Broadband in America - 2nd Edition

Where It Is and Where It Is Going

(According to Broadband Service Providers)

An Update of the 2009 Report Originally Prepared for
the Staff of the
FCC's Omnibus Broadband Initiative

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# Acknowledgements

The research effort that went into this report was undertaken two CITI interns. The research was started in June, 2010 by:

Travis Korte (University of California, Berkley BA, 2010), and **Timothy Krompinger** (University of Connecticut, BA, 2011.

In addition, other members of CITI's staff and a number of CITI friends and affiliates contributed their experience and expertise by reviewing and critiquing drafts.

We would also like to thank the many organizations that responded to our requests for broadband data and information and those individuals who verified their organization's data presented in the Appendix of this report.

CITI, as an institution, does not author or publish articles or reports. Therefore, we, as the authors, are responsible for the content of this report.

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Project Background

This is the second edition of "Broadband in America: *Where It is and Where It Is Going*". It is an update and expansion on the original report that was submitted to the Federal Communications Commission (FCC) in November 2009 as part of the FCC's development of a National Broadband Plan (NBP).

The first three sections of this second edition are general updates of the factual data submitted to the FCC approximately in late 2009. The fourth section is entirely new: it comprises analysis and commentary by a few leading broadband experts who provide their insights into some of the issues associated with Broadband in America.

- **The First Edition**

In mid-2009, the staff of the FCC's Omnibus Broadband Initiative (also known as the National Broadband Plan Task Force) asked the Columbia Institute for Tele-Information (CITI) to conduct an independent analysis of publicly announced broadband network deployments (both new and upgraded networks) of companies in the United States, for the purpose of informing the FCC's efforts in developing its National Broadband Plan. On August 6, the FCC announced that CITI had agreed to undertake the analysis project.[1]

Two members of CITI's management staff, Bob Atkinson and Ivy Schultz, undertook the 2009 project. They worked independently of the FCC and conducted the project with CITI's research resources and without any project funding from the FCC or any other organization. As a result, these project arrangements ensured the independence and integrity of the work product.

As requested by the FCC, the project encompassed a comprehensive examination and analysis of companies' announcements and similar public information, industry analysts' reports, and other relevant data sourced to the broadband service providers to measure and assess broadband plans. Also at the FCC's request, the report included an assessment of where broadband deployments will be in 3 – 5 years and a comparison of results with previously released plans that are in progress or complete. To avoid duplication and to focus the resulting report on what broadband service providers were doing and planning, the project purposefully did not include data and other information already gathered and published by the FCC.

The research for this project focused on the three specific areas requested by the FCC, each of which is addressed as a section in the First and Second Reports:

[1] FCC Press Release, http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-292598A1.pdf.

Section 1: Listing of All Publicly Announced Broadband Plans, sorted both (1) by company and (2) by technology (e.g. DSL, cable, fiber (FTTx), fixed wireless, wireless, satellite), with a description of relevant details such as (1) general details of the plan, including company, technology, and timeline, (2) expected capital outlays and operating expenditures, (3) expected deployment/coverage footprint, (4) expected broadband performance and quality, and (5) expected ARPUs (Average Revenue Per User).

Section 2: Comparison of All Publicly Announced Broadband Plans, based upon the Listing of All Publicly Available Broadband Plans. This looks backwards to what was announced at the time the plan was established and then compares the announcement with the outcomes of completed plans and the current status for those plans still in progress.

Section 3: Future Projection: This is an analysis of where the publicly announced broadband plans that are yet to be commenced or still in progress will be in 3-5 years, including LTE, WiMAX, DOCSIS 3.0, backbone, etc. This includes a summary of analyst capital expenditure forecasts and a "lessons learned" component.

Section 4: Essays & Analyses (only in Second Report) by five leading broadband experts based on their presentations at a March 18 conference organized by CITI and Georgetown University's Communication Culture and Technology Program to commemorate the first anniversary of the National Broadband Plan.[2]

After receiving the First Report, the FCC released it for public comment and received a number of comments from various companies and trade associations involved in the National Broadband Proceeding. Most of the comments endorsed the Report and none took issue with the methodology or analysis. The CITI authors presented the Report at a public meeting held at the FCC on December 10, 2009. The presentation was recorded and is available on the FCC website at http://www.broadband.gov/ws_deployment_research.html and the CITI website at http://www4.gsb.columbia.edu/citi/research/current .

General Research Methodology

This Second Report follows the same general methodology used in the First Report. CITI researchers worked independently of the FCC and conducted the project with CITI's research resources and without any project funding from the FCC or any other organization. As a result, the project arrangements continue to ensure the independence and integrity of the work product.

[2] See: http://www4.gsb.columbia.edu/citi/events/NBP2011 for the conference presentations and video.

Since the FCC's original request was for a review of the state of broadband in America based on what the broadband service providers have publicly announced, researchers assigned to this project again collected data primarily from: 1) service providers' public reports and statements; 2) reports by investment analysts and research firms (which are generally based on information obtained directly from the service providers themselves); 3) news reports directly quoting the service providers; and, 4) information compiled by industry trade associations directly from their member companies. Consequently, **we did not develop independent data or evaluate the validity of the data reported by the service providers and, to avoid repetition and duplication, we did not use academic, government or other studies regarding the state of broadband that are available to the FCC and the Commission's staff.**

Relying on information provided as directly as possible by the service providers has its own limitations. Each service provider has a natural inclination and incentive to present information about itself in a way that it regards as most beneficial to its interests. For competitive and other business reasons and to comply with securities laws regarding disclosure of material information, publicly traded broadband service providers are careful about releasing detailed information about their current performance and future plans regarding broadband deployments and financial results. Small private companies are similarly reticent to provide detailed information about their future plans, even to their trade associations.

The public and anyone with relevant information are invited to submit additional information and data to a dedicated email address: CITI-broadband@gsb.columbia.edu.

Executive Summary

One principal conclusion drawn from the First Report was that by 2013-4, broadband service providers expected to be able to serve about 95%[3] of U.S. homes with at least a low speed of wired broadband service and they expected to offer to about 90% of homes advertised speeds of 50 mbps downstream.[4] Service providers expected to provide many homes with access to these higher speeds by 2011-2012.[5] Another conclusion was that wireless broadband service providers expected to offer wireless internet access at advertised speeds ranging up to 12 mbps downstream (but more likely 5 mbps or less due to capacity sharing) to about 94% of the population by 2013. The First Report also concluded that, in addition to several wireless broadband choices, the majority of American homes will have the choice of two wired broadband services. Upstream speeds for wired and wireless services will generally be significantly lower than downstream. The updated information included in this Second Report continues to support all of these expectations.

Another principal conclusion drawn in the First Report was that a significant number of U.S. homes, perhaps five to ten million (which represent 4.5 to 9 percent of households)[6], will have significantly inferior choices in broadband: most of these homes will have wireless or wired service broadband available only at speeds substantially lower than the speeds available to the rest of the country. Some of these homes will have no choice except satellite broadband, which has some performance attributes that make it less satisfactory for many applications than a terrestrial broadband service. Once again, these conclusions remain valid.

The First Report also concluded that adoption of broadband service will continue to lag substantially behind the availability of broadband for the foreseeable future. Last year, investment analysts forecast that about 69% of households will subscribe to wired broadband by 2015, and that 53% of the population will subscribe to wireless broadband services by 2013.[7] The updated forecast included in this Second Report has not significantly changed, although many analysts note that current broadband growth has been slower than in recent years.

With respect to adoption rates, analyst forecasts and service provider expectations included in the First Report did not take into account the effect of various broadband stimulus programs or any changes in government policies that may affect deployment or adoption. A year later, this is

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[3] See Section 3, p.65.
[4] See Section 3, p.65.
[5] See Section 3, p.65.
[6] See Section 3, p.65.
[7] See Section 3, p.65.

still the case since the various broadband stimulus programs are still in their infancy. Forecasts also do not expect substantial price reductions that might stimulate greater adoption of broadband by price-sensitive customers.

Broadband coverage

Wireline Coverage: If just the two largest telephone companies (AT&T and Verizon) achieve their stated goals for wireline broadband deployment, at least 50 million homes will be able to receive advertised speeds of 10 megabits per second or more downstream within the next two years. Other telephone companies will be providing similar offerings in their service areas. Specifically, industry researchers estimated that fiber to the home (FTTH) was available to about 15.2 million homes (homes passed) in March 2009, 18.2 million in March 2010 (an increase of 20 percent), and 21 million in March 2011 (an increase of 14.6 percent).[8] In 2009, the largest provider of FTTH service, Verizon, announced that it would complete its FTTH deployment and be capable of serving 17 million locations by 2010.[9] A number of other smaller companies, including small rural telephone companies, will be covering additional homes with FTTH. In mid 2010, Verizon announced that the download speed of its DSL broadband service would double.[10] The other large telephone company, AT&T, announced it would offer DSL from fiber-fed cabinets (fiber to the neighborhood: FTTN-DSL) to 30 million homes by 2011.[11] AT&T currently offers advertised speeds of up to 18 megabits per second downstream[12] (although the actual speed can be much lower), with increases possible with pair bonding.

