ITS OPPORTUNITIES RESULTING FROM DEVELOPMENTS IN HOME BROADBAND TELECOMMUNICATIONS

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Milda K. Hedblom
Adjunct Professor
Humphrey Institute of Public Affairs
University of Minnesota
1801 Summit Avenue
St. Paul, MN 55105
651/645-5051
651/645-5023 (fax)
hedblom@visi.com

Frank Douma
Research Fellow
State and Local Policy Program
Hubert H. Humphrey Institute of Public Affairs
University of Minnesota
301 19th Avenue South, Room 130
Minneapolis, MN 55455
612/626-9946
612/626-9833 (fax)
fdouma@hhh.umn.edu

ABSTRACT

Telecommunications represents the next frontier in transportation innovation, in that many applications of Intelligent Transportation Systems technologies depend upon the ability of geographically dispersed travelers to obtain information quickly. As the ability to access this information in the home is central to the success of many of these applications, deployment of high speed, or "broadband" connections to residential customers is a key objective. This article examines the current status of residential "broadband" penetration in the form of cable and Digital Subscriber Line (DSL) use, as well as other, less common, media, then discusses the opportunities presented by two emerging pathways: Wireless Fidelity and Fiber to the Home. The paper then considers current residential uses of the Internet and suggests applications that transportation planners may want to promote in light of these emerging broadband technologies.

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Fifteen years ago, mentioning broadband telecommunications to the home prompted both smiles and frowns accompanied by some predictable questions. Ordinary users asked, "What is broadband? Why would someone want or need it? Telecommunications companies asked "Who will pay to build and deliver it to the home?" because they tended to think that broadband service was important for larger businesses but not for the home or smaller business. It was not too many years later, however, that insightful transportation planners began to imagine Intelligent Transportation System (ITS) applications that would allow users to obtain significant, useful transportation information at home, and that the benefits from these applications would be maximized through consistent, reliable high-speed connections provided by broadband.

BROADBAND TELECOMMUNICATIONS, TRANSPORTATION AND COMMUNITY WELL-BEING

Today, in developed economies, the underlying importance of widespread access to broadband telecommunications for economic and community well-being is broadly accepted even while a vigorous debate continues about the scope, cost, spread and benefits of broadband networks within a single community, within a region or state, across the nation and around the world. This acceptance is the legacy of an extraordinary period of growth in telecommunications networks and services that encouraged and supported new modes of living and working referred to as the "information society." The concept of an information society is variously understood but it embraces the idea that fully realized widespread access to telecommunications and computer networks can and will transform almost all human activities. (*1*)

Transformations in many areas such as Intelligent Transportation Systems (ITS), tele-work, e-commerce, e-government, e-health, e-education, e-democracy, e-culture and e-information continue today but have already left their mark on how we live and work. Some aspects of electronic life are more established than others but massively computerized networks and remote centers for services in transportation information, shopping, personal finances, health care, education are now the norm. From the perspective of the individual household the nature and extent of telecommunications connectivity directly relates to the ability to benefit from ITS, especially advanced traveler information systems (ATIS). In light of the undoubted importance of safe and reliable transportation in the information society, how does the current development, scope and prospects for broadband networks to the home relate to this new mode of living and working?

SCOPE, PROFILE, AND PROSPECTS OF BROADBAND NETWORKS TO THE HOME

During the decade of the 1990's a great deal of hope and hype supported the expansion of telecommunications network capacity likening the development of the "information highway" to the building of the transportation network of the 19th and early 20th centuries in the U. S. The telecommunications and information services sectors were looked at as lead sectors supporting economic expansion and productivity gains. At the same time ideas and entrepreneurs rushed to stake their claims in the dot.com sector aiming to provide services and gain profit in the unfolding of the information society in the workplace and in the home. But by the end of the 90s, the so-called dot.com “bubble” burst and the telecommunications and information services business sector moved into a deep recession from which it has yet to emerge.

However, during the last several “post-bubble” years, expansion of broadband telecommunications services to the home has registered strong growth which is a vindication of the essential vision that a home based platform for engaging in electronic life would be as essential in this century as the plain old telephone was for most of the last century.

