

Broadband Open Access: Lessons from Municipal Network Case Studies

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Abstract

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A growing number of communities in the United States and abroad are investing in publicly-owned “last-mile” broadband infrastructure platforms to deliver telephone, video, and broadband data services. In a number of jurisdictions, policy-makers have chosen to insist that municipalities interested in offering communication services over publicly-owned infrastructure must do so on a wholesale-only basis, providing open access to multiple retail service providers. To gain a better understanding of the challenges and implications of open access for broadband services and to provide a foundation for evaluating the advisability of mandatory open access policies, we discuss the lessons learned from a series of case studies of municipal networking in the United States and abroad. In some cases, an open access approach was adopted voluntarily (e.g., Spencer IA or Ashland OR), in others open access was mandated by state law (e.g., Grant County WA), while in many others, no open access is offered (e.g., Braintree MA). These case studies reflect a diversity of approaches that helps elucidate the relationship between open access and the technology/architecture used for the last-mile network, the business strategies employed by municipal communication service providers, and the regulatory environment in which the municipal networks operate. Important differences include the type of open access being provided (e.g., for Internet access v. telephone v. video v. for a bundle of services); whether the open access provider also competes in downstream retail markets; and the choice of technology or system architecture (e.g., HFC

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or FTTH). A better understanding of alternative open access scenarios is necessary before it is possible to evaluate whether (or how) public policy should promote open access. Additionally, these case studies shed interesting light on how future markets for broadband multimedia services may evolve in the future.

I. Introduction

Local access to the Internet has been a bottleneck. Slightly less than half of all U.S. end-users still connect over low-speed dial-up connections that severely limit the quality of multimedia services that can be delivered.⁴ For the Internet to continue to evolve, we need ubiquitous broadband access services. Moreover, for next generation networks, we need broadband access at data rates significantly faster than the 500Kbps to 3 Mbps DSL and cable modem services that are currently available. With 50 Mbps (or more) per home, a broadband access platform could deliver a comprehensive bundle of interactive video, data (Internet), and telephony services to each home. In many cases, the technology of choice will involve significant amounts of fiber optic transmission capacity deployed deep into neighborhoods (FTTx), perhaps all the way to the home (FTTH).⁵ Putting the local access infrastructure in place to support the ubiquitous delivery of such services will require upwards of a hundred billion dollars in new investment.⁶

Because fiber optic cables are long-lived assets and installing facilities in "last-mile" networks involves a substantial commitment of fixed/sunk costs, it is usually economic to install substantial excess capacity (relative to initial demand). Typically, each deployment includes sufficient capacity to serve 100% of the homes in a neighborhood. While it is certainly possible that in many locales there will be two or more facilities-based providers that are willing to invest in such infrastructure (*e.g.*, the incumbent local telephone and cable television companies), it is also possible that such next generation infrastructure will turn out to be a natural monopoly at least in some locales. For this reason, even if multiple providers do install high-capacity facilities, it is not clear whether effective competition will be sustainable.

In markets where facilities-based competition for next generation broadband access platforms proves unsustainable (or insufficiently robust), last-mile facilities will remain a "bottleneck."⁷ In such situations, policymakers will need to consider how best to regulate open access to bottleneck "last-mile" facilities. If there are inadequate facilities-based alternatives, then failure to ensure open access will pose a severe threat to

⁴ Auchard, Eric, "Broadband Passes Dial-up in U.S." MSNBC.com, August 18, 2004. <http://www.msnbc.msn.com/id/5750968/> visited August 26, 2004.

⁵ Both incumbent cable television and local telephone providers have been installing fiber deeper into their distribution networks, although it is still rare for fiber to be deployed all the way to the home or curb.

⁶ Estimates of the costs for deploying FTTH range from \$1,000 to \$2,000 per home for 108 million residences in the U.S.

⁷ That is, even though technically adequate capacity may exist to support all of the desired services, last-mile access will remain an economic "bottleneck."

competition in all of the upstream and downstream equipment and service markets that depend on access to a digital conduit between the home and wider-area network services.⁸

This paper examines the mix of technical, regulatory, and business strategy issues that arise if one contemplates implementing open access on next generation broadband platforms. Our analysis draws from lessons learned from a series of case studies of municipal utilities that have decided to deploy broadband access infrastructure. The cases were selected to reflect a diversity of approaches to open access. Some provide only wholesale access (*e.g.*, the publicly-owned utility in Grant County, Washington, is required by state law to offer communication services on a wholesale-only basis); some provide no wholesale access (*e.g.*, the publicly-owned utility in Braintree, Massachusetts, does not resell access to its platform to any third parties); and some are in between (*e.g.*, the publicly-owned utility in Jackson, Tennessee, provides wholesale access for voice and data services, but not for video services). These case studies provide insight into the challenges and drivers for adopting an open access strategy.

Focusing on municipally-owned infrastructure to better understand the evolution of broadband access infrastructure and open access policies is interesting in several respects. First, as already noted, municipally-owned utilities reflect a diversity of open access strategies while sharing certain common features that may allow us to better focus on how they differ with respect to “open access.” Obviously, for a more complete understanding, it would be useful *also* to study the technology and business choices by investor-owned communication service providers with respect to open access (*e.g.*, AOL/Time Warner’s decision to support unaffiliated Internet Service Providers (ISPs) on their cable network or Verizon’s policies toward DSL resellers).⁹

Second, focusing on municipally-owned utilities’ “open access” policies is interesting in the context of the larger debate regarding the appropriate role for publicly-owned communications infrastructure. Inspired by fears of unfair or inefficient public-sector competition, a number of states have passed laws prohibiting (*e.g.*, Texas) or limiting (*e.g.*, Washington) public participation in communication services. To fully assess the merits of such legislation, it is necessary to understand the landscape of approaches being employed by municipalities. The fact that municipal utilities that offer telecommunication services typically have *not* adopted open access policies (*e.g.*, provide wholesale access to their networks for unaffiliated telecommunication service providers)

⁸ These include all of the local and long distance telecommunication and data communication services that depend on a local access connection into the home; the media content and applications that are delivered via electronic communication networks; and the network and customer premise equipment that are used in the networks.

⁹ Voluntary adoption of open access among investor-owned service providers is rare. For example, the provision of open access in the two cases cited has been driven by public policy: the FTC required Time Warner to open its cable modem networks as a condition of the merger with AOL; Verizon is constrained to provide open access over DSL by Computer Inquiry 3. The FCC’s 2002 Video Competition Report found only two instances of a cable company voluntarily opening its network to competing ISPs (Stern, 2003).

suggests that such legislation – when it exists – is very important in influencing the utilities' strategies.

Third, while the share of communities served by municipally-owned telecommunication providers represents a tiny share of the U.S. population, municipal deployments represent a sizable share of the homes served by fiber optic access networks and by new fixed broadband wireless services (*e.g.*, WiFi-based networks and precursors to WiMax).¹⁰ Therefore, municipal deployments offer "early-adopter" insight into the technical and associated business strategies that are likely to characterize competition in next generation broadband platform services.

As already noted, the municipal telecom providers reflect an interesting diversity in open access approaches. Whether and how to provide open access is intimately bound up with the choice of technology and network architecture (*e.g.*, active star or PON?); the choice of a business model (*e.g.*, which services are offered on a wholesale or retail basis?); and regulatory policy (*e.g.*, who is allowed to share the infrastructure and how are “wholesale” prices for access set?). For example, it appears easier to implement dynamic open access to video services provided over a fiber system that employs an active star rather than a BPON architecture with an RF video overlay.

The balance of this paper is organized into three sections. Section II provides a descriptive overview of open access as it applies to next generation broadband access infrastructure in theory and practice. In Section III we identify a number of the challenges and issues that arise with respect to open access. Section IV concludes.

II. Open access to next generation infrastructure in theory and practice

A. What is “Next Generation Infrastructure”

There are a number of technologies and architectures that may be used to deploy next generation broadband infrastructure (wired or wireless), however to qualify as "next generation" -- as we define it here -- the infrastructure should be able to support multimedia voice telephony, broadband data (at rates in excess of 10 Mbps per household), and multichannel video distribution. This is likely to require 50 Mbps or more per household.

The “next generation” infrastructure is distinguished from the current generation of services provided by local cable television or telephone companies which offer broadband data at rates that are typically significantly below 10Mbps and do not (generally) support all three services (*i.e.*, no video for telecoms, no telephony for cable

¹⁰ There are about 2000 communities in the U.S. with municipally-owned electric power companies. Only a small share of these offer broadband Internet access, and very few non-municipal-electric companies appear to offer public telecommunications services. See, Gillett, Lehr, and O'sorio (2004), Vos (2004), and Alvarion (2004).

companies). Of course, both types of carriers are in the process of upgrading their networks to address these issues.

In many cases, fiber optic cables are a critical component in the next generation infrastructure. Fiber optic cables are long-lived and costly to install. Because of the high and largely fixed/sunk costs of local fiber facilities, and the very high transmission rates they support, it may be desirable for multiple service providers to share access to local fiber facilities. This may be necessary either if neighborhood fiber proves to be a natural monopoly, or adequately robust retail-level facilities-based competition proves unsustainable.

Upgrading to "next generation" local access networks will require substantial new investment, and the choice of technology will be heavily influenced by local conditions (*e.g.* terrain and outside plant construction cost factors) and the condition of legacy infrastructure (*i.e.*, telephone and cable television infrastructure in-place). Even if one abstracts from strategic effects (*e.g.*, is it a telephone company or a cable company whose plant is being upgraded?), the choice of technology and architecture are likely to be different if it is a greenfield *v.* rebuild *v.* overbuild situation (*e.g.*, new sub-division *v.* upgrading monopoly legacy plant *v.* new entry in neighborhood already served by incumbent provider).

Additionally, strategic factors will also prove important. A desire to shape future competitive or regulatory conditions may influence technical and architectural choices. For example, as already noted, it is more difficult to implement full open access on some architectures than on others. A carrier may seek to pre-empt future open access by their choice of last-mile architecture.¹¹

B. Defining Open Access: Economic/Regulatory Theory

Today, last-mile access networks comprise a technical *and* economic bottleneck. After being upgraded, "next generation" networks should no longer present a technical bottleneck that limits the range of service bundles that may be supported. However, if there are not a suitable number of facilities-based alternative access networks serving each home, these may still comprise an economic bottleneck. In economic terms, a "bottleneck facility" is an essential input for production of some service or good for which there is no economically viable alternative source of supply.

In its most abstract form, open access allows multiple downstream competitors to share a bottleneck facility that is a critical input for the services that are provided. In most cases, the bottleneck facility is owned by one of the firms that also competes in the downstream market. The access is open if it is sufficiently non-discriminatory that all competitors can access the bottleneck facility under equivalent cost and quality terms. This ensures that if the bottleneck provider competes downstream, that it does not realize a significant competitive advantage by virtue of its ownership of the facility.

¹¹ Banerjee and Sirbu (2005).

From the customer's perspective, there is effective open access if an end-customer can elect to receive service from multiple service providers offering services that could reasonably be considered substitutes¹² which are provided over a common last-mile infrastructure platform; and if the customer's range of choice is not unduly constrained by the inability of competitors to obtain access services.

In practice, it will be necessary to determine how many and what kind of choices are sufficient.¹³ For example, are two to three choices enough, or should it be some larger number? Should customers be able to choose among bundles, or perhaps, different service providers for each service? How dynamic should choice be? For example, should customers be able to choose video programming on a yearly, monthly, or call-by-call/program-by-program basis? Flexible and dynamic customer choice supports competition. On the other hand, architectures that enable very dynamic and flexible customer choice are likely to be more expensive to construct and operate, and result in higher customer churn. This is the downside of increasing customer choice. Presumably, the benefits of expanded customer choice in terms of enhanced competition and innovation will more than offset the higher costs of supporting increased churn. Additionally, in a world of high churn, adopting an open access regime that decouples network and retail-level decision-making may offer the best way to reduce churn costs¹⁴ and protect incentives to invest in infrastructure.¹⁵

¹² That is, in the "same market" as an economist would define it.

¹³ There may be technical or economic (minimum efficient scale) constraints that limit the number of effective retail competitors. How many is enough may vary from service to service, and market to market. For example, in an earlier era, policymakers debated the viability of sustaining a fourth or fifth national over-the-air television broadcast network; and today, policymakers are debating whether it is viable to sustain more than four mobile service operators.

¹⁴ That is, an "open access" friendly architecture is designed precisely to allow flexible customer choice and therefore lowers the cost of supporting any given level of potential churn. Of course how much flexibility is optimal also will be influenced by implementation costs (*e.g.*, how expensive is it to allow full *a la carte* service choices?).

¹⁵ In a market characterized by competition among vertically-integrated facilities-based providers with closed architectures (*i.e.*, limited wholesale access to networks), the investments in retail-level and network-related activities are co-specialized and the higher churn costs may result in reduced incentives to invest in infrastructure. That is, the demand that matters for infrastructure investment is the retail demand retained by the infrastructure owner. In contrast, if competition at the network level is decoupled from retail-level competition, the impact of churn may actually make adoption of an "open access" architecture lower cost. That is, an "open access" approach/architecture that enables flexible "mix-and-matching" among wholesale providers and retail-service providers (or, if the network is a bottleneck so there is only one wholesale provider, at least supports multiple retail-service choices) may actually have lower churn (switching) costs because this is precisely what it is designed to support. And, the investment in infrastructure (if a bottleneck) is driven by overall retail-level demand, not by the retail-level demand captured by any particular firm. If the expansion in customer choice results in faster aggregate demand growth (*i.e.*, sufficiently fast to overcome the higher costs associated with accommodating churn), infrastructure investment may be enhanced.