The cable industry is the other major provider of wireline broadband service. Cable broadband is currently available to 92% of households according to a research firm that tracks the cable industry.[13] This percentage has not changed from 2009 to 2010. Cable broadband is being upgraded to the DOCSIS 3.0 standard[14] and is becoming widely available at advertised speeds as high as 50 mbps downstream (with one firm advertising 101 megabit speeds).[15] Since cable broadband capacity is shared among groups of customers, the actual speed utilized by any one customer may be substantially lower than the advertised "up to" speed. Comcast, the largest cable company addressing nearly half the United States, expected in 2009 to cover nearly all its

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[8] RVA Market Research and Consulting, "North American FTTH Status – March 31, 2011" http://s.ftthcouncil.org/files/rva_ftth_status_april_2011_final_final_0.pdf

[9] See Section 3: Uncompleted Broadband Plans, p. 65.

[10] Verizon, "New Copper-Based Broadband Tier More Than Doubles Existing Maximum Download Speeds for Consumers and Small Businesses" August, 2010.

[11] See Section 3: Uncompleted Broadband Plans, p.65.

[12] See Section 1: 1.1 Technology, p. 21.

[13] See Section 1: 1.3 Expected Deployment/Coverage Footprint, p.36.

[14] DOCSIS is a standard developed by Cable Labs and stands for "Data Over Cable Service Interface Specification"

[15] See Section 1: 1.1 Technology, p.18.

50.6 million homes passed[16] by 2010 and it is likely to achieve this goal, based on recent statements. One analyst believes DOCSIS 3.0 will be available by 2013 to "nearly all"[17] the homes covered today by cable modem services.[18] That would be about 92% of 112 million households, or 103 million homes.

Wireless Coverage: A number of wireless broadband service providers expect to deploy Long Term Evolution (LTE) and WiMAX technologies (so-called fourth generation or "4G" wireless services) between 2010 and 2013 and, if successful, bring multi-megabits speeds to a majority of U.S. homes and population.[19] The wireless services offer shared bandwidth, so the speeds obtained by users will be dependent on actual traffic loads at each cell-site, and in particular on how many users are simultaneously using bandwidth-intensive applications, such as watching video on wireless Internet connections. As one example, by 2013 Verizon expects that LTE will provide subscribers with 5 to 12 mbps downloads in a deployment planned to reach all of its covered population (at the end of 2008, Verizon's network covered 288 million people[20] or 94% of the U.S. population).[21] Other wireless companies cover a smaller share of the population. Entrepreneurial and independent Wireless Internet Service Providers (WISPs) provide WiMAX-type services to at least 2 million customers[22] in rural areas, including many areas not covered by the national wireless companies.

Satellite Coverage: Satellite broadband is available at almost any location in the country that has an unimpeded line-of-sight to the southern sky and therefore can provide broadband service to the most remote and difficult-to-serve locations. However, the current satellite services have relatively low speeds and latency problems, and cost more than terrestrial broadband services. Two new satellites with greater capacity are expected to become operational beginning in 2011, with the operators announcing that each satellite will be capable of providing 2-10 mbps[23] service. Transmission rates may average 5 megabits per second downstream by 2011,[24] but the bandwidth available to each user will vary inversely with the actual traffic load as overall bandwidth is shared among all users.

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[16] See Appendix A.
[17] See Section 1: 1.3 Expected Deployment/Coverage Footprint, p. 36.
[18] See Section 1: 1.3 Expected Deployment/Coverage Footprint, p. 36.
[19] See Section 3, p. 66.
[20] Verizon Communications, "2008 Annual Report," Verizon Communications Inc., 2009, at 9.
[21] See Section 1: 1.1 Technology, p.18.
[22] See Section 1: 1.1 Technology, p. 29.
[23] See Section 3: 3.3 Status of Broadband Satellite Plans, p. 68.
[24] See Section 3: 3.3 Status of Broadband Satellite Plans, p. 68.

Broadband Transmission Rates

Faster Wireline Transmission Rates: Most U.S. homes will be served by advertised "up to 50 megabit per second" speed options within the next few years from at least one supplier, as cable is expected to cover nearly its entire footprint (92% of households) with DOCSIS 3.0[25] and telcos expand FTTH services which have virtually unlimited speed capability although currently offered speeds are in the "up to" 50 mbps range. Slower DSL-fiber hybrids, called "fiber to the node," currently are advertised as providing "up to 24 mbps[26]" downstream by AT&T. DSL bonding, now in commercial deployment, is intended to double DSL speeds. Including hybrid fiber-DSL (FTTN-DSL) and bonded DSL, sixty to seventy million homes will have a choice of providers for advertised speeds of 10 megabits downstream or higher. "Phantom pair" technology and other developments may further extend the life of DSL-type technology.[27]

Faster Wireless Speeds: Verizon indicates that its LTE deployment will be capable of delivering practical speeds of 4 to 12 mbps. However, wireless bandwidth is shared, and until the networks are tested under substantial load it is not clear whether speeds above 5 mbps can be obtained regularly by more than a few subscribers at the same time.[28] The demand for wireless broadband bandwidth has been growing rapidly[29] and growth is expected to continue, especially if wireless broadband is used for video over the Internet. Future pricing arrangements for wireless broadband are likely to greatly affect how much video traffic and other bandwidth-intensive applications are carried on the wireless broadband networks.

Improved satellite broadband data rates: Satellites, like terrestrial wireless systems, share the available bandwidth covered by each spot beam so the speed obtained by a user will depend on the simultaneous usage of other users. ViaSat expects to offer shared speeds of 2 to 10 megabits starting in 2011.[30]

Upstream speeds: Most consumer broadband services are asymmetrical, with downstream speeds significantly faster than upstream speeds.[31] FTTH offerings currently provide advertised upstream speeds of around 20 mbps,[32] although fiber has the capacity for much higher speeds.

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[25] See Section 1: 1.3 Expected Deployment/Coverage Footprint, p.36.
[26] See Section 1: 1.1 Technology, p. 21.
[27] See Section 1: 1.1 Technology, and Alcatel Lucent, p. 22.
[28] See Section 1: 1.1 Technology, p. 29.
[29] AT&T's mobile data traffic has increased nearly 50 times in the past three years, presumably largely due to the iPhone. M. Meeker et al., "Economy + Internet Trends," Morgan Stanley, 2009, at 57, http://www.morganstanley.com/institutional/techresearch/pdfs/MS_Economy_Internet_Trends_102009_FINAL.pdf.
[30] See Section 2: Comparison of All Publicly Announced Broadband Plans, p.52.
[31] See Appendix A.
[32] See Appendix A: Verizon.

DOCSIS 3.0 upstream is only in commercial trials in the United States. Until upstream DOCSIS 3.0 is fully deployed, upstream cable speeds will be in the range of 768Kbps to 5mbps.[33]

Broadband adoption

In 2009, approximately 63% of U.S. homes utilized a wireline broadband service and in 2010 the figure was approximately 65%. This figure is expected to increase slowly to about 69% by 2014, implying market saturation, at least at current pricing levels.[34] In 2009, investment analysts estimated that 31% of Americans over the age of 14 currently used wireless broadband (broadband does not include Short Message Service "texting"). In 2010, this figure increased to 38% and it is expected to increase steadily with analysts expecting wireless broadband adoption to pass 50% by 2013.

Many households and individuals will subscribe to both wireline and wireless broadband services, just as they subscribe to fixed and mobile voice telephone services. And just as some individuals have "cut the cord" and rely exclusively on a mobile telephone for voice services, some families and individuals may choose to go wireless-only for broadband,[35] particularly if they are not using broadband for video or video-intensive applications that require the higher speeds generally obtainable only from wired services.

The government's various broadband stimulus plans may influence these adoption forecasts through increased deployment of broadband to unserved areas and encouraging increased adoption of broadband services. However, the results of these programs are not yet observable.

Backbones

Backbone bandwidth traffic volume and capacity will grow roughly at the same pace, with a leading network equipment firm forecasting growth in North American IP traffic of 39% (CAGR) from 2009 to 2013.[36] For the same period, capacity is forecast to increase by approximately 44% on major routes so that major route backbone capacity should keep up with demand and

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[33] See footnote 42.

[34] Since a computer is a prerequisite to utilizing a wired broadband service, it might be more accurate to measure adoption as a percentage of computer-equipped households rather than all households. As one investment analyst noted, "We estimate there are 67M broadband subscribers in the U.S., representing 60% of occupied households and ~70% of PC homes. Given broadband availability in roughly 90% of homes, normally distributing PC homes across broadband available homes puts real penetration at almost 80%." UBS Investment Research, "Sorting Through the Digital Transition," UBS AG, 2009, at 5.

