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## Bowling for Broadband 2: Toward Citizen-Centric, Broadband-Based E-Government

### Introduction

Much has changed since NASCIO published its initial broadband brief, “Bowling for Broadband: Promoting High-Speed Internet Access for Economic Development,” in late 2004.<sup>1</sup> Public-private community wireless networks have emerged as the solution of choice for getting citizens online with high-speed Internet connections, which raises infrastructure issues. Rich-media is beginning to dominate the communications experience, making broadband and wireless connectivity more of a necessity than a luxury when it comes to taking advantage of what the Internet has to offer as a medium for delivering entertainment, information, and services (including government services). Meanwhile, the market for dial-up and broadband services might have reached a plateau, leaving service-providers and policymakers to deal with a hardcore segment of non-adopters. Finally, telecommunications providers have begun to tackle infrastructure and pricing issues with an array of possible reforms, which has, in turn, raised new access implications that state governments will have to address in the near future.

In the recent past, online service developers were constrained by browser rendering of HTML, monitor sizes, and a variety of dial-up modems (with speeds ranging from only 14 to 56kpbs). Thanks to technological innovation, those limitations are a thing of the past. But newer, disruptive technologies are always emerging. Today we are constrained by the limitations of a consumer audience split between introductory, mainstream, and emerging levels of broadband access (with a range of access speeds measured in Megabits, not kilobits). Already, moving graphics, streaming audio, in-browser video and other rich media applications are becoming standard website features, while peer-to-peer file-trading services are feeding what one leading publication has called a “global bandwidth binge.”<sup>2</sup>

Alcatel has developed a useful “Broadband Hierarchy of Needs” that can be adapted to serve as a public-sector, citizen-centric reference point for this discussion. However,

Figure 1 – A Citizen-Centric Hierarchy of Broadband E-Government Needs



<sup>1</sup> See <[http://www.nascio.org/nascioCommittees/economic\\_development/index.cfm](http://www.nascio.org/nascioCommittees/economic_development/index.cfm)>.

<sup>2</sup> Joanna Glasner, “P2P Fuels Global Bandwidth Binge,” *Wired News*, 14 April 2005, <<http://www.wired.com/news/business/0,1367,67202,00.html>> (19 May 2006).

for purposes of this discussion, the layer of the pyramid that Alcatel has designated “Entertain Me” can be re-cast for the public-sector as “Engage Me” since governments rarely seek to entertain citizens and employees (at least intentionally). In approaching the development toward a citizen-centric, broadband-based e-government experience and looking at it holistically should lead to an environment where citizens and public servants can take advantage of e-government as follows:

- via any type of device (i.e., laptop/tablet PC, wireless PDA, mobile phone).
- over any type of broadband connectivity (i.e., wire-line, wireless, satellite or mobile 3G).
- with single subscription/authentication.
- with consistent customization/personalization.
- with transparent synchronization.<sup>3</sup>

### Connect Me (Local- and State-Level Opportunities)

Of course, the first step in bringing citizens into the Internet age is simply getting them online. The United States continues to make incremental steps toward full national adoption of the Internet as a personal and business solution. However, without an announced national goal along the lines of “sending a man to the moon,” it is difficult to assess the nation’s status. So, we are left to consider a series of disjointed indicators.

#### Hardcore Non-Adopters

Recent developments in the market place for Internet access threaten to render the old online vs. offline digital-divide debate a moot point. The nearly 30% of Americans who don’t have any type of Internet access can now be considered hardcore Internet non-adopters. The Internet has been a high-profile part of the nation’s culture for a decade and monthly dial-up access has been universally available for well under \$10.00 per month for nearly as long. So, it is hard to make a case that these Americans have not made the intentional choice to stay off line or use someone else’s access. However, broadband providers are still optimistic they can persuade this demographic of the value of broadband. A recent study by Leichtman Research Group shows that the coaxial cable and DSL providers are not simply engaged in a zero-sum competition for each other’s customers. They are actively marketing to the 30% of offline Americans and the 28% who use dialup access with a wide range of packages and prices that are competitive even with “enhanced” dial-up services.<sup>4</sup>