Scope of Broadband Services

Today, the ordinary user has an intuitive understanding that “broadband services” means the “fast” Internet and telecommunications services that companies vigorously market to customers, though the broadband label can cover significantly different rates of “fast service.” Increasingly users also identify broadband with digital television and high definition television. Within the next decade users will also come to think of Internet telephone (Voice Over Internet Protocol) as part of the meaning of broadband services. The primary focus of this discussion is on the growth of broadband data services to the home.

In this last year, the growth rate has been characterized as “torrid” because the rate ran at 50% increase by year-end. Figure 1 tracks this growth. The measurement of overall growth includes all kinds of services which may be delivered by wireline telephone companies, by cable providers, by terrestrial wireless providers, by satellite providers, and by any other facilities based providers of advanced telecommunications capability such as fiber to the home facilities.

However, this news about the uptake of broadband Internet services to the home should be read in light of two factors which suggest that the pace of growth may moderate. First, there are fewer among those who use the Internet regularly through dial-up modems who say they want to change to broadband. Second, among those who want but do not have broadband to the home, lack of service by any means may make the changeover impossible.

While the overall growth rate is strong, it understates the surge of growth in the residential and small business sector because the overall growth rate includes businesses of all kinds. When one looks only at residential and small businesses, the growth is even more robust registering a full year increase of 58%. Still another insight into the importance of high speed access in homes and small business is the estimate that of the 17.4 million high speed lines about 10.8 ml provide advanced services which means services are running at speeds that exceed at least 200 kbps in both directions. (See Figure 2)

Profile of Broadband Services to the Home: DSL and Cable Networks

In the evolution of data telecommunications services for the home, voice service (telephone) came first, over a wire engineered for voice and reached over 95% of U.S. homes nationwide. One of the remarkable feats of "broadband" engineering has been to adapt the copper telephone wires to deliver data service over the same outside plant or infrastructure that delivers voice service. The driving force behind this adaptation was the growing armada of computers in office and home whose users wanted to connect, especially via the nascent Internet. In terms of home service, the modem for dial-up Internet service, the ISDN (integrated services digital network) connection and the DSL (digital subscriber line) service have all evolved through the "broadband engineering" of the voice service network.

Worldwide, DSL is in a dominant position. On a worldwide basis more people rely upon DSL lines for high-speed service than on any other technology. Initiative in building a market for broadband service to the home is strongest among the telephone companies that already had been providing broadband to businesses though in the United States a significant number of companies were formed specifically to deliver DSL services in at various levels of access speed to homes and businesses. The growth rate in 2002 for DSL services worldwide was 90% with the highest rate of growth in the Middle East. However, in absolute numbers of users the United States and Japan are neck and neck for most numbers of users.

In the U.S. however, more than twice as many users rely on cable network modems for their broadband service to the home. Just over 21 million homes use cable modem service for broadband that is a margin of more than two to one over DSL service. Just as the voice network was adapted for broadband data service, so too was the video network--based on coaxial cables and now frequently combined with optic fiber in the network--adapted to deliver “broadband” data service. As a result many Americans have a choice between either DSL or cable modem broadband service to the home, although some have no option for this service and a small percentage of others rely on wireless or even higher speed lines than either DSL or cable. The distribution of how home broadband users connect demonstrates the overwhelming importance of cable and DSL service for home users. (See Figure 3)

This difference in number of cable versus DSL users is not mainly a matter of price difference. The faster rate of growth in cable service is partly a result of the cable industry having recognized the revenue gains to be made by investing in upgrades to enable the delivery of data services. Once the decision to upgrade is made, it can be done almost anywhere within the cable service map.

By contrast the spread of DSL service has been limited by the distance problems in DSL technology. These limits meant that service was not possible beyond a given distance from the central office. However, recent advances in DSL capabilities promise to reduce those limits significantly and this promise has already translated into more competitive service pricing and aggressive marketing on the part of DSL providers. There are some differences in users experience in that cable modems users may experience network slowdown or overload due to network sharing and breaches of security can occur more easily with cable modems. Nevertheless, cable modems far outnumber DSL connections as the broadband pathway and in the last year that advantage was slightly increased.