C. Open Access in Practice

Based on a series of interviews conducted in 2003-4 with representatives from municipal networks and 3rd-party service providers, and supplemented with secondary research sources, we conclude that there is no single definition of open access as it is offered in practice. In response to varying legal requirements and choices of technology and business model, diverse arrangements have arisen between network operators and 3rd-party service providers. Table 1 summarizes the independent dimensions along which these arrangements vary, presented from the perspective of a network operator defining an open access offering. Table 2 summarizes examples of specific municipalities and their choices within this space; more detailed narrative descriptions of the open access situation in some of these communities can be found in the appendix. With the exception of Braintree MA, which was selected as a control, communities were included in the study because they provide some form of open access. In addition to the cases studied in some depth and listed in Table 2, we are also aware of open access deployments in progress in three Public Utility Districts in Washington (Clallam, Douglas, and Mason Counties) as well as in Provo, Utah.¹⁶

1. Services

A municipality building a telecommunications infrastructure needs to make a number of inter-related decisions. These include deciding what services to offer and choosing a business model for offering those services. Residential services may include Internet access, telephony, and video (including both broadcast video and video-on-demand—VOD). Business services may include dark fiber leasing, point to point circuits (*e.g.* DS1 or OC3) or metro Ethernet. The business model will require choosing which customer classes to serve (residential, business, and/or local government), over what region (ubiquitously in the community or only in specific locations), and which to offer at a wholesale (*e.g.* to unaffiliated service providers) and/or retail level. In some cases, the business model decision will be constrained by state legislation: *e.g.* Public Utility Districts in Washington state may only provide wholesale services to retail service providers.¹⁷ Open access can be provided to any combination of supported services that the provider chooses (or is required by law to choose), and this choice determines the possible bundling strategies available to third party service providers. Which services to offer and whether to offer them on an open access basis are separable decisions. The technology deployed must necessarily be congruent with the choice of services and the business model.

¹⁶ Because data does not appear to be collected on which communities do open access (no doubt partly because of the difficulty of defining the term), we cannot claim to have an exhaustive list. Our knowledge of communities with open access is derived from the list of municipal FTTH deployments provided by the FTTH Council (available at <http://www.ftthcouncil.org/dbfiles/techexchange/2004%20-05-19%20OptFiberCommunList.pdf>), and personal communications with Ron Lunt, Director of Broadband Services for the American Public Power Association (APPA) and attorney James Baller of the Baller Herbst Law Group.

¹⁷ Revised Code of Washington, 54.16.330 available at <http://www.leg.wa.gov/RCW/index.cfm?fuseaction=section§ion=54.16.330>

2. Open Access and Layering¹⁸

Open Access can be provided technically in several different ways, and at several different “layers” of the network architecture (see Table 3). As one moves up the “Layers,” the facilities-based provider is providing an increasingly sophisticated and “finished” communications service.

At the most basic level, the municipality can supply conduit and collocation facilities, and competitors can pull their own fiber strands and supply their own electronics. We will refer to this as open access at “Layer 0”. This approach minimizes the municipalities’ role and allows service providers the greatest degree of flexibility in broadband access network they implement.

At a higher level of involvement, a community could adopt “Physical Layer” or, equivalently, “Layer 1” unbundling. This also leaves service providers a high degree of flexibility over the broadband network architectures and services that are implemented. For example, the community may deploy dark fiber and lease fiber strands to competitive providers. The community provides the physical infrastructure, but leaves the electronics and other higher-level service provisioning decisions to the service providers that lease the facilities. There are already active markets for dark fiber in local and long-haul transport markets. Such Layer 1 unbundling is analogous to when an ILEC leases copper strands as Unbundled Network Elements.

Layer 1 unbundling in a fiber network may also occur at the optical layer. In one model, each service provider transmits on its own wavelength and multiple suppliers are supported using Coarse Wavelength Division Multiplexing (CWDM). Alternatively, using Dense WDM, each user is served by a unique wavelength per user. Optical layer unbundling is consistent with Passive Optical Network (PON) designs (see Table 3 for a simplified taxonomy of FTTH architectures). Wholesale services at the optical layer can be found in long haul markets, but has yet to be seen in the access market.¹⁹

With Layer 1 unbundling, the municipality is assuming responsibility for the longest-lived elements of the local access network: the physical outside plant structures and fiber cable facilities. Meanwhile, the electronics (hardware and software) elements of the network, which are subject much more rapid economic depreciation are selected by the service providers.²⁰

The most common form of open access is at the Data Link layer, or Layer 2. In this case, the infrastructure provider deploys both the fiber and the link layer electronics at either end. Service providers are offered a basic network service which they can use as

¹⁸ For a more detailed discussion of open access in FTTH networks see Banerjee and Sirbu (2005).

¹⁹ (Mindel and Sirbu 2001b)

²⁰ Although there is also rapid technical progress in optical fiber and other outside plant infrastructure (*e.g.* antenna design, fiber installation technology), the presence of substantial sunk costs associated with installing physical infrastructure reduces the economic depreciation.

a platform for delivering a bundle of retail-level services. This can be accomplished using a variety of architectures. For example, where the deployed link layer is an Ethernet-like service, each service provider and its associated customers are assigned to a separate VLAN. If the operator is providing an ATM-based link layer service, then customers are assigned separate PVCs which are switched to the designated service provider. This is not unlike what happens in DSL networks today when an ILEC provides DSL service on a wholesale basis to an unaffiliated ISP via an ATM interface to the ISP. While providing the electronics for lighting the fiber, the operator might also provide what is normally viewed as a Layer 1 service: point-to-point circuits, for example using SONET Add/Drop Multiplexors (ADMs).

Finally, open access might occur at the network layer ("Layer 3"). Once again, this may be implemented in a number of ways. For example, in HFC networks, the cable modem and cable modem termination system implement an IP Layer 3 service over the cable. Policy based routers, or Multi-Protocol Label Switching (MPLS)-based Virtual Private Networks (VPNs) are used to separate traffic going to competing ISPs.²¹ This is the technology that allows Time Warner cable to provide wholesale service to Earthlink and United as well as to affiliates AOL and Road Runner.

The choice at which layer open access is provided thus has important implications over the extent of the community's investment and on-going role as a telecommunications service provider. It also influences how many service providers may be supported and what services they may offer. For example, while it is technically feasible to support video, voice, or data over an IP-based network and while an IP-based service can be implemented on most Layer 2 networks, this does not mean that all Layer 2 or 1 networks can support unbundling of all of these services. Implementing an adequate Layer 3 IP service to support open access for a comprehensive bundle of services is not feasible on all physical architectures. The complex relationship between the choice of open access architecture and unbundling options is best demonstrated via reference to how video services may be unbundled over broadband platforms.

Video services to the subscriber may be provided in one of two ways. In HFC networks, and some PON networks, multiple broadcast channels are frequency division multiplexed to form a broadband RF signal, which is sent in analog form over a fiber. In an HFC system, this signal is detected at a neighborhood node, and sent the remaining way over coaxial cable to the subscriber's TV or set-top box. In a BPON FTTH system, a wavelength separate from the data wavelength carries a similar RF multiplex, only the conversion takes place in an Optical Network Termination (ONT) unit on the side of the house, with coax used only for in-home wiring. In both HFC and BPON, one or more 6 MHz channels may be used to carry digitally encoded video rather than an analog signal, allowing for up to 10 channels in the same bandwidth as a single analog channel. In both HFC and FTTH PON systems, the same optical carrier serves 32-500 households. Typically, there are not enough channels available on the video wavelength to allow multiple service providers to each send their own package of programming to this group

²¹ Brayley (2003), Sonneson (2004), Flinsenber and Sijben (2004)

of households. Consequently, open access to video is inconsistent with HFC or BPON architectures.

An alternative approach to video delivery sends switched video as part of the IP data stream. Only the video program(s) currently being watched is delivered to that household as part of the data stream. An upstream IP message from a settop box sends a request to the switch to deliver a requested video broadcast to the household. With this approach, video is just another form of IP traffic, and multiple video programmers can be accommodated as easily as multiple ISPs. Delivering video in the data stream can greatly increase the amount of data traffic per household. For example, an HDTV signal requires 10-18 Mbps; multiple TV (or DVR) households might easily consume 40-50 Mbps of continuous video transmission. Because Active Star networks typically deliver 100 Mbps Ethernet to the subscriber, open video systems are more often associated with Active Star architectures and always with IP video delivery.²² Further, in order to minimize middle mile transport costs, switches and settop boxes must efficiently support multicast IP and the associated signaling protocols. Interoperability of settop boxes, switches and video headends for IP video delivery remains limited. Only in the last two years, with the rise of IP video delivery in Asia and Europe, have reliable, inexpensive, and interoperable products become widely available.

3. Partnership Model

Open access models also vary along regulatory and business dimensions, as shown in Table 1's options for partnership between network operators and 3rd-party service providers. The value proposition for both parties is shaped by whether the operator is a pure wholesaler (analogous to structural separation) or also competes downstream (analogous to vertical integration with a retail affiliate); the level of control the operator exercises over service provider entry; and whether the operator collects revenues directly from customers, or indirectly through regulated or negotiated wholesale prices to service providers. A network operator may have a choice regarding some of these aspects, but state laws may determine others. For example, Washington directly restricts Public Utility Districts to providing wholesale-only services, while Utah imposes burdensome restrictions on municipalities unless they provide only wholesale services (see APPA (2004) for further details).

The communities shown in Table 2 exhibit significant diversity along these dimensions, reflecting differences not only in state policies but also local historical and competitive realities. For example, at the time Spencer, IA was developing its business plan, HFC was the only economically viable approach. Spencer did not even consider providing open access to video, nor could they have, given the limitations of HFC. By contrast, Spencer was already served by four dial-up ISPs at the time the community was

²² By encoding multiple digital video signals in each 6 MHz channel, it is possible to transport more channels than there are subscribers served on a wavelength. This would permit the assignment of at least one channel to each subscriber, allowing for switched video delivery over an HFC or BPON network. This is how VOD is delivered today on HFC networks. A switched rather than broadcast approach would allow for support of multiple video service providers even on HFC or BPON.

considering building a municipal communications utility. The public decision process included a 1997 referendum, required by Iowa law before a feasibility study could be paid for, and a 1998 postcard campaign requested by Spencer Municipal Utilities (SMU) to show continued support once the system's costs were better understood. Both were very successful campaigns, in no small measure because the promise of 3rd-party access by the ISPs brought in its wake political support for the more advanced underlying network from the ISPs' customers. Spencer also chose to be the sole retailer of telephony services over the network as well. Once the initial 3-year agreement with local ISPs had expired, however, SMU found itself in a changed competitive environment. The local investor-owned cable TV system had been upgraded to provide broadband by its new owner, an operator with a larger regional footprint. Facing a vertically integrated competitor who could bundle TV and ISP service and could subsidize aggressive price competition based on revenues from other communities, SMU entered the retail ISP business in competition with its partners in March 2004. Representatives of both SMU and open access ISPs in Spencer observed that the ability to sell bundled packages of services was essential to the continued financial viability of the municipal data network. This case demonstrates the challenge of supporting open access in the presence of vertically integrated competition in one or more of the supported services.

Grant County PUD in Washington was one of the first to build an open access FTTH system, a choice dictated, as noted above, by state law. Grant County selected an Active star Ethernet architecture that allows them to provide separate VLANs to each service provider. Video and voice are both carried on the system as IP traffic. At the present time there are numerous ISP retailers but only two video and two voice service providers. While this approach offers a significant degree of "open access," it was also quite expensive (in part, because of issues with a "bleeding edge" technical platform) and the extent of voice and video competition does not appear overly robust. This is due, in part, to non-network-related factors associated with competition in video and voice services (*e.g.*, programming and customer-acquisition costs)²³.

Amsterdam has recently announced its intention to build a system with a unique business model. The city will deploy dark fiber. This in turn will be leased to a private provider, with exclusivity for the first ten years. This operator will in turn add electronics to create a layer 2 service which will be marketed on a wholesale basis to competitive Service Providers (SPs) (Figure 1) The city has left itself the option of allowing additional competitors at layer 2 after the initial period of exclusivity expires.

In some cases, municipalities have altered their views on open access in response to market realities. Kutztown, PA initially set out to build a wholesale-only, open access system. When they were unable to find service providers who were willing to provide retail service over their proposed FTTH network, they chose to provide service themselves. Jackson Energy Authority set out to build a closed system. However, when a lawsuit by a CLEC threatened to delay their financing at a time of rising interest rates, they agreed to settle the suit by allowing the CLEC to offer voice and ISP services over

²³ See further discussion below on importance of legacy issues on influencing extent of service competition.

their network. Video service delivery remains closed. Jackson's EPlus network is interesting for another reason: unlike ZippNet, where the retailers bill the end user and pay ZippNet for wholesale service, Jackson bills for EPlus along with its gas and electric services on a single bill, and forwards the revenue, less its wholesale charges, to the retailer.

Dial-up ISP service in the United States evolved under the constraints of Computer Inquiry 2, when "enhanced services" such as the Internet had to be offered by a separate, arms-length subsidiary acquiring basic telecommunications, such as incoming telephone lines, pursuant to tariff. Because the circuits were available through non-discriminatory tariffs, telephone companies exercised little control over who could get into the dial-up ISP business – as evidenced by the large number of companies that did. By the late 1990's there were more than 8,000 ISPs in the U.S.²⁴

Not surprisingly given the laws of their states, Grant County in Washington and the Utopia initiative in Utah have the most open access. Indeed, unlike the LECs, the network operator in these systems does not compete in retail services, and is in fact prohibited by law from doing so. However, unlike with dial-up, the wholesale price that the service provider pays is unregulated and voluntarily negotiated. Furthermore, because of the technical novelty and complexity of FTTH networks intended to carry IP services, the network operator has more control over what kind of service the 3rd-party provider gets. Early ISPs acquired simple telephone circuits and leased lines from the underlying carrier. Municipal wholesalers provide a much more complex service. The Ethernet VLANs offered by Grant County to service providers has different characteristics than the ATM PON service deployed in Chelan County.