However, the digital divide cannot be looked at exclusively in terms of the availability of Internet access. Households must have the devices (i.e., PCs, modems, etc.) and know-how that

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<sup>3</sup> Allison Cerra and Dennis Kan, “User-Centric Broadband Services: Demand Drivers and Market Opportunities,” *Alcatel Strategy White Paper*, 1st Quarter 2005, <[http://www.alcatel.com/doctypes/articlepaperlibrary/pdf/ATR2005Q1/S0503-UCBB\\_services-EN.pdf](http://www.alcatel.com/doctypes/articlepaperlibrary/pdf/ATR2005Q1/S0503-UCBB_services-EN.pdf)> (20 June 2006).

<sup>4</sup> Marguerite Reardon, “DSL strikes a chord with frugal shoppers,” *News.com*, 19 June 2006, <[http://news.com.com/DSL+strikes+a+chord+with+frugal+shoppers/2100-1034\\_3-6084717.html](http://news.com.com/DSL+strikes+a+chord+with+frugal+shoppers/2100-1034_3-6084717.html)> (20 June 2006).

will allow them to connect to available broadband services. Recognizing that the cost of a computer is often the primary barrier to getting online, the state of Kentucky has launched a “No Child Left Offline” effort whereby retired state government computers will be refurbished and distributed to offline households with eighth graders. Since the program was announced in the fall of 2005, nearly 900 refurbished computers have been distributed to eighth-graders and their families in five Appalachian counties. The state has also set a goal to make broadband universally available statewide by 2007 (up from the current 82% availability).<sup>5</sup> The widely-publicized municipal wireless project in Philadelphia is expected to generate \$5 million in net revenue that will be partially re-invested in low-cost broadband services as well as in home PCs and training for low-income users.<sup>6</sup> Despite these initiatives and others to reduce the entry-level costs of getting online, affordability and the recurring investment remains a key barrier to wider broadband adoption.

### Community WiFi

Each new advance in Internet technology—whether it be increasingly interactive and entertaining websites, low-cost Internet telephony (i.e., VoIP), or plug-and-play wireless mobility—makes Internet access more appealing to some portion of those whose interest in the Internet has lagged previously. The recent trend toward community-based WiFi (802.11g) networks promises to bring PCs out of homes and offices and into the public. Public-private municipal WiFi deployments have already overtaken municipal wire line projects.<sup>7</sup> This is probably due less to legislative restrictions against municipal broadband deployments than to the reduced costs and shorter deployment time for wireless mesh grids along with the ease of providing private infrastructure providers with easy access to existing public infrastructure, such as utility poles.

This development provides state governments with new opportunities to help move the market. Understanding that all broadband is local, the state of Michigan has initiated a seven-stop road show across the state to educate municipal and county leaders on how to develop public-private broadband deployment efforts in their communities. Representatives of Michigan’s Department of Information Technology (MDIT) have met with representatives of more than 200 local units of government. The day-long sessions have included a guidebook that provides cities and counties with baseline information for developing broadband action plans. Additionally, Cisco Systems’ European consultancy has produced a report, “(2010) Broadband City - A Roadmap for Local Government Executives,” that harvests many insights that are applicable in North America. (See <http://www.cisco.com/web/about/ac79/wp/>.)

### Telecom Reform

Congress has recently taken on “telecom reform” and “net neutrality,” which turned out to be far more contentious issues than initially expected. Again, given the continued trend toward private deployment of broadband infrastructure, the major telecommunications companies have been seeking alternate funding models for extending and upgrading that infrastructure. They seek to

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<sup>5</sup> --, “‘No Child Left Offline’ Receives National Award,” *press release*, 6 June 2006, <<http://connectkentucky.org/events/pressreleases/ncloward.htm>> (20 June 2006).

<sup>6</sup> The Wireless Philadelphia Executive Committee, “Wireless Philadelphia Business Plan,” 9 February 2005, <<http://www.phila.gov/wireless/pdfs/Wireless-Phila-Business-Plan-040305-1245pm.pdf>> (27 June 2006), 41.