[35] See Section 3: Cutting the Cord, p.65.

[36] See Section 1: Status of Internet Backbone, p.13.

significant problems of backbone congestion on major routes are not expected. However, localized congestion may occur on lower capacity routes including connections to cell towers that experience rapid wireless broadband growth.

Capital spending

Service providers rarely break broadband out of their overall capital spending figures for all their service offerings so it is difficult to isolate broadband-specific capital expenditures.[37] Indeed, much of the service providers' capital is invested in multi-purpose (or "converged") digital networks that carry voice, data (including broadband) and television services simultaneously. Therefore, determining what constitutes "broadband" capital often requires an allocation, which is inherently subjective to some degree.

In 2009, market researchers and investment analysts estimated that as much as two-thirds of current investments are being made to provide and expand wired and wireless broadband,[38] and the proportion allocated to broadband has been growing over the past few years. This trend is expected to continue over the next five years.

Overall, total industry capital expenditures for all services were about $64 billion for 2009 (the prediction in the First Report was about $60 billion) and analysts expect that number to be down slightly at $62 billion for 2010 and to then decrease in the next few years into the mid-$50 billion range annually as the major new basic infrastructure deployments come to an end and capital is devoted more to upgrades and expanding the capacity of the deployed systems rather than entirely new deployments.[39]

With respect to broadband, the First Report forecast that total ***broadband*** capex would be $30 billion in 2009. This Second Report estimates that the actual capex in 2009 was $31.3 billion, a decline of $3 billion from 2008. Looking forward, this update forecasts that the capital investments in broadband infrastructure will remain flat at approximately $33 billion per year for the next few years. At the same time, as noted above, total capex in all the sectors (Telco, Cable, Wireless, Satellite, Towers and WISP) is expected to decline from $64 billion in 2010 to $56 billion in 2012.

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[37] Such a break out would also be subject to allocation of capital among types of services for jointly used facilities, such as back office systems and backbone transport facilities that carry conventional telephone, wireless, broadband and video traffic.
[38] See Section 1: 1.4 Expected Capital Outlays/ Operating Expenditures, p. 39
[39] See Section 3: Total Capital Expenditures for 3 Largest Telcos and 7 Major Cable Companies.

Section 1: Listing of All Publicly Announced Broadband Plans

As a first step, the FCC asked for a list of all publicly announced broadband plans,

> "…sorted both (1) by company and by (2) technology (e.g. DSL, cable, fiber (FTTx), fixed wireless, wireless, satellite), with a description of relevant details, such as (1) general details of the plan, including company, technology, and timeline, (2) expected capital outlays and operating expenditures, (3) expected deployment/coverage footprint, (4) expected broadband performance and quality, and (5) expected ARPUs."

To find the details of broadband plans for publicly traded companies, our researchers examined companies' investor relations websites, including their Annual Reports from 2004-2010, looked at quarterly reports and earnings call transcripts for the first two quarters of 2010, searched for investment analysts' reports using the Thomson One database, and finally, used general web searches to obtain additional information.

Obtaining information about privately held companies was more difficult. Since many of the non-public companies are small cable, telephone and wireless Internet service provider (WISP) companies that tend to serve the more rural parts of the country, information was scarcest for the "unserved" and "underserved" populations. To obtain information about private companies or divisions of public companies, our researchers reviewed company websites, contacted relevant trade associations, and performed general web searches. Aggregated information about smaller companies was obtained from reports and surveys by cable, wireless, and telephone company trade associations.

Once the preliminary information was compiled, company-specific information was sent to the subject company asking for verification of the information gathered to that point. Responses were received from some companies and adjustments were made based on a company's suggestion after confirming the accuracy of the additional information.

The complete database is available online.[40] The Appendix to this Second Report contains company-by-company information extracted from the online database for 33 companies (there were 29 company profiles in the First Report) with publicly announced broadband plans. The information was sorted by company and by technology, where possible. As always, we welcome further updates and additional information from any company involved in the provision of broadband services and will update the database accordingly.[41]

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[40] See http://www4.gsb.columbia.edu/citi/research/current

[41] Updated and additional information should be sent to: CITI-broadband@gsb.columbia.edu.

The details of the database can be seen in the Appendix, which lists information, including details of current broadband deployments, for the following:

Company	Page	Company	Page
AT&T	A-2	MediaCom	A-23
CableOne	A-6	MetroPCS	A-24
Cablevision	A-7	OpenRange	A-25
CenturyLink	A-8	Qwest	A-26
Charter	A-9	RCN	A-27
Cincinnati Bell	A-10	Sprint Nextel	A-28
Clearwire	A-11	T-Mobile	A-31
Comcast	A-13	Time Warner Cable	A-32
Cox	A-14	Verizon	A-33
EchoStar Corp	A-15	ViaSat	A-37
Fairpoint	A-16	WildBlue	A-38
Frontier	A-17	Windstream	A-39
Gilat	A-18	WISP Industry	A-40
Hughes	A-19	OPATSCO	A-41
Insight	A-20	American Cable Assoc.	A-42
Knology	A-21	NTCA	A-43
Leap Wireless	A-22		

To reiterate, the FCC asked us to focus our research on the information provided by the broadband service providers. The following narrative broadly summarizes the information in the database with respect to six categories specified by the FCC:

1) Technology,

2) Timeline for Deployment, Expected Deployments,

3) Coverage Footprint and Penetration,

4) Expected Capital Outlays/Operating expenditures,

5) Expected Broadband Performance and Quality,

6) Expected ARPUs.

What's New:

To update the First Report, CITI research assistants followed the same methodology (described above) used to prepare the original Report adding updates for merged companies and, for the first time, including plans for tower companies since such companies clearly provide a crucial part of the wireless infrastructure.

Details describing the 2009-2010 changes are noted in each subsection of this report. In summary:

- Since the release of the original Report in November 2009, there has been evolutionary growth in the newer broadband technologies, including FTTH, DOCSIS 3.0, and 4G wireless services. Both the telcos and cable companies have been gaining subscribers with their higher speed offerings and wireless broadband is growing briskly with the introduction of 4G wireless clearly on the horizon. By contrast, the number of subscribers utilizing the more mature and somewhat obsolescent DSL technology has been declining.

- In 2010, cable and wireless broadband providers increased their capex spending, while wireline telco broadband providers decreased their capex spending. The net result is that total broadband capital expenditures have been decreasing and the downward trend is expected to continue.

- Average revenue per user (ARPU) for broadband services is increasingly difficult to calculate since many broadband services are purchased as part of a discounted bundle of voice, video, and even wireless service. For the broadband ARPUs that are available, the trend has been slightly upward, as the result of price increases of about 2% annually.

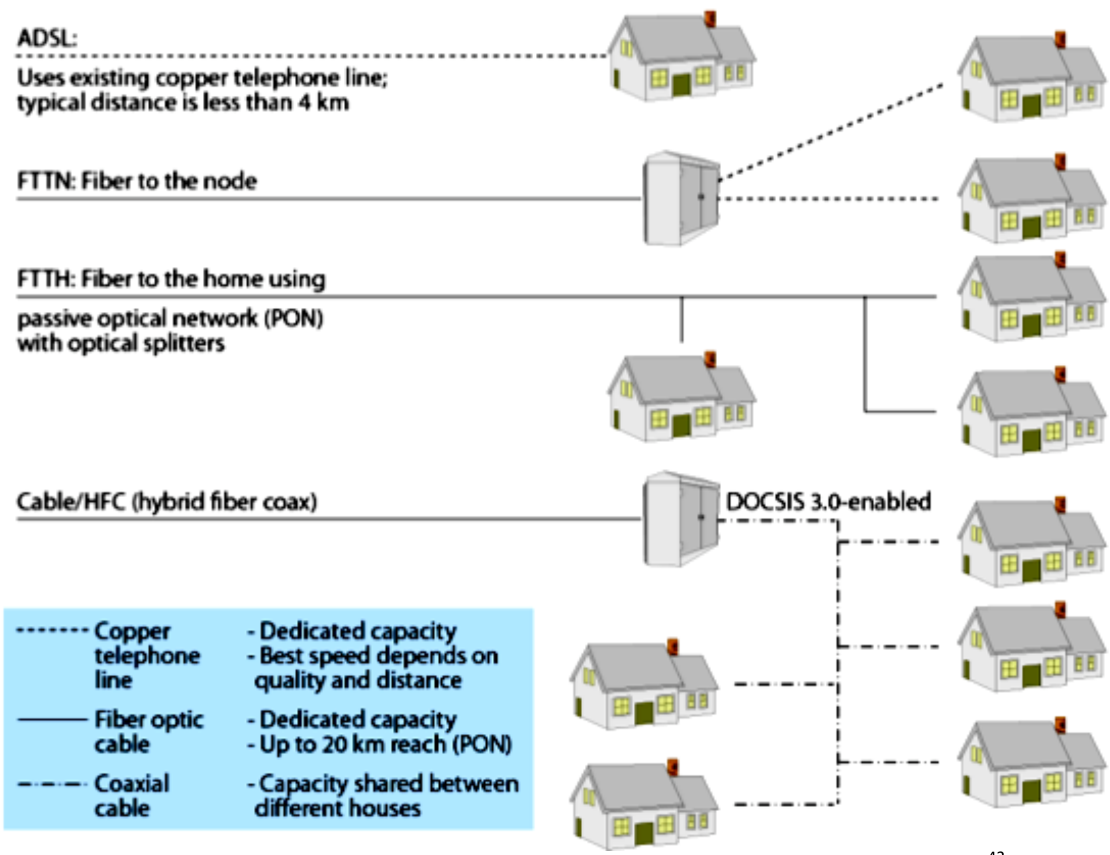
1.1 Broadband By Technology

The Appendix can be sorted to show the wireline, cable, wireless, and satellite broadband providers as well as wireless tower companies. The following section briefly summarizes the information contained in the Appendix and the online database in terms of these sub-categories.