The question of how much control the network operator exercises over entry by 3rd parties is still in a great deal of flux. At one extreme, Utopia tried to make a one-year exclusive agreement with AT&T to induce them to provide retail services, but the agreement was invalidated by the Utah legislature. At the other extreme, Spencer, IA simply provided access to all the dial-up ISPs in its community as well as a wireless ISP from a neighboring community that wished to expand into Spencer. In between, Tacoma puts ISPs through a "rigorous" qualification process before it allows them on its network, ending up with three providers. The fixed costs of setting up an ISP are small, and thus, not surprisingly, the greatest number of retailers is typically in the ISP services segment. Over Grant County's ZippNet, for example, there are 18 Internet SPs, 2 Video SPs and 2 voice SPs and one home alarm SP.²⁵ Until it was revised in July, 2004, ZippNet's wholesale price schedule favored SPs offering bundled services.

4. Beyond the Last Mile

Open access can also involve sharing of resources beyond the last-mile network. Voice and data services need to interconnect with the larger telephone and Internet

²⁴ <http://www.thelist.com>

²⁵ <http://www.gcpud.org/zipp/providers.htm>, Visited August 28, 2004.

networks, while video services depend on head end systems to collect programming for local distribution. As Table 2 shows, some communities have included sharing of such upstream resources as part of their open access arrangements.

For example, in Tacoma WA the municipal operator manages a backhaul link to nearby Seattle, and shares it with its 3rd-party ISPs. Backhaul to more remote areas is often a large enough challenge to require a cooperative approach among multiple communities. Grant County, located in rural eastern Washington, gets its backhaul from the Northwest Open Access Network, a regional fiber consortium of Public Utility Districts. In Spencer IA, each ISP arranges for its own backhaul, but both SMUNet and some of its 3rd-party ISPs get their traffic to Des Moines via Iowa Network Services, a statewide fiber consortium formed in the mid-1980s to provide equal access from rural telephone cooperatives to competing long-distance telephone companies.

Blacksburg VA provides an alternative model: while it does not provide a last-mile network, it does administer a neutral point of interconnection among local commercial providers, so that less backhaul capacity is needed. The regional approach to backhaul is built into the Utopia initiative, which aims to build interconnected FTTH networks in multiple (14 as of this writing) Utah cities and towns.

Grant County built its own video headend; it leases the use of the headend to retail video service providers. Because of the immature state of video IP technology when ZippNet began its deployment, it believed that controlling the headend as well as the ONT and settop boxes would insure interoperability. Moreover, a video headend represented a large fixed cost that acted as a barrier to entry for would-be service providers in its small market. By contrast, Utopia plans to leave all head end investment to private-sector operators. The difference in approaches may reflect timing; Grant County was one of the earliest adopters of IP video technology, and needed to seed the market for video over IP service providers. When I-Provo sought video SPs, it signed its first contract with a provider that got its start in Grant County.²⁶

Finally, Grant County operates a VoIP gateway with a standard 303 interface to a circuit switch. It is thus able to offer CLECs a virtual loop with a circuit interface, whereas the actual voice traffic travels as IP between the ONT and the gateway. They have even offered to provide wholesale softswitch services, but as yet there have been no takers.

III. Challenges to Providing Open Access

Several themes emerge from our review of the open access experiments already underway. In this section we highlight preliminary lessons learned and identify challenges that arise in formulating or evaluating an open access strategy. These are organized loosely into pricing issues; issues that arise as a consequence of or are tied to

²⁶ Gubbins (2004)

the underlying technology and how that is evolving; those that are an element of or constrained by regulatory policy; or, are associated with the business/industry economics.

A. Pricing Open Access

Given the absence of regulation, municipalities have been free to adopt a wide variety of approaches to pricing their wholesale services. Some communities, such as Grant and Chelan Counties, have published tariffs; others treat wholesale pricing information as proprietary and require would-be retailers to sign non-disclosure agreements. Jackson Energy is currently negotiating a contract with one retailer based not on prices for specific wholesale services, but on a percentage of retail revenues.

The challenge facing the infrastructure provider is that most of the costs for deploying the infrastructure to a home do not depend on the volume of services offered over it. Shared feeder or central office costs, which may be traffic sensitive, are a relatively small portion of the average cost per subscriber. This has led to wholesale pricing schemes which reflect that bundled services put little more burden on the infrastructure than standalone services. Thus, in Grant County²⁷, a wholesaler who provides telephone service only is charged \$10/mo/subscriber line (at the 303 gateway). An ISP only is charged \$15/mo/subscriber for 1 Mbps. However, a provider of both voice and ISP service pays the same \$15/subscriber to offer ISP and one telephone line. This gives a significant advantage to a provider that offers both ISP and telephone service.

Reflecting the limited impact of traffic on costs, upgrading from 1Mbps/subscriber to 10Mbps plus a phone line increases costs to only \$25/subscriber. 10Mbps is sufficient to provide IP video service, though a set-top box, headend, and content represent additional costs. The point is that a provider offering a triple play—and earning the revenues that represents—pays little more for the basic infrastructure than a service provider offering only Internet or only telephony.

Each subscriber served by a retail service provider will be assigned to the service provider's VLAN. The service provider will also need to purchase a high speed interface to the VLAN at the CO, or, pay additional fees for Internet transit, or, in the case of a video provider, for headend services.

B. Technical Architecture and Open Access Are Related

1. Technical Challenges

As noted previously, the decision to operate an open access network has implications for the type of technology deployed. On an HFC architecture, such as in Spencer, open access is provided at layer 3, given the limitations of the DOCSIS standards. PON systems corresponding to the ITU G.983 standards are ATM based, and can provide open access at layer 2 using ATM switching. Many of the Active Star

²⁷ ZippNet tariff dated 8/01/03.

products in the market are based on Ethernet, and thus separate service providers using VLANs. Whether at layer 2 or layer 3, providing open access to ISPs is relatively straightforward.

More difficult is providing open access for voice. One approach is to provide a virtual loop to CLECs, similar to what might be provided to a CLEC by an ILEC. On an HFC system, loop service, until recently, would be provided using circuit-switched or TDM technology. Some FTTH products also break out loops to a TDM interface at the Central Office Optical Line Terminal (OLT), particularly those based on ATM at layer 2.

Other systems, simply packetize speech using VoIP standards, and carry voice packets the same as data packets in the access network. This traffic can be converted back into TDM voice by a gateway in the central office, allowing traffic to be handed to a CLEC as though it came from conventional digital loop carrier equipment. Or the packet traffic can be routed directly to the CLEC in much the same way as data traffic is routed to an ISP. Signaling standards and lack of full interoperability of ONTs and softswitches, make this a more problematic solution, though Jackson Energy is taking this approach with its EPlus network. Handing the traffic off in packet format, particularly if both caller and callee are on the same network, avoids the cost of two gateway conversions, and so is likely to become more common as standards and interoperability mature.

To the extent that the infrastructure provides low latency “best effort” ISP service, any third party, such as Vonage or ATT Callvantage, can propose to offer telephony service to an existing ISP customer, without the infrastructure provider being able to realize additional revenues when this happens. Thus, a decision to provide open access ISP service may be tantamount to opening voice service to competition as well. However, when open access voice service is provided as part of the business model, CLECs may benefit from QoS capabilities that are only provided to voice service providers.²⁸

As noted earlier, open access video is difficult to deliver in a PON network using a video overlay. Open access for video implies IP video, which in turn implies significantly higher average data rates per household. This has implications for the access network design. Eliminating a video overlay can save money in electro-optics, while raising costs for increased IP transport and switching. The additional data traffic has led open access video providers to prefer Active Star architectures because bandwidth per household growth can more easily be accommodated. We found no examples of open video access over an HFC plant or a PON plant using a video overlay wavelength.

2. Economics of Open Access

A shared municipal infrastructure removes the barrier to entry represented by the high fixed costs of outside plant deployment. Nevertheless, each retailer will also have

²⁸ Cable MSOs who are providing both VoIP and Internet access—even when the latter is open access—limit the use of the DOCSIS standard QoS capabilities to their own voice offerings; they are not available to ISPs.

some fixed costs associated with providing service. An ISP retailer will need to invest in servers (email, DHCP) as well as middle mile transport; a video service provider needs a headend, contracts with content providers, operations support and billing systems, etc. The size of these investments imply a minimum market size for retailer viability, and thus a limit on the number of retailers sustainable over a given infrastructure. AT&T is quoted as saying that it needs a minimum market of over 100,000 households to justify its investment as a Utopia retailer. The municipality can reduce these service specific investments by investing in additional capital plant to be shared by competing service suppliers, as Grant County has done by building a shared video headend, or selling ISP transit over its NOAANet investment.

C. Regulatory and market legacy influences open access

The choice of services that are unbundled also owes much to the legacy regulatory and market issues associated with each service. For example, there is legacy of open access for Internet (ISPs), and to a lesser extent for voice (which is different yet again for local and long distance telephone service), but only in a much more limited sense for video.²⁹ These differences are due in part to the legacy of how the infrastructure for supporting these services evolved. That is, "data" services were an application that shared the Public Switched Telephone Network (PSTN); "voice" telephone services were the principal focus of the PSTN; and "video" (television) services were delivered over separate broadcast over-the-air and, later, coaxial cable networks.³⁰ The services and the infrastructure were closely coupled, and opportunities for cross-service bundling were limited (*i.e.*, video on PSTN or voice on cable networks). Service-specific and "conduit" (network) specific regulation evolved in each case.

In addition to these historical factors, there were additional legacy market issues associated with the type of community (*e.g.*, rural v. urban, level of economic development) and whether there was a municipally-owned power utility that affects the extent of and perceived justification for local or other government involvement in provisioning communication infrastructure services. These two are linked in that locally-owned power utilities are associated with two waves of development. The first was associated with municipal lighting companies that were established over a hundred years ago to provide street lighting in a number of early industrialized towns and cities (*e.g.*, Watson was a co-founder of the municipal utility in Braintree). These naturally evolved into electric power distribution companies. The second is associated with the post-Depression-era push for rural electrification and economic development that gave rise to rural electrical cooperatives and additional municipal electric power companies.³¹

²⁹ As will be discussed further below, the principal open access rules for video (television) have focused on content-level regulation. Cable television networks, although heavily regulated, have not been subject to strong open access rules.

³⁰ Of course, the video broadcasters leased facilities from the PSTN providers for program distribution to their cable head-ends and over-the-air broadcasting stations.

³¹ For further discussion, see Osorio (2004).

As a consequence of these divergent legacies, it is not surprising that unbundling data services appears easiest and is most common. This is true, in part, because there is an existing industry of ISPs who can be counted as customers for a wholesale ISP service. The emergence of the ISP industry is due in part to the legacy of telephone regulation that precluded Incumbent Local Exchange Carriers (ILECs) from restricting ISPs from using dial-up voice circuits to support data traffic. Common Carriage rules and the Computer II decision constrained the ILECs ability to provide discriminatory access to basic telephone transport services.

1. Telephone Regulation, Data Services and the Emergence of the Internet

The open access tradition with data services also benefited from the fact that these were used principally by commercial customers, and in decades past, mostly by large enterprises. Additionally, because of the heterogeneity of data traffic and its requirements (*e.g.*, connections between super computers v. an airline reservation system v. corporate email), much of the investment and infrastructure associated with data networks is owned and controlled by end-users. While the PSTN did provide facilities for data transport among customer-locations, this was, in the case of IP, viewed as an "information service" and was subject to substantially less regulation than was the "basic telephone services" that were the principal focus of PSTN regulation³². Because data communications were not a mass-market service the need for and support for direct government regulation was less.

Over time, as competition became feasible, the legacy monopoly regulation of the PSTN has been relaxed for successive portions of the network. This happened first for telephone handsets and other customer premise equipment (CPE) starting in the 1960s. Open access for CPE was ensured by defining clear demarcation points for where the PSTN ends and the customer's premises network begins. Technical interface specifications helped ensure open interconnection of CPE to the PSTN, and the monopoly provider of the PSTN, the Bell System, was precluded from competing in computer equipment markets. This separation helped protect computer software and hardware markets from the burden of telecommunications regulation and from a risk of monopoly leveraging by the Bell System.

Competition for long-haul services began to emerge in the 1970s,³³ which culminated in the divestiture of the Bell System into separate long distance and local telephone service markets in 1984. The traditionally integrated end-to-end telephone network was separated into separate local and long distance serving markets on the basis

³² Other switched data network services, such as X.25, Frame Relay, and ATM have all been classified as "basic" telecommunications, although they typically have not been subject to close price regulation. See Mindel and Sirbu (2001a).

³³ For example, MCI emerged as a provider of private leased lines in the 1970s. It's expansion into switched telephone services helped propel the eventual divestiture of the Bell System.

of regulatory-defined LATA boundaries.³⁴ This created the framework for transitioning to competition in long distance (interLATA) services. The Bell Operating Companies (BOCs) which became the local telephone service providers continued to be regulated as franchise monopolies. To ensure all long distance carriers, "open access" to last-mile network facilities controlled by the BOCs, the BOCs were required to implement "Dial-1 Equal Access,"³⁵ and at the same time, were prohibited from participating in interLATA services.