Profile of Broadband Services to the Home: Other Pathways

Other modes of delivery for broadband services to the home exist including satellite, wireless, T-1 lines and fiber-to-the-home pathways. According to the Pew Internet and American Life surveys, fixed wireless and satellite services together account for about 4% of home use while T-1 and fiber services account for about 1% of home use. (*2*) The market for satellite and fixed wireless delivery is found in more specialized applications rather than the general home market. Delivery of Internet service via T-1 lines typically goes to multiple dwelling complexes in densely populated areas. These are modest numbers and are not likely to grow dramatically. However, there are two pathways that are likely to become more important players in the provision of broadband services to users in the next period of expansion.

Wireless Fidelity

The first of these newer possibilities is Wireless Fidelity or Wi-Fi , which significantly alters the geographic and economic possibilities of broadband use. Wi-Fi enabled computers can send and receive data wirelessly anywhere within range of a base station and can be several times faster than even the speediest modem connection. Wireless Home Networks alter the geography of use in the home setting unchaining users from the wired desktop and transforming laptops into mobile companions. Most significantly, Wi-Fi alters the basic economics of infrastructure in favor of users. The cost to deploy Wi-Fi to the premise of the end user is less costly than other forms of newly installed infrastructure such as copper wire, coaxial cable or fiber, the types of infrastructure over which most current broadband access is obtained. The high cost of such installations has been one of the main reasons cited by existing providers for rates of deployment that have left some significant numbers of home and small business users without the choices they say they want. It has also kept the cost of existing service high. So Wi-Fi networks that provide wireless access for about a third less (or even much less) than other systems have strong appeal, though the costs vary depending upon the geography of an area and whether standard or enhanced security is needed, among other factors.

Wireless networks for employees use within schools, colleges, homes, offices, businesses, and service sectors such as hospitals are already widely developed, and in the last half dozen years, a new form of access has been evolving which might be thought of as public access Wi-Fi. In this approach each "hot spot" has one or more Wi-Fi radio transceivers or "access points" physically connected to the Internet and capable of interacting with any Wi-Fi enabled laptop or handheld devices within range. By contrast in the usual home broadband access only one household has access to the physical connection such as DSL or cable modem lines. But within the range of Wi-Fi transmission, some larger number of users can travel to the physical access point through the hot spots. If the hot spots are close enough, a wireless access cloud is created which gives seamless coverage for many within range. In this scenario not every user is compelled to pay for individual physical access to the Internet.

It is not clear how the dominant providers of DSL and cable modem broadband service will respond to the growing appetite for Wi-Fi hot spot access and to the phenomenon of aggregating users onto a single access point in public or neighborhood locales. Technically cable modem service companies already ban public sharing of single user hook-ups in their service contracts while phone companies providing DSL service vary in their contract provisions. The history of new telecommunications technology tells us that the existing service providers will attempt to preserve the status quo ante as long as possible but that eventually a modus vivendi develops which makes a place for the new technology and its services. Therefore, Wi-Fi will continue to grow and become an established part of broadband access options. The question is how this growth should affect planning in other service arenas, such as transportation.

For mobile workers, a hot spot access point becomes a temporary office and stopping where a hot spot is available becomes part of the driving travel plan of the day. As the mobile worker population has grown, hot spot analysis should become part of the analysis for transportation planning, especially in metropolitan areas. The ability to continue to access e-mail in a cost effective and efficient way while moving around a large metro area in the course of a work day might become a critical factor in making or not making another trip within the work area.

The most well developed form of public Wi-Fi is the creation of hot spots in public areas such as airports, cafes, coffee houses, malls, bars, restaurants, and hotels. Often the access is free though in other places owners are attempting to create a revenue stream from the provision of hot spot services. Wi-Fi networks have also emerged with ordinary citizens setting up semi-public networks to create a neighborhood cloud of hot spots. One such network has surfaced in Prior Lake, Minnesota, where a small group of neighbors have created a neighborhood Wi-Fi network through a string of wireless-enabled houses that overlap to create a single, seamless wireless environment. As a result every home in the wireless cloud can tap into a single, shared high-speed Internet connection and also communicate on a neighborhood basis at very high speeds as well. It is possible to view the overall development of dots or nodes of the nascent wireless public network by following the web maps compiled by the Twin Cities Wireless Users Group (www.tcwug.org).