Wired Broadband

As this diagram shows, there are a number of different ways to provide broadband services over "wired" facilities:

Figure 1: Types of Broadband Services



Source: Forrester Research, The Shift from Broadband to Wideband, updated June 12, 2009[42]

[42] D. Williams, "The Shift From Broadband To Wideband," Forrester Research Inc, 2009, http://www.forrester.com/Research/Document/0,7211,53419,00.html.

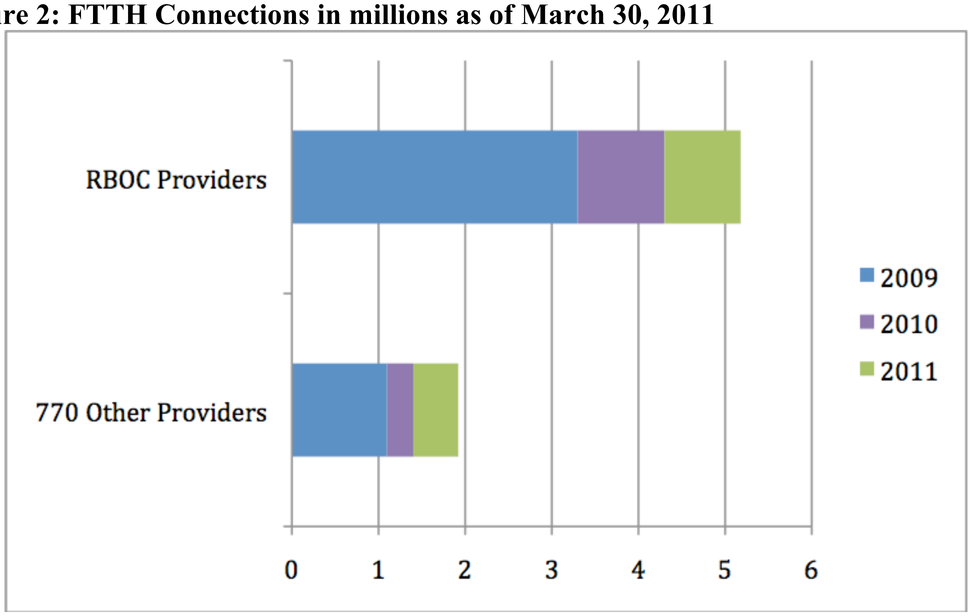
Wireline – Fiber

Most telephone companies utilize fiber optics for a significant portion of their distribution networks. Most use fiber to the node or neighborhood (FTTN)[43] and a few utilize fiber to the home (FTTH).[44]

It is has been estimated that, as of March 30, 2011, there were 20.9 million homes passed by FTTH technology in North America, 97% of which are in the United States, compared to 18.25 million at the same date in 2010 (a 14.6 percent increase). Within this 20.9 million, there are 7.1 million "homes connected," or receiving service over a FTTH connection.

The next graph illustrates the distribution of these FTTH connections and the year-to-year growth. While the majority of FTTH connections (approximately 5.2 million) are provided by RBOC's (AT&T, Qwest, and Verizon), Verizon has the largest portion by far of these "homes connected". There are also 770 other service providers (an increase of 20 compared to the prior year) that delivered FTTH service to approximately 1.9 million homes[45].

Figure 2: FTTH Connections in millions as of March 30, 2011



Source: RVA Market Research and Consulting, March 31, 2011.

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[43] Also referred to as Fiber to the Neighborhood.
[44] Also referred to as Fiber to the Premises (FTTP).
[45] RVA market research and consulting, "North American FTTH Status-March 31, 2011". http://s.ftthcouncil.org/files/rva_ftth_status_april_2011_final_final_0.pdf

While the majority of non-RBOC FTTH service is provided by other local exchange telephone companies (ILECs), FTTH is also provided by facilities-based CLECs, real estate developers, and municipalities. As the research firm noted,

> "Verizon and Tier 3 ILECs (generally small, single independent local exchange carriers) have actually penetrated a relatively high percent of their customer base. These providers – who we may call aggressive ILECs - cover roughly one third of the US population"[46]

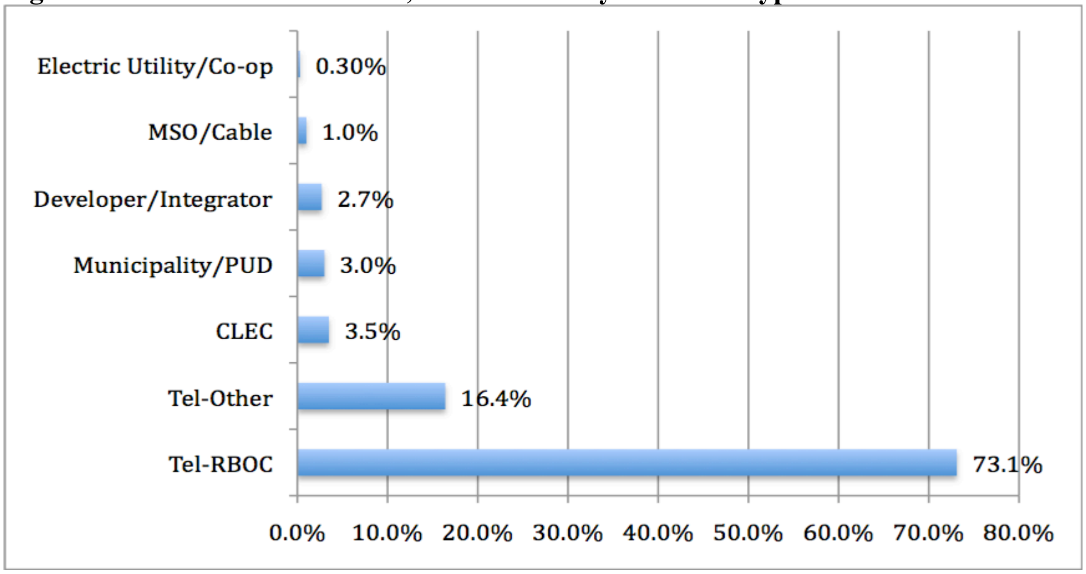
Perhaps most surprising is the commitment of some small, usually rural, telephone companies to fiber deployment. The research firm explained that

> "Drivers for the rural independent telcos [to deploy FTTH] include aging copper lines in need of replacement, the opportunity to deliver video given a more robust platform, and a pioneering tradition. In some cases, these providers have also been aided by loans and subsidies such as rural broadband loan programs and universal service funds."[47]

In addition to the "Tier 3" telephone companies, municipalities (particularly those in rural areas) have deployed FTTH systems, which are "…usually undertaken after private service providers have declined to upgrade their networks or build such systems."[48] The First Report reported 57 public FTTH systems in the U.S., mostly in small rural towns. There is no 2010 update for this total.[49] Distribution of fiber subscribers among RBOCs and non-RBOC providers are given in the following graph.

[46] RVA market research and consulting, "North American FTTH Status-March 31, 2011". http://s.ftthcouncil.org/files/rva_ftth_status_april_2011_final_final_0.pdf
[47] Ibid.
[48] D. St. John, "Municipal Fiber to the Home Deployments: Next Generation Broadband as a Municipal Utility," FTTH Council, 2009, at 1, http://www.baller.com/pdfs/MuniFiberNetsOct09.pdf.
[49] For the list of the 57 municipalities, see ibid at 5.

Figure 3: US FTTH Subscribers, Connections by Provider Type



Source: RVA Market Research and Consulting, "North American FTTH Status-March 31, 2011."

Currently offered and advertised speeds vary among FTTH/FTTN-DSL providers with Verizon leading the way at 50 Mbps downstream. While FTTH currently provides upstream speeds of up to 20 mbps,[50] fiber has the ability to provide much higher speeds. An overview of top RBOC speeds and predicted "marketed households" is given in the next chart.

