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**STATE OF NEW HAMPSHIRE  
BEFORE THE  
PUBLIC UTILITIES COMMISSION  
DT 07-011**

**Joint Petition by Verizon New England, Inc., et al.  
and FairPoint Communications, Inc.  
Transfer of New Hampshire Assets of  
Verizon New England, Inc. et al.**

**Rebuttal Testimony of Douglas C. Sicker, Ph.D.  
On Behalf of  
FairPoint Communications, Inc.**

**September 10, 2007**

Summary: Dr. Sicker's testimony describes the appropriateness of Digital Subscriber Line (DSL) as an evolutionary technology path for FairPoint Communications, Inc. (FairPoint) to serve the Verizon customer base upon acquisition of related assets in Maine, Vermont and New Hampshire. Dr. Sicker discusses why DSL is the appropriate technology now and how it provides the base for future expansion as the needs for bandwidth grow. In addition, Dr. Sicker comments on FairPoint's broadband deployment plan, concluding that the plan is sound and reasonable for the State of New Hampshire.

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## INTRODUCTION

2 Q. Please state your name and business address.

3 A. My name is Dr. Douglas C. Sicker. My business address is ECCR1B54, 430 UCB,  
4 Boulder, CO 80309-0430.

5 Q. What is your position and by whom are you employed?

6 A. I am the Director of the Interdisciplinary Telecommunications Labs and an Assistant  
7 Professor in the Department of Computer Science at the University of Colorado and am  
8 employed by the University of Colorado.

9 Q. Please provide your educational background and professional experience.

10 A. Prior to becoming a professor I was Director of Network Architecture at Level 3  
11 Communications. And prior to this, I was Chief of the Network Technology Division at  
12 the Federal Communications Commission (FCC). I worked on numerous broadband  
13 rulemakings and acted daily in an advisory capacity to the Common Carrier Bureau,  
14 Commissioners and Chairman on such pertinent topics as broadband deployment,  
15 unbundled network elements, network reliability and DSL compatibility. I received my  
16 Ph.D. and M.S. in Telecommunications and my B.S. in Natural Sciences from the  
17 University of Pittsburgh.

18 Q. On whose behalf are you testifying?

19 A. I am testifying on behalf of FairPoint.

1 Q. What is the purpose of your testimony?

2 A. The purpose of my testimony is to describe how FairPoint's broadband plan benefits the  
3 residents of the State of New Hampshire. I will also provide information on the  
4 appropriateness of Digital Subscriber Line (DSL) as an evolutionary technology path for  
5 FairPoint to serve the Verizon customer base upon acquisition of related assets in  
6 Maine, Vermont and New Hampshire. I will testify as to why DSL is the appropriate  
7 technology now and how it provides the base for future expansion as the needs for  
8 bandwidth grow.

9 Q. Please summarize your analysis.

10 A. Based on my extensive experience as an academic and professional in the field of  
11 communications technology and my evaluation of information about both FairPoint's  
12 current broadband deployments and its initial plans for Northern New England, as well  
13 as interviews with FairPoint's internal subject matter experts, I conclude that DSL is a  
14 logical solution for New Hampshire (and is in fact the technology of choice), and that it  
15 provides a prudent migratory path toward even higher-rate data services such as Fiber  
16 To The Home ("FTTH"). I also conclude that the goal of increasing broadband  
17 deployment is not well-served by ordering a specific deployment with specific data rates,  
18 specific technology and specific timelines. To do so would fail to provide the flexibility  
19 that a carrier requires to evolve its network in response to consumer demands, financial  
20 factors and technology evolution.

Specifically concerning the FairPoint broadband deployment plan, I conclude that: (1)  
the FairPoint's plan is sound given the economics of broadband deployment; (2) the plan  
is consistent with the technologies currently being deployed by other operators in the

United States and abroad; (3) the plan is designed to ensure a significant and wide-spread build-out to large numbers of additional customers; (4) the plan will provide appropriate broadband capacity for current uses and the network can be evolved as needed to meet even higher-speed customer needs; and (5) the plan will position the infrastructure required to meet the needs of particular high-capacity customers.

Q. Could you provide a simplified description of the Internet and explain how technologies like DSL and FTTH fit into the Internet?

8 A. Technologies such as DSL and FTTH are part of the network system that is the Internet.  
9 It is important to understand how that system is designed in order to understand the  
10 value of different access technologies (technologies that provide end-users with access  
11 to the network). Just as putting racing tires on an old car won't make it go faster, the  
12 network's performance and an Internet user's experience are based on many parts.  
13 Modern telecommunications systems are moving to "network convergence," meaning  
14 that subscribers' voice, video and data network services are provided by a single  
15 common connection to the Internet. DSL and FTTH are network access technologies  
16 that connect a home or business (endpoint) to a network provider.

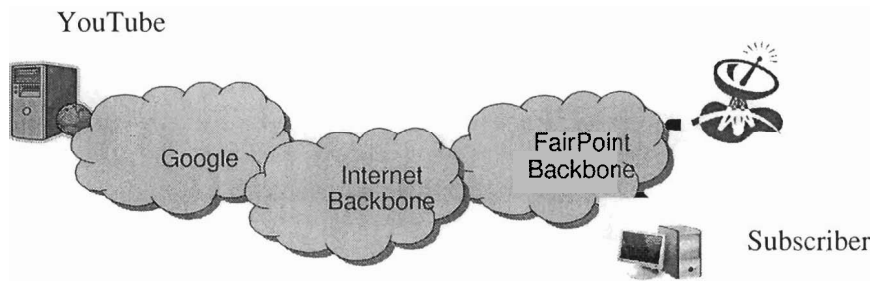
Q. How does an access network fit into the Internet?