Open access for data services was supported via the FCC's classification of telecommunications into "basic" and "enhanced services." The basic services, which included basic telephone service, were subject to common carriage regulations which required service providers to offer these services at tariffed rates subject to substantial regulatory oversight. However, drawing the boundary between what constitutes a basic and enhanced service was not always simple and has become less so with the convergence of communications and computing technology. This gave rise to the sequence of so-called "Computer Inquiries".³⁶ Computer I (1966) sought to delineate the distinction between common carrier telecommunication services and unregulated data processing services. Computer II (1980) introduced the "basic" and "enhanced services" distinction to further clarify the boundary and maintain adequate structural separation between traditional voice services which were heavily regulated and enhanced services which the FCC chose to forbear from regulating under Title II, relying on structural separation. These rules were further reformed in Computer III (1987) in light of the changes in industry structure after the divestiture of the Bell System and the further progress of industry convergence. Computer III relaxed the separate subsidiary requirement but sought to implement a set of safe guards that would allow the dominant carriers – the BOCs and AT&T -- to provide enhanced services with only an accounting separation, provided they opened their network to competing ESPs. An "Open Network Architecture" model was adopted under which the dominant carriers were required either to unbundled their entire network (ONA) or to offer Comparably Efficient Interconnection (CEI) plans which specified how the carriers would provide competitors with wholesale access at tariffed rates to the services used to support the carrier's own offering of enhanced services. These safeguards sought to ensure a level of open access for enhanced serving provisioning without requiring structural separation of the wholesale network and affiliated enhanced services retail operations.

³⁴ LATA is the acronym for Local Access Transport Area, which defines the geographic area in which a local telephone company may provide service and was intended to approximate the dimensions of a local calling area.

³⁵ Previously, all "dial-1" long distance calls were automatically routed to AT&T (the former long distance part of the Bell System). Calls to other long distance providers needed to be routed first to the carriers switch via a separate number. Equal Access was implemented to allow end-users to pre-select their "Dial-1" long distance provider. Although it has never been used much, it is also possible to select among long distance carriers on a call-by-call basis by dialing a seven digit Carrier Access Code (101-XXXX) before each call. See FCC(2002c).

³⁶ See Esbin (1998) for an excellent discussion of the evolution of FCC policy for regulating data services.

With the passage of the Telecommunications Act of 1996 ("TA96"), open access was extended to local telephone service markets which mandated Layer 1 unbundling. The ILECs were required to provide Unbundled Network Elements (UNEs) to provide facilities-based "open access" to new Competitive Local Exchange Carriers (CLECs). On the promise of the TA96, hundreds of CLECs invested billions of dollars nationwide to enter local access markets,³⁷ but they remain heavily dependent on ILECs for last-mile access facilities provided under the TA96's open access rules.³⁸

The TA96 also established a state-by-state process for relaxing the restriction against BOC participation in interLATA long distance services pending a regulatory finding that the BOC had complied with the TA96's open access rules (*i.e.*, Section 271 approval).³⁹ With the general granting of Section 271 approval, the regulatory-induced separation between long distance and local telephone services was expected to disappear.

This legacy of strong wholesale-based open access regulation for the physical-infrastructure of telephone networks coincided with the emergence of the Web and the Internet as the first mass-market platform for data communication services in the 1990s. Although there was concern about a "Digital Divide" that was analogous to the earlier concerns that helped motivate support for universal telephone service,⁴⁰ there was no general agreement as to how best to promote universal Internet access (or even the need for such promotion) and there was strong opposition to extending to the Internet the same sort of universal service rules and implicit subsidies that characterized telephone service regulations. Internet services were regulated as an "information service" which meant that ISPs and CLECs supporting Internet access were free from many of the obligations that encumbered providers of basic telephone service.

The emergence of a competitive ISP industry also benefited from the fact that mass market access was initially provided mostly over switched dial-up lines, the provision of which were subject to strong local retail rate and service regulations. This helped create a unified market with low entry costs for ISPs. The highest cost elements were associated with CPE or with the local access infrastructure. The former was under the responsibility of the end-user, while the latter was heavily regulated by PUCs and the FCC.

The promotion of open access in broadband services via telephone networks was initially supported at the logical layer by the CI3 rules, and at the physical layer by the

³⁷ ALTS (2003) estimated cumulative CLEC investment since 1996 of \$71 billion.

³⁸ As of December 2002, the FCC reported that CLECs were serving 13.2% of end-user access lines in the United States, but only about a quarter of these were served over CLEC-owned facilities.

³⁹ Sections 251 and 252 of the TA96 established the open access unbundling and resale obligations; while Section 271 established the conditions and process for approving BOCs for interLATA entry. The FCC was tasked with establishing the detailed rules for implementing the TA96, with much of the actual implementation being left to state Public Utility Commissions (PUCs).

⁴⁰ The push for universal telephone service was driven as much by concerns over interconnection as by concerns over making telephone service ubiquitously available in the United States (see, Mueller, 1997).

FCC's broad interpretation of the TA96's open access rules. The latter enabled the emergence of data-focused CLECs, or "DLECs" such as Rhythms Netconnections, Covad, and Northpoint which provided the infrastructure for emerging DSL broadband services provided over ILEC copper loops. This provided ISPs with a migration path that would not require them to integrate forward into ownership of the underlying data link or physical infrastructure in order to continue to survive in a broadband world.

2. Television and Cable Regulation

The dominant video service has historically been television which was originally delivered via terrestrial over-the-air broadcast networks. The focus of regulatory oversight for television has been on providing access to RF spectrum for broadcasting networks and on content regulation to ensure adequate programming diversity and to limit objectionable content (censorship).

Over-the-air broadcasters opposed the emergence of coaxial cable television networks which held the promise of offering an alternative physical distribution channel for television. Nevertheless, these systems were extended over time and have substantially transformed the television entertainment industry. The local cable distribution networks were regulated as municipal franchises, which lead to a hodge-podge of intrastate and interstate regulatory policies. Over time, the industry has become dominated by a few national multi-system operators such as Comcast, Cablevision, and Time-Warner which operate national distribution networks that cover most of the same homes that are also passed by local telephone networks.

In contrast to telephone regulation, television services have not been subject to significant facilities-level or "conduit" open access regulation. The open access rules that have existed have been associated with "content" regulations that were intended to promote programming diversity and access to content for alternative distribution media. Program access, "must carry," and media channel ownership restrictions were used to ensure open access to content.

The emergence of a national cable television industry gave rise to national regulation of cable television networks. Cable television married the concerns of traditional broadcast "content" regulation and telecom "conduit" regulation, and gave rise to its own form of national regulation with the creation of a separate cable services bureau in the FCC. National rules for retail rate regulation were established and cable television services went through a see-saw of regulation, deregulation, and reregulation during the 1980s and 1990s, culminating in the Telecommunications Act of 1996, which sought to eliminate or curtail regulatory barriers and constraints on cable television providers (*e.g.*, by eliminating municipal or state limits on cable television entry).

With the emergence of cable modem broadband access to the Internet, and with AT&T's acquisition of national cable properties (subsequently divested to Comcast in 2002) and the AOL/Time-Warner merger, there was growing concern regarding the need

for open access to cable television networks for data services.⁴¹ Although this debate continues, strong open access rules analogous to what has been required for telephone infrastructure have not been mandated.

Additionally, with the growth of alternative distribution media channels in the form of the Internet and direct broadcast satellites (DBS), there has been increased pressure from the industry and from the FCC to relax media ownership rules that would have facilitated the further deregulation of broadcasting and content services. The progress of this trend, however, has been challenged recently by a reaction among the public and in Congress to protect media ownership diversity and to institute stronger content censorship rules, which may extend to the Internet.

3. Digital Broadband Convergence

With the transition to broadband, the regulatory situation becomes much more complex. The progress of technology makes it feasible today for each of the network platforms to offer similar services, bringing into collision the requirements and concerns of legacy service/network/industry-specific regulation. It is no longer feasible to neatly classify networks, services, or providers as broadcasters vs. cable television providers vs. telephone service providers.

The patchwork of conflicting and diverse regulatory frameworks is illustrated in Table 5, which identifies some of the complexity as it existed in 2001. For example, ILECs had been required to provide facilities-level unbundling of DSL services, but this is no longer required. Cable companies have not been required to unbundle modem service, but the regulatory debate over open cable access continues.

Under Chairman Powell's leadership, the FCC has moved to roll-back substantially the open access provisions of the TA96. The elimination of line-sharing for DSL was one example, and the FCC's Triennial Review Order ("TRO")⁴² anticipated further reductions in UNE obligations, particularly for advanced FTTH networks, where not unbundling obligation will be imposed. With the First Circuit's overturning of the FCC's TRO, further relaxation in the remaining open access rules imposed on ILECs are anticipated.

Thus, in the near-term at least, it looks like federal policy is moving toward further deregulation of both telephone and cable television local access infrastructure, and away from strong "open access" regulation.

⁴¹ See, for example, Lemley and Lessig (2001).

⁴² See *In the matter of Review of the Section 251 Unbundling Obligations of Incumbent Local Exchange Carriers, Federal Communications Commission*, CC Docket No. 01-338, *Implementation of the Local Competition Provisions of the Telecommunications Act of 1996*, CC Docket No. 96-98, and *Deployment of Wireline Services Offering Advanced Telecommunications Capability*, CC Docket No. 98-147, "Report and Order and Order on Remand and Further Notice of Proposed Rulemaking," No. FCC 03-36, Released August 21, 2003 (the "Triennial Review Order," or "TRO").

At the state-level and local level, the regulatory picture is more mixed. For example, there is a growing trend towards municipal entry into telecommunication services, as noted earlier. States have adopted divergent policies towards such entry, with some passing legislation to prohibit it. A recent Supreme Court decision leaves this patchwork of divergent state rules intact, at least for now.⁴³ Whether states or local governments will seek to fill a perceived regulatory void or whether Congress or the FCC will move to preempt additional regulation of last-mile services remains to be determined.

Finally, the uncertain regulatory environment is further aggravated by the growth of Voice-over-IP (VoIP) services. With all types of carriers using IP-based transport to support portions of voice telephone calls and with the growing prominence of Internet-based telephone service providers like Vonage, VoIP services are once again acting as a forcing function for regulatory policy. With improvements in the underlying infrastructure and management of IP networks, it is increasingly feasible to offer VoIP services that have comparable quality to traditional fixed line services. As the services become more similar from a retail, customer-perspective, it becomes increasingly difficult to retain divergent regulatory treatment for voice telephony that varies based on the type of carrier or network over which a call is carried. The growth of VoIP presents its greatest challenge for intercarrier compensation schemes that set different regulatory rates – typically well-above economic costs – for access (*e.g.*, interstate vs. intrastate, switched vs. special, interLATA vs. reciprocal compensation). These divergent rates are inconsistent with promoting effective competition and providing appropriate investment incentives for incumbent and new carriers.

The growth of VoIP helps drive industry convergence and increases the likelihood that, at a minimum, there will be duopoly competition between the incumbent cable and telephone companies, at least with respect to bundled (first-generation) broadband data and telephone services (local and long distance). While both incumbent telephone and cable carriers are continuing to expand access throughout their coverage areas to first-generation DSL and cable modem broadband services, and incumbent cable television companies appear to be moving rapidly to deploy telephony services (sometimes via VoIP and sometimes via other technologies), ILECs face a bigger challenge with respect to offering video services.⁴⁴ Delivering video services to homes over ILEC last-mile facilities that are comparable in scope and quality to what cable companies can currently do will require substantial new investment by ILECs.

If the ILECs make the necessary investments, it is unlikely that they would simply replicate the capabilities of existing cable companies. At the same time, the cable

⁴³ See *Nixon vs. Missouri Municipal League*, which ruled that the Telecommunications Act of 1996 did not pre-empt state laws of this kind which might restrict municipal entry; however, the Court did not address the merits of such laws.

⁴⁴ One approach that has been considered would combine DBS and ILEC services. For example, in April 2002, SBC and EchoStar announced a joint venture to market video programming (see, <http://www.sbc.com/gen/press-room?pid=4800&cdvn=news&newsarticleid=7500>).

companies are continuing to invest and modify their network architectures to expand the range and quality of services they can deliver. As we noted earlier, it remains unclear how intense competition will be among whoever ends up building next generation networks.

Although the precise nature of future regulatory policy remains uncertain, it appears likely – and indeed desirable – that if open access regulation persists in the future that it will need to be more homogenous across access platforms. As the traditional technical, service, and industry classifications have eroded, so has the viability of retaining divergent regulatory treatment across the physical networks.

D. Voluntary Adoption of Open Access Remains Rare

We estimate that 250-300 communities in the U.S. operate a publicly owned network that offers communications services to the public,⁴⁵ while only about 25-30 of these offer some form of open access. In other words, around 90% of publicly owned communications systems in the U.S. are vertically integrated and closed to third parties for all the services they offer. The cases we have studied suggest that sustained open access is unlikely to emerge in the absence of regulations requiring it.

Communities have diverse reasons for making public investments in communications infrastructure. If the goal is to jump-start a transition to competition, an open access strategy may be adopted. The concern of many communities, however, may be less with competition than with getting any local investment at all into advanced communications capabilities, in support of (relatively short-term) economic development. Particularly if the local public utility has a long history of strong public support, open access may simply never be considered as an option. Competition in the last mile may also not seem as urgent if other parts of the value chain (e.g. middle-mile backhaul) are monopolistic bottlenecks as well.

It is conceivable that open access would become more prevalent among emerging municipal FTTH systems. As discussed above, FTTH encompasses a range of technical architectures, some of which make open access relatively easier to support. In addition, the large investments required to deploy all-fiber networks, and the network's ability to support a full range of services, raise political concerns about monopolization of the system and public sector investments competing unfairly with private. Both of these concerns can be addressed by adoption of an open access strategy in which the market in communications services is left to private sector competitors.

