Access Act (Blumenauer) -** an open access cable bill that would require providers of broadband Internet providers via cable to provide open access to

[8] AMICUS CURIAE BRIEF OF THE FEDERAL COMMUNICATIONS COMMISSION – from AT&T v. City of Portland. Case No. CV99-65PA, pg. 25.
[9] AMICUS CURIAE BRIEF OF THE FEDERAL COMMUNICATIONS COMMISSION – from AT&T v. City of Portland. Case No. CV99-65PA, pg. 27.
[10] AMICUS CURIAE BRIEF OF THE FEDERAL COMMUNICATIONS COMMISSION – from AT&T v. City of Portland. Case No. CV99-65PA, pg. 29..

competing ISPs. It states that the FCC "may require cable operators that provide interconnection, using cable system facilities, with the Internet to offer such interconnection on terms and conditions that are fair, reasonable, and nondiscriminatory."

Section 2.6. Recent Activity

- On February 18th, 2000 the FCC denied a petition by Internet Ventures Inc., requesting that the agency provide ISPs unaffiliated with cable service providers the right to lease access to the cable network. In their decision, the FCC's five commissioners unanimously ruled that the services provided by ISPs such as Internet Ventures fail to constitute programming as defined by applicable regulations. Moreover, an FCC spokeswoman said Internet Ventures had already reached agreements with a number of cable companies to lease their networks and that the FCC encourages them to continue pursuing such solutions. In response to the FCC's decision, Don Janke, President of Internet Ventures, stated that "there's open access, there's leased access and now there will be NO access. The FCC's regulation today will deprive thousands of ISPs and their subscribers of the benefits of the broadband revolution."[11]

- While its court case with AT&T is under review by the Ninth Circuit Court of Appeals, the city of Portland has sought alternative means for providing its residents with Broadband Internet access over cable. In mid-March, its cable regulatory commission held a public meeting with four companies interested in constructing an “overbuild” Broadband Cable Network for Portland that would provide subscribers with access to the ISP of their choice.

[11] Kathy Chen, "FCC Ruling Deals Blow to ISPs Wanting 'Open Access' Cable," Wall Street Journal, February 22, 2000.

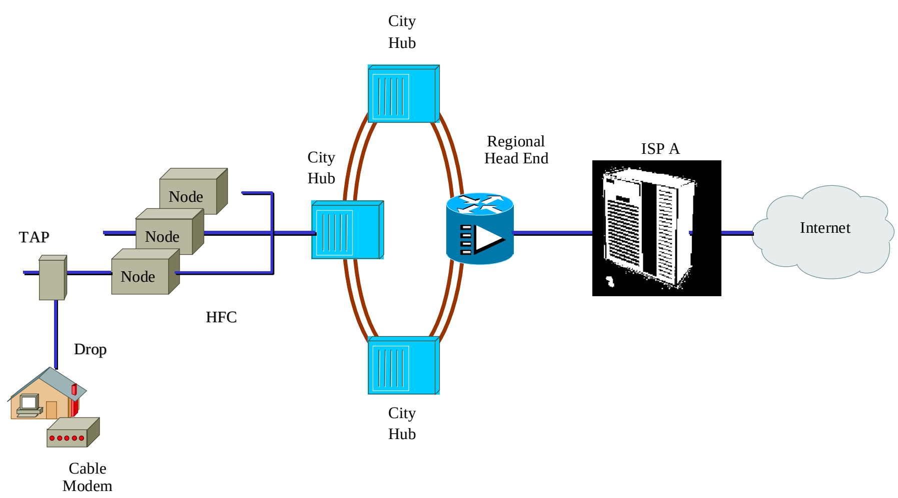
Section 3. Open Access Cable Network Architectures

Section 3.1. Hybrid Fiber-Coax Cable Network

In order to enable two-way high-speed data transmission, the cable operator must upgrade the existing cable TV network to hybrid fiber-coax (HFC). As the name implies, a HFC network is comprised of coaxial and fiber-optic cable; fiber-optic lines extending to the neighborhood and coaxial cable extending to the home. The cable modem network also includes a connection to the Internet, routers, servers, network management tools, security and billing systems.

The cable modem network is a shared network in that the upstream and downstream bandwidth is shared by all the homes connected to a cable network segment. One television channel of 6 MHz in the spectrum range of 50-750 MHz is usually allocated for downstream data traffic. The downstream capacity is typically 0.5-1 Mbps with a maximum downstream capacity of 27 Mbps. Another channel in the 5-42 MHz band is allocated to carry upstream signals. The upstream capacity is typically 256-500 Kbps with a maximum upstream capacity of 10 Mbps, depending on the amount of spectrum allocated for service. The cable network lends itself to fast bursts of data. Figure 3.1 below shows the architecture of a typical closed access cable network[12].

FIGURE 3.1: HFC CABLE MODEM NETWORK



The cable modem network is composed of the following components:

- **Home.** The home contains a cable modem that connects to a personal computer (PC). The cable network may require special client software to be installed on the PC. The homes are connected to the neighborhood node through the coaxial cable network, forming a shared Ethernet network.

- **Neighborhood Node**. The neighborhood node (also known as fiber node) typically serves 500-1,000 homes passed, with 50-500 cable modem subscribers[13]. It connects the network's fiber-optic lines to the coaxial network. It contains equipment that converts and transfers the signal from fiber-optic lines to electrical signals carried through coaxial cable to the home. Neighborhood nodes are connected to the city hub over fiber-optic lines.

- **City Hub.** The city hub (also known as the local head end) serves anywhere from 20,000-100,000 homes[14]. It contains a cable modem termination system (CMTS) which connects to the cable modems in subscriber homes to create a virtual local area network (LAN) connection. The CMTS modulates and demodulates data and multiplexes the return data traffic. The city hub also contains routers or bridges to direct data traffic. The city hub may also contain network and address management equipment and content servers. However, these are usually located in the regional head end for large systems. The city hubs are connected to the regional head end through a metropolitan fiber ring.

- **Regional Head End.** There is typically one regional head end per major market and it serves anywhere from 150,000 to 1,000,000 homes[15]. The regional head end provides the point of connection to the Internet through the ISP. It feeds data and video signals to the city hubs through the metropolitan fiber ring to the city hubs. The regional head end contains equipment that performs the following functions:
  - Receiving and transmitting video signals
  - Performing network and IP address management
  - Connecting and routing traffic to and from the Internet
  - Conducting billing and subscriber management
  - Caching content.

Section 3.2. Open Access Technology Options

In an open access cable network, the subscriber can access the Internet through the ISP of their choice. The designated ISP provides Internet connectivity and services such as email, DNS, etc. In order to support such a scenario, multiple ISPs connect to the regional head. See Figure 3.2 below.