<sup>7</sup> See *News.com*’s “Municipal broadband nationwide” map at [http://news.com.com/Municipal+broadband+and+wireless+projects+map/2009-1034\\_3-5690287.html](http://news.com.com/Municipal+broadband+and+wireless+projects+map/2009-1034_3-5690287.html).

provide Internet protocol television (IPTV) and other bandwidth-intensive services, so they would like to be able to charge early adopters and other high-end consumers a higher rate in order to provide them with greater bandwidth and higher-priority packet routing that will ensure that the data arrives with smooth-flowing full-screen images (as opposed to the glitchy, viewer-based images most users see today). Such packet prioritization could be applied to customers with high-value, mission-critical applications, tele-health consumers, public-safety communications, and so forth. But, IPTV is the driving concern at this time.

Some content providers and ISPs are concerned that telecommunications providers would provide priority packet routing or server caching for content providers with whom they have a contractual relationship. Thus, they argue for “net neutrality,” whereby telecommunications providers would not be allowed to prioritize a user’s access to or experience with any destination on the Web. This is essentially an argument for a transport layer that does not interfere with the content moving over it in any way. Today, many ISPs do provide prioritized packet routing and greater bandwidth to business and residential customers who pay more, but that prioritization and bandwidth is not affected by the end points to which and from which the customer chooses to push and pull packets. Sen. Ted Stevens (R-AK), chairman of the Commerce, Science and Transportation Committee, has tried to broker a compromise with a limited “Internet Consumer Bill of Rights” that would prevent consumers from having legally available sites blocked for commercial reasons. This is a more specific protection than had previously appeared in viable Congressional legislation.

### The Mobile Civil Servant

While state governments might not be among the primary drivers of broadband adoption by citizens, they do control whether their employees remain tethered to their desks and back-office databases and paper files or are liberated to serve constituents in the field as occurred recently with workers at Texas Child Protective Services.<sup>8</sup> So far, it has been easy for governments to recognize the value of technological mobility for workers whose jobs (by their very definitions) pull them out into the fields, as with child-protective case workers. However, bringing mobility to the rest of the government workforce will require more than a commitment to technology. It will require business-process changes that are embedded in decades-old traditions and even in statute. Also, given the fact that rarely a month goes by without a high-profile loss or exposure of citizen and/or employee records by some public entity, government decision makers will eventually have to bestow the necessary resources and authority on state information security offices that will allow them to assure public information.



The loss of mobile devices, such as laptops/tablet PCs, PDAs, cell phones, and portable memory, looks to be every bit as serious a concern as the threat of having systems “hacked” via the Internet. Data sets in portable memory and devices with real-time access to back-office systems simply cannot be allowed out into the field without significant investment in internal

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<sup>8</sup> Triani Jones, “CPS Case Workers Go Wireless With ‘Tablet PC,’” *CBS 11 News*, 13 June 2006, <[http://cbs11tv.com/local/local\\_story\\_164222755.html](http://cbs11tv.com/local/local_story_164222755.html)> (20 June 2006).

access controls that keep data from leaving the office when it shouldn't and ensuring that it can't be accessed remotely by unauthorized parties when it does leave the office. Government entities must decide whether they would rather conduct state business securely or roll the dice as to whether they will have to pick up the tab for providing free credit-check services to citizens and employees whose personal information is compromised.

Finally, living in a geographically expansive nation with dramatic climatic conditions, rarely a year goes by where at least one region of the nation is not affected by some sort of natural disaster. That fact, combined with a trend toward homeland security and all-hazards preparedness, puts a premium on having state government workforces that are capable of maintaining order and providing emergency and minimum-essential government services remotely as part of responding to and recovering from various types of attacks, accidents, or disasters.<sup>9</sup> Therefore, the user-centric broadband requirements of bandwidth-intensive tools, such as intranets, VoIP, and GIS, should be considered within the context of tele-work processes and continuity of operations plans.