Table 1: Speeds for FTTN/FTTH Households

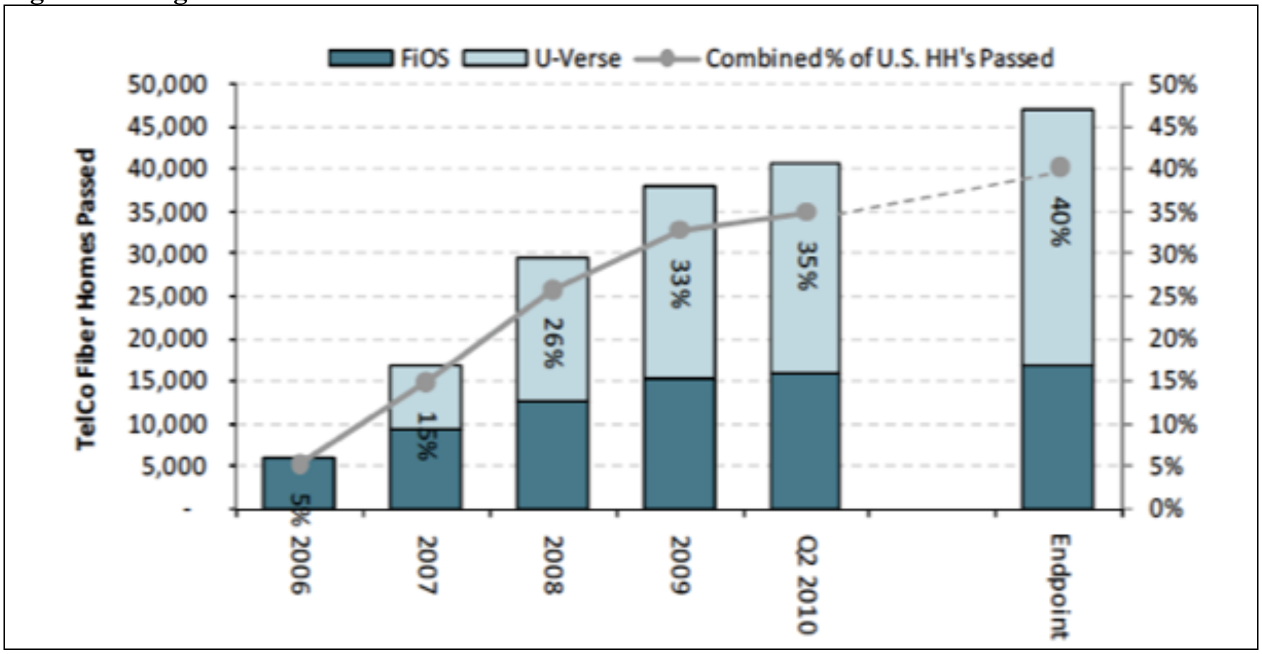
Marketed HHs	Top Speed	YE 2010E	YE 2012E
VZ FiOS	50Mbps	18,000	18,000
T U-verse	24Mbps	26,500	31,500
Q	40Mbps	4,000	7,000
% of HHs		**41%**	**47%**

Source: Adapted from BofA Merrill Lynch Global Research, Telecom Services/Cable May 24, 2010

AT&T's U-Verse and Verizon's FiOS currently cover approximately 35% of US households and plan to reach 40% at the end of their deployment schedule.

[50] See Appendix A: Verizon.

Figure 4: Largest Telco Fiber Homes Passed and Percent of Households



Source: Bernstein Research, US Telecommunications and US Cable, October 18, 2010

Wireline – DSL

DSL utilizes the traditional copper telephone wires to deliver a broadband signal to customers' homes. Because DSL broadband transmission rates are inversely related to the length of the copper wires (among other factors), for many years telephone companies have been deploying fiber optics to an electronic node in a neighborhood and connecting to relatively short distance copper wires at that point. So, in many cases, DSL service is provided by a hybrid fiber to the neighborhood-copper architecture (FTTN-DSL).

The speed of DSL has also increased, particularly over relatively short distances, such as from a neighborhood fiber node.[51] For example, VDSL2 used with FTTN can support speeds in the 20-50 Mbps range.[52] However, analysts have suggested that, "(By 2012) DSL will likely truly be akin to

[51] Lucent-Alcatel and Bell Labs recently announced "Phantom Pair" technology that may boost DLS speeds, although there are no plans for deployment. See http://www.alcatel-lucent.com/wps/portal/newsreleases/detail?LMSG_CABINET=Docs_and_Resource_Ctr&LMSG_CONTENT_FILE=News_Releases_2010/News_Article_002043.xml&lu_lang_code=en

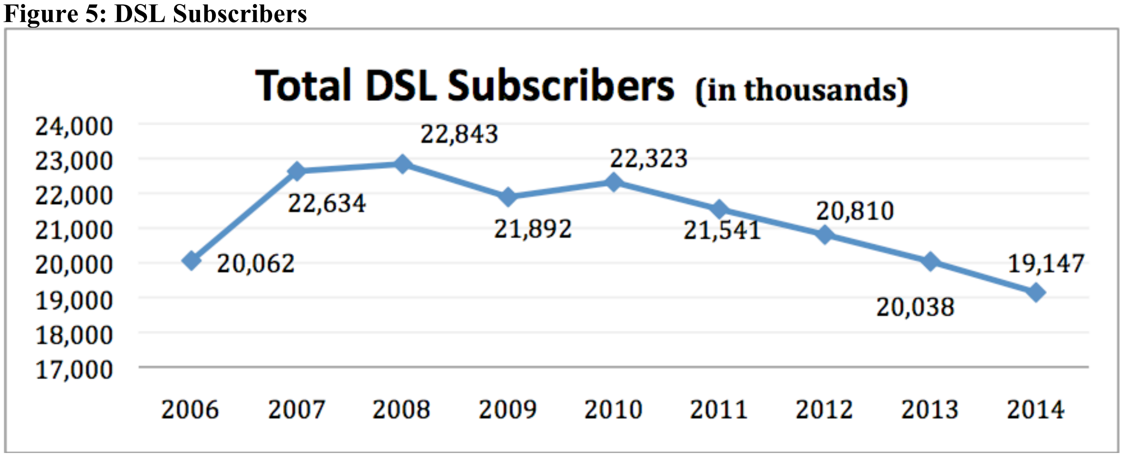
[52] Light Reading, "Report: Very High Speed DSL (VDSL2) could drive copper higher long term," Resource Investor, 2009, http://www.resourceinvestor.com/News/2009/7/Pages/Report-Very-High-Speed-DSL-VDSL2-could-drive-copper-higher-long-term.aspx.

current dial-up offerings when compared to DOCSIS 3.0 Speeds".[53] Nevertheless, AT&T announced that it plans to stretch the limit of their FTTN-DSL network with trials of 80Mbps DSL service beginning in the summer of 2010. The trial, if successful, could lead to a retail offering in 2011. Such an offering would far exceed AT&T's current top advertised speed of 24Mbps. The new top speed would still trail top cable DOCSIS 3.0 speeds, however, as cable operators are increasingly touting top speeds of 100+Mbps"[54]

While most local exchange telephone companies, including the smallest and most rural, offer DSL service in their service areas, only the larger publicly traded companies have made what can be characterized as "announcements" about their DSL plans. These companies include AT&T, CenturyLink (CenturyTel/ Embarq), Cincinnati Bell, Qwest, Verizon, and Windstream Communications.

Because DSL generally offers lower speeds than broadband services offered by competing cable companies or, in the case of Verizon's FTTH "FiOS" service, as illustrated in the following graph the number of DSL subscribers is declining as customers switch to the higher speed offerings:

Figure 5: DSL Subscribers



Source: Investment analyst data provided to CITI

Overall DSL broadband additions have been negative since the second quarter of 2009. To compensate and compete with cable, telephone companies have been steadily converting pure DSL services to hybrid FTTN-DSL by pushing fiber closer to customers' premises as well as by deploying additional FTTH.