⁴⁵ Based on an annual survey conducted and validated by the American Public Power Association, 246 public power companies in the U.S. offered some form of communications service to the public as of December 2003; another 323 operate communications networks for their own internal purposes, such as automated monitoring and management of the electrical system; see Gillett, Lehr and Osorio (2004) for further discussion of this data. Systematic data does not appear to be collected about non-public-power deployments, but to the best of our knowledge, these are relatively rare. Utopia is one example, while Vos (2004) also lists 13 U.S. non-public-power communities offering wireless services to the public.

Given the nascent state of municipal FTTH, however, it is too early to judge whether open access will actually be more common in these communities. Most public FTTH deployments are still in the planning or early deployment stages, and as the stories of Kutztown PA, Spencer IA, and Jackson TN described above illustrate, eventual open access policies can differ from original intentions.

Not surprisingly, the communities with the most open forms of access are those in Utah and Washington, where state law requires (or essentially requires, in Utah) public operators to restrict themselves to a wholesale-only role. Our case studies suggest that these laws have been essential to holding the public operators to their originally stated intentions. Grant County WA, for example, struggled with lackluster performance from the one CLEC that originally opted to provide telephone service on their system, and if they had the choice would probably opt to provide this service themselves to make the overall system more successful. Utopia seemed to find it necessary to promise a year of exclusivity to AT&T in order to entice them to provide triple play services, but this agreement was invalidated by the state legislature. Iowa has no such law, which allowed Spencer's SMUNet to change its open access policy after several years to compete with its 3rd-party ISPs in retail services. This change in policy reflects a structural incentive that arose because SMU was already vertically integrated into all its other services, and faced serious competitive pressure from the local cable TV and broadband provider with bundled offerings that consumers preferred.

A key rationale for open access is to promote service competition where it would otherwise not be possible, because of natural monopoly in the underlying facilities. However, while it may be true that an all-fiber last-mile network is likely to be the only one in its community and have economic characteristics of natural monopoly, it is almost never the only network when one considers subsets of the supported services.⁴⁶ None of the U.S. communities in Table 2 has a triple-play competitor, but all of them have vertically integrated competitors in single services (telephony, cable television or consumer broadband ISP), and some in dual services (e.g. telephony and DSL, or cable TV and cable modem). As Spencer's story suggests, open access limits the flexibility of overall competitive response, for example in the face of bundled pricing for packages of services. Given that access costs per subscriber are relatively fixed and independent of the services carried, a viable wholesale pricing scheme may lead to such a large access cost that only retailers of bundled services can afford the fixed costs of access per subscriber. Alternatively, it may make more sense to sell access separately to the subscriber, leaving retailers to charge only the incremental cost of services. This is not unlike what is happening in the broadband market today where subscribers buy broadband ISP access and pay separately for VoIP or video delivery services over the connection. It has been alleged that open access may have the perverse consequence of

⁴⁶ The entire U.S. has access to satellite-based cable television. Aside from Indian reservations, practically every U.S. community has a copper-based telephone network, many of which have been upgraded to support DSL, as well as access to mobile telephony. Most communities also have wired cable television, and a large fraction of those have been upgraded to support cable broadband. A few communities also have wireless broadband providers.

making a next generation network financially unsustainable in the face of competition from older and less technically advanced, but vertically integrated, networks.⁴⁷ This would especially be true if customers do not find the technical advancements particularly compelling – a distinct possibility in the short term, since given the nature of network effects and the early adopter nature of municipalities *vis a vis* next generation infrastructure, the applications necessary to take advantage of these technical advancements will take some time to emerge.⁴⁸

In this respect, state laws requiring open access may have been essential to seeding the market for advanced services and companies to provide them. Open access can only work if private companies find it in their interest to act as 3rd-party service providers, and as the discussion in the previous paragraph suggests, the competitive viability of the open access arrangement may be enhanced if those companies take innovative advantage of what next generation infrastructure has to offer. For example, Kutztown PA faced no legal requirement for open access. When the national vertically-integrated service providers that serve Kutztown had no interest in acting as 3rd-party service providers, and other providers declined to antagonize large competitors over such a small market, Kutztown simply elected to provide video and data services themselves, while trying harder (and this time succeeding) to find a 3rd-party telephony provider, given the barriers imposed by state licensing rules for CLECs. In contrast, Grant County WA, because of its legal requirement to provide open access in all services, went to some lengths to enable the emergence of a video-over-IP service provider (the Video Internet Broadcasting Corp. or VIB.TV). This firm is now offering services in other communities as well, including Douglas County WA and Provo, UT, making it easier for them to successfully pursue open access approaches.

IV. Conclusions

Prospects for competitive access to next generation last-mile broadband network services remain uncertain. If facilities-based competition for broadband access turns out to be inadequate, then it seems likely that some kind of mandatory open access framework will be required. However, excess regulatory uncertainty or fear that the policies will be inappropriate can retard investment in next generation infrastructure. Fear that a bottleneck will persevere in the future and market power over the bottleneck may be leveraged into adjacent markets (*e.g.*, CPE, content, or enhanced services) may deter investment in complementary assets (*e.g.*, home networking, interactive media, or VoIP technologies). On the other hand, fear that regulators may implement open access in a way that denies the bottleneck carrier an opportunity to recover its economic costs (including earning a fair return on invested capital) may deter investment in bottleneck facilities. The stakes are high since a failure may preclude the emergence of effective

⁴⁷ In particular, this criticism has been leveled at Tacoma WA's Click! Network: see See Tuerck *et al* (2001).

⁴⁸ Further research is needed to illuminate the dynamics and sustainability of competition between open access and vertically integrated providers under different demand scenarios.

competition and the realization of continued growth in broadband Internet infrastructure and services.

Our review of the issues demonstrates the high degree to which the policy debate is inherently multi-disciplinary and complex. There are a mix of technical, economic, and legacy business and regulatory factors that affect what type of open access is feasible and the cost-benefit assessment of these alternatives. Moreover, these are changing over time with technical progress, the growth of broadband Internet services and applications, and with the learning experiences from early adopters.

We see little evidence that open access would be adopted voluntarily, in the absence of a strong policy-framework that encourages its adoption. Arguably, one might suppose that municipalities might be more inclined than investor-owned, profit-maximizing providers to adopt an open access policy, and yet we see few choosing such an approach. The few who have have been heavily influenced, if not fully constrained by, regulatory policy.

We also do not see wide support for mandatory open access policy at either the federal or state level. Although a number of states have considered mandating structural separation for ILECs, none has yet to do so. Additionally, a growing number of states have adopted legislation that limits or encumbers local government entry into communication services. At the federal level, the FCC appears poised for further deregulation of broadband services, with little appetite for imposing open access on cable television providers or of retaining UNE requirements for services used to support broadband access.

This would suggest that "open access" may be a policy with limited prospects for the future. However, we believe such a conclusion would be premature. The fact that implementing open access is difficult provides a sufficient reason for why it has lost favor among policymakers. On the other hand, the risks of failing to ensure open access if facilities-based competition fails to evolve successfully are potentially also quite large. Additional research into how open access might be effectively implemented and its implications for regulatory policy, technology, and industry structure enriches our understanding of industry economics and prepares for the eventuality where we may find ourselves needing to impose mandatory open access on next generation broadband infrastructure. The analysis presented here demonstrates the importance of past decisions regarding the choice of architecture, regulatory policy, and business models on the costs and success of open access policies. This provides a further justification for prospective analysis to reduce the costs of current and future regulations.

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VI. Tables

Table 1: Open Access Decision Points for Network Operators

Open Access ...	Options
...to which services?	<ul style="list-style-type: none"> • Voice: Telephone • Data: Internet access (i.e. consumer-oriented ISP services) • Data: Broadband transport (i.e. dark fiber, point-to-point circuits) • Video: Television, video on demand
...at what layer?	<ul style="list-style-type: none"> • Physical: Ducts, conduits, poles; Dark fibers; RF channels; Synchronous circuits • Data link: ATM PVCs, Ethernet VLANs • Network: VPNs
...with what partnership model for service providers?	<ul style="list-style-type: none"> • Network operator also competes in retail, or not? • What type of control does network operator exercise over identity and number of service providers? • Who bills customer / who pays whom, and on what basis? • Wholesale prices negotiated or regulated?
...to facilities beyond "last-mile" distribution?	<ul style="list-style-type: none"> • Voice and data: Shared middle-mile backhaul; shared VoIP Gateways; interconnection point(s) • Video: Shared head end

Table 2: Examples of Municipal Choices *vis a vis* Open Access

Community	Architecture	Services / Layers / Upstream				Partnership Model	VII. Comments
		Voice	Data (ISP)	Data (xport)	Video (TV)		
Braintree, MA (Braintree Electric Light Department)	HFC, 750MHz digital cable plant	Not offered	Closed	Closed	Closed	None	Open access not considered. Competes as second cable operator in community served by both investor-owned telco and cableco with broadband.
Spencer, IA (Spencer Municipal Utilities, SMUNet)	HFC	Closed	Open network layer. Independent backhaul for each ISP.	Closed	Closed	4 3 rd -party ISPs. As of 2004, SMU also competes as retail ISP. For 3 rd -party ISPs, customer pays separate charges for network & ISP service (though can be on one bill).	Original commitment to open access helped motivate ISP customers in referendum. 3-year agreement with ISPs, not renewed in face of bundled competition from vertically integrated cableco.
Ashland, OR (Ashland Fiber Network)	HFC/GigE	Not offered	Open network layer	Closed	Closed	8 "Certified" ISPs	
Tacoma, WA (Click! Network)	HFC	Not offered	Open network layer; Click! manages backhaul to Seattle, shared by ISPs	Closed	Closed	3 ISPs. Click! not a retail ISP. "Rigorous" RFP process for ISP selection. Customer pays ISP, who pays Click! negotiated price based on # customers at different bandwidth tiers.	Governed by Utility Board appointed by City Council. Utility management might prefer reduced managerial complexity and revenues associated with non-open access.
Grant County, WA (GCPUD/Zippnet?)	FTTH, star with active video	Open @ L2 (VLANs) shared gateway for CLECs	Open @L2 (VLANs) middle mile services via NOAANet	SONET and Ethernet services	Open @ L2 (VLANs); Provides shared head end for video providers,	wholesale model is mandated, but wholesale prices not regulated. 18 ISPs, 2 video, 2 voice, one alarm service	State law requires wholesale-only for PUDs.
Chelan County, WA PUD	FTTH PON	Open@L2	Open@L2	Dark fiber and leased	Not yet available	Wholesale model is mandated, prices are not regulated	

Kutztown, PA (Hometown Utilicom)	FTTH, Optical Solutions 2 fiber ATM PON	Open@L2	Closed	??	Closed	Shared headend for video providers	Customer pays Conestoga Telephone Co. who pays HU \$7.50/8.50 per mo per residential/business customer	Wanted to but claimed could not find 3 rd party willing to assume retail functions for data and video. Now that market proven, Conestoga interested in ISP but HU not.				
Jackson, TN	FTTH Active Star+PON (Wave7 system)	Open L2	Open L2		Closed			Voluntary to settle CLEC law suit seeking access that was under appeal.				
Taunton, MA	FTTH							Trial, being talked about for open access.				
“Utopia,” UT (11 communities)	FTTH	Open L2	Open L2		Open L2	Open L2	Retail service provision severely restricted by state law; wholesale-only models exempt (Utah HB 149)	Previous exclusive deal with AT&T was disallowed by State legislature.				
Amsterdam, The Netherlands	FTTH	Open L1 & L2	Open L1 & L2		Open L1 & L2	Open L1 & L2		Dark fiber leasing and initially an exclusive franchisee for L2 wholesale services, with potential for additional wholesale franchisees in future. Franchisee is also sales agent for dark fiber.				
Stockholm, Sweden	FTTBbuilding	Open L1	Open L1		Open L1	Open L1		Carriers and municipality jointly own fiber and multiple carriers integrate L2 and above to offer competing services.				
Pasco, Wa	Wi-Fi wireless		Open L2									

Table 3: Open Access and Layering

Layer:	Municipality provides...
0	Conduit and collocation facilities.
1 (Physical Layer Unbundling)	Dark fiber leasing, or perhaps, Optical Layer unbundling (CWDM or DWDM) in PONS
2 (Data Link Layer Unbundling)	Dark fiber and link-layer electronics at each end. For example, Ethernet-based VLAN, or ATM-based PVCs.
3 (Network Layer Unbundling)	Basic network service provided. For example, IP Layer 3 service over cable to support MPLS-based VPN.

VIII. Table 4: FTTH Technology Support for Service-Level Competition

Architecture	Description	What's Shared
HomeRun	Dedicated fiber per subscriber (direct connection between subscriber and meet point)	Meet point. Customer chooses how to use fiber and whom/what to connect to.
Active Star	Signals switched at node between user and meet point (e.g. Ethernet)	Between meet point and node.
Passive Star	Signal's power split at node between user and meet point (virtual bus architecture, e.g. FSAN/ATM PON)	Between meet point and user.
WDM PON	Evolving: Dedicated wavelength per ... (service, provider, or subscriber)	Depends. Frequency unbundling, maybe.