### Organize Me (The Coming PHR Revolution)

Even though most governments have not fully graduated from the “Connect Me” phase of e-government, the nation will soon be moving into the “Organize Me” phase. The potential to provide citizens with a more integrated and coherent view into their recorded relationship with government has been in place for quite some time. Up until now, there has been no significant market event to drive demand for such organized presentation in the public sector. However, skyrocketing healthcare costs are now that driver. States, like every other healthcare provider, are looking to reduce the costs of serving consumers—such as prisoners and the not-insignificant percentage of citizens who use public/university hospitals and clinics. States are looking for ways to pay for outcomes rather than incidents of service for the insurance coverage they provide to citizens (via Medicare) and employees. Healthcare consumers—particularly the aging Baby Boomers—are seeking more control over their healthcare consumption. This is where electronic/personal health records (PHRs) come in and the lessons that will be learned from the national effort to implement them will bleed over into many other areas of business.

PHRs promise to provide consumers with a unified view of their healthcare “account” over time and across multiple service providers in the same manner they have come to expect from single-source providers, such as Amazon.com or eBay. Already, with the establishment of a National Coordinator for Health IT within the U.S. Department of Health and Human Services, this industry is seeing movement toward national standards for e-health records. The goal is that in the next ten years consumers and their attending physicians, through the use of elaborate record-locator services, will be able to pull up a complete history (accessible only to them) of their healthcare and, thus, provide continuity and outcomes-based services that are not common today.

None of this is particularly bandwidth intensive until the exchange of healthcare-related images is considered. X-rays, MRIs, and other images (maybe even audio files) can be attached to your permanent electronic record, so to speak. And, given that care for chronic conditions (such as heart disease, emphysema, diabetes, HIV, depression, and high-blood pressure) drives the vast majority of healthcare spending, the opportunities to provide more consistent and cost-

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<sup>9</sup> See sections 7(c) and 15 of Homeland Security Presidential Directive (HSPD)-7 at <<http://www.whitehouse.gov/news/releases/2003/12/20031217-5.html>>.

effective care via tele-health technologies cannot be underestimated. So, while tele-health transactions don't appear to be bandwidth-intensive today, scaling up to millions of tele-health and PHR transactions per day becomes a concern on par with any other peer-to-peer exchange of rich-media files.

In time, citizens might come to expect an electronic public record (ePR) that will allow them to see a record of all their interactions with government. This might allow them to see all the taxes they've paid, update personal contact information once (rather than for each separate governmental entity), and conduct more business online using the stronger identity management that will be available in the wake of REAL ID. However, before citizens will be able to organize their relationship with government, governments will have to organize themselves through improved business processes and information sharing architectures.

## Engage Me

Governments have been informing citizens and employees via the Internet since Day One. However, this has mostly occurred as a one-to-many type transaction through the display and distribution of text-based information. A user-centric, broadband-based e-government promises more citizen and employee interaction via rich-media. Indiana, Kentucky, and Nebraska are examples of states that have begun providing access to real-time and on-demand video footage of state legislative sessions. Oregon is providing audiocasts of legislative sessions. Some governors are providing rich-media versions of their state-of-the-state addresses, and other public announcements. Delaware provides a multimedia portal site for a directory of content (see <http://www.state.de.us/gic/mmedia/>). However, much more can be done along these lines. State agencies can provide more than just welcome messages from directors and cool graphical animations. Audio and video—including web animation (e.g., Flash)—can be used to provide more engaging instructions as to how citizens and employees can complete specific processes and do business with the agency. These techniques can also provide accessibility to those with special needs and can reduce calls from citizens and employees to help desks.

In addition to rich-media options, states can also pursue a variety of not-so-bandwidth-intensive technologies designed to engage citizens and employees on their terms. Such options include mobile/3G access to state web sites (e.g., see Michigan at <http://mobile.mi.gov>), RSS feeds (e.g., <http://www.state.de.us/gic/subscribe/services/rssnews.shtml>), podcasts (e.g., <http://www.governor.state.mn.us/mediacenter/podcasts/index.htm>), and blogs (e.g., <http://gov.ca.gov/index.php/blog>). Several years ago, the state of Maine used Flash technology to allow citizens to develop and submit their own budget priorities in a very user friendly format that gave them real insight into the tradeoffs in generating revenue and funding major programs as well as a chance to share their opinions with elected officials.