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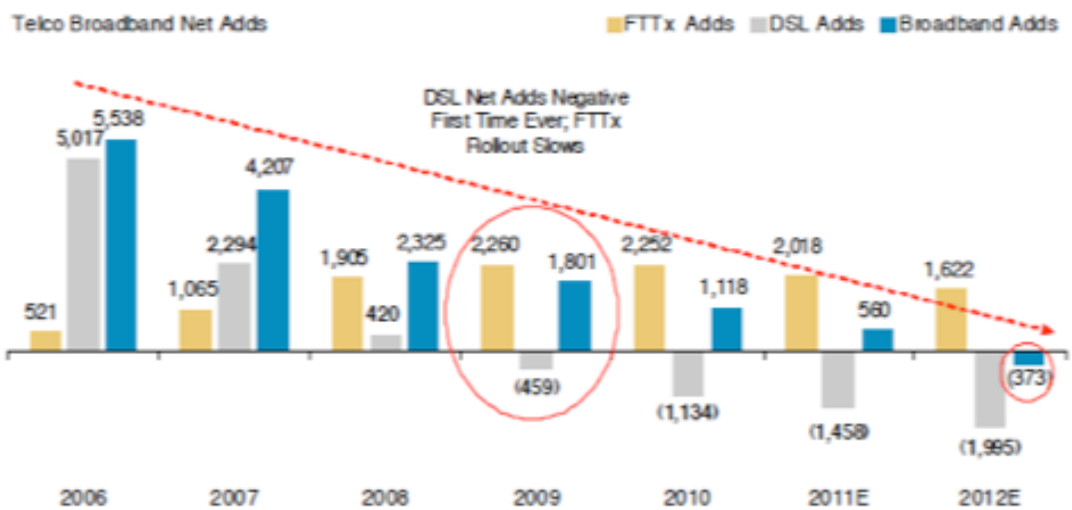
[53] Merrill Lynch, Telecom Services/Cable TV Report, May 24, 2010
[54] Ibid

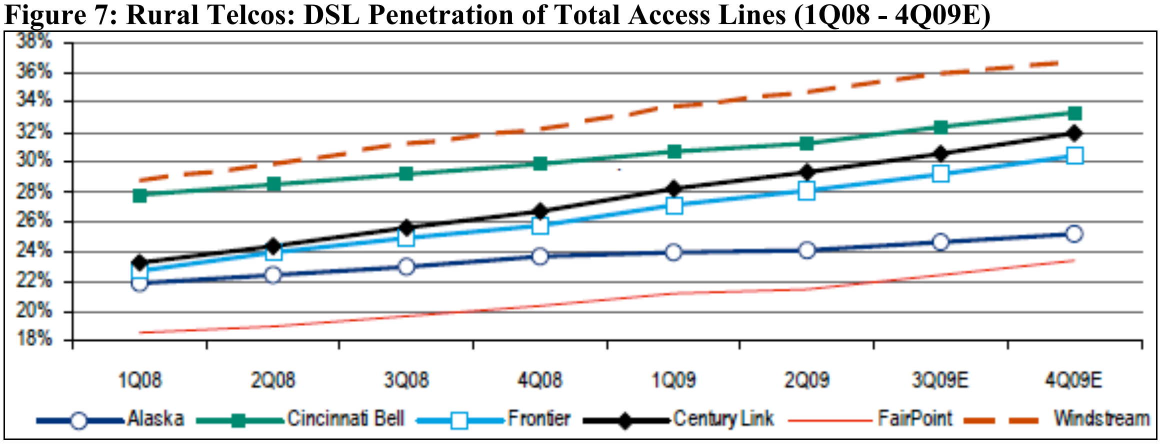
Figure 6: Telecom Broadband Adds (DSL Loss)



Source: Morgan Stanley Research, US Cable, Satellite, Telecom 1Q11 Outlook, April 19, 2011 (Companies include AT&T, Verizon, Qwest, Frontier, TDS, Windstream, Century Link, and Cincinnati Bell)

However, DSL broadband continues to grow in areas served by the non-RBOC telephone companies, which are generally more rural in nature. This is because fiber deployments are relatively expensive on a per household basis in rural areas and such areas are less subject to competition from cable DOCSIS 3.0 service.

Figure 7: Rural Telcos: DSL Penetration of Total Access Lines (1Q08 - 4Q09E)



Source: Bank of America Merrill Lynch, 3Q09 Telecom results preview and model book - Duck & Cover, Oct. 14, 2009 at 22.

In 2009, one investment analyst suggested that broadband penetration as a percentage of total subscribers was higher (30.5%) for rural telephone companies compared to the RBOCs (27.7 % for Verizon, AT&T and Qwest[55]) because rural carriers generally face lower cable penetration and a less competitive environment than the major telephone companies. The analyst also pointed out, however, that the rural carriers may have less growth potential than the more urban carriers because of lower personal computer penetration in rural homes.

The smallest telephone companies represented by the National Telephone Cooperative Association (NTCA) also have a high penetration of broadband lines in their rural areas. Last year NCTA reported that:

> "...our survey results showed that respondents were offering broadband service in excess of 768 kbps to 83% of their customers. Applying that number to our estimate of 3.5 million access lines give 2.9 million broadband lines served by NTCA member companies."[56]

NTCA has not provided updated numbers for access lines or broadband lines for 2010.

Wireline- Cable: Cable television companies have been significant providers of broadband internet access services for many years and currently provide internet access to an estimated 39% of households (versus 31% for telco broadband).[57] Cable penetration numbers have increased by two percent from 2009 to 2010.

Cable broadband generally uses a hybrid fiber-coax architecture: fiber optics brings cable services to a neighborhood node at which point connections are made to coaxial cables that serve the customers' premises. In contrast to telephone companies' FTTH and FTTN, clusters of hybrid fiber-coax users share the capacity of each node so actual speeds vary depending on the simultaneous use by others served by the same node.[58] Most cable broadband systems are currently capable of providing download speeds of at least 10 mbps.[59]

The five largest cable Multiple System Operators (MSOs) account for a substantial number of homes passed and can supply broadband service to nearly all of these homes, as expressed in the following graph:

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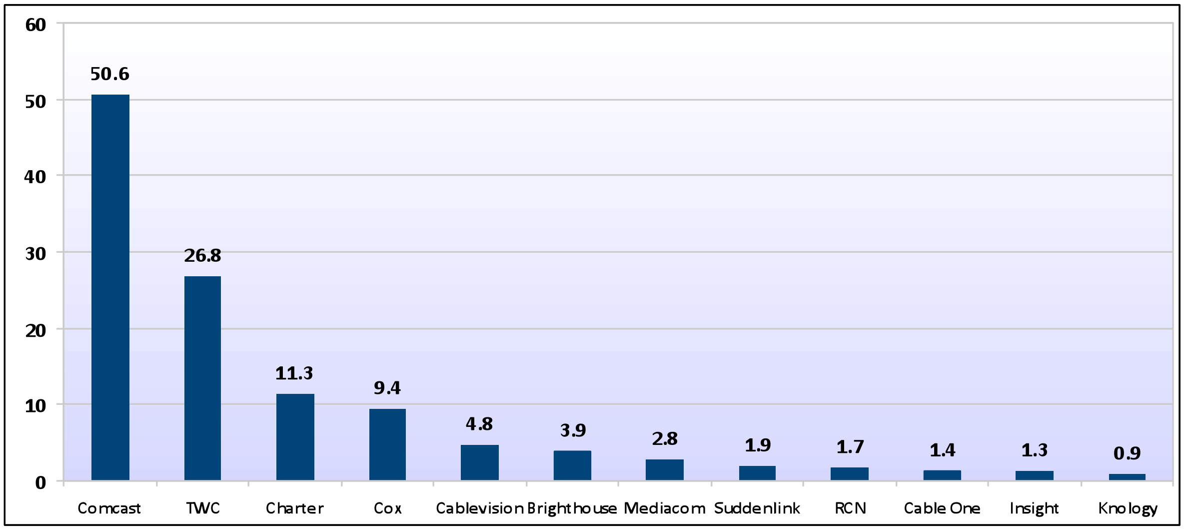
[55] Morgan Stanley Research, "Telecom Services," Morgan Stanley, 2009, at 42.
[56] Data provided from NTCA to CITI, 2009. NTCA also noted that "the margin of error could potentially be fairly large."
[57] J. Armstrong et al., "Americas: Communications Services," The Goldman Sachs Group Inc, 2009 at 15. ; Goldman Sachs Research, US Services Review (1Q10), May 2010 at 17.
[58] D. Williams, "The Shift from Broadband to Wideband," Forrester Research Inc, 2009, http://www.forrester.com/Research/Document/0,7211,53419,00.html.
[59] Ibid.