18 A. The devices in a home are connected to an access network that is provided by a  
19 broadband network provider. That network provider also has a backbone network that  
20 connects all the different access devices and provides access to other networks. The  
21 Internet is a "network of networks," allowing different broadband providers to access the  
22 same content.

1 Q. Could you give an example of how information might travel across this “network of  
2 networks” giving different access networks, including broadband providers, access to the  
3 same content?

4 A. For example, the following diagram provides a schematic illustration of how subscribers  
5 to FairPoint’s network might access content from YouTube.

**Figure 1. From YouTube to Your Tube**



7 The subscriber (represented by the PC and monitor) directly connects to the FairPoint  
8 network; that network connects, or peers, with other Internet backbones. In order to  
9 receive a video from YouTube, the data will flow from the computer located at a Google  
10 datacenter, through Google’s internal networks, across the Internet backbone networks,  
11 through FairPoint’s network and then to the subscriber’s PC. Data travels through the  
12 network at the speed of the slowest link – since “backbone” networks combine traffic  
13 from many subscribers, those backbone networks must also be well designed.

14 Q. Does all information necessarily travel across the full Internet?

A. Not all data traverse the full Internet. For example, video services for a broadband network may originate at a regional satellite dish farm (see Figure 1) and then be distributed through a broadband provider's network to subscribers. The power of the Internet is that it allows various kinds of content (e.g., video or information) to be distributed from broadband provider networks or distant Internet providers, such as YouTube.

Q. Please explain how the design of "backbone networks" can affect the performance and cost of broadband services?

9 A. The design of the backbone networks can influence greatly the cost and performance of  
10 broadband services. Some Internet backbone networks arose by adapting existing  
11 telecommunication networks that were primarily designed for voice traffic. These  
12 networks use technology called Asynchronous Transfer Mode (ATM)<sup>1</sup> to establish  
13 "virtual circuits" through the telecommunications network. This technology approach  
14 was a direct outgrowth of the design of the local telecommunications networks in which  
15 telephones were connected by "circuits" to a central office. Once data enter a "circuit,"  
16 the information doesn't exit until it reaches its endpoint, no matter how many "switches" it  
17 may traverse. Adapting these networks to transport Internet data involves adding  
18 "abstraction layers" that hide the "circuit like" nature of the network.

New network deployments use "IP networking," which uses Internet Protocol (IP) to move or route data. The main differences are that most "IP Networking" equipment

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<sup>1</sup> From the NTIA glossary, "Asynchronous Transfer Mode (ATM): A high-speed multiplexing and switching method utilizing fixed-length cells of 53 octets to support multiple types of traffic. Note: ATM, specified in international standards, is asynchronous in the sense that cells carrying user data need not be periodic."

moves larger “chunks” of data, such as multicast data<sup>2</sup> and the path that data takes through the network is much more flexible than in ATM networks (leading to higher efficiency). It is easiest to understand this difference by way of analogy:

### **Railroads (ATM) and Freeways (IP)**

5 Traditional ATM telecommunications networks are like railways, while IP networks are  
6 more like freeways. In a rail network, trains enter at specific points on the network and  
7 have uncontested rights-of-way to their destinations; however, it is difficult and  
8 expensive to add new “exits” to a rail line. By comparison, cars make “routing  
9 decisions” at each roadway intersection, and it is relatively simple to add new  
10 intersections to serve new homes because of this design choice. It is also possible to  
11 design roadways, like Interstate highways, that are more efficient as a result of limiting  
12 the number of on ramps and exits.

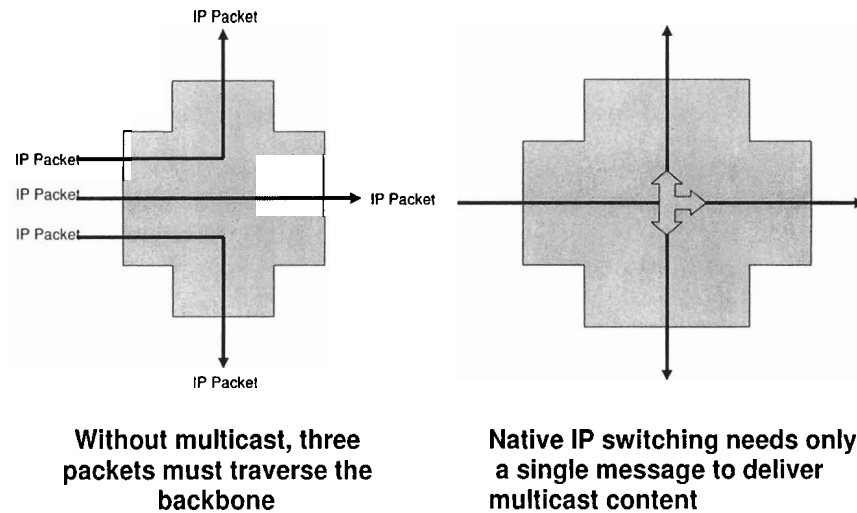
13 The analogy falls short for one important kind of Internet traffic: IP multicast. Multicast  
14 data originates from a single location (such as a TV satellite) but is directed to multiple  
15 different receivers. Multicast mechanisms are the basis for delivering TV services  
16 efficiently over IP networks. In an IP network, the router and switches that make up the  
17 “intersections” of the highway are designed to duplicate multicast data directly, and are  
18 shown in Figure 2.

### **Figure 2. Digital Railways and Digital Freeways - The Benefits of Native IP Multicast**

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<sup>2</sup> Multicast data originates from a single location (such as a TV satellite) but is directed to multiple different receivers.