## Empower Me

As citizens and employees become more savvy and aware of the potential applications of rich-media and other bandwidth-intensive applications, they will seek to use what has traditionally been considered “government-held” public information for their own purposes. An emerging example along these lines has been geographic information systems (GIS) and geo-spatial data. Online tools such as MapQuest and, now, Google Earth promise to raise citizen expectations for the use of mapping technologies. ESRI is already forecasting the emergence of a GeoWeb that will facilitate these citizen desires.

The GeoWeb will be a “system of systems” that will make an ever-larger and more diversified body of geospatial data available to all types of users. A recent report by ESRI discusses the prospect of a “geodata-rich society” where (possibly within the next six years) “we will have a hundred times more satellite imagery available...and the real-time monitoring of various geographic phenomena will be increasingly available in consumer as well as professional applications.”<sup>10</sup> This means that businesses, non-profits, and even individual citizens will become increasingly GIS-savvy. Citizens will move beyond simple activities, such as conducting preliminary investigations of locations to site a structure or plotting a data element or two (e.g., criminal activity, voter registration, fishing-lake depths, school-district boundaries, etc.) against a street or topographical map. Soon real estate agents might want to plot census, police, and school system data on a hybrid satellite/street map when advising potential homebuyers and sellers.

Knowing that few users will have true GIS software on their PCs, GIS and mapping service providers have stayed with browser-based applications. But, they have already begun moving toward multi-layered applications that provide more user-customizability, which makes these services much more bandwidth-intensive. Users will visit these sites out of curiosity and quickly graduate to restaurant hunting and vacation planning. Eventually, they will begin to see applications in other areas of their lives.



This transformation represents more than technological advance. It holds the potential to leverage the entire citizenry as an open-source for the review and analysis of public data sets. Government executives will face added pressure and increased scrutiny when—for example—a graduate student at the local university, using a geo-coded data set of criminal activity, disproves the local sheriff’s claim to reducing crime in a given neighborhood. But, savvy government decision makers will learn to invite public scrutiny to improve policy and implementation. They will leverage the increased input and buy-in to invert the traditional government-to-citizen relationship for one-to-many (G2C) arrangements into many-to-one arrangements (C2G) in more than just the symbolic sense. Broadband-based, grassroots e-government of this sort will take its place with e-learning, e-health, entertainment over IP, and e-commerce as the primary pillars of the Internet Age.

## Conclusions

Creating a broadband-based form of citizen-centric e-government is the first great challenge since the rise of portals in the post-Y2K era. Right now, most citizens are content to live with “introductory” or “mainstream” broadband access. (See “Appendix A” below.) And, given the rate of progress in America’s broadband rollout, most citizens will be in this range into the foreseeable future. Fortunately, government does not have to keep pace with HDTV or other citizen desires driven by consumer technologies, but they should take into account a rising level of citizen expectations for e-government.

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<sup>10</sup> ESRI, “Development of Geospatial Lines of Business and the Emergence of a *GIS for the Nation*,” May 2006, <[http://www.gis.com/documents/glob\\_part21\\_format.pdf](http://www.gis.com/documents/glob_part21_format.pdf)> (16 May 2006), 5-6.

Most citizens—and virtually all state employees—now enjoy adequate bandwidth to take advantage of a richer e-government experience than is widely available at this time. Governments will not be able to abandon mail- and telephone-based interaction anytime soon. A number of surveys still report that citizens prefer telephone communications for most government services. They will likely have to maintain alternate, low-bandwidth website presentations as well so that dial-up and low-end broadband users can access pages free of moving graphics, background audio, or pop-up video windows. However, this does not preclude governments' abilities to better connect, organize, engage, and empower citizens through broadband-based e-government.

In the end, every state CIO can contribute by educating policymakers at the state and local levels regarding the key technological, demographic, and regulatory issues affecting the rollout of broadband in that state. He or she must serve as a trusted voice that can advise their governors and legislators as to what these and other strategic issues mean to state business. State CIOs can also serve as a representative of state government, collaborating with other state leaders and non-governmental, community-based organizations (e.g., [ConnectKentucky](#), the OneGeorgia Authority's [BRIDGE initiative](#), and West Virginia's nascent Community Connect Foundation) to educate citizens and encourage efforts by the private sector.