Table 5: U.S. Requirements for support of service-level competition (as of 2001)

		Type of Service		
		Voice	Data	Video
Type of Provider	ILEC	UNEs, collocation and resale (TA '96 §251c)	<ul style="list-style-type: none"> • UNEs, collocation and resale (TA '96 §251c) • Line sharing, DSL UNEs (FCC Report & Orders 3 & 4) • Separate subsidiary: not (merger conditions invalidated by courts; but, watch PA) 	3 choices under TA '96 §302 <ul style="list-style-type: none"> • None ("cable"): just usual broadcast and programming rules • Hybrid: "open video" • VDT: "common carriage video"
	Incumbent cable operator	Allow access to rights of way, don't prohibit resale, etc. ("CLEC" rules: TA '96 §251b)	<ul style="list-style-type: none"> • Statutory: none • Court rulings: none <ul style="list-style-type: none"> • ATT v. Portland: locality can't require, but FCC can • MediaOne v. Broward County: open access violates 1st Amendment • Merger conditions <ul style="list-style-type: none"> • AOL/TW: FTC consent decree (5 years) • ATT/TCI/MediaOne: none 	None (1984, 92 cable acts; ineffective "leased access")
	Rural telco	None (TA '96 §251f exemptions pre-empt §251c) ⁴⁹	None (TA '96 §251f exemptions pre-empt §251c)	None
	Alternative facility provider	Allow access to rights of way, don't prohibit resale, etc. ("CLEC" rules: TA '96 §251b)	None	None
Municipality (typically through electric utility)	Unclear whether even allowed (differing state laws, pending court cases)	None (although may be locally required, <i>de jure</i> or <i>de facto</i>)	None (although may be locally required, <i>de jure</i> or <i>de facto</i>)	

⁴⁹ Cable-telephone cross-ownership restrictions are also lifted for rural telephone companies. We speculate that companies that are already allowed to provide both video and voice services might be more likely to offer integrated services over a future FTTH network.

Figure 1⁵⁰

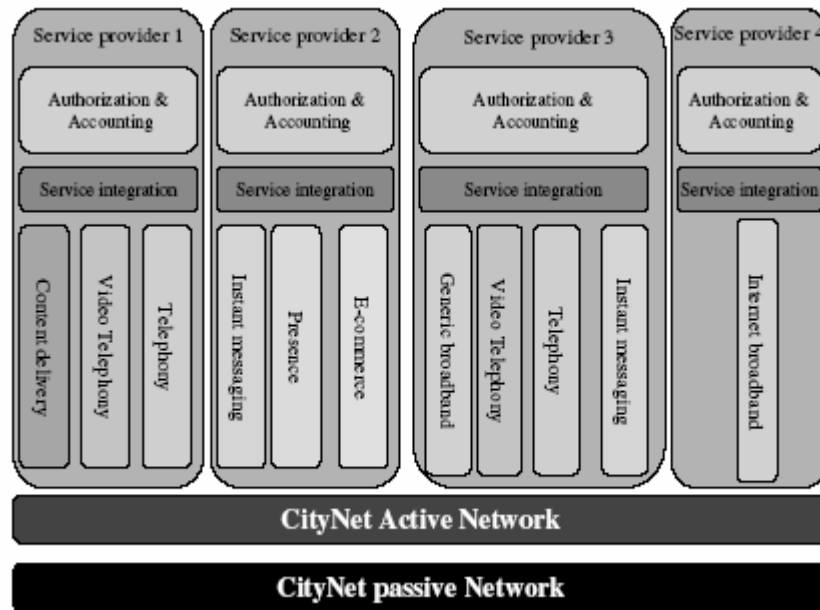


Figure 1. Multiple Service Providers on one network

IX. Appendix: Case Studies

Case 1: Braintree, MA

Braintree (MA) is an urbanized suburb in the greater Boston area with 13 thousand homes (34 thousand population). Home values, per capita income, and educational attainment are all above the national average. It has a diverse business base and in close proximity to a major urban and academic center. BELD, the MEU, is one of the oldest in the country. BELD currently offers broadband modem and cable television service, but no telephone service. Braintree is also served by Comcast and Verizon, who each also offer broadband service, and in the case of Comcast, similar cable television services. BELD decided to enter communication services in 1998 to take advantage of an HFC plant that had been installed to support its electric power operations. It began offering broadband cable modem services in 1999. At the time, the community was unhappy with the cable service available from the incumbent who was offering service via an old analog system. BELD took advantage of the window of opportunity and expanded into cable television services in 2001. As of the end of 2002, it was providing service to approximately 4 thousand households over a 400-home, 750MHz digital HFC plant. This represented 42% of the cable households served in Braintree. Since 2001, Comcast has upgraded its HFC plant (860MHz) and has recently started to compete aggressively to recapture market share in broadband and cable television services. BELD never seriously

⁵⁰ Sijben (2004)

considered offering open access and its entry is analogous to entry by an investor-owned over-builder. It took advantage of a perceived market opportunity (under-served, dissatisfied residential market) and scope economies (already had the fiber for its electrical operations) to expand into an adjacent market to tap another source of revenue and to better respond to its customer's needs.

The Community

Braintree, Massachusetts is an urbanized suburb and part of the greater Boston metropolitan area, with a diverse economic base of local businesses. It covers an area of 14 square miles and has a population of 34 thousand (2000 Census). There are approximately 13 thousand households with a density of 14 homes per square mile, which is substantially above the national average. It is a relatively wealthy community, with per capita income and educational attainment at levels that exceed the national average.

Braintree is served by Verizon, the local telephone company, and Comcast, the local cable company. Both currently offer broadband services (DSL and cable modem services).

Braintree is governed by representative town meeting (with 240 elected representatives) and by a board of elected selectmen. Braintree was founded in 1634 and was the birthplace of Presidents John Adams and his son, John Quincy Adams.

The MEU

Braintree Electric Light Department ("BELD") is the municipally-owned electric power utility which was one of the first municipally-owned power companies in the nation. It was founded in 1891 to provide street lighting, and over time evolved into the principal provider of electric power to residences and businesses in Braintree. BELD was founded by Thomas Watson and has a proud and long history of community-oriented service.

BELD is a non-profit, and in lieu of taxes, makes a payment to Braintree's general revenue fund. BELD is administered by three elected town commissioners and an appointed superintendent/plant manager.

BELD's charter restricts them from expanding beyond Braintree.

The Architecture

BELD's communications infrastructure is a hybrid-coax (HFC) plant that includes a SONET ring (originally installed in 1995 for BELD's electrical operations) and a 750MHz digital cable television system, based on 400-home nodes that was completed in 1998.

BELD's plant consists of 170 miles of fiber with 34 nodes serving essentially all of the homes in Braintree. The plant is owned by the electric utility which leases the facilities to the communications subsidiary.

Model for Entry into Telecommunication Services and Experiences to Date

BELD had upgraded its IT infrastructure to manage its electric power business in 1995 with the construction of an OC-1 SONET ring and with the addition of SCADA capabilities. In 1997, BELD submitted a plan to the town for expanding its entry into data communication services.

At the time, Waler McGrath was BELD's general manager (1985-2002). Mr. McGrath was an active member of the APPA and was a leader in organizing the APPA's task group to coordinate and share information on member's expansion into communication services. McGrath was influenced by the prospect of forthcoming electric power deregulation and the need to enhance BELD's IT capabilities to improve its efficiency and to better respond to customer needs in a more competitive future. Additionally, McGrath saw the burgeoning telecommunications markets and Internet as potential growth opportunities and sources of incremental revenues for BELD.

Shortly after BELD completed its HFC plant in 1998, it began offering broadband cable modem services to residential consumers. The initial success of this offering, which quickly garnered over a thousand customers, outstripped BELD's initial projections. BELD considered expanding its offerings to include cable television services, and a marketing research study, identified strong support for such an offering from BELD's customers.

At the time, the competing cable carrier was Cablevision, which was providing service over a legacy analog system and which had a poor reputation for service in the community. The Braintree cable property was sold to MediaOne which was subsequently acquired by AT&T, and then, subsequently divested to Comcast, the current owner.

In light of the poor quality of service offered by the current cable franchisee and the turmoil associated with the on-going reorganization of investor-owned cable assets, there was a perceived window of opportunity for BELD to expand into cable television services. A feasibility study was completed in 1999, a bond for construction of the plant was approved in 2000 (for \$3.2 million), and residential cable services were initiated in 2001.

As of December 2002, BELD was serving about 4K subscribers, representing approximately 42% of the cable homes served in Braintree. To control programming costs, BELD is a member of a program buying cooperative. It collaborates with Comcast in supporting a Public, Education, and Government (PEG) broadcast production facility for the Town.

BELD never considered offering telephone service, although they do provide communication services for the town. BELD indicated that they had no indication that their customers were dissatisfied with the telephone services provided by Verizon.

BELD's broadband and cable television services are comparably priced to the services offered by Comcast, although there are some differences in the programming line-ups each offers.

Since BELD initiated service, Comcast has also upgraded its plant (860MHz HFC) to support digital cable services that can offer an expanded range of channels and also supports cable modem services.

Until late 2002, BELD faced lackadaisical competition from Comcast, which was focusing on other markets. Beginning in late 2002, Comcast initiated an aggressive campaign to regain market share. For the first time, BELD has seen its churn begin to increase and it is continuing to deal with the challenges.

BELD has no plans currently for substantially upgrading its plant to support next generation broadband services. Primary upgrade plans center around expanding the capability to offer video-on-demand services and to expand to offer digital television services.

BELD is only now rolling out automatic meter reading services.

BELD does lease some dark fiber, but does not actively sell services to commercial customers. The focus of its communications business is the residential market.

There has been little demand for enhanced communication services from Braintree's town government, although Braintree has put in place some infrastructure that can be expanded at low incremental cost in the event that the Town does seek to enhance its eGovernment capabilities.

Open Access Policy

BELD does not have an "open access" policy. With the exception of some limited leasing of dark fiber, BELD is the sole retail operator providing communication services over its infrastructure.

Early on, before BELD launched its communication services, it was in discussions with Comcast and RCN, a cable over-builder and CLEC that was active in a number of towns in the area, regarding the possibility of BELD constructing the infrastructure and leasing it to these carriers. BELD was unwilling to commit not to compete in retail services and it was quickly clear that the parties could not agree on a suitable plan for sharing/paying for facilities, so the talks were abandoned quickly.

Comments and Other Issues

BELD's case is interesting because it demonstrates the viability of MEU entry even in markets that are served by both cable and telephone service operators. However, it seems likely that had BELD faced a competitor like the Comcast of today, BELD would have been less likely to have expanded into cable television services. BELD's decision to enter was predicated, in part, on the perception that there was an under-served opportunity to offer higher-quality cable television services in Braintree.

BELD's on-going operations are challenged by pressure from Braintree to increase its contribution to Town revenues and by the increasingly aggressive competition from Verizon and Comcast, both of which benefit from substantial scale and scope economies that are less available to BELD (*e.g.*, with respect to back-haul and program acquisition costs).

The decision by BELD to enter communication services relatively early (that is among MEUs) appears to owe a lot to the leadership of its then-general manager, Walter McGrath.

Case 2: Spencer, IA

(Based on a series of interviews with Curtis Dean, Spokesman for Spencer Municipal Utilities, and Don Miller, General Manager of Northwest Internet, conducted October 2003–June 2004, a January 2001 report on Spencer’s system written by visitors from Batavia, Illinois, and secondary research from the U.S. Census and ABI/Inform.)

A. Community and Utility Context

Spencer is a city of about 5,000 households (11-12,000 people) located in northwest Iowa and founded in the 1840s. It is the county seat of Clay County, and a market town serving the retail needs (*e.g.* a Super Wal Mart) of the farming areas that surround it. Its housing density is somewhat lower than the national average (477 vs. 541 units/sq mi, 2000 Census). The only higher education institution in Spencer is a branch of Iowa Lakes Community College, and Spencer has experienced a “youth drain;” its population is older than the national average and gradually decreasing. It is also overwhelmingly white (98% vs 85% US average, 2000 Census).

Spencer Municipal Utilities (SMU) was formed in 1942, and now encompasses 4 types of utilities: water, electric, communications, and the remaining assets of a steam utility that no longer provides service. It is governed by a 5-member utilities board, which is appointed by the mayor and confirmed by the 7-member city council. The board appoints the General Manager of Utilities, and the city council approves the utility’s budget. The communications utility is financially separate from the electric and water operations.

B. Origins of the Communications Network

In 1996-7, a grass-roots citizens’ group called ACT Now (ACT = Advanced Communications Technology) was initiated by Christine Fletcher, a local housewife who felt that the operator of the local cable TV franchise (Triax Cablevision, at that time) was brushing off her complaints. ACT Now consisted of 10-20 individuals representing a diverse cross-section of the community, from factory workers to business owners. The group tapped into community dissatisfaction with Triax’s picture quality, customer service, and slow upgrade schedule at a time when other communities in Iowa were either getting cable modem service from their local cable franchisee, or actively considering municipal networks.

As ACT Now researched what other towns in Iowa had done (including the municipal utilities in Harlan, Hawarden, and Cedar Falls, which had already built communications systems), their motivation spread beyond better cable TV to the potential impacts of broadband Internet access on economic development and quality of life. The group approached SMU about developing a communications utility; SMU had made its first foray into telecommunications in 1994-5, when they constructed Phase 3 of the Iowa Communications Network (ICN) for Clay County. ICN was a state-owned fiber network connecting communities for distance-education purposes, and Phase 3 involved connecting local schools to a central point in each county. SMU built a fiber backbone linking local schools, which it paid for out of construction reserves, because the utilities board felt it was important to start installing fiber both for the community’s economic benefit, and for the utility’s future use in more automated monitoring and management systems.