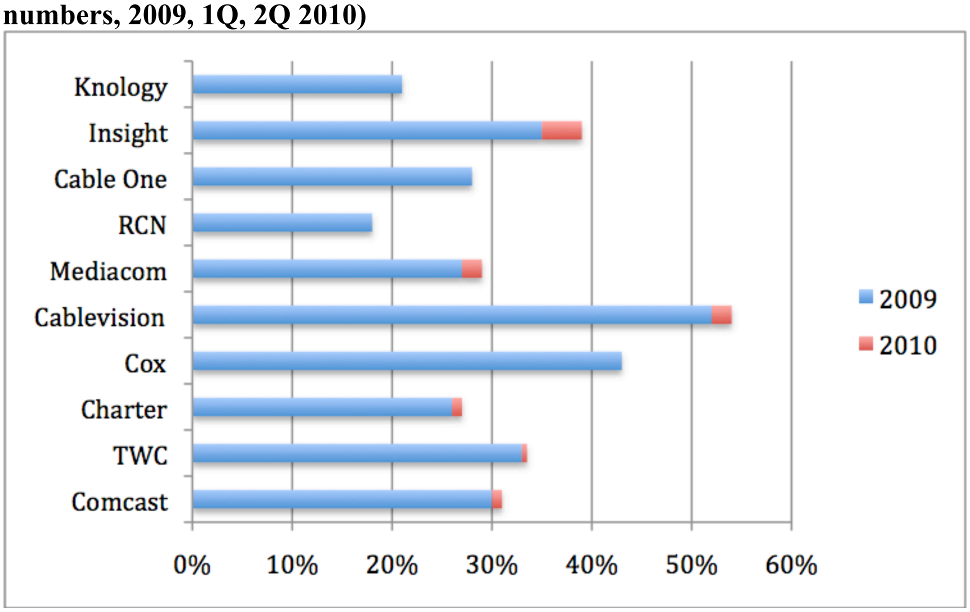
Figure 8: Homes Passed by Cable Companies



Source: Company Annual Reports, Quarterly Earnings Reports, Analyst Reports

The following chart describes the percentage of the homes passed which actually took broadband services from the ten largest cable companies in 2009 and 2010:

Figure 9: MSOs Broadband Subscription Penetration of Homes Passed (most current numbers, 2009, 1Q, 2Q 2010)



Sources: Companies' 2009 annual reports, companies' first and second quarter 2010 reports, analyst reports (not all companies have listed updated information)

Cable companies are currently at various stages in the process of upgrading from DOCSIS 2.0 or 1.1 to the DOCSIS 3.0 protocols that provide substantially higher broadband speeds but DOCSIS 3.0 is now widely available:

Figure 10: Cable DOCSIS 3.0 Roll-out

Company	Footprint by YE 2010
CMCSA	100%
TWC	Rollout will be surgical
CVC	100%
MCCC	50%
Cox	67%+

Source: BofA Merrill Lynch Global Research, Telecom Services/Cable May 24, 2010

Having done the fiber build-outs to customers' neighborhoods over the past 10-15 years to facilitate the distribution of digital television programs, upgrading to the DOCSIS 3.0 broadband standard is a relatively quick and inexpensive task for cable companies compared to the telcos' current infrastructure deployments of FTTH or FTTN. For example, Charter has indicated that the cost of upgrading its network to DOCSIS 3.0 (including the cable modem termination system and routing gear in its network but not new cable modems at customer premises) will be about $8 to $10 per customer."[60] An investment analyst estimated in 2009 that the cost of DOCSIS 3.0 upgrade is $15 per home passed.[61] The total amount to deploy DOCSIS 3.0 to a home, including the modem at the customer's premises, has been estimated at a range of $70 to $100.[62]

The speeds resulting from the 3.0 upgrade are a substantial improvement over previous DOCSIS platforms.[63] DOCSIS 3.0 is advertised at speeds as high as 50 megabits downstream and even 100+ megabits in specific markets.[64] Most upstream speeds on cable systems are in the range of 768 Kbps to 5 mbps[65] Cable companies' DOCSIS 3.0 upstream deployment schedules are not yet set, with U.S. commercial deployments beginning in 2010. For example, Comcast is trialing a 120 mbps DOCSIS 3.0 upstream that will be shared among users (so each user will likely obtain significantly lower speeds),[66] CableLabs[67] has stated that at some time in the future it will not

[60] D. Williams, "The Shift From Broadband To Wideband," Forrester Research Inc, 2009, http://www.forrester.com/Research/Document/0,7211,53419,00.html.
[61] S. Flannery and B. Swinburne, " U.S. Cable, Satellite, Telecom 3Q09 / '09 / '10 Outlook," Morgan Stanley Research, 2009, at 22.
[62] S. Higginbotham, "DOCSIS 3.0: Coming Soon to a Cableco Near You," The GigaOM Network, 2009, http://gigaom.com/2009/04/30/docsis-30-coming-soon-to-an-isp-near-you/.
[63] CableLab's DOCSIS Primer describes the features of the various iterations of the DOCSIS. See, http://www.cablelabs.com/cablemodem/primer/
[64] According to CableLabs, "Channel bonding provides cable operators with a flexible way to significantly increase speeds to customers, with compliant devices supporting up to at least 160 Mbps in the downstream and 120 Mbps in the upstream." http://www.cablelabs.com/cablemodem/primer/
[65] Ibid.
[66] D. Williams, "The Shift From Broadband To Wideband," Forrester Research Inc, 2009, http://www.forrester.com/Research/Document/0,7211,53419,00.html.

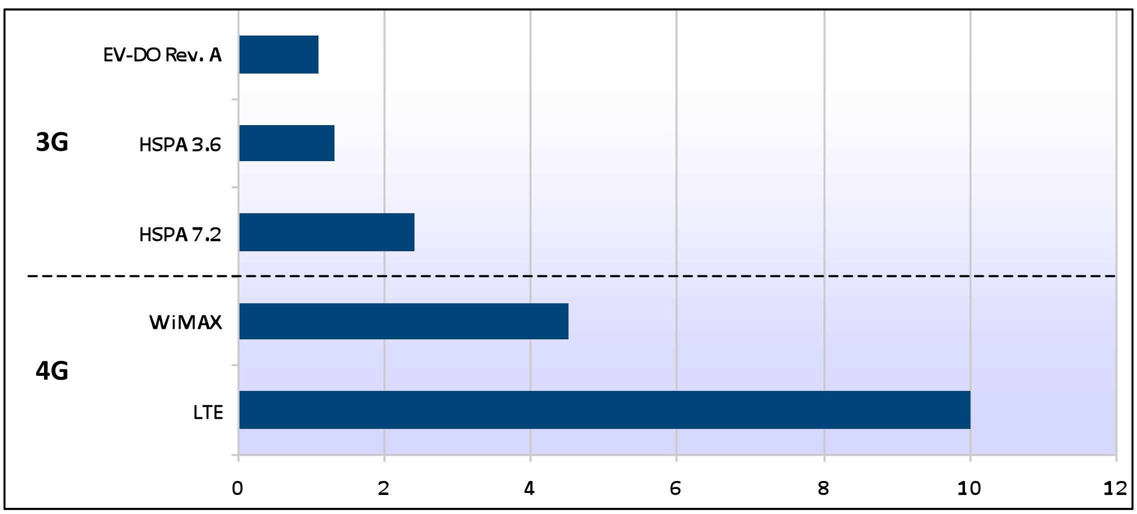
certify cable modem termination systems (CMTS) as compliant with DOCSIS 3.0 without upstream bonding. However, it is certifying downstream-only systems at this time.[68]

In addition to the large MSO cable companies, many smaller, usually rural, cable companies are deploying broadband. The American Cable Association (ACA), which represents over 900 small, independent cable companies, reported that 803 of its members have deployed "some form of high-speed internet service."[69] The ACA did not report on types or speeds of services or numbers of homes passed or customers subscribing to broadband. A 2009 ACA survey found that four additional companies had plans to deploy high-speed Internet service within a year and 36 companies had no plans to deploy high-speed Internet service. During a telephone interview, an expert on the cable industry's broadband coverage estimated that the small rural telephone companies are capable of providing broadband service to 75% of the homes they collectively pass.[70]

Wireless: A range of wireless broadband technologies is currently in use by the various cellular telephone companies. Second generation (2G and 2.5G) digital technology was the first to support Internet access and that second generation is being rapidly supplanted by third generation (3G) wireless even as deployment of 4G has begun.

The next chart indicates the expected average downstream speeds for the various 3G and 4G technologies.

Figure 11: Expected Downstream Speeds of 3G and 4G Wireless Broadband (Mbps)



Source: BofA Merrill Lynch Global Research estimates, company filings and presentations. Speeds are based on company commentary and marketing material and may differ from user experiences, which are

[67] Cable Television Laboratories, Inc. is a non-profit research and development consortium that specifies the DOCSIS standards.
[68] CableLabs, "CableLabs® Announces Tiered Test Program for DOCSIS® 3.0," Cable Television Laboratories Inc., 2009, http://www.cablelabs.com/news/newsletter/SPECS/AprilMay_2007/index.html.
[69] Data provided by American Cable Association to CITI, 2009.
[70] Interview with SNL Kagan, Oct, 7, 2009.

impacted by number of users, distance from cell site, and topography among other factors. Theoretical speeds are higher.
Adapted From: Bank of America Merrill Lynch, 4G Footrace – Carriers refine deployment plans, Sept. 30, 2009 at 6.

A number of fourth generation wireless broadband technologies are in various stages of deployment, planning and testing. Major wireless companies that have made broadband announcements include AT&T Wireless, Cablevision, CenturyLink (the merged CenturyTel/Embarq), Cincinnati Bell, Clearwire, Comcast, Cox Communications, Frontier Communications, LightSquared, MetroPCS, Sprint, T-Mobile and Verizon.