Source: Author's construct

ATM networks are at a disadvantage for multicast traffic. The switches that make up most of an ATM telecommunication network don't "see" the IP multicast data directly, and thus can't duplicate the traffic in the network. This requires more data to be sent through the network backbone, leading to yet more overhead – it is as if the train is carrying cars, but is unable to benefit from the advantages of cars.

The design of backbone networks is important and integral when planning high-speed access networks. Modern "high speed" access networks allow throughput of 25-100 megabits per second (Mb/s) of downloadable data. If a thousand customers use a 100 Mb/s network at the same time, a typical OC-3 of 155 Mb/s used for backhaul would be

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Multicast mechanisms are the basis for delivering TV services efficiently over IP networks.

exhausted. Therefore, it is imperative that carriers properly evolve both their backbone and access networks as they attempt to bring higher data speed products and service to their customers. As part of that network evolution it is important to keep in mind that the efficiency of IP backbone networks can provide significant performance benefits and cost advantages beyond older network designs.

Q. Could you give an overview of the bandwidth demands of different common applications?

8 A. Yes. Most broadband providers are focused on the “triple play” of providing voice, video  
9 and data networking to subscribers. Of these services, voice uses the least amount of  
10 bandwidth (less than 100 kilobits per second (Kb/s)). The necessary bandwidth  
11 demands of data or Web networking are more difficult to quantify because “more is  
12 better,” up to a point. If we have a gigabit access network, Web data will be received no  
13 faster than the web server can provide it. In most cases, 20-30 Mb/s is considered more  
14 than sufficient at the upper end for Web access.

15 Video data would appear to be the most demanding kind of traffic. Industry reports  
16 advocating the deployment of high-speed fiber networks point out that uncompressed  
17 video consumes tens of megabytes of bandwidth. The bandwidth available in cable  
18 networks largely is used to transmit multiple video streams. However, video transmitted  
19 in modern IP networks uses compression technology to achieve the same video fidelity  
20 with much less bandwidth. As would be predicted by Moore’s Law,<sup>3</sup> video compression

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<sup>3</sup> “..(T)he first microprocessor only had 22 hundred transistors. We are looking at something a million times that complex in the next generations—a billion transistors. What that gives us in the way of flexibility to design products is phenomenal.” Intel founder, Gordon E. Moore, in 1965. Moore’s Law is invoked more generally to describe the tremendous expansion of speed and capacity by all kinds of computer-like devices.

1 technology improves with time, leading to less bandwidth consumption with each  
2 iterative improvement.

3 The following table summarizes the bandwidth needs for two generations of video  
4 compression technology. The first, MPEG2, is the technology used in DVD movies. The  
5 second, H.264, is the technology used in the HDTV, HD-DVD and Blu-ray video  
6 formats.

7 **Figure 3. Improvement in Video Compression**

	SD Video	HD Video
MPEG2	4-6 Mb/s	~30 Mb/s
H.264	1-2.5 Mb/s	6-9 Mb/s

9 Thus, a subscriber wanting to use voice, data and view a single HD video stream all at  
10 the same time would need as little as 12 Mb/s of bandwidth (6-9 Mb/s for the video  
11 stream with 3-6 Mb/s for data and voice). If 50 Mb/s were available, the subscriber could  
12 simultaneously watch 3-4 HD videos, provide two voice streams to each of the family's 5  
13 children and browse the web using an 8 Mb/s connection (as fast as the most up-to-date  
14 cable modems). Obviously, despite some advocacy of "gigabit to the home," existing  
15 Internet applications would be unable to make use of most of that extraordinary  
16 bandwidth.

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1 Q. How do access networks differ in the physical infrastructure they employ?

2 A. One of the Internet's design goals was to permit the user to operate over many different  
3 physical networking media. Different network technologies have been used by  
4 businesses, incumbent telecommunications, cable companies and others. Each  
5 technology offers the same capabilities, but at different performance and cost. There are  
6 many technologies to consider, and those technologies continue to evolve in terms of  
7 performance (speed) and cost.

8 Q. Please review the specific different types of access technology and their primary  
9 characteristics.

10 A. There are five main types of access technology, Ethernet, Digital Subscriber Line (DSL),  
11 Cable Broadband, Wireless Broadband, and Fiber. I will briefly describe each one.

### **Ethernet**

13 Ethernet is used within most business premises and some homes, multi-unit dwellings  
14 and increasingly for distribution in "edge networks." Because the technology is a widely  
15 adopted commodity standard, components can be relatively inexpensive. Ethernet over  
16 copper cabling has limited range (<1km and ~100m for 1 gigabit speeds). Ethernet  
17 using fiber has longer distance limits, providing 1 gigabit and 10 gigabit speeds to  
18 distances exceeding 20km. Ethernet is used in some high-speed broadband  
19 deployments, but adoption of the technology for residential broadband is limited by the  
20 rapidly-improving capabilities of existing incumbent wiring technologies (i.e., DSL and  
21 Cable Modems) and the lack of a large market for gigabit residential connections.  
22 Ethernet technology is being deployed in some "greenfield" networks such as the Utopia

network in Utah.

## Digital Subscriber Line

DSL is a family of technologies developed to use the existing telephone wiring access plant. All of the technologies are designed to work in conjunction with existing voice telephony services. The most commonly used variant of DSL is called ADSL (asymmetric digital subscriber line), which uses the available bandwidth to provide up to 6 Mb/s of downlink connectivity and up to 640 Kb/s of uplink connectivity. Many subscribers are limited to the G.lite version of ADSL, which constrains downlink bandwidth to 1.5 Mb/s and uplink bandwidth to 256 Kb/s.