SMU declined to take the initiative on a communications utility, however, but said they would do it “if people say they want it, and it doesn’t have a negative financial impact on SMU.” Accordingly, ACT Now organized a referendum to authorize a communications utility operated by SMU. Because Iowa law requires voters to approve an issue before a feasibility study can be performed, there was no price tag associated with the proposed utility, nor any details of what services it would deliver. ACT Now spent under \$4,000 on the referendum campaign, primarily focusing on radio and newspaper ads, as well as yard signs and door-to-door and service (e.g. Rotary) club appearances. Triax spent \$40,000, primarily on telemarketing and direct mail. Held on May 6, 1997, the referendum attracted a voter turnout of 33%, and was approved by over 90% of those who voted. According to Dean, voters were mainly energized by the potential for better cable TV service. Although there was some business frustration over long waits to get upgrades or add lines with the local telephone company (US West, the precursor to Qwest), people were generally satisfied with their telephone service, and telephony was not much discussed as a driver for the referendum (at that time, it was also not yet legal for municipal utilities in Iowa to offer telephone service). A few individuals were also motivated by the dot-com dream of attracting Silicon Valley-style companies, jobs and salaries to the area.

In 1997-8, a feasibility study was conducted and paid for out of utility reserves. The conclusion was that a hybrid fiber-coax system, including circuit-switched cable-telephony equipment (including subscriber side-of-house boxes that were expensive at the time) and direct fiber for businesses (including the local hospital, city and county facilities), could be built to deliver video, voice and data at a cost of \$16-20m. FTTH was considered but rejected, since it cost 50% more. Wireless was not considered; although it was sufficient for consumer Internet, it was not robust enough for cable TV and telephony, and cable TV was still considered the prime motivation.

With the costs now better known, SMU asked ACT Now to re-take the public pulse and provided \$20,000 of SMU funds for a postcard campaign. SMU required 50% of households to sign a statement saying they would buy comparably priced communications services from SMU; 60% signed within 6 weeks, so SMU agreed to go ahead.

C. Current Status

Construction began July 1999 and was completed a few months later than expected in January 2001. The system now serves all of Spencer, plus a mobile home park that is just outside the city limits.⁵¹ Cable TV was the first service offered (Fall 2000), then cable modem (Spring 2001), then telephony (Summer 2001).

Upstream voice and data connectivity consists of T1 circuits purchased from Iowa Network Services (INS), a consortium that was formed in the mid-1980s by rural telephone cooperatives to provide equal access for long-distance (INS provides fiber connecting to a single access tandem for the state). SMU purchases some of its TV programming individually, and buys the

⁵¹ SMU had to run fiber by the mobile home park to reach their TV tower, so when enough residents signed up, SMU was willing to serve the park. This mobile home park had always been turned down by private cable previously because not enough customers.

rest through the National Cable TV Cooperative (NCTC), a buying coop based in Lenexa, KS that serves municipal and other small cable operators.

As of October 2003, SMU sends 3900 communications bills (combined telephone, cable, and data). Of these:

- 2300 buy cable television, which is about half of the town, and more than half of the cable subscribers since not everyone in town subscribes to cable. SMU cable subscribers grew 14% in 2003, but the growth rate was projected to slow to 5-6% in 2004.
- 1200 buy residential cable modem service. Best guess is that this is out of 2500 cable modem subs total, i.e. half of town subscribes to cable modem broadband Internet – a much higher penetration rate than the national average. Growth estimated at 34% for 2003, projected 15-20% for 2004.
- 3077 buy residential telephone service, up 30% in 2003. (SMU's telephone subscriptions really started growing when Local Number Portability became available in early 2002.)
- 250 buy commercial Internet service, i.e. businesses buying cable modem services.
- 1200 include commercial telephone lines, up 83% in 2003, and projected to grow 15-20% in 2004. Half of the town's 600 businesses (including local government) are SMU telephone customers.

As of December 2003, SMUNet has also begun offering wireless Internet access to most of the rural areas of Clay County beyond Spencer, utilizing antennas on the TV tower. The offering is based on 2.4 GHz (i.e. unlicensed) line-of-sight equipment and offers data services only, in partnership with the ISP Webb Wireless. This offering is not part of the open access arrangement with ISPs, but rather utilizes a 50/50 cost split. The launch price was \$39.99/mo for 256 Kbps service.

D. Costs and Financing

The actual cost of the system was \$17.5m, or about \$3500 per household, which is relatively high for HFC. Part of the high cost is a result of Spencer's non-aerial construction: the fiber is in conduits and the coax is buried, in keeping with the utility's practice since the 1980s of using underground construction, both for community beautification and resilience to winter ice. Another contributor is timing: many cable plant upgrades were taking place in that time frame, putting skilled contractors in high demand. Outside plant construction (including trucks and tools) cost about \$12.5m; an additional \$1m was spent on telephone switching gear, and another \$1m on the cable head end. The remaining cost was for customer interface boxes.

Construction was funded from electric utility reserves, which were estimated at \$30m prior to the communications project. The electric utility owns the fiber and coax in the system, and leases it to the communications utility. To fund the rest of the construction expenses, the electric utility

loaned the communications utility \$8m at 4.5% interest. Spencer was not rural enough to qualify for funding from the Rural Utilities Service.

The feasibility study estimated that half of telephone and cable TV subscribers would need to switch to the municipal utility to make it financially successful over a long period of time (for example, 15 years rather than 3-4). Demand for data services was considered more uncertain at the time. The penetration figures quoted above suggest that these goals had been met more quickly than expected. While the exact payback periods used in the study are not made public, SMU's representative agreed with the interviewer's suggestion that it may be more appropriate to compare the system with other municipal infrastructure (e.g. power systems – it takes 5 years to bring a new power plant on line, and the bonds are typically 20 years) than with private-sector payback periods.

After a series of legal flip-flops in Iowa, municipalities were allowed to provide telephone service in the spring of 1999.⁵² SMU is a CLEC and received its license in Iowa in August 2000. Telephone revenue was critical to Spencer's financial feasibility model, and reality has borne this out as telephone service provides many kinds of "hidden" revenues, such as access charges. Dependence on these revenues suggests vulnerability to future competition from VoIP, however.

E. Competition

Qwest is the local ILEC, and has not been particularly focused on competition in Spencer. Qwest only started offering DSL in Spencer in the fall of 2003, and offers less than half the speed of SMU at the same introductory price.

McLeod Communications is an Iowa CLEC (reselling Qwest facilities) that still has long-term contracts with about a third of the business telephone accounts in Spencer, down from about double that during the telecom boom. McLeod is now out of Chapter 11 and continues to lower its rates and compete with SMU.

DirecTV claims only about 2-300 television subscribers in Spencer; local channels are not available through the satellite service.

SMU's most vigorous competitor is **Mediacom**, the incumbent cable operator that purchased the Triax franchise in 1999 and upgraded the cable system.⁵³ Mediacom's strategy has been to use low-cost Internet to retain cable TV customers: customers can buy cable TV and cable modem for \$20/month each (total \$40/month), vs. \$44/month for cable modem alone. Mediacom serves

⁵² The political effectiveness of the Iowa Association of Municipal Utilities (IAMU) appears to have been important in achieving this outcome.

⁵³ Mediacom did not exist when SMU built their system, but through acquisitions has now become the 8th largest U.S. cable operator, passing 2.7m households (and serving 1.5m) mainly in small and medium-sized cities such as Des Moines, Iowa (see Jesse Drucker and Peter Grant, "Mediacom to Sell Phone Service Over Cable in Deal with Sprint," Wall Street Journal, August 25, 2004, p. D3). Mediacom bought the former TCI/AT&T cable systems in Iowa in 2001. Triax, in contrast, had only about 300,000 subscribers concentrated in Iowa and Minnesota.

most other communities within 30 miles of Spencer, and there they charge \$45/mo for cable modem alone, and \$44/month for the cable TV package that costs \$20/month in Spencer.⁵⁴

In addition, Mediacom has been engaged in a lawsuit against SMU since September of 2000. After 3 years, this lawsuit has resulted in many motions, counter motions, and discovery requests, but no depositions.

F. Open Access

Spencer had 4 dialup ISPs in 1997, with an estimated 2,000 subscribers. ACT Now wanted ISPs to help sign up their customers in support of the municipal network, and one way to get that was to agree to provide open access to the network for those ISPs, which SMUNet did with a 3-year agreement. SMU agreed not to compete with the ISPs for levels of service at or below 750 Kbps down/256 Kbps up. However, Spencer reserved to itself the exclusive right to serve business customers with larger bandwidth needs. SMU has about 2 dozen customers buying T1-class service, at \$150/mo for 1 Mbps down/500 Kbps up and \$200/mo for 1.5 Mbps down/750 Kbps up. The rationale seems to have been both to ensure use of the system for local economic development, as well as to ensure data revenues for SMU adequate to recover their costs.

As of October 2003, SMU had 4 open access ISPs, 3 of which roughly split the market.⁵⁵ The SMU representative observed that open access makes it particularly easy for customers to switch ISPs – 20 phoned SMU to switch when 1 ISP had a week-long outage because of a distributed denial-of-service attack. Each ISP deals with its own backhaul individually. SMU has 3 T1s out of town from Iowa Network Services, which provides some diversity since 2 of the ISPs use other providers (one of which is AT&T).

In March of 2004, SMU implemented a policy change regarding open access. ISPs would still be able to provide 3rd-party service to consumers, but SMUNet would now compete in this retail service as well. In exchange, their 3rd-party ISPs would be allowed to compete in providing retail data services to businesses as well.

This policy change brought with it a change in the flow of money through the system. Under the original open access regime, the customer saw 2 separate charges: a bandwidth charge from SMU, and a charge for retail services (including e-mail address, customer support, etc.) from the chosen ISP.⁵⁶ The customer did not necessarily see 2 bills, however, since they had the option to have the ISP fees billed via SMU (Northwest Internet and Evertek opted for this arrangement). The terms of the open access agreement limited the ISP portion of the charge to \$17 for 500k

⁵⁴ The SMU representative points out that Spencer's lower Mediacom cable rates induced by competition from SMU represent a form of return on the public's investment, since money stays in local pockets as a result.

⁵⁵ 3 of the 4 open access ISPs pre-date SMU: Northwest Communications, Long Lines, and Iowaone.net. A fourth ISP, Rural Connections decided not to participate as an open access ISP, and was later purchased by Earthlink in early 2001. Earthlink provides pure dialup in Spencer and still has a few customers. The fourth open access ISP is Evertek, which was already a licensed (LMDS) wireless cable & broadband provider in Everly, a neighboring town.

⁵⁶ This arrangement was chosen to avoid tripping over an Internal Revenue Service rule that public utilities cannot receive more than 30% of their revenue from "private" use. The fear was that consumer data revenue flowing to SMU via ISPs would look like "private use" revenue. This concern appears to have become irrelevant given the later policy change.

service, and \$35 for 750k service. Prices were publicly posted on the SMUNet web site, as reproduced below:

2. Choose Your Service Level [bandwidth charge]	
Residential Standard (500k/128k)	\$13.00
Commercial Standard (500k/128k)	\$20.00
Residential/Commercial Deluxe(750k/256k)	\$30.00

Prices above are \$5.00 higher if you do not have SMU cable TV or telephone.

3. Choose Your Internet Service Provider [ISP charge]	
iowaone.net	\$16.50
Long Lines	\$16.95
Northwest Internet	\$16.95
Evertex	\$15.95

Prices above are as of February 17, 2002. Activation fees, other fees, and promotional offers may apply. Call SMU or your ISP for details.

4. Choose Your Cable Modem	
Purchase-One Time Charge	\$150.00
Purchase-Three Monthly Payments Of	\$50.00
Rental-Monthly Charge Of	\$10.00

There is a one-time installation charge of \$25.00; this charge is waived if you purchase your cable modem.

In the new regime, however, customers of open-access ISPs pay the ISP directly, and the ISP pays a wholesale bandwidth charge to SMU. Prices are no longer publicly posted.

The change in policy had a swift and significant impact on 3rd-party ISPs, who began to experience a net loss of residential customers to SMU, which now had the flexibility to compete more effectively with Mediacom's low-priced bundles. A community spirit – described as an Iowa cultural phenomenon – is evident as customers feel they are helping to keep the local utility alive against aggressive (some might say unfair) competition from the “outside” cable operator (Mediacom).

Some of the ISPs have other ongoing partnerships with SMU, and remain philosophical about the change; one reports that the outcome in Spencer was better than in Algona, IA, where the ISP had most of the dial-up market and swiftly lost nearly all of it when the municipal utility implemented a broadband network with no open access. In that representative's view, open access gave ISPs time to adapt to the broadband transition, and gave SMU time to develop their expertise in Internet services.

If Iowa law had precluded SMU from offering retail services, SMU would not have gone into the communications business. The utility is fiscally conservative, and felt it needed the service revenues to cover the infrastructure investment cost.

G. Impacts

SMUNet has already had economic impacts:

- Municipally owned system gives community discretion to negotiate economic development deals. E.g., Attracted telemarketer to town with aggressive package rate for phone services; 100 jobs, many part-time. Similarly, a major insurance company wanted to locate a claims processing center in fall 2000 when SMU was coming online. 300 jobs, \$30k/yr, good business, but picked another community in which broadband buildout had just completed. However, had Spencer not had broadband in the works, they would not have been considered at all.
- Helping businesses grow, interconnect multiple sites in town via direct fiber connect. Example: Freudenberg NOK – a manufacturer.
- Perceived increase in the number of telecommuters, including people who work at home and (most important) people who work elsewhere while continuing to live in Spencer
- Increased global competitiveness of local businesses, especially smaller ones. This was different type of economic development from what most people expected. Examples include Emagine Marketing, a web site developer that emerged when a previous dial-up ISP got out of that business. Emagine's success stories include Carl's Footwear, a shoe store based in Sheldon, IA with a second store in Spencer. Went online thru SMU net, starting selling lots of shoes (1000 pairs a week?) online, presumably well beyond Iowa. Had to expand space in Sheldon to hold some of the online inventory. A menswear store catering to older gentlemen had a similar experience with web sales. Online shopping cuts both ways: on the one hand, it helps small local businesses compete in the presence of Wal Mart. But on the other hand, it lets Spencer residents buy elsewhere more easily too.
- The range of business cable modem customers is broad – travel agents and law firms but also gas stations. Everyone has to deal with vendors online now.