Regarding strategic options, TechNet's 2003 "State Broadband Index" provided a list of strategic options for state government's seeking to expand broadband availability, including recommendations that states...

- "standardize and expedite" right-of-way (ROW) permitting
- "limit fees imposed for ROW access"
- adopt a "broadband strategy and formal plan"
- assess "broadband status" through mapping and cataloguing of existing infrastructure
- "allow municipalities to provide wholesale services"
- undertaking "innovative supply-side initiatives"
- provide "financial incentives for broadband deployment, especially for underserved communities"
- provide incentives for public- and private-sector users to access broadband networks
- "encourage broadband usage by citizens through e-government initiatives"
- "encourage government usage of broadband applications"
- provide "financial support that encourages the development of broadband applications that improve government services or support next-generation technologies"<sup>11</sup>

Gartner analysts Hackler and Cowles offered a few additional public policy recommendations that aren't cited above, including...

- "Encourage collaborative efforts of the State, counties, and municipalities"
- "Establish a clearinghouse for best practices"
- "Create 'regulatory free' zones"
- "Participate in solving intellectual property (IP) issues at the national level"
- "Require new housing developments to include fiber or conduits to fiber"

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<sup>11</sup> TechNet, "The State Broadband Index – An Assessment of State Policies Impacting Broadband Deployment and Demand," n.d., 3-4.

- “Require broadband be capable of replacing existing communications services”<sup>12</sup>

Together, these studies provide a fairly comprehensive survey of the strategic options and approaches for expanding broadband availability at the state level. Going back to 2002, the [Strategic Planning Committee](#) of the Arizona Telecommunications and Information Council (ATIC) has implemented a wide ranging program for the “development of a statewide telecommunications infrastructure to support business, education, economic, and community development.”

## Case Studies

### **New Brunswick, Canada**

Completed in June 2006, the province of New Brunswick and the Canada, the Canada Strategic Infrastructure Fund (CSIF), and Aliant Corporation have provided all regional health care centers, business parks and First Nations communities, as well as most New Brunswick residences and businesses, with access to high-speed Internet service. The Government of Canada provided up to \$16.5 million for this infrastructure project, with the Government of New Brunswick investing \$12.5 million and Aliant \$15.6 million. Installation and upgrades of broadband equipment extended coverage to 327 communities throughout rural New Brunswick.

CSIF: “Successful broadband program completed ahead of schedule” (29 June 2006)

[http://www.infrastructure.gc.ca/csif/publication/newsreleases/2006/20060629fredericton\\_e.shtml](http://www.infrastructure.gc.ca/csif/publication/newsreleases/2006/20060629fredericton_e.shtml)

### **Global Fiber-to-the-Home (FTTH)**

A recent report predicts that global FTTH connections will grow from “about 11 million this year to about 86 million 2011.” Approximately 59 million of those connections will be in Asia. The report also predicts that this surge will make broadband connectivity of 100Mbps (symmetrical) the standard for convergent media. In a related event, Verizon [launched web sites](#) for Chinese and Korean language access to its FiOS FTTH offerings.

EE Times: “Study: Global Fiber-to-the-home use to surge” (21 June 2006)

<http://www.eetimes.com/news/latest/business/showArticle.jhtml?articleID=189500441>

For more information about Alcatel’s user-centric broadband concepts, visit the *Alcatel Telecommunications Review* (1st Quarter 2005 edition) at

[http://www.alcatel.com/atr/DATR\\_table\\_of\\_contents.jhtml?atrissue=tcm%3A172-220541635](http://www.alcatel.com/atr/DATR_table_of_contents.jhtml?atrissue=tcm%3A172-220541635).

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<sup>12</sup> Kathie Hackler and Ron Cowles, “Harnessing Broadband for Economic Growth,” Gartner PowerPoint presentation, 24 June 2003, 14.