Beyond the development of numerous individual hot spots or the creation of localized neighborhood networks, the next step is to install public hot spots covering an entire metropolitan area so as to create a seamless cloud of access for broadband connectivity among wireless users in the whole municipal area. Municipalities and/or state agencies that regard wireless infrastructure as another fundamental tool in economic development planning lead these initiatives. It is also seen as a way to bring service to users left without broadband access. And it is seen as a way to introduce some competitive pricing into the broadband service industry because wireless infrastructure is relatively cost-effective. This has already been done in some cities and is under active development in many more. For example, Athens, Georgia and Tallahassee, Florida have already created Wi-Fi clouds aiming to flood large areas with bandwidth.

Important challenges remain for those who would like to see Wi-Fi become a really major player in broadband services. Equipment standardization is needed, more spectrum is needed, and international agreements on service bands are needed. Reliability and security remain challenges, but are improving rapidly enough so that more and more large scale community public safety services are adopting this pathway for their needs. The idea that wireless might become a major player in broadband services is very attractive because, among other reasons, the implementation costs are so much lower than with any other technology currently being deployed.

Fiber to the Home

The second pathway, which promises to grow into an important broadband service to the home, is known as fiber-to-the-home. As the name implies broadband telecommunications services are delivered by optic fibers to the side of every home or apartment. Since fiber optic lines have enormous capacity, the possibility of supporting big bandwidth uses at home becomes a reality. Such capacity is a real necessity for the serious home office, home business user. More broadly other uses include the delivery of high bandwidth content such as movies, complex computer games, streaming video and audio and other uses. Fiber-to-the-home enables the equipped provider to bring all the home services of voice, video and data to the home user over the fiber system and allows the home user to work with one provider company, all of which promises lower costs for providing the service and lower costs to the user for the service. If a small, service oriented service provider offered the converged services--made possible because of the technology-- the consumer benefits even more.

Up to the present, fiber to the home networks have largely been built by more rural telephone companies where the DSL or cable data service was unlikely or was equally costly. Those companies then aimed to provide multiple services over the fiber networks. However, fiber to the home has also become an option among new housing developments, especially in those developments known as residential master planned communities. The defining characteristic of those communities is that a single developer maintains a significant degree of control over all the design elements of the area. This opens up the possibility for the developer to install fiber to the home as part of their overall service plan for the community and to place the cost for the infrastructure into the overall price for lot development.

In this scenario, telecommunications services may be provided through partnership contracts with existing provider companies. Or alternatively the more innovative approach is for the developer to launch and own the telecommunications company which offers some or all of the voice, video and data services to the development's residents as they move in.

There has been little dispute that fiber to the home should be the next stage in the evolution of broadband services to the home. However, the equipment and installation costs are significant (in the $1500 to $2500 per user) and up until very recently few companies were manufacturing equipment for field installation at cost effective prices. The costs were special obstacles if the area to be served was not a new residential development. While most providers would agree that a fiber to the home platform for delivery of broadband access was desirable it was not considered cost effective for extensions of existing service or for overbuilding in order to provide competitive services. As a result the overall deployment of fiber to the home at the present time is still dominated by small and spotty deployments among small independent telephone companies, by utilities, by municipalities and by master planned residential developers in new housing developments.

However, very recently (May, 2003) three of the largest telecommunications provider companies made an announcement that could turn the tide strongly in favor of fiber to the home (FTTH) or fiber to the premise (FTTP) installations. Verizon, SBC and BellSouth indicated that they were defining common technical standards for fiber deployments to businesses and residences. That means the cost of equipment for fiber installation per user could drop down to the $800 to $1,000 range, which could spur demand for services and new fiber deployments among both residences and businesses. (*3*) By comparison, somewhat less than a decade ago, the DSL industry took a decisive step forward when similar agreements on technical standards were reached by that industry. However, it is only in the last two years that really rapid growth registered in DSL service.