The majority of DSL deployments in the U.S. use ADSL and ADSL G.lite. Many countries, including France, Sweden, Japan and South Korea, have begun to deploy VDSL, and some countries started deploying VDSL2 in 2007. Recently, Texas Instruments developed a technology called UDSL (uni-DSL) that allows the different DSL standards to be deployed over the same physical plant, reducing the cost for technology changes.

**Figure 4. Distances for Various DSL Technologies**

DSL Type	Range (kft)	Downstream Rate	Upstream Rate
ADSL G.lite	18 kft	1.5 Mb/s	0.256 Mb/s
ADSL	12 kft	6.0 Mb/s	0.640 Mb/s
VDSL	3.2 kft	26 Mb/s	3.0 Mb/s
	1 kft	52 Mb/s	6 Mb/s
VDSL2	3.2kft	50 Mb/s	50 Mb/s
	1.63kft	100 Mb/s	100 Mb/s
LR-VDSL	16 kft	1-4 Mb/s	0.600 Mb/s
ADSL2+	3 kft	24 Mb/s	1.1 Mb/s
	12 kft	6 Mb/s	0.512 Mb/s
UDSL		Same as VDSL2	

2

3       The different types of DSL support provision of broadband at various distances from the  
 4       network switching equipment. The enhancements in speed and distance over time are  
 5       based on the innovation and technology improvements of the equipment located at the

end of the copper wires.

2 In the DSL marketplace, distances are usually specified in kilo feet (1 kft is  
3 approximately 300 meters). The distances in the DSL specifications are from the point of  
4 distribution, which can be either a central office or a remote distribution point in a multi-  
5 dwelling unit (MDU), business or neighborhood. Thus, if a group of customers lives far  
6 from a central office, it may be more cost effective to run fiber to a distribution unit near  
7 their homes and then use the existing copper infrastructure to deliver 100 Mb/s VDSL2  
8 connections to the homes, rather than to provide new fiber connections to each home.  
9 The highest-speed DSL technologies, such as VDSL and VDSL2 are being adopted in  
10 the United States. In order to achieve the higher speeds provided by VDSL, most  
11 providers are overlaying a fiber network to individual MDUs or neighborhoods. This is  
12 done to balance the cost of deploying new infrastructure to each residence when the  
13 existing telephone infrastructure is capable of 100Mb/s speeds.

In short, DSL is an evolving standard because the performance of the electronics and  
the physical architectures permit meaningful improvements to copper-based speeds if  
the loop lengths are shortened and more advanced versions of DSL are deployed.

### **Cable Broadband**

18 Cable broadband services are provided by cable television providers using an existing  
19 coaxial cable plant (coax). The DOCSIS standards ("Data Over Cable Service Interface  
20 Standards") govern the physical and logical signaling over the coax plant. Just as DSL  
21 standards work in conjunction with existing voice signals on a phone line, the DOCSIS  
22 standards work in conjunction with existing standard-definition (SD) and high-definition  
23 (HD) television signals over the coax infrastructure.

1 The current DOCSIS 2 standard provides performance of up to 42 Mb/s downstream  
2 and 30 Mb/s upstream using a single 6 MHz channel. That bandwidth is shared  
3 between multiple users and individual usage is usually “capped” at 8 Mb/s downstream  
4 with 384 Kb/s upstream. Equipment meeting the recently released DOCSIS 3 standard  
5 can theoretically achieve downstream performance of 160 Mb/s using multiple channel  
6 frequencies (although it is not certain that this technology will operate at these rates in  
7 the field). Unlike earlier DOCSIS standards, the entire 160 Mb/s theoretically may be  
8 made available for a single user. As with DSL networks, data signals are distributed to  
9 cable modem termination equipment using a fiber network (forming a so-called hybrid  
10 fiber-coaxial network).

### **Wireless Broadband**

12 Broadband Fixed Wireless (BFW) refers to various technologies used to provide high  
13 data rate wireless services to users whose locations are fixed. BFW can be viewed as a  
14 substitute in some applications for other current broadband access technologies, such  
15 as DSL and cable modem (although BFW is not necessarily a true substitute). In the  
16 recent past, BFW has most often been deployed through technologies such as Local  
17 Multipoint Distribution Service (LMDS) and Multi-channel Multipoint Distribution Service  
18 (MMDS). The initial rollout of BFW technologies did not result in the market penetration  
19 that many observers anticipated. Some of the reasons for the shortfall included high  
20 deployment costs, poor service availability and complications from the use of proprietary  
21 technology. The development of new standards, including 802.16 (also called WiMAX),  
22 may breathe new life into the BFW market.

23 The 802.16 standard has only recently been deployed. Speeds of 6 Mb/s have been



measured at distances of 6km (19kft).

### Fiber

3 Unlike basic ADSL technologies, solutions using optical fiber that extends all the way to  
4 the customer's premises require a new physical plant to be installed. Most fiber services  
5 being deployed in the United States use *passive optical networking* or PON networks. In  
6 these systems, a signal is modulated by a laser at a central office or a local distribution  
7 center. Different variants provide different speeds and ranges. The current BPON and  
8 EPON services provide a total of 1.2 Gb/s bandwidth at distances up to 20 km (65 kft).  
9 Recent standards such as GPON increase the bandwidth to 2.5 Gb/s at distances of up  
10 to 60 km. The bandwidth is shared among as few as 16 and as many as 256 users,  
11 resulting in a per-user bandwidth of 75 Mb/s to 4.6 Mb/s, depending on the number of  
12 subscribers for EPON/BPON. GPON rates would double the throughput. As with  
13 coaxial cable TV distribution systems, passive optical networks allow additional  
14 broadcast distribution of TV signals by simply splitting the fiber to multiple homes. By  
15 comparison, *active* fiber networks use switches throughout the network to deliver peak  
16 speeds of up to 1 GB/s to individual users. Active fiber networks lack the ability to  
17 broadcast a common signal using passive optics; instead, active fiber networks must use  
18 switch protocols such as IP multicast. Generally, active fiber networks are thought to  
19 cost more to deploy than passive networks due to these additional switches and lasers.