As explained in the source note for the graph above, wireless bandwidth is shared, and until the networks are tested under substantial load it is not clear whether speeds above 5 megabits can be obtained consistently by more than a few subscribers at the same time. As one analyst observed, "4G wireless networks offer a major step-function in wireless broadband capabilities – 3G today typically 0.5-1.5mbps – WiMAX to initially deliver 2-4mbps – LTE likely to deliver 3-6mbps".[71] Others are more optimistic, suggesting that 4G wireless systems will provide download speeds in the 4 – 12 mbps range, as long as systems aren't overloaded with too many subscribers using bandwidth-intensive applications.[72]

WiMAX 4G is currently being deployed, including by Sprint, Clearwire and Open Range. Hundreds of smaller Wireless Internet Service Providers (WISPs) have deployed wireless (mostly WiMAX) Internet service in rural areas and it is expected that they will continue the deployments. However, many of these WISP companies are small private ventures and tend to be secretive about their deployment plans.[73] The 350 members of the WISP Association—far from the total number of WISPs— provide fixed broadband wireless services to over 2 million locations.[74]

Not all WISPs are small, independent, local businesses. OpenRange is effectively a national WISP funded in part by a $267 million Broadband Access Loan from the Department of Agriculture and $100 million of private investment. It plans to use WiMAX to initially serve 6 million people

[71] S. Flannery and B. Swinburne, " U.S. Cable, Satellite, Telecom 3Q09 / '09 / '10 Outlook," Morgan Stanley Research, 2009 at 17
[72] Verizon reports a range of download speeds from 8-12mbps, and Clearwire's WiMax will offer up to 6mbps. See: K. Brown, "Verizon: LTE speed will be 8–12 mbps," One Touch Intelligence LLC, 2009, http://www.onetrak.com/Uploads/scott/WIRELESSTRAK%20-%20July%202009.pdf.
See also, Morgan Stanley, Telecom Services, April 19, 2011, at 7: "Verizon has noted that it is seeing 4G/LTE speeds consistently around 10 Mbps…"
[73] An association of WISPs has published a map and directory which indicates where some WISPs are currently offering services. See: WISP, "Welcome to WISP Directory," wispdirectory.com, http://www.wispdirectory.com/index.php?option=com_mtree&task=viewlink&link_id=300&Itemid=53.
[74] Filing of WISPA in FCC GN Docket 09-51, 2009, at 1-2.

in 546 communities in 17 states[75] and is offering its first services with a $38.95 per month broadband service. [76]

Long Term Evolution or "LTE" is the 4G technology adopted by Verizon and AT&T, which together serve 56.3% of the market.[77] Verizon is currently on target to cover 200 million POPs by the end of 2011 and provide full national coverage by 2013[78]and AT&T reported that it is on track with updating their network to LTE. Other companies including Cox and MetroPCS are also planning to use LTE technology for their 4G services.

HSPA+ is a 3G upgrade with the potential to deliver "4G like speeds." T-Mobile is marketing HSPA+ as a 4G network and planed to cover 100 major metropolitan areas--185 million people--with HSPA+ by year-end 2010.[79] AT&T has also begun deploying HSPA+ as a "stepping stone" for their full upgrade to LTE in 2011.[80] The technology has been used to help make the conversion from original 3G networks to 4G networks a smoother process.

Satellite - Broadband services to residences and small businesses via communications satellites are offered by EchoStar, Gilat, Hughes, LightSquared, ViaSat, and WildBlue.[81] The most attractive attribute of satellite broadband is that it is available in almost any location in the United States that has electrical power and a line-of-sight to the southern sky where satellites are "parked" in geostationary orbits over the equator. However, the latency caused by the time required sending a signal to the satellites and back means that satellites are less satisfactory than terrestrial broadband services for latency-sensitive applications such as voice telephony, interactive gaming, and online video applications.

Satellite broadband is also more expensive than terrestrial broadband services: in addition to paying a monthly subscription charge that can be twice the cost of typical terrestrial services, the user must also purchase a satellite "dish" at prices that range from $149.95 to $299.99.

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[75] Open Range Communications, "Open Range Communications Secures $374 Million to Deploy Wireless Broadband Services to 546 Rural Communities," Open Range Communications, 2009, http://www.openrangecomm.com/pr/pr_022009.html.

[76] Open Range Communications, "Perfect Package – High Speed Internet, Digital Phone, and E-Mail," Open Range Communications, 2009, http://www.openrangecomm.com/packages.html.

[77] "ComScore Reports March 2010 U.S. Mobile Subscriber Market Share", May 6, 2010 <http://comscore.com/Press_Events/Press_Releases/2010/5/comScore_Reports_March_2010_U.S._Mobile_Subscriber_Market_Share>

[78] Deutsche Bank, CTIA Wireless 2011:Day 1 Meetings Summary, March 23, 2011 at 2.

[79]Fiecewirless, June 15, 2020 "T-mobile expands HSPA+ to 25 markets, will call it '4G'"<http://www.fiercewireless.com/story/t-mobile-expands-hspa-25-markets-will-call-it-4g/2010-06-15>

[80] Ibid.

[81] WildBlue has been acquired by ViaSat.

A new generation of two-way High Throughput (HT) satellites is being built for launch beginning in early 2012. These new spot beam satellites will have 100 gbps of capacity, which is 18-25 times the capacity of satellites that were launched a few years ago.[82]

Backbone: An essential component of broadband services, whether wired or wireless, are the so-called backbone networks that are effectively the core "superhighways" of the Internet. Backbones are typically multiple optical fibers bundled into cables with the capacity of each fiber measured by optical carrier or "OC". An OC-3 line is capable of transmitting 155 mbps while an OC-48 can transmit 2.48 gbps. State of the art technology today is OC-768 or 40 gbps per fiber with 100 gpbs on the verge of general deployment.

Major backbone capacity providers in the U.S. include AT&T, Cogent, Global Crossing, Level 3, Sprint, and Verizon.[83] XO Holdings, Zayo Group, and TW telecom should also be considered as large contributors of backbone capacity.

Cisco Systems[84] and TeleGeography[85] estimate that the U.S. Internet backbone will grow at about 40% per year. The University of Minnesota's MINTS estimates a higher growth rate of 50%-60%.[86] In addition to growing volumes from wireline broadband customers, wireless traffic is also growing rapidly and is expected to dramatically increase when 4G networks are deployed.

As the following chart illustrates, backbone connections with huge capacities are needed between major cities where the population density is high and business activity is strong.

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[82] F. Valle, "Satellite Broadband Revolution: How The Latest Ka-Band Systems Will Change The Rules Of The Industry. An Interpretation of the Technological Trajectory," Springer Science+Business Media, 2009, http://www.springerlink.com/content/x0x51281h3520202/fulltext.pdf.

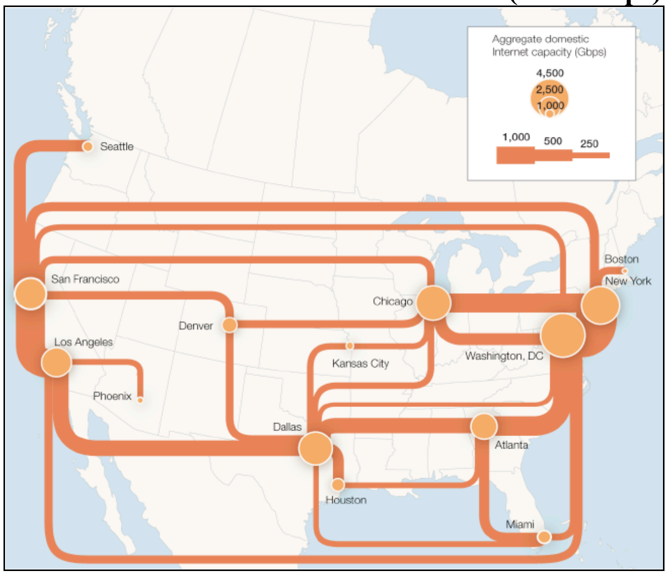
[83] TeleGeography Research, "Global Internet Geography United States," PriMetrica Inc., 2009, http://www.telegeography.com/ee/dm/gig2010/42148.php.

[84] Cisco Systems, "Cisco Visual Networking Index: Forecast and Methodology 2008-2013," Cisco Systems Inc, 2009, http://www.cisco.com/en/US/solutions/collateral/ns341/ns525/ns537/ns705/ns827/white_paper_c11-481360_ns827_Networking_Solutions_White_Paper.html.

[85] TeleGeography Research, "Global Internet Geography United States," PriMetrica Inc., 2009, http://www.telegeography.com/ee/dm/gig2010/42148.php.

[86] Andrew Odlyzko, "Minnesota Internet Traffic Studies (MINTS)," University of Minnesota, 2007, http://www.dtc.umn.edu/mints/home.php.

Figure 12: Major Internet Backbone Routes in the U.S. (>250 Gbps)



Source: TeleGeography Research, 2009

The bandwidth used in the largest 30 intercity connections in the U.S. grew at a compound annual growth rate (CAGR) of 38% during the period from 2002 to 2009, with some routes growing as much as 90%.[87] There is no reason to doubt that growth will