Appendix A – Some Suggested Broadband “Speed Bands” and Their Relative Capabilities<sup>13</sup> (as of July 2006)

Introductory Broadband	Mainstream Broadband	Rich-Media Broadband	Convergent Broadband
From 200Kbps minimum to 2.048Mbps <sup>14</sup>	From 2.048Mbps minimum to ~12Mbps	From ~12Mbps to ~24Mbps	From ~24Mbps to ~100Mbps
<b>Copper Wire:</b> <ul style="list-style-type: none"> <li>• “Enhanced” dial-up services that use compression to provide speeds “up to five times faster” than typical 48-56Kbps connectivity</li> <li>• ADSL (lower tier)</li> <li>• Access BPL (lower tier)</li> <li>• Coaxial cable/DOCSIS (lower tier)</li> </ul> <b>Pure Wireless:</b> <ul style="list-style-type: none"> <li>• Satellite (lower tier)</li> </ul>	<b>Copper Wire:</b> <ul style="list-style-type: none"> <li>• Access BPL (upper tier)</li> <li>• ADSL (upper tier)</li> <li>• ADSL2</li> <li>• Coaxial cable/DOCSIS (middle tier)</li> </ul> <b>Pure Wireless:</b> <ul style="list-style-type: none"> <li>• Mobile cellular (3G)</li> <li>• Satellite (middle tier)</li> </ul>	<b>Copper Wire:</b> <ul style="list-style-type: none"> <li>• ADSL2+</li> <li>• Coaxial cable/DOCSIS (upper tier)</li> <li>• VDSL</li> </ul> <b>Coaxial Cable or xDSL to the Premises with Wireless to the Device:</b> <ul style="list-style-type: none"> <li>• Wi-Fi/802.11g</li> </ul> <b>Pure Wireless:</b> <ul style="list-style-type: none"> <li>• Satellite (upper tier)</li> </ul>	<b>Fiber-to-the-Home (FTTH)</b> <ul style="list-style-type: none"> <li>• e.g., Verizon FiOS</li> </ul> <b>FTTN/FTTC with Copper Wire to the Premises:</b> <ul style="list-style-type: none"> <li>• Coaxial cable/DOCSIS (very upper tier)</li> <li>• VDSL2/2+</li> </ul> <b>FTTN or WiMax (802.16) Backhaul with Wireless to the Device:</b> <ul style="list-style-type: none"> <li>• Wi-Fi/802.11e</li> </ul> <b>Pure Wireless:</b> <ul style="list-style-type: none"> <li>• Satellite (very upper tier)</li> </ul>
<b>Capabilities</b> <ul style="list-style-type: none"> <li>• Voice-quality audio/VoIP (64-128Kbps/stream)</li> <li>• Videoconference-quality video (100Kbps/stream)</li> <li>• VCR-quality video/MPEG-1 (~1.5Mbps/stream)</li> </ul>	<ul style="list-style-type: none"> <li>• Digital video/MPEG-2 (2-6Mbps/stream)</li> </ul>	<ul style="list-style-type: none"> <li>• Single-stream high-definition digital video/HDTV (~20Mbps/stream)</li> <li>• MPEG-4 video (~12Mbps/stream)</li> <li>• Introductory “triple-play” convergence of data with VoIP and IPTV</li> </ul>	<ul style="list-style-type: none"> <li>• Multi-stream high-definition video/HDTV (~20Mbps/stream)</li> <li>• Full “triple-play” convergence of data with VoIP and IPTV</li> <li>• Smart appliances/pervasive household Internet</li> </ul>

<sup>13</sup> NOTE: These estimations include the author’s research of current market offerings, research by South Dakota’s Bureau of Information Technology Services (BITS), and Wikipedia’s “List of device bandwidths” at <http://en.wikipedia.org/wiki/List\_of\_device\_bandwidths> (12 June 2006).

<sup>14</sup> NOTE: This range was set by using the FCC definition of “advanced Telecommunications capability” of at least 200Kbps as the lower limit and the International Telecommunication Union Standardization Sector (ITU-T) recommendation I.113 that defines broadband as a transmission capacity that is *faster* than an Integrated Services Digital Network (ISDN) primary rate interface (PRI), at 1.544Mbps (T-1) to 2.048Mbps (E1), as the upper limit.