Impacts have also been felt in e-government:

- SMU facilitated interconnection of county government facilities in 5 different buildings via fiber for common network, phone system.
- Sheriff's office in center of town had opportunity to expand into building in outskirts, and fortunately SMU's fiber ran right by the building.
- Facilitated working with county for teleconferencing for INS court hearings in Spencer for Sioux City and Omaha (judges in Sioux City and Omaha, petitioners in Spencer) – received federal grant to make this happen.
- Schools had already been using fiber SMU put in thru ICN; worked with them on upgrades, etc. This saved money for the town.

Case 3: Grant County, Washington⁵⁷

Grant County, Washington has a total population of 77,000 spread over 2681 square miles, for an average of 29 person per square mile. The county seat is Ephrata with 6,855 population. Moses Lake accounts for 15,700 and the remaining towns are 3,000 or less. Per capita income is \$20,000.

The first fiber installed by the Grant County PUD in the mid 1990's was to connect the hydroelectric generating stations to the network operations center. Beginning in 1999 they began discussing the idea of constructing an FTTH network (ZippNet). At the time there was little service from incumbent providers. Cable TV was not widely available, there was no cable modem service, and there was no DSL from the telephone incumbents (Qwest, Verizon, Sprint and Century Tel). Indeed, some isolated farms had no wired telephone service at all, relying in cell phones.

In March of 2000 the Washington legislature passed a bill allowing utilities to offer wholesale communications services, but not retail.

1. Construction schedule

The network design was based on an Active Star architecture with neighborhood nodes serving up to 500 homes within a six mile radius. Financing was to be provided from free cash flow from the utility operations.

In 2001 25 hubs were built, spread around the county so as to spread the benefits. For 2002 a new strategy was adopted. In order to determine where to build first, Grant County asked neighborhoods to petition if they wanted to be included. 85 neighborhoods qualified, but only 20 could be built from the available funds. The procedure was changed for 2003: would-be subscribers were asked to sign up in advance; only if 50% of households in the neighborhood signed up would they qualify. Fourteen hubs were qualified at the beginning of 2003. However, in January 2003 two new commissioners were elected to the board of the PUD. They changed the policy to make linking in the public schools a priority. By the end of 2003 only nine new hubs had been installed, but all the schools had been connected. Also in 2003 they began interconnecting the hubs in a ring to achieve greater reliability.

In July, 2003, Grant County applied for \$60 million in RUS funding to complete the buildout. Then in the fall of 2003, the PUD was rocked by a scandal. It appeared that managers at the PUD had channeled funds to a neighboring PUD in an effort to motivate them to become a retail service provider on ZippNet, a violation of state law restricting PUDs from investing in retail services on their own network. The manager of the PUD was replaced and several ZippNet officials were placed on leave and later released.

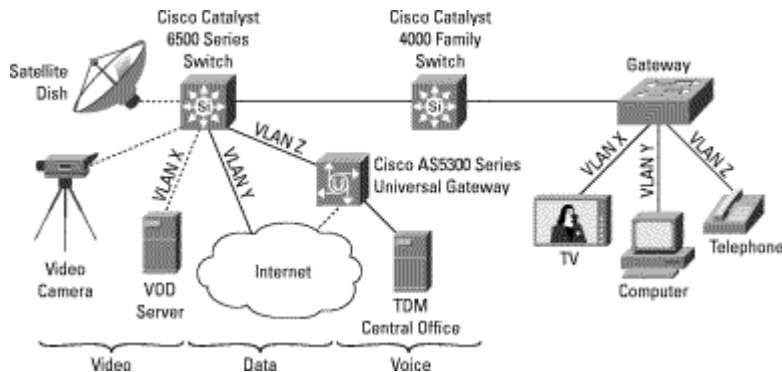
The PUD convened a 12-person citizen's advisory board to determine the future of ZippNet. Five voted to build out the network to completion, six voted to halt further expansion, and one

⁵⁷ Based on interviews with management of ZippNet, articles in the trade press, and press releases and presentations on the ZippNet website.

voted to get out of the business altogether. In July, 2004, the PUD raised the wholesale rates, and in August withdrew their application for RUS funding. The future of ZippNet is uncertain at the present time. As of August, 2004, the network passes roughly 10,000 homes and there are 4,400 subscribers as of July, 2004.

2. Technology

The ZippNet network is based on an Active Star architecture using Cisco Ethernet switches in the neighborhood nodes providing 100 Mbps service to each household. The nodes are connected by one or more Gigabit Ethernet backhaul links to the Regional Node. (See Figure).



Grant County Architecture

Settop boxes for IP video have been a major expense, as Grant County was one of the first to provide IP Video. In 2001 these cost \$800 each, but have since declined to \$150-300. Originally they used boxes from NCSI; more recently have been deploying Fujitsu-Siemens boxes. Video is not encrypted, but providers are on separate VLANs.

To lower the barriers to entry for video service providers, ZippNet built and operates a video headend, which was constructed in late 2001. ZippNet provides the transport of the content, but Service Providers (SPs) must contract with content owners for the necessary rights. There are two video service providers

ZippNet serves ISPs by reselling regional transport which we acquire from NOANET, a regional fiber network owned by 16 PUDs in Washington and Oregon, that connects with multiple Tier 1 ISP backbone providers. There are 18 ISPs and 95-98% of subscribers take ISP service.

ZippNet also purchased a softswitch at the request of one voice SP who wanted to lease service from them, but the SP later backed out and ZippNet currently has no customers for it. They operate a New ERA VoIP gateway that provides a Telcordia GR303 interface to a Class 5 telephone switch, just as Digital Loop Carrier equipment does. Two service providers lease the use of the gateway. There have been technical problems in supporting modem and fax calls.

Attached is the Rate Schedule as of August, 2003 for wholesale services.

**PUBLIC UTILITY DISTRICT NO. 2 OF GRANT COUNTY, WASHINGTON
RATE SCHEDULE 100**

FIBER OPTIC NETWORK SERVICE

AVAILABLE: To service providers desiring to use the District's Zipp® fiber optic network. The network is available within portions of Grant County and may also be used to access the NoaNet network for wider access.

EFFECTIVE: These rates will be effective August 1, 2003 and shall remain in effect until superseded by the adoption of a Commission resolution revising the same.

BILLING RATES: Use of the Zipp® Network shall be billed in accordance with the charges listed below as well as other charges on the District's Official Zipp® Network Price Sheet. NoaNet charges not included below shall be passed through to service providers with an appropriate administrative charge.

Service:	Monthly Charge
<u>Bandwidth per VLAN per device:</u>	
1 Mbps	\$15.00
10 Mbps	\$20.00
100 Mbps	\$150.00
1000 Mbps	\$1,200.00
Single Plain Old Telephone Service (POTS) port on LE-22 or equivalent device	\$10.00
Two POTS ports on LE-22 or equivalent device	\$15.00
<u>Bundling Options:</u> (the following prices are for ports on an LE-22 or equivalent device)	
Single POTS port with a single 1Mbps connection	\$15.00
Two POTS ports with a single 1Mbps connection	\$20.00
Single POTS port with a single 10Mbps connection	\$25.00
Two POTS ports with a single 10Mbps connection	\$35.00
<u>Connections For Apartments and Hotels:</u>	
LE-22 or equivalent equipment	\$2.50 per port, minimum of \$20 per building
LE-211 or equivalent equipment	\$2.00 per port, minimum of \$28 per LE-211.
<u>Set Top Box Lease</u> (monthly charge for each box)	\$5.00
<u>Use of District-Owned Video Head End:</u>	
Receipt of Analog Signal (charge is per subscriber per channel per month)	\$0.07
Receipt of Digital Video Signal (charge is per subscriber per channel per month)	\$0.01
Receipt of Digital Music Signal (charge is per subscriber per channel per month)	\$0.001
<u>Use of Video Encoder for Public Access Programming:</u>	\$55.00 per month or \$10.00 per day

**PUBLIC UTILITY DISTRICT NO. 2 OF GRANT COUNTY, WASHINGTON
RATE SCHEDULE 100**

X. FIBER OPTIC NETWORK SERVICE

	1. Monthly Charge										
<i>a) Video Storage On District-Owned VOD Server</i>	\$0.125 per minute of storage										
<u>Use of Telephone Soft Switch:</u>											
Per T1 Line	\$44.80										
<u>Use of V-Packets Boxes for Multi-Line Telephone Service:</u>											
V-Packet 5100, 8 Ports, No Lifeline	\$40.00										
V-Packet 6100, 8 Ports	\$50.00										
V-Packet 6100, 24 Ports	\$90.00										
<u>Collocation of Customer Equipment in District Facilities</u> (prices for single 19" rack):											
Without UPS or Backup Generation	\$200.00										
With UPS and Backup Generation	\$300.00										
<u>Dark Fiber</u> (per strand per mile)	\$30.00										
<u>Upstream Internet Service:</u> (if a service provider desires to purchase upstream Internet transport from the District there are three options available)											
1. Residential or Commercial subscriber based charges: (available to service providers offering basic service connections to residential or commercial subscribers served on a fiber optic network inside or outside Grant County for retail Internet services. Not available for dial-up customers or connections larger than basic service. If the District determines that a service provider's customers are using significantly more bandwidth than is being paid for under this flat rate, the District reserves the right, after providing reasonable notice to the service provider to move the service provider off the flat rate and onto one of the other upstream Internet service options.)	\$5.00 per residential subscriber										
2. Fixed Bandwidth Charges: charge per 1Mbps of upstream bandwidth. (Under this option, the service provider chooses the amount of upstream bandwidth that they wish to purchase to serve their customers and the District will lock down the service provider's port so that no more than the chosen bandwidth will be available.)	\$250.00 for each 1Mbps of upstream access										
3. Metered Bandwidth: charge per each 1 Mbps of average metered use. (Under this option, the service provider's port will NOT be locked down or capped and the service provider's customers can burst to the total amount of bandwidth available to the PUD. These charges are based on the monthly average megabits per second use and are calculated as follows. (1) District equipment will take readings every five minutes of the bits traveling outward and inward over the customer's connections to the District's equipment, (2) The inward readings shall be averaged to calculate an inward monthly Mbps average, (3) The outward readings shall be averaged to calculate an outward monthly Mbps average, and, (4) The higher of the inward or outward monthly averages will be used for billing.)	<table style="margin-left: auto; margin-right: auto;"> <tr> <td style="text-align: right;"><7 Mbps avg</td> <td style="text-align: left;">\$350/Mbps avg</td> </tr> <tr> <td style="text-align: right;">7.1 – 10.0 Mbps avg</td> <td style="text-align: left;">\$290/Mbps avg</td> </tr> <tr> <td style="text-align: right;">10.1 – 25.0 Mbps avg</td> <td style="text-align: left;">\$280/Mbps avg</td> </tr> <tr> <td style="text-align: right;">25.1 – 50.0 Mbps avg</td> <td style="text-align: left;">\$260/Mbps avg</td> </tr> <tr> <td style="text-align: right;">50.1 – 100.0 Mbps avg</td> <td style="text-align: left;">\$250/Mbps avg</td> </tr> </table>	<7 Mbps avg	\$350/Mbps avg	7.1 – 10.0 Mbps avg	\$290/Mbps avg	10.1 – 25.0 Mbps avg	\$280/Mbps avg	25.1 – 50.0 Mbps avg	\$260/Mbps avg	50.1 – 100.0 Mbps avg	\$250/Mbps avg
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25.1 – 50.0 Mbps avg	\$260/Mbps avg										
50.1 – 100.0 Mbps avg	\$250/Mbps avg										

PUBLIC UTILITY DISTRICT NO. 2 OF GRANT COUNTY, WASHINGTON
RATE SCHEDULE 100
XI. FIBER OPTIC NETWORK SERVICE

	1. Upfront Charge
<u>Special Fiber Construction</u> (anything other than electric meter)	Prepayment of 75% of actual cost
<u>Set Up of New Service Provider</u>	\$500.00

	2. Monthly Charge
<u>Each STS-1 Sonet Pt-Pt Data Path</u> (sold in increments of STS-1, but provisioned using OC-3, OC-12, OC-48, & OC-192 line rates)	\$400.00

Wholesale Video Content:	Price Per Month Per Subscriber
KREM CBS Spokane	\$0.10
KXLY ABC Spokane	\$0.10
KHQ NBC Spokane	\$0.10
KSPS PBS Spokane	\$0.10
KAYU Fox Spokane	\$0.10
KCTS PBS Seattle	\$0.10
KWPX PAX Seattle	\$0.10
KSKN WB Spokane	\$0.10
KSTW UPN Seattle	\$0.10
TVW Olympia	\$0.05
Use of shared TV Data Contract	\$0.50
Use of Myrio Middleware	\$2.00
Myrio Service Bundle Fees (The service bundle fees only apply if the service provider is using the shared servers, otherwise these fees are paid directly to Myrio. These fees cover the PPV, VOD, DMX and Web browsing services provided by Myrio.)	\$2.50
<p>Any additional charges that the District incurs as a result of the service provider's use of Myrio services will be passed through to the service provider. In addition, there are charges that may be assessed by Myrio directly to the service provider. The service provider should make sure that they understand all of these charges before starting to use the Myrio services.</p>	

SERVICE: Service under this Schedule is subject to the terms and conditions in the District's Telecommunications Policies, as the same may be amended from time to time.

TAX ADJUSTMENT: The amount of any tax levied by any city or town, in accordance with RCW 54.28.070 of the Laws of the State of Washington, will be added to the above charges.