However, active networks also enable flexible networking organizations that allow companies to allocate dedicated bandwidth for specific tasks and services, such as providing reliable VoIP, Internet and TV services over the same infrastructure.

4 Q. Please summarize how these various access technologies are suited to different  
5 situations.

6 A. The key insight in the short summary above is that there are several very viable and  
7 cost-effective technology options that all provide high data rates up to 100 Mb/s or 150  
8 Mb/s per residence and the “appropriate” technology depends on various factors,  
9 including density, geography, likely customer demand, the presence or absence of  
10 existing facilities and their condition, and financial issues.

11 Q. According to your assessment, is DSL still a viable technology, or should other access  
12 technology be mandated?

13 A. It is a fallacy that DSL is a “dead-end” technology and that DSL and fiber technologies  
14 are in opposition. Each technology has a place in the deployment of Internet  
15 technologies, as has been shown in deployments in South Korea and Japan. South  
16 Korea largely has deployed VDSL and VDSL2. Japan has a combined deployment of  
17 VDSL and fiber-to-the-home: DSL technologies are used when existing physical plant is  
18 available, while fiber is used when greenfield networks are possible or when economics  
19 warrant the build-out. In short, mandating a particular technology, such as fiber to the  
20 home (FTTH), is not a wise choice. Illustrating this principle, some telecommunications  
21 providers are deploying passive optical networking, which is a technology with its own  
22 limitations, as it may not be able to offer gigabit speeds to individual users. Switching to  
23 active optical networking would require additional investment, highlighting that

technologies (even those such as FTTH) are in evolution and that it is prudent to build networks that can be evolved.

Q. Is the FairPoint technology deployment strategy consistent with that of other broadband providers both in the U.S. and abroad?

5 A. The FairPoint broadband deployment plan, which I describe in more detail below, is  
6 consistent with the technologies currently being deployed by other operators in the  
7 United States and abroad. There are some areas in the U.S. where companies are  
8 deploying FTTH, but those regions typically are either greenfield developments or areas  
9 where deployment costs are low relative to the potential returns (more urban and  
10 suburban, high population density regions).<sup>4</sup> Almost all major telephone company  
11 broadband projects in the United States use DSL and cable modem technology (and, to  
12 a lesser extent, wireless) as the primary "last mile" connection to customers. In fact, it is  
13 well documented that DSL is the technology of choice for most telephone companies  
14 investing in broadband and that FTTH comprises only a small percentage of the  
15 deployed broadband.<sup>5</sup> According to the Organization for Economic Cooperation and  
16 Development (OECD), the breakdown of broadband technologies globally in December  
17 2006 was as follows:

- DSL : 63%
- Cable modem : 29%
- FTTH/FTTB : 6%

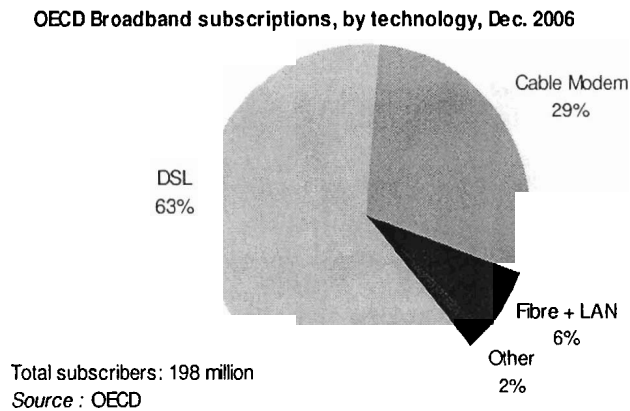
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<sup>4</sup> "Broadband access evolution Pathways beyond ADSL", Alcatel Technology White Paper.

<sup>5</sup> [http://www.oecd.org/document/7/0,3343,en\\_2649\\_37441\\_38446855\\_1\\_1\\_1\\_37441,00.html](http://www.oecd.org/document/7/0,3343,en_2649_37441_38446855_1_1_1_37441,00.html)

- Other (e.g. satellite, fixed wireless, powerline communication) : 2%

**Figure 6. Broadband Access Technologies**



4 Q. Can you summarize the economic and deployment issues facing broadband?

5 A. Yes. It is understood that the cost of deploying technology varies greatly and that  
6 different technologies have different strengths based on a variety of demographic  
7 considerations.<sup>6</sup> Therefore, the decision regarding the broadband technology in which  
8 to invest requires an understanding of a complex and evolving number of variables.  
9 Investment decisions are based on engineering, economics and market conditions.  
10 These decisions are not being driven by explicit government obligations. At the end of  
11 the day, a fair-minded analysis is required. The decision how far to push fiber toward  
12 the customer is based on an evaluation of whether the market will support the  
13 deployment cost.

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<sup>6</sup> See "Broadband access evolution Pathways beyond ADSL", Alcatel Technology White Paper. This article provides data on the relative capex required to deploy a variety of broadband access technologies and shows how DSL is a logical migratory path to FTTH.

Q. Given such varying economic and technical factors, would it be wise to implement a policy mandate regarding what architecture of services should be adopted?

3 A. Such a mandate would ignore the complex financial investment and operating cost  
4 decisions associated with broadband build out. Such a mandate would also ignore the  
5 diversity of complex issues associated with the evolution of the technology. The idea of  
6 mandating a specific data rate or technology platform ignores the determinative factors  
7 that drive investment decisions. (A similar analysis must be done for a public investment  
8 decision.) A specific data rate might be established as a goal, but requiring a carrier to  
9 invest when the return on investment is unknown makes poor business sense. It also  
10 puts at risk other basic regulatory goals, such as affordability of service and the financial  
11 integrity of the provider.

12 The New Hampshire Public Utilities Commission Staff (Staff) suggests that a condition of  
13 approval be imposed upon FairPoint such that FairPoint be required to meet a ninety-  
14 five percent (95%) broadband availability to its New Hampshire customer base. One  
15 must recognize that very low population density, remoteness and terrain make the  
16 provision of DSL or most other broadband technologies to the most remote customer  
17 economically challenging. Given these constraints, FairPoint's success in reaching 92%  
18 of its current customer base is impressive in my opinion.

19 By committing to push broadband out to approximately eighty percent (80%) of the New  
20 Hampshire customers Verizon currently serves (in addition to serving classic FairPoint  
21 customers), FairPoint will do an extraordinary amount to provide broadband services  
22 within the State of New Hampshire. Although I am not an economic development  
23 expert, I am impressed by FairPoint's approach to the relationship between economic

1 development and broadband, which Mr. Nixon describes in his rebuttal testimony as  
2 “connectivity-enabled” economic development. As to the reasonableness of the  
3 technology, the few carriers that have adopted a “mainly fiber” model generally have  
4 relatively concentrated service areas or are focusing the investment in denser areas -  
5 and not areas such as that described in the pre-filed rebuttal testimony of Msrs. Brown,  
6 Harrington and Smee. Given the deployment considerations that I have described,  
7 policymakers with plans to promote broadband deployment must consider not only the  
8 speed of the broadband network, but also how rapidly the service is deployed, the  
9 breadth of deployment within the service territory, the costs of investment, the resultant  
10 price of service, the financial health/longevity of the provider, and the ability to upgrade  
11 the deployment as the technology and customer demand evolve.

12 Q. Turning specifically to the FairPoint broadband plan, please describe its basic design  
13 philosophy?

14 A. FairPoint follows the well-understood best practice of first ensuring that the core  
15 (backbone) of the network is sufficiently robust to handle the subsequent build out of  
16 edge (or access) technologies. In following this philosophy, the company is  
17 implementing an Internet Protocol/Multiple Protocol Label Switching (IP/MPLS) core  
18 backbone, which will support 10 Gigabit per second data rates. This is a modern  
19 technology allowing for more efficient network use and network management. The  
20 FairPoint approach makes use of newer technology, namely Gigabit Ethernet, which  
21 allows the Ethernet frame from the customer to be more easily routed through the  
22 network with less overhead. ATM has over a 20% overhead and Ethernet has a 5-6%  
23 overhead due to encapsulation, but Gigabit Ethernet can reduce that overhead to 1%.

1           Moreover, IP routers and switches are designed to process Ethernet data directly,  
2           making for a more efficient network.

3           A second FairPoint design practice involves choosing the access technology that best  
4           matches the customer's needs. After first upgrading the core (backbone) of the network,  
5           FairPoint then is able to modernize the edge (or last mile) of the network. In the second  
6           tier of its network, FairPoint will make use of Multi Service Access Nodes (MSAN), which  
7           is network equipment that can support a range of access technologies, e.g., basic  
8           telephone service, ADSL, VDSL and FTTH. FairPoint presently plans to deploy ADSL2+  
9           and VDSL2, which will support up to 25 Mb/s and 100 Mb/s, respectively (depending  
10          upon distance). However, MSANs will allow FairPoint to deploy FTTH for greenfield  
11          builds, new businesses and other rebuilds.

12          In its current service areas across the U.S., FairPoint today serves its broadband  
13          customers using different access technologies, including copper, fiber, copper/fiber  
14          hybrid, and wireless (in the form of radio frequency transmission). More specifically,  
15          FairPoint provides broadband service to its customers with FTTH, ADSL, ADSL2+,  
16          VDSL and WiMAX. Ultimately, the customer is indifferent to the specific access  
17          technology, provided the service offers reliable and appropriate speeds, consistent with  
18          the customer's demand.

19          FairPoint's initial deployment plan in New England anticipates the use of several types of  
20          technologies, with a view to supporting a migration toward higher-speed<sup>7</sup> architectures

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<sup>7</sup> More accurately, higher "bit rate," which is the number of bits that are conveyed or processed per unit of time. Bit rate is often expressed as connection speed, transfer rate, channel capacity, maximum throughput or bandwidth capacity.

such as fiber-to-the-home. Part of FairPoint's success in rolling out broadband has been based on the ability to deploy a mix of technologies and tailor technology choices to suit the demands and conditions of each geographic area. The key insight is that FairPoint has the flexibility to evolve its entire network in a way that best ensures meeting the customers' demands in a cost-effective and efficient manner.

6 Q. Are you able to provide an evaluation of the FairPoint Broadband Network Design Plan  
7 (FairPoint Plan) for Northern New England and New Hampshire specifically?