Comparing Wireless Fidelity and Fiber to the Home

In comparing the two technologies—Wi-Fi and fiber to the home--most likely to become stronger players in provision of broadband access to the home (and to small businesses) we see that Wi-Fi has the immediate advantage of lower installation costs and the ability to aggregate multiple users to take advantage of a single physical connection to the Internet. As currently developed, it has some disadvantages of security and reliability and, at the top end, of inadequate speed. Fiber to the home has the advantage of running on a platform that brings top class services to the home with the same capability, reliability and security found in the best corporate settings. As currently deployed, it is being offered to the customer at about the same or slightly lower prices as conventional broadband access for DSL or cable modem. It has the disadvantage of a higher installation cost than other current technologies for broadband to the home, an installation cost which must be offset somewhere in the operational budget of the provider.

Fiber to the home represents a major step in the direction of enabling home users to carry out the same sophisticated work at home as in the best-equipped offices. It also offers the possibility to use the capacity of the network for neighborhood development. Because fiber to the home enhances so substantially the work environment capacity of the home it is the best test case possible for realizing the potential of data-intensive ATIS applications, as well as maximizing the impact of high-speed broadband access on work at home, and other behaviors which affect the transit and transportation patterns of users.

Importance of Broadband Services to the Home: Public Policy and Private Market

The most remarkable feature of the expansion of broadband telecommunications is the growing importance of this to home users, at least if one measures importance by the fact that people must specifically chose to buy the service in addition to the purchase of video or voice service. At the end of March 2003, 31% of home Internet users had a high-speed connection at home according to the Pew Internet & American Life surveys. This translates into approximately 31 million people who live in homes with a broadband connection. Looked at another way, it means that 16% of all Americans are fast Internet users--double the number at the end of 2001. That represents a 50% increase in the past year alone.

Nevertheless, despite the sharp increase this past year in broadband adoption, other countries outpace the United States including South Korea and Canada. Both countries developed public policies—in cooperation with providers-- that fostered rapid expansion of broadband services. For South Korea it was part of an overall growth strategy and for Canada it reflected an expectation that Internet communications could reduce rural isolation, enhance social cohesiveness and foster growth in the economy.

In the United States the growth of home broadband connectivity has been largely a matter of private market expansion, though that expansion was supported by some macro regulatory policies at both federal and state levels as well as by encouraging rhetoric. In policy terms the Federal Communications Commission has chosen to shield Internet access services from regulatory classifications, which would subject them to the family of charges, and surcharges that have grown up around telephone services. This helps contain the cost charged to end users for Internet service. In short, the policy in the U.S. at the national level has been to provide some modest support for broadband service to migrate into the home, but left it largely up to the individual consumer to choose whether or not the service was important enough to buy.

Minnesota's public policy approach to the provision of broadband has largely followed the national one, meaning that no major new initiatives have been taken at the state level, though for much of the last decade proposals for statewide initiatives were debated rather intensively. A major factor in the discussion was the concern that a lower level of affordable broadband access in small towns and rural areas would contribute to the growing economic development gap between Minnesota's larger cities and others, add to pressure for rural depopulation and contribute to poorer quality education for children and adults in the less well serviced areas. These concerns have not disappeared, but whatever the proper response should or will be, the telecommunications factor in the equation remains to be seen.

The Minnesota Legislature did include a strong provision for on-line education in the 2003 session.

HOW BROADBAND ACCESS IS USED AT HOME

While the public policy debate and private market actions evolve, we are gaining a better understanding of the answer to this question: What do the 31 million Americans who buy high speed Internet access do with the service? Many, many anecdotal accounts about the appetite for and consequences of Internet activity exist but have recently been supplemented by more systematic survey reports. One of the more ambitious and recent reports comes from the Internet and American Life Project of the Pew Foundation (*2*), which takes what it calls a new look at Internet access the digital divide, and how people use the Internet.