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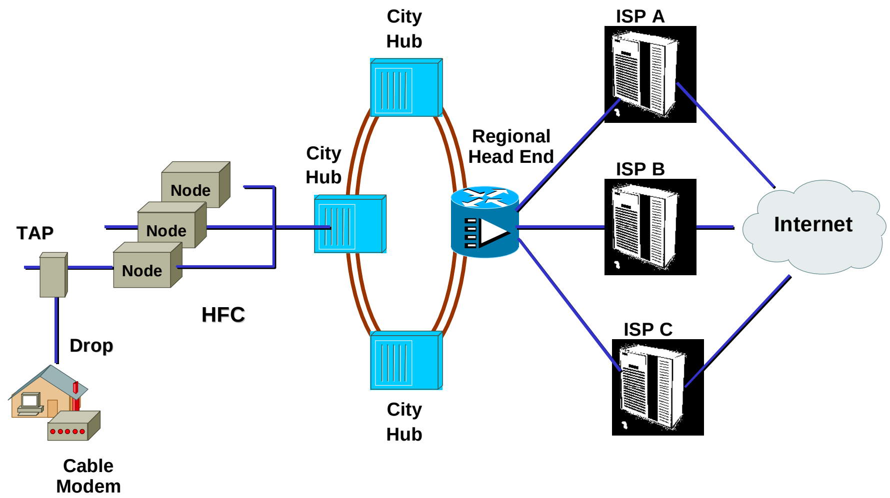
[12] Closed Access is defined as a cable network permitting only one ISP to access the local loop
[13] McKinsey report, Broadband!
[14] Id.

FIGURE 3.2: OPEN ACCESS CABLE MODEM NETWORK



Two technical questions must now be resolved: 1) How does the subscriber access their specified ISP? and, 2) Considering that the cable network is shared, how does the cable network route data from the subscriber through to the specified ISP's network? This section describes three technical options for implementing an open access cable network. These options include:

1. Point to Point Protocol over Ethernet (PPPoE)
2. Layer 2 Tunneling Protocol (L2TP)
3. Source Based Routing

The first two options use tunneling protocols such Point to Point Protocol over Ethernet (PPPoE) and Layer 2 Tunneling Protocol to enable a Point to Point Protocol session between the subscriber and the specified ISP[16]. A tunnel can be thought of as a virtual dedicated connection between two points in a network. Tunneling allows data to traverse through an "intervening" network of a different protocol. Tunneling works by encapsulating data in one protocol's format into another protocol's format.

PPP is a data-link framing protocol that runs over dedicated point to point links. PPP is traditionally used for dialup Internet access over a phone line. PPP provides a link-control protocol (to maintain integrity of data transferred over the link), identification and authentication functionality (PAP and CHAP), and IP address provisioning. PPPoE enables PPP to run over bridged networks. L2TP enables PPP to run over routed networks.

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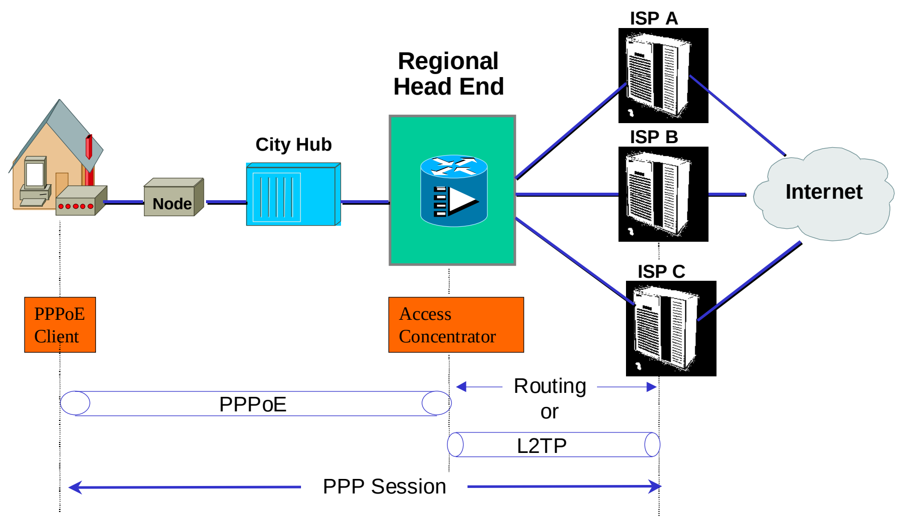
[15] Daniel Fryxell, Carnegie Mellon University150,000 from Time Warner, 1,000,000 from AT&T

The third option, source based routing, uses the source IP address of the subscriber's data to route traffic to a specific ISP. The subscriber's PC gets an assigned IP address from the pool of IP addresses associated with the chosen ISP. The router in the regional head end contains information about the IP address and its associated ISP, and routes the traffic accordingly.

Section 3.3. Point to Point Protocol over Ethernet (PPPoE)

PPPoE adapts PPP to traverse over a Layer 2/shared Ethernet network such as a bridged cable network in a way that is transparent to the user and ISP. PPPoE encapsulates PPP frames within a PPPoE packet that contains an Ethernet header. PPPoE has been submitted to the Internet Engineering Task Force (IETF) as RFC 2516. Figure 3.3 below shows the implementation of an open access cable network using PPPoE.

FIGURE 3.3: OPEN ACCESS CABLE MODEM NETWORK USING PPPOE



The changes required include the installation of a PPPoE software client[17] on the subscriber PC and the installation of a specialized router called an access concentrator in the regional head end. The access concentrator supports virtual routing – the implementation of multiple software routers called contexts and/or domains in one physical device. In an open access network, the access concentrator associates a context or set of domains with each ISP instead of having a different physical router for each ISP. The access concentrator is able to forward traffic based on PPP session information as well as IP addresses.

[16] GTE conducted a test in Clearwater, Florida where GTE modified its cable network to use PPPoE and L2TP in order to enable three ISPs (AOL, CompuServe, and GTE.net) to share "the cable broadband infrastructure and to obtain direct access to their customers".

This option requires minimal changes at the ISP because PPPoE uses the PPP access paradigm The ISP can use existing equipment to perform authentication, subscriber management, and IP address provisioning. The ISP can use the same equipment to handle dialup connections as well as cable network PPPoE connections. Since PPPoE is a layer 2 protocol, the subscriber PC is known by the MAC address with the cable network. Either the ISP or the access concentrator can assign a global IP address for the subscriber PC.

The PPPoE client establishes a PPP session between the subscriber PC and the ISP using the Access Concentrator as an intermediary. The PPPoE client creates a PPPoE tunnel beginning at the subscriber PC and terminated by the Access Concentrator. The access concentrator forwards PPP frames either by routing them to the specified ISP based on the PPP session id or by sending them through a L2TP tunnel established between the access concentrator and the specified ISP's Network Access Server. Note that when an L2TP tunnel is used, a L2TP Network Server (LNS) needs to be installed at the ISP.

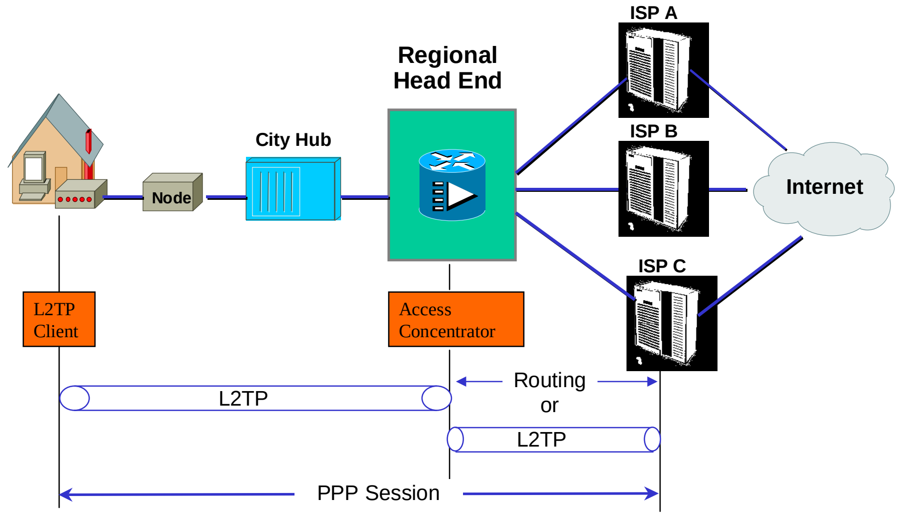
Section 3.4. Layer 2 Tunneling Protocol (L2TP)

In a routed cable network, the L2TP protocol is used to provide a dedicated connection (a L2TP tunnel) over which the PPP session is established. L2TP works by encapsulating an IP packet within another IP packet, implementing a double IP layer. When L2TP is used, the subscriber PC is assigned two IP addresses: a global IP address and a local IP address that is known only within the local cable network. It is considered a Layer 2+ protocol.

L2TP is based on Cisco Layer 2 Forwarding (L2F) protocol and the Microsoft Point to Point Tunneling Protocol (PPTP). A L2TP tunnel is established between a L2TP client and server: the L2TP Access Concentrator (LAC) and the L2TP Network Server (LNS). The LAC is a device that initiates the L2TP tunnel and the LNS is a device that terminates the L2TP tunnel. A PPP session is established over a sequence of one or more L2TP tunnels. PPP frames ride through the tunnel(s). L2TP is often used to implement Virtual Private Networks (VPN) to implement secure network connections over public networks. Figure 3.4 below shows the implementation of an open access cable network using L2TP.

FIGURE 3.4: OPEN ACCESS CABLE MODEM NETWORK USING L2TP

[17] Vendors include RouterWare/WindRiver, NTS



The L2TP client creates a tunnel between the subscriber PC and the access concentrator located in the regional head end. The tunnel is then terminated into routing or switched to a second tunnel terminating at the LNS in the ISP. In this case, the access concentrator acts both as a LAC and LNS. Note that this open access architecture is very similar to PPPoE. In both cases, the client establishes a PPP session between the subscriber PC and the ISP using the Access Concentrator as an intermediary. Note that the tunneling is handled transparently, so all the subscriber sees is the PPP connection to the ISP.

Section 4. Incremental Capital Cost Model

Section 4.1. Background

The preceding sections have examined public policy and technical dimensions of the open access debate. This section presents a cost model that analyses the incremental capital costs (incurred by the cable provider) associated with upgrading the existing cable network architecture to support open access. The objective of the cost model is to provide likely estimates of incremental costs by presenting three scenarios (U.S. market, Boston, Massachusetts market, and Portland, Oregon market) and comparing sensitivity analyses of each. The cost model does not intend to provide an absolute analysis but a comparative analysis. The capital cost associated with upgrading to open access will vary depending upon dynamics of a particular market. Our analysis will reveal that open access is clearly cost-effective in the short and long-term in the expected scenario, Boston.

Section 4.2. Methodology

Our analysis estimates one-time and ongoing incremental capital costs over several years (2000E-2004E) in three markets: the U.S. overall; Boston, Massachusetts; and Portland, Oregon. The incremental capital cost consists of the cost of client software and the access concentrator equipment (see Section 4.7 for illustrations).

Cost of Client Software + **Cost of Access Concentrator Equipment** = **Incremental Capital Cost**

Scenario #1, the U.S. market, is the low cost estimate because the Internet cable modem penetration rate is only estimated at 6.4% in the year 2000. Scenario #2 is the Boston market and represents the cost estimate that most cable companies should expect to see. The penetration rate in Boston in 2000 is approximately 25% and that rate, assuming demand for broadband remains robust, is likely to be the average penetration rate for many population centers in America. Scenario #3 is the Portland market and is the high estimate because its penetration rate of roughly 40% ranks as one of the highest, if not the highest, in the nation.

The penetration rate is the central parameter in each scenario.

Using this core parameter and several assumptions, we define a base case for comparing one-time incremental capital costs in the year 2000 and ongoing incremental capital costs seen in the next 4-5 years. The incremental costs per cable home passed in each year 2000E scenario are run through a sensitivity analysis that alters two variables: Internet cable modem penetration rate, and percentage of subscribers on-line (simultaneous usage at peak). The range of possible one-time costs incurred in 2000E is seen in Section 4.8.

The incremental capital cost estimated in each scenario's base case is used to estimate incremental capital costs incurred in years 2001-2004 as new cable modem service subscribers are added. Capital costs are largely driven by the Internet cable modem penetration rate. Future penetration rates were projected using a 28.9% compound annual growth rate (see Section 4.6). Our central findings are the incremental capital costs estimated in 2000 and the cumulative total of incremental capital costs incurred from 2000E-2004E.

Section 4.3. General Parameters and Assumptions for 3 Scenarios (U.S., Boston, Portland)

There are two central assumptions in our analysis: 1) Residential customers and small businesses will steadily increase their demand for broadband delivery over the next 4 to 5 years, and 2) Cable companies will continue dominating the market by investing heavily in HFC upgrading to meet that demand. Competition to deliver broadband is between companies that offer HFC, DSL, Fixed Wireless, or MMDS (defined as Sprint and MCI WorldCom-owned MMDS).

Cable currently dominates with cable modem subscribers constituting 85% of the total broadband delivery market. The best potential residential customers live in areas already serviced by upgraded cable and the proposed AOL merger with Time Warner demonstrates that cable offers the broadest set of broadband assets currently available.[18] However, DSL, which presently operates on the open access principle, is likely to be the biggest threat to cable. To maintain dominance in the market, cable must embrace the open access principle. Based on our analysis we predict that the cost of doing so will not be prohibitive.

In our analysis we assume that the number of households served by a regional head end is 500,000. The amount of households that can be served ranges from 150,000 to 1,000,000. We chose a number that was close to the center of the range. Using this number allows us to draw meaningful conclusions between the three markets. The number of homes with cable modem service subscribers was determined by best estimates available of Internet cable modem penetration rates.[19]

The number of subscribers on-line is based on scenarios of simultaneous usage at peak time in a joint industry study by McKinsey & Company and Sanford C. Bernstein & Co.[20] Purchasing client software costs $1, after a volume discount, in all but one scenario. L2TP is bundled into an operating system and is not likely to have any cost in the scenario with the lowest # of cable modem service subscribers per household, scenario #1 (U.S. market overall). See Table 4.1 below.

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[18] McKinsey and Sanford C. Bernstein, pp. 30-31.

[19] Projected penetration rate for the U.S. for the years 2000E-2004E calculated from the McKinsey and Sanford C. Bernstein joint industry report (pp. 26, 31).

[20] McKinsey and Sanford C. Bernstein, pg. 113.

TABLE 4.1: KEY PARAMETERS AND ASSUMPTIONS

	(U.S.)	(Boston)	(Portland)
# of Households Served by Regional Head End	500,000	500,000	500,000
Range of Households {150,000 ~ 1,000,000}			
Internet Cable Modem Penetration Rates (a)	6.4%	25.0%	40.0%
Percentage of Subscriber's On-Line	20.0%	50.0%	80.0%
Price of software per L2TP client	$0.00	$1.00	$1.00
Price of software per PPPoE client	$1.00	$1.00	$1.00

(a) Total cable modem subscribers as a percentage of homes upgraded for cable modem service.

Section 4.4. Equipment Description and Prices

The additional equipment needed to implement an open access cable network are the access concentrators located in the head end, and the client tunneling software located on the subscriber PC.

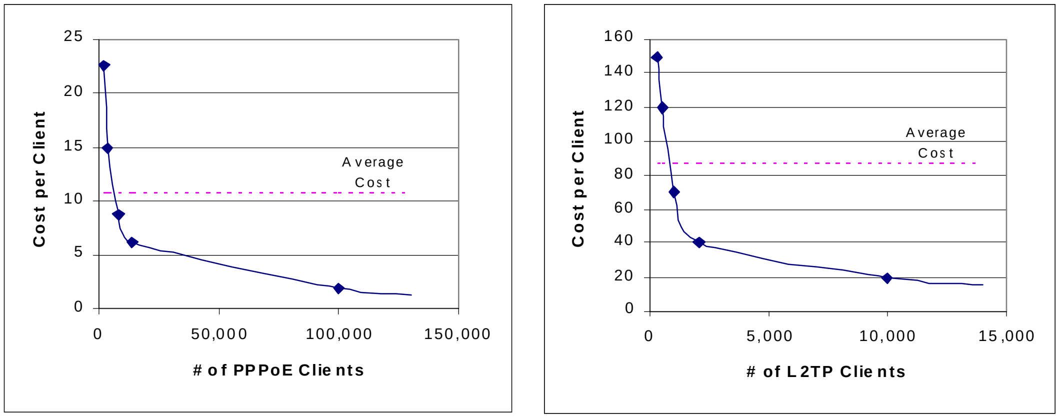
The access concentrator is also known as an ISP manager, subscriber management system or broadband access node. Multiple commercial products are currently available[21]. These products are more commonly used in DSL deployments than in cable modem networks. Some access concentrators have the ability to handle DSL, cable modem and dialup Internet access traffic transparently within one system. The access concentrator enables the dynamic selection and delivery of dedicated network services. In addition to broadband Internet access, the access concentrator also enables services such as secure access to corporate networks (for both voice and data services) using Virtual Private Networks (VPNs) and multi-point videoconferencing.

Basically, an access concentrator has two primary functions: 1) the access concentrator aggregates traffic, providing the aggregation of PPP sessions and PPPoE and L2TP tunnels 2) it directs the traffic to various service providers. An access concentrator resides at edge of the access provider’s network providing the point of interconnection to the ISPs and other service providers. The access concentrator may also allow subscribers to dynamically select on-demand services. It then switches user traffic to the selected services.

In addition, the access concentrator may also apply QoS policies and perform IP address assignment and subscriber management functions. The configurations of access concentrator vary greatly from vendor to vendor. Therefore, in our cost model, we use the average cost per PPPoE or L2TP client connection. However, this is a conservative estimate, since the equipment costs exhibit economies of scale. As the number of clients that an access concentrator supports increases, the cost per client decreases as shown in Figure 4.1.

[21] Products include the Redback Subscriber Management Systems (SMS 1,800 and SMS 10,000) and the Cisco 6400 Access Concentrator.

FIGURE 4.1: ACCESS CONCENTRATOR COSTS PER CLIENT



The access concentrator equipment prices utilized in the cost model reflect volume discounts to the cable operator of 20%-30%. The model assumes that the steady increase over the next 4-5 years in new cable modem service subscribers will result in an average annual increase of 5% in the equipment price discount.

Note that the basic hardware configuration of the access concentrator supports only 2 ISPs since it has one upstream network card with 2 ports. In order to support more ISPs, more network cards need to be added (about $20,000/$22,000 for one DS-3/OC-3 card[22]). We did not include this cost in the model, because we assume that the ISP would pay for the card as part of their network connection fees.

As for the client software, the cost of PPPoE and L2TP client software is available at $1 per license when bought in bulk by the cable operator. The model also assumes here that the increase in subscribers will result in an average annual increase of 5% in the software price discount. Also, the L2TP client software is bundled into Windows 2000 and is assumed to not have any financial ramification in the low incremental capital cost scenario, the U.S. market.

Section 4.5. Bandwidth Overhead

A mechanism was built into the model to account for bandwidth overhead due to the required PPPoE or L2TP heading that is attached to each packet of data traveling through cyberspace. Higher equipment costs will be realized per PPPoE or L2TP client in scenarios #2 and #3 because the Internet cable modem penetration rates and assumed on-line subscriber percentages will result in bandwidth overhead. The bandwidth overhead assumptions are indicated in Table 4.2 below.

TABLE 4.2: BANDWIDTH OVERHEAD SUMMARY

	(U.S.)	(Boston)	(Portland)
Bandwidth Overhead due to Protocols (a)			
Percentage Overhead (L2TP) (b)	0.0%	10.0%	20.0%
L2TP	$ 70.12	$ 77.91	$ 87.65
Percentage Overhead (PPPOE) (b)	0.0%	5.0%	10.0%
PPPOE	$ 9.83	$ 10.35	$ 10.92

(a) Represents increase in equipment cost as a result of a reduced number of clients supported.

(b) Percentage overhead based on GTE estimates of 4% overhead for PPPoE and 15% overhead for L2TP.

Section 4.6. Projected Penetration Rates and One-Time and Ongoing Capital Costs

Table 4.3 below displays the breakdown of capital costs and the Internet cable modem penetration rates. Based on data from the McKinsey and Sanford C. Bernstein report, the compound annual growth rate (CAGR) in the Internet cable modem penetration rate in the U.S. overall is 28.9%. This CAGR was applied to the 2000E base case penetration rate in Boston (25%) and Portland (40%) to obtain estimated penetration rates for 2001E-2004E. These penetration rates are the chief drivers of the incremental capital cost of upgrading to open access.

TABLE 4.3: PROJECTED PENETRATION RATES AND ONE-TIME AND ONGOING CAPITAL COSTS

(A) United States	**Projections for United States**				
	2000E	**2001E**	**2002E**	**2003E**	**2004E**
Total Homes Upgraded for Cable Modem Service	63,558	71,871	75,853	76,945	77,919
HFC Subscribers	4,047	6,149	9,178	11,576	13,678
Internet Cable Modem Penetration Rate (a)	6.4%	8.6%	12.1%	15.0%	17.6%
Cost of Client Software					
L2TP	-	-	-	-	-
PPPOE	$ 31,837	$ 10,394	$ 15,993	$ 12,624	$ 10,220
Cost of Access Concentrator Equipment					
L2TP	$ 446,477	$ 145,762	$ 224,280	$ 177,036	$ 143,330
PPPOE	$ 62,594	$ 20,435	$ 31,443	$ 24,820	$ 20,094

(B) Boston, Massachusetts	**Projections for Boston Using 28.9% U.S. Penetration Rate CAGR**				
	2000E	**2001E**	**2002E**	**2003E**	**2004E**
Internet Cable Modem Penetration Rate (b)	25.0%	32.2%	41.5%	53.5%	68.9%
Cost of Client Software					
L2TP	$ 125,000	$ 34,266	$ 41,946	$ 51,348	$ 62,856
PPPOE	$ 125,000	$ 34,266	$ 41,946	$ 51,348	$ 62,856
Cost of Access Concentrator Equipment					
L2TP	$ 4,869,378	$ 1,334,844	$ 1,634,024	$ 2,000,258	$ 2,448,576
PPPOE	$ 646,734	$ 177,289	$ 217,025	$ 265,667	$ 325,211

(C) Portland, Oregon	**Projections for Portland Using 28.9% U.S. Penetration Rate CAGR (d)**				
	2000E	**2001E**	**2002E**	**2003E**	**2004E**
Internet Cable Modem Penetration Rate (c)	40.0%	51.5%	66.4%	85.6%	100.0%
Cost of Client Software					
L2TP	$ 200,000	$ 54,826	$ 67,114	$ 82,157	$ 58,726
PPPOE	$ 200,000	$ 54,826	$ 67,114	$ 82,157	$ 58,726
Cost of Access Concentrator Equipment					
L2TP	$ 14,023,810	$ 3,844,352	$ 4,705,988	$ 5,760,743	$ 4,117,810
PPPOE	$ 1,747,619	$ 479,075	$ 586,451	$ 717,892	$ 513,153

(a) Penetration rate estimates for 2000-2004 from "Broadband!", a January 2000 joint industry study by Sanford C. Bernstein & Co.. And McKinsey & Company, Inc.

(b) Penetration rate for Boston in 2000 is believed to be 25%, future penetration rate estimates based on a 28.9% penetration rate for the U.S.

(c) Penetration rate in Portland in 2000 is believed to be 40%, future penetration rate estimates based on a 28.9% penetration rate for the U.S.

(d) Penetration rate in Portland in 2004E is based on 16.8% growth from 2003E because a 28.9% growth would put the penetration rate above 100%.

[22] Source: Danial, CMU.

Section 4.7. Incremental Capital Cost Summary

The projected incremental capital cost associated with open access from 2000E to 2004E is shown below in Table 4.4. In each scenario, it is estimated that the largest costs in a single year occur in 2000. This is because the largest number of customers will be seen in the first year, resulting in the largest purchase of client software and access concentrator equipment.

Capital costs are lower in succeeding years because they only reflect the number of new subscribers per regional head end in each respective market. In all scenarios, the incremental capital cost estimate associated with the L2TP architecture will likely be the realized cost of upgrading cable networks to support open access. L2TP is deployed over routed networks and approximately 70% of the existing infrastructure is a routed network.

The projected number of subscribers is also included in this table.

TABLE 4.4: PROJECTED ONE-TIME AND ONGOING INCREMENTAL CAPITAL COSTS

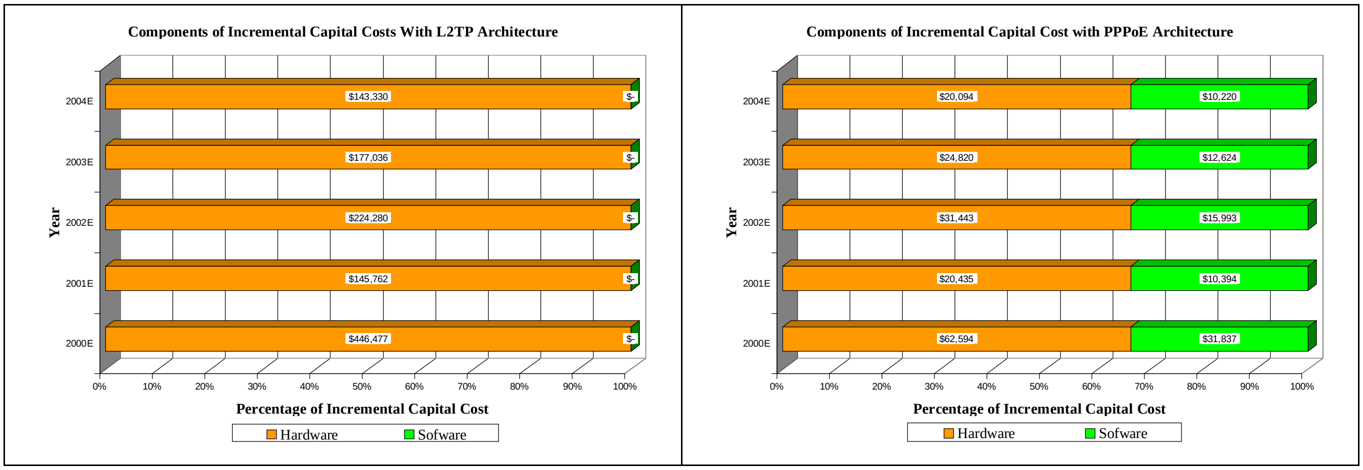
Scenario (a)	2000E	2001E	2002E	2003E	2004E	Total
U.S. Market Overall						
# of Subscribers (b)	31,837	10,941	17,721	14,724	12,548	87,771
Incremental Cost of Upgrade/Homes Passed (L2TP)	**$ 0.89**	$ 0.29	$ 0.45	$ 0.35	$ 0.29	**$ 2.27**
Incremental Cost of Upgrade/Homes Passed (PPPOE)	**$ 0.19**	$ 0.06	$ 0.09	$ 0.07	$ 0.06	**$ 0.48**
Boston, Massachusetts Market						
# of Subscribers (b)	125,000	36,070	46,478	59,890	77,171	344,609
Incremental Cost of Upgrade/Homes Passed (L2TP)	**$ 9.99**	$ 2.74	$ 3.35	$ 4.10	$ 5.02	**$ 25.20**
Incremental Cost of Upgrade/Homes Passed (PPPOE)	**$ 1.54**	$ 0.42	$ 0.52	$ 0.63	$ 0.78	**$ 3.89**
Portland, Oregon Market						
# of Subscribers (b)	200,000	57,712	74,365	95,823	72,100	500,000
Incremental Cost of Upgrade/Homes Passed (L2TP)	**$ 28.45**	$ 7.80	$ 9.55	$ 11.69	$ 8.35	**$ 65.83**
Incremental Cost of Upgrade/Homes Passed (PPPOE)	**$ 3.90**	$ 1.07	$ 1.31	$ 1.60	$ 1.14	**$ 9.01**

(a) The incremental capital cost is per 500,000 cable homes passed in a regional head end.
(b) Reflects the total estimated number of subscribers in 2000 and the number of new subscribers added each year.

Section 4.7.1. Scenario #1 (U.S.)

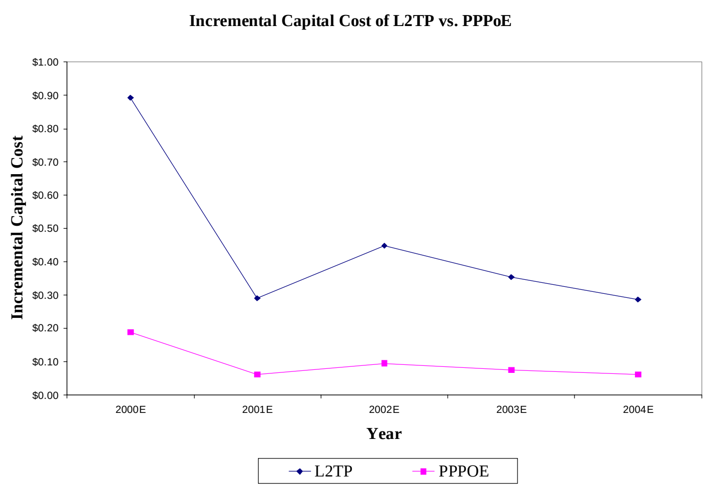
As stated earlier, the incremental capital cost consists of the cost of client software and the cost of access concentrator equipment. The contribution of each to incremental cost in years 2000E-2004E varies according to the open access architecture in each scenario. In the U.S. scenario, hardware is 100% of incremental cost in L2TP due to software cost of 0$. In the PPPoE architecture, hardware only comprises approximately 66% of incremental cost. See Figures 4.2 and 4.3 below for graphical illustration.

FIGURE 4.2: INCREMENTAL CAPITAL COST COMPONENTS IN U.S. SCENARIO



In the U.S. scenario, the incremental capital cost of L2TP is approximately 5 times that of PPPoE each year.

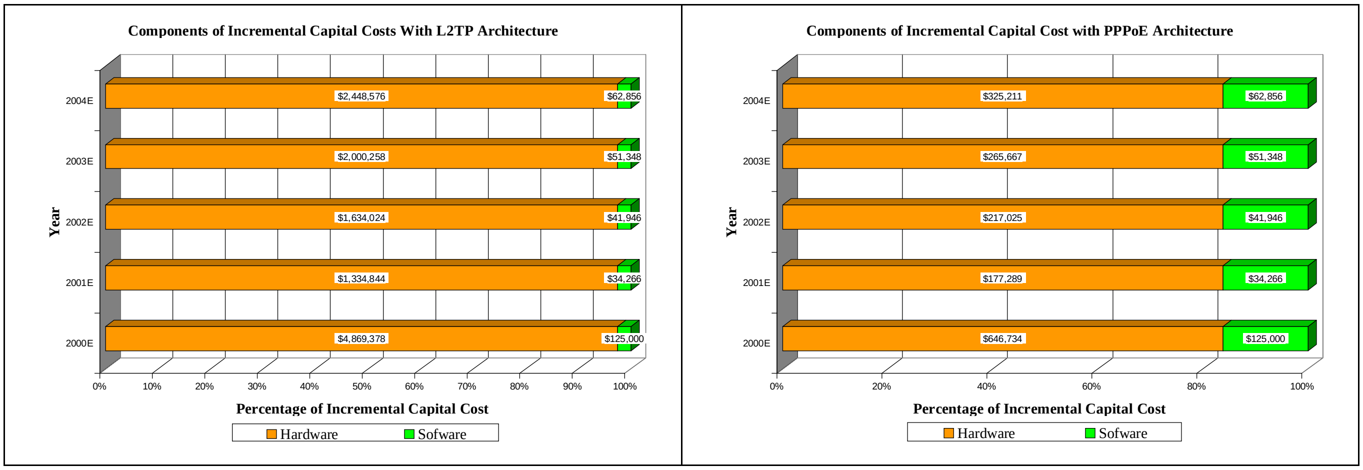
FIGURE 4.3: INCREMENTAL CAPITAL COSTS IN U.S. SCENARIO



Section 4.7.2. Scenario #2 (Boston)

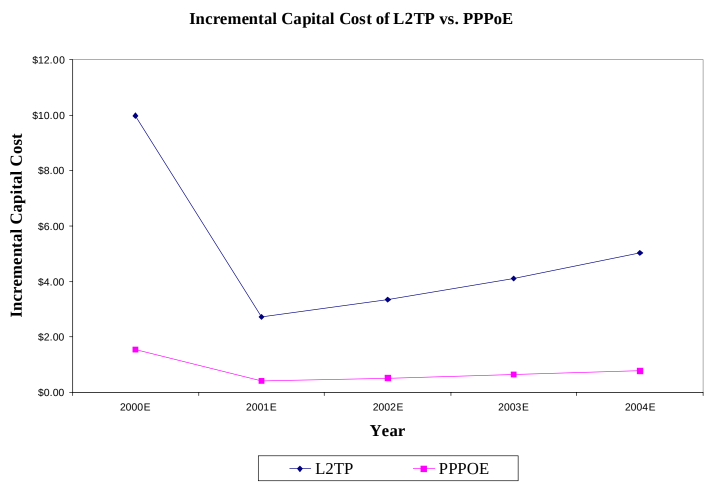
In the Boston scenario, hardware is 97.5% of incremental cost with L2TP. In the PPPoE architecture, hardware only comprises approximately 84% of incremental cost. See Figures 4.4 and 4.5 below for graphical illustration.

FIGURE 4.4: INCREMENTAL CAPITAL COST COMPONENTS IN BOSTON SCENARIO



In the Boston scenario, the incremental capital cost of L2TP is approximately 6.5 times that of PPPoE each year.

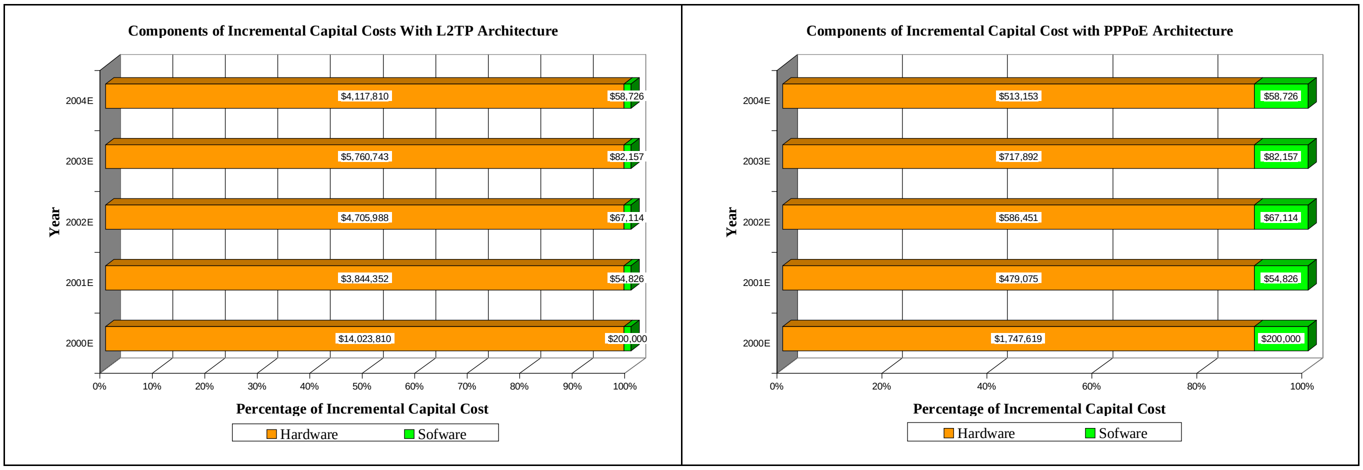
FIGURE 4.5: INCREMENTAL CAPITAL COSTS IN BOSTON SCENARIO



Section 4.7.3. Scenario #3 (Portland)

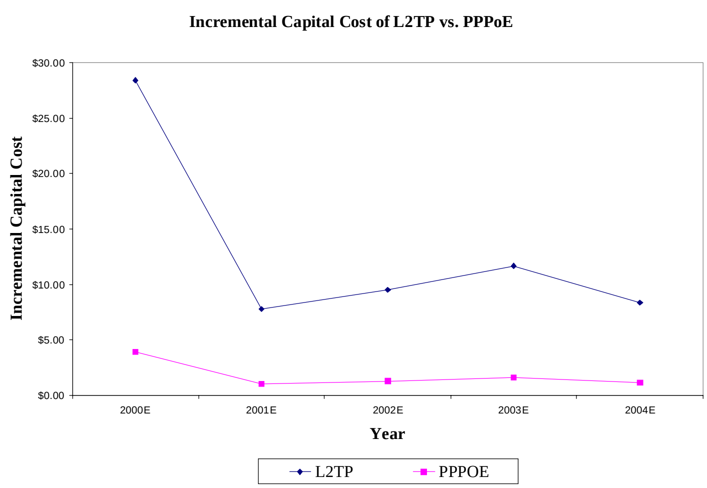
In the Portland scenario, hardware is 99% of incremental cost in L2TP. In the PPPoE architecture, hardware only comprises approximately 90% of incremental cost. See Figures 4.6 and 4.7 below for graphical illustration.

FIGURE 4.6: INCREMENTAL CAPITAL COST COMPONENTS IN PORTLAND SCENARIO



In the Portland scenario, the incremental capital cost of L2TP is more than 7 times that of PPPoE each year.

FIGURE 4.7: INCREMENTAL CAPITAL COSTS IN PORTLAND SCENARIO



Section 4.8. Sensitivity Analysis for One-Time Initial Costs in 2000E

A sensitivity analysis was conducted on each scenario for the one-time cost of purchasing the requisite client software and access concentrator equipment to meet consumer demand in the year 2000 (see Tables 4.5 - 4.7 below). The variables that were altered were the Internet cable modem penetration rate and the percentage of subscribers on-line. The base case regarding these variables is bordered in each table. The matrices reveal that as the penetration rate and on-line percentage rate increases the incremental capital cost increases.

TABLE 4.5: SENSITIVITY ANALYSIS FOR INCREMENTAL CAPITAL COSTS IN U.S. SCENARIO

L2TP

		Internet Cable Modem Penetration Rates					
		6.4%	16.4%	26.4%	36.4%	46.4%	56.4%
Percentage of	20.0%	$ 0.89	$ 2.30	$ 3.70	$ 5.10	$ 6.50	$ 7.90
Subscribers	50.0%	$ 2.23	$ 5.74	$ 9.24	$ 12.75	$ 16.26	$ 19.76
On-Line	80.0%	$ 3.57	$ 9.18	$ 14.79	$ 20.40	$ 26.01	$ 31.62
	100.0%	$ 4.46	$ 11.48	$ 18.49	$ 25.50	$ 32.51	$ 39.52

PPPoE

		Internet Cable Modem Penetration Rates					
		6.4%	16.4%	26.4%	36.4%	46.4%	56.4%
Percentage of	20.0%	$ 0.19	$ 0.49	$ 0.78	$ 1.08	$ 1.38	$ 1.67
Subscribers	50.0%	$ 0.38	$ 0.97	$ 1.56	$ 2.15	$ 2.74	$ 3.33
On-Line	80.0%	$ 0.56	$ 1.45	$ 2.34	$ 3.22	$ 4.11	$ 5.00
	100.0%	$ 0.69	$ 1.77	$ 2.86	$ 3.94	$ 5.02	$ 6.10

Sensitivity Analysis for Year 2000 Scenario 1 *Low* (U.S.)

TABLE 4.6: SENSITIVITY ANALYSIS FOR INCREMENTAL CAPITAL COSTS IN BOSTON SCENARIO

L2TP

		Internet Cable Modem Penetration Rates					
		25.0%	35.0%	45.0%	55.0%	65.0%	75.0%
Percentage of	20.0%	$ 4.15	$ 5.80	$ 7.46	$ 9.12	$ 10.78	$ 12.44
Subscribers	50.0%	$ 9.99	$ 13.98	$ 17.98	$ 21.98	$ 25.97	$ 29.97
On-Line	80.0%	$ 15.83	$ 22.16	$ 28.50	$ 34.83	$ 41.16	$ 47.50
	100.0%	$ 19.73	$ 27.62	$ 35.51	$ 43.40	$ 51.29	$ 59.18

PPPoE

		Internet Cable Modem Penetration Rates					
		25.0%	35.0%	45.0%	55.0%	65.0%	75.0%
Percentage of	20.0%	$ 0.77	$ 1.07	$ 1.38	$ 1.69	$ 2.00	$ 2.30
Subscribers	50.0%	$ 1.54	$ 2.16	$ 2.78	$ 3.40	$ 4.01	$ 4.63
On-Line	80.0%	$ 2.32	$ 3.25	$ 4.18	$ 5.10	$ 6.03	$ 6.96
	100.0%	$ 2.84	$ 3.97	$ 5.11	$ 6.24	$ 7.38	$ 8.51

Sensitivity Analysis for Year 2000 Scenario 2 *Expected* (Boston)

TABLE 4.7: SENSITIVITY ANALYSIS FOR INCREMENTAL CAPITAL COSTS IN PORTLAND SCENARIO

L2TP

		Internet Cable Modem Penetration Rates					
		40.0%	50.0%	60.0%	70.0%	80.0%	90.0%
Percentage of	20.0%	$ 7.41	$ 9.26	$ 11.12	$ 12.97	$ 14.82	$ 16.68
Subscribers	50.0%	$ 17.93	$ 22.41	$ 26.89	$ 31.38	$ 35.86	$ 40.34
On-Line	80.0%	$ 28.45	$ 35.56	$ 42.67	$ 49.78	$ 56.90	$ 64.01
	100.0%	$ 35.46	$ 44.32	$ 53.19	$ 62.05	$ 70.92	$ 79.78

PPPoE

		Internet Cable Modem Penetration Rates					
		40.0%	50.0%	60.0%	70.0%	80.0%	90.0%
Percentage of	20.0%	$ 1.27	$ 1.59	$ 1.91	$ 2.23	$ 2.55	$ 2.87
Subscribers	50.0%	$ 2.58	$ 3.23	$ 3.88	$ 4.52	$ 5.17	$ 5.82
On-Line	80.0%	$ 3.90	$ 4.87	$ 5.84	$ 6.82	$ 7.79	$ 8.76
	100.0%	$ 4.77	$ 5.96	$ 7.15	$ 8.35	$ 9.54	$ 10.73

Sensitivity Analysis for Year 2000 Scenario 3 *High* (Portland)

Section 5. Conclusions

Section 5.1. Technical Conclusions

What is at stake in the open access debate is whether cable companies should be required to offer unaffiliated Internet Service Providers (ISPs) wholesale access and interconnection to their cable modem networks. The ISPs could then use this access to provide high-speed Internet services to consumers. According to this scenario, the consumer would be able to subscribe to their choice of ISP. Eventually, the ISPs could offer services such as IP telephony and streaming video services using the cable pipeline.

This paper demonstrates that interconnection and transport for multiple ISPs over the cable modem network is not only feasible, but costs relatively little to implement. Moreover, our results make it clear that open access cable networks can be implemented using products currently offered by multiple major vendors. Still, one area requiring further research is the computation of operating costs for an open access cable system.

In a production system, the cable companies and ISPs would need to coordinate operations such as IP address assignment, billing and subscriber management, and network management. Even so, our preliminary research indicates that this is more a matter of logistics than a technical barrier

The primary technical issues remaining to be resolved concern bandwidth allocation and quality of service. Still, these are issues that face existing closed access cable modem networks as well. The issue of multiple ISPs' customers contending for the same bandwidth raises the probability of disputes over fair allocation and usage between the ISPs and the cable companies. Finally, another area of research should be to extend the cost model to other open access options, in particular, source-based routing.

Section 5.2. Cost Model Conclusion

As stated earlier in this paper, the open access debate has three dimensions: economic considerations, technical feasibility and financial cost. The cost model in this paper delves into the third dimension by examining incremental capital costs incurred by the cable modem service provider to upgrade the existing closed access system to an open access system. A traditional opponent of open access, the cable industry, has steadfastly maintained that deploying the requisite equipment (even if technically feasible) would not be cost-effective. Our research indicates that deployment is not only technically feasible, but cost effective as well.

The central finding of this analysis is that the incremental capital cost (per homes passed) of upgrading to an open access system by the end of the year 2000 would only cost $1.54 for a bridged network (PPPoE) and $9.99 for a routed network (L2TP). The total cost over 5 years (2000E-2004E) is estimated to be $3.89 for a bridged network and $25.20 for a routed network. The cost model examined capital costs in three markets: 1) U.S., 2) Boston, and 3) Portland. The central finding is based on what we believe to be the expected scenario, Boston. The results in Boston, given our assumptions (see Sections 4.2 and 4.3) are most likely to be applicable to cities across the United States because the Internet cable modem penetration rate in the year 2000 in Boston is estimated at 25%.

The limitation of this cost model is that it only deals with the capital cost component of total financial cost. It does not include operating costs, revenue projections or an analysis of how a cable company would finance such an upgrade. Depending on company size and capital structure, some cable companies could finance an upgrade to open access by accessing existing cash reserves, issuing equity, floating public debt or seeking a merger partner. Operating costs, revenue projections, and financing assumptions cannot be generalized across the cable industry with a sufficient degree of statistical confidence because they are subject to numerous variables, including a company's marketing budget, level of efficiency, capital structure, cost of capital, management objectives, and economies of scale. Consequently, a cost model incorporating all of these variables is beyond the scope of this report and remains an area for further research. In contrast, findings concerning capital costs can be generalized with a higher degree of statistical confidence because fewer variables need to be considered.

Section 5.3. How Does this Inform the Public Policy Debate?

A significant portion of the policy debate focuses on the issue of competitiveness and monopoly, and whether or not open access will stifle future investment in broadband infrastructure. However, as our analysis is of technical/cost metrics rather than economic in nature, we have nothing additional to add to this aspect of the debate. Rather, as stated above, our analysis has led us to conclude that Open Access cable architectures can indeed be implemented without the prohibitive costs or technical barriers that opponents claim make it unfeasible. Moreover, we believe that open access over cable would be beneficial for everyone involved. Not only would it offer consumers a larger number of alternatives in selecting an ISP, but it would also make the cable network architecture more competitive with broadband over DSL, which is currently regulated to operate under the principle of open access. Consequently, we believe that the FCC should step forward and require that broadband over cable be procured in an open access fashion and at a reasonable cost, as has already occurred with DSL. At the same time, we believe that great care is required in the crafting of such a regulation in order to insure that such a requirement does not result in the hodgepodge of state regulations for pricing of this access by cable providers, as previously occurred with TELRIC pricing. Excessive regulation can yield inefficiency. Free market principles should guide the formation of public policy concerning open access over cable but a complete Laissez-faire approach can unnecessarily allow market failure to occur. In conclusion, we believe that open access should be implemented in such a manner that would result in increased competition in the provision of broadband over cable, in increased quality of service and in lower costs for consumers.

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http://www.ind.alcatel.com

Anti open access
http://www.att.com/press/item/0,1354,2331,00.html
Excite @ Home Open access web page:
http://www.home.net/source
especially:
http://www.home.net/pdf/broadbnd.pdf
http://www.home.net/source/techdetails.html

Pro open access
Open Net Coalition:
http://www.opennetcoalition.org
Larry Lessig's web site

CRTC website w/ info about their implementation of open access:
http://www.crtc.gc.ca/ENG/PROC_REP/TELECOM/1998/8638/C12-17.html
Look under
1998/11/10 - Canadian Cable Television Association (CCTA)
tekoct27.doc - MS*Word - 1274KB
for an architectural document. Yes, the CRTC web site sucks. Ironically,
so does the FCC website.

For learning about cable network architectures:
http://www.cable-modems.org

Residential Broadband (a book)
George Abe
chapter 3

Sharon Gillett's thesis: ""

Websites:

Cisco website
http://www.cisco.com
Excite@Home website
http://www.home.net
GTE website
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Internet over Cable Technology Primer
http://ab.videon.ca/Technology/netpt5.htm
Knology website
http://www.knology.com
Francois Menard homepage
http://www3.sympatico.ca/francois.menard3/hsiafaq.txt
OpenNet Coalition website
http://www.opennetcoalition.org

Lawrence Lessig's website
http://www.cyber.law.edu/lessig.html
CRTC website
http://www.crtc.gc.ca/ENG/PROC_REP/TELECOM/1998/8638/C12-17.html
Cable Modem tutorial
http://www.cable-modems.org

Other:
ATT News Release 12/6/99
Letter to FCC Chairman William Kennard
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Dodd, Annabel Z. *The Essential Guide to Telecommunications*

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