8 A. Yes. FairPoint's plan for New Hampshire is consistent with FairPoint's plans for Northern  
9 New England. FairPoint has been successful in deploying broadband to lower-density  
10 areas. Ninety-two percent of FairPoint's current northern New England customers have  
11 access to FairPoint broadband. The FairPoint Plan is a reasonable and sound approach  
12 to aggressively deploy broadband to consumers throughout the region. FairPoint will  
13 enable New Hampshire central offices (COs) that do not now support broadband.  
14 Additionally, FairPoint will aggressively upgrade digital loop carriers (remote terminals)  
15 with MSAN equipment to reach more customers with broadband. The FairPoint Plan is  
16 based on an investment approach that targets both improvement of the core network  
17 and deployment of broadband services to consumers. Specifically, FairPoint plans to  
18 deploy an IP/MPLS backbone network to ensure that its broadband users do not  
19 experience major source congestion as data travels to and from other networks.  
20 Additionally, FairPoint plans to increase the availability of broadband to a much higher  
21 percentage of locations in the region. The FairPoint Plan, which is described in the Joint  
22 Rebuttal Testimony of Messrs. Brown, Harrington and Smee, describes how much will be  
23 invested in the network and when the investment will occur. It also describes the types



1 of technologies that will be deployed and how the technology supports migration toward  
2 higher-speed architectures such as FTTH.

3 Q. In summary, what has your research and analysis revealed about the FairPoint  
4 broadband plan for New England?

5 A. FairPoint is approaching the evolution of its broadband service to New England  
6 customers in a way that is consistent with well-understood best practices in network  
7 design. The company is building out the core of its network to ensure that the  
8 architecture is more flexible and that no bottlenecks exist as higher data rate services  
9 are deployed at the edge. The company is expanding the reach of broadband to  
10 customers in northern New England so that availability is expected to improve markedly  
11 from the current level. Finally, FairPoint is designing its network to support a variety of  
12 emerging technologies, which will allow for the deployment of various broadband access  
13 technologies that match the needs of the customer. To review the summary at the  
14 beginning of my testimony, I conclude:

- 15 1. *The FairPoint broadband plan establishes a solid network core that can efficiently*  
16 *service customers using a variety of access network technologies that are appropriate to*  
17 *specific locales.*
- 18 2. *The plan is consistent with the technologies currently being deployed by other operators*  
19 *in the United States and abroad.*
- 20 3. *The plan is designed to ensure a significant and wide-spread build-out to large numbers*  
21 *of additional customers.*

4. *The plan will provide increased capacity for most current uses and can be evolved as needed to meet higher speed customer needs.*
5. *The plan will help develop the infrastructure required to meet the needs of particular high-capacity customers.*

Therefore, I conclude that FairPoint's broadband plan is a sound approach to broadband deployment and that DSL is a reasonable, forward-looking technology.

### **Consistency with New Hampshire's Broadband Goals**

- Q. Does the FairPoint plan help achieve the goals enumerated by the New Hampshire Division of Economic Development (DEC) of the Department of Resources and Economic Development?
- A. Yes. I understand two (2) of the goals for the Director of the DEC, broadly speaking, are as follows:
1. Identify shortcomings in the deployment of telecommunications infrastructure throughout all parts of the state.
  2. Work with providers of telecommunications services, educators, and municipal, county, state, and other government officials to assist efforts to enhance the deployment of telecommunications services.<sup>8</sup>

FairPoint's plan addresses these goals by specifically targeting lower-density, rural, unserved areas. FairPoint has demonstrated success in deploying broadband to such

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<sup>8</sup> RSA 12-A:45 Telecommunications Planning and Development Initiative, see also, The New Hampshire Internet Information Center at <http://www.technologynh.com/isp/vwho.php>.

lower-density areas, as demonstrated by the high percentage of current FairPoint northern New England customers that have access to broadband services. As discussed above, FairPoint will enable additional COs in New Hampshire that do not already support broadband to do so. FairPoint also will upgrade DLCs with MSAN equipment to further enable broadband to more customers. Thus, FairPoint plans to upgrade the current telephony infrastructure to deploy broadband services to customers that can be reached, but do not currently have broadband availability through Verizon.

8 FairPoint's plan also takes into consideration the development of bandwidth,  
9 synchronicity, reliability and security. FairPoint's plan calls for intensive infrastructure  
10 installation and upgrades, building out a robust core, or backbone network and  
11 modernizing the access network, thus providing bandwidth for current needs and the  
12 capability to meet increasing future bandwidth needs, including synchronicity (uplink  
13 rates equal to downlink rates), as well as providing the reliability and security of a next  
14 generation network. Further, as recommended by state witnesses Brevitz and Baldwin,  
15 FairPoint helps New Hampshire to reach its broadband availability goals by providing a  
16 specific plan for broadband DSL deployment. The FairPoint Plan explicitly states how  
17 much will be invested in the network and when the investment will occur. It also  
18 describes the types of technologies that will be deployed and how the technology  
19 supports migration toward higher-speed architectures such as FTTH.

Q. How do FairPoint's intensive upgrades and extension of DSL availability affect the affordability of its DSL service?

A. Affordability is an important factor in broadband availability. The DEC determined "availability *and affordability*" to be "major concerns of educators, businesses, and

economic development leaders”<sup>9</sup> and state witness Baldwin notes the importance of affordability. Impressively, while upgrading the core and access network extensively and greatly expanding DSL availability FairPoint is committing to offer DSL retail rates equal to those charged by Verizon at the time of the transaction closing;

5 Q. Could you provide the details of how FairPoint’s plan meets the goal of providing  
6 bandwidth, synchronicity, reliability and security with increasing use of modern fiber  
7 optic, IP/MPLS based technology with respect to the core or backbone portions of its  
8 network?

9 A. Yes. FairPoint’s planned core network, as described above, will clearly support a goal of  
10 developing a next generation network capable of providing bandwidth, synchronicity,  
11 reliability and security. It will support the video, Internet, voice and emerging  
12 applications that business, education and enterprise will demand. To give a specific  
13 example, IP/MPLS and IP/Ethernet backbone architectures allow for IP multicast  
14 services such as IPTV. This same multicast capability also can be used for schools and  
15 businesses to broadcast video or audio from one location to multiple locations. This can  
16 be used to provide for broadcast of lessons from one school location to many and for  
17 video conferencing from one business location to several on the network. Including  
18 Internet Group Multicast Protocol (IGMP) allows for minimal bandwidth usage on the  
19 network and minimizes the risk of network congestion. FairPoint presently offers IPTV  
20 services in Yelm Washington and is developing them for use in Missouri across the  
21 IP/Ethernet based network. This service includes 145 plus channels of Video, 45  
22 channels of Music and Video on Demand. Thus, FairPoint’s plan supports a goal of next

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<sup>9</sup> Moving New Hampshire Into the Digital Economy, November 2002, p.2.

generation networks that satisfy business, education and enterprise and goes beyond by supporting IP multicast services while minimizing any congestion when utilizing this application.

4 Q. How does FairPoint's plan meet the goal of providing bandwidth, synchronicity, reliability  
5 and security in next generation networks capable of delivering video, very high speed  
6 Internet, and voice with increasing use of fiber optic technology with respect to the  
7 access network portions of its operation?

8 A. A second FairPoint design practice involves choosing the access technology that best  
9 matches the customer's needs. After first upgrading the core (backbone) of the network,  
10 FairPoint then is able to modernize the edge (or last mile) of the network. In the second  
11 tier of its network, FairPoint will make use of Multi Service Access Nodes (MSAN), which  
12 is network equipment that can support a range of access (last mile) technologies, e.g.,  
13 basic telephone service, ADSL, VDSL and FTTH (Fiber To The Home). FairPoint  
14 presently plans to deploy ADSL2+ and VDSL2, which will support up to 25 Mb/s and 100  
15 Mb/s, respectively (depending upon distance). MSAN devices also support the  
16 provisioning of fiber to the home utilizing either Gigabit Passive Optical Networks  
17 (GPON) or Active Ethernet standard technology to allow 2.4 Gb/s of total bandwidth with  
18 an average bandwidth of 75 Mb/s per customer using GPON or up to 1 Gb/s with Active  
19 Ethernet.

20 As stated earlier, MSANs will allow FairPoint to deploy FTTH in the future for greenfield  
21 builds, new businesses and other rebuilds. FairPoint has deployed FTTH from this  
22 same platform in several new Greenfield subdivisions in Washington, Florida and  
23 Missouri using both GPON and Active Ethernet. In its current service areas across the

1 U.S., FairPoint today serves its broadband customers using different access  
2 technologies, including copper, fiber, copper/fiber hybrid, and wireless (in the form of  
3 radio frequency transmission). More specifically, FairPoint provides broadband service  
4 to its customers with FTTH, ADSL, ADSL2+, VDSL and WiMAX. Ultimately, the  
5 customer is indifferent to the specific access technology, provided the service offers  
6 reliable and appropriate speeds, consistent with the customer's demand. FairPoint's  
7 initial deployment plan in New England anticipates the use of several types of access  
8 technologies, with a view to supporting a migration toward higher-speed architectures  
9 such as FTTH. Part of FairPoint's success in rolling out broadband has been based on  
10 the ability to deploy a mix of technologies and tailor technology choices to suit the  
11 demands and conditions of each geographic area. The key insight is that FairPoint has  
12 the flexibility to evolve its entire network in a way that best ensures meeting the  
13 customers' demands in a cost-effective and efficient manner. The FairPoint Plan is a  
14 reasonable and sound approach to aggressively deploy broadband to consumers  
15 throughout the region. The FairPoint Plan also is based on an investment approach that  
16 targets both improvement of the core network and deployment of broadband services to  
17 consumers through the access network.

18 Q. Will FairPoint's plan to expand its access network to such an extent preclude other  
19 access technology to unserved or under served areas of New Hampshire?

20 A. State witness Baldwin notes that wireless providers should not be opposed. While  
21 FairPoint's broadband deployment plan offers vast improvements in broadband  
22 performance and greatly extends DSL availability, it recognizes that other access  
23 technologies, such as wireless may be better suited to some populations. In particular,  
24 there are very remote areas where currently it is nearly impossible to provide DSL or

extremely sparsely populated areas where it is not economically reasonable and a solution such as wireless access technology would be appropriate.

### CONCLUSION

4 Q. Why do you conclude that FairPoint's plan for broadband deployment in New Hampshire  
5 is sound and reasonable?

6 A. Specifically, FairPoint plans to deploy an high data rate, IP/MPLS backbone network to  
7 ensure that its broadband users do not experience major source congestion as data  
8 travels to and from other networks. Additionally, FairPoint plans to increase the  
9 availability of broadband to a much higher percentage of locations in the region by  
10 upgrading central offices and remote terminals that connect to the access network. The  
11 FairPoint Plan explicitly states how much will be invested in the network and when the  
12 investment will occur. It also describes the types of technologies that will be deployed  
13 and how the technology supports migration toward higher-speed architectures such as  
14 FTTH.

15 FairPoint is approaching the evolution of its broadband service to New England  
16 customers in a way that is consistent with well-understood best practices in network  
17 design. The company is building out the core of its network to ensure that the  
18 architecture is more flexible and that no bottlenecks exist as higher data rate services  
19 are deployed at the edge. The company is expanding the reach of broadband to  
20 customers in Northern New England so that availability is expected to improve markedly  
21 from the current level. Finally, the company is designing its network to support a variety  
22 of emerging technologies, which will allow for the deployment of various broadband

1 access technologies and allow the provisioning of more enhanced services and data  
2 rates as they are requested.

3 Q. Does this conclude your rebuttal testimony?

4 A. Yes. Thank you.