The Pew report argues that to speak of a digital access divide between users and non-users misses the fluidity of actual use. Instead, among the 42% of Americans who say they don't use the Internet, there are three distinct groupings. Net evaders actually live in homes with Internet access, but rely on other family members to send their e-mail or do their searches. Net dropouts once were active users but might have current problems such as broken equipment, service provider problems or financial problems with paying for access. True non-users or the truly disconnected also exist but are a smaller group than evaders or dropouts.

An important fact is that a majority of respondents are aware of the Internet and know where a public access point to it is in their community. This is especially important for the young, urban, poor non-white populations who want to be on-line at home but are unable to pay for it. In that perspective public and private programs to insure public computer access are important as are those aiming to make broadband access more affordable. Demographic characteristics are the strongest predictors of whether people use the Internet (education, income, race, among others). But orientation and social habits also matter. An outward orientation to the world along with watching and reading the news increases the chance of being an Internet user. On the other hand social habits reflecting a "close-in" social network tend to reduce the chance. If both are true, outward orientation trumps the close-in social capital network in that such a person is likely to be online.

For those who do have broadband access at home, how do they use the service? If you take all Internet users in the aggregate including broadband access users and dial-up users, 57% of Americans go online on an average day and that translates into 109 million people. Rather than report typologically on use, the data can be used to highlight some important points about usage. By far the most important use is that of e-mail with 93% of daily use. This may seem self-evident now, but it was not self-evident to the telecommunications service industry a decade ago. It was looking to e-commerce or entertainment as the "killer application."

However, we travel down the usage chart to 61% of daily use before any e-commerce application registers (buying a product) and down further to 41-37% before any entertainment applications registers. We must travel very far down the usage chart (19%) to find users who are "creating" content for the Internet. The intriguing question is whether this somewhat passive orientation to the Internet will become more active as the Internet lifeline grows. Last, the use of access at home for running a business, tele-commuting or virtual private network connection to one's workplace does not seem to be reflected in the overall findings (except possibly “research for their job” which did register at 52%). Yet growth in that area of use promises to be closely related to broadband access in the home.

CONCLUSIONS

The best guidance in looking ahead is to emphasize how little was understood about the potential importance of the Internet to home life (or to business and service life for that matter) at the beginning of the nineties. The easiest and most personal use of the Internet at that time -- e-mail – is still the leading use today. In thinking about the role of broadband access to the home, we know that broadband access is helpful but not essential to that use.

Nevertheless, while extrapolation from the usage profile of today is risky, the advances being made in broadband indicate that changes may be coming. Wi-Fi and Fiber to the Home provide opportunities for flexibility and ease of accessing information that are not currently available through DSL and cable connections, and these advantages could lead to much greater, and content-rich, telecommunications activity in the home. Departments of Transportation should continue to track and promote these developments, as detailed travel information and other data-intensive uses of telecommunications that can lead to real changes in travel behavior will become much more usable once this next generation of home connections comes on-line.

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ENDNOTES

(1) World Summit for the Information Society, http://www.wsis.org

(2) "How Home Broadband Users Connect" Pew Internet and American Life Project, April, 2003 (www.pewinternet.org/)

(3) Telecommunications Reports Daily, June 4, 2003

TABLES AND FIGURES

Figure 1: American Adults with Broadband at Home

	40												
	35												
Mls	30												+
of	25											+	
Amer	20							+		+			
	15						+						
	10				+								
	5	+											
	0												
		J-00	S-00	D-00	M-01	J-01	S-01	D-01	M-02	J-02	S-02	D-02	M-03

Source: Pew Internet & American Life Project, April, 2003

Figure 2: Growth Rate of High Speed Lines to Residential and Small Business (Over 200 kpbs in at least one direction)

December 2001	**June 2002**	**December 2002**
11 million lines	14 million lines	17.4 million lines
Full Year Percentage Increase:		58%

Source: FCC, "High Speed Services for Internet Access"

Figure 3: How Home Broadband Users Connect (March 2003)

Cable Modem	**67%**
DSL	**28%**
Wireless	**4%**
T-1/Fiber	**1%**

Source: Pew Internet and American Life Project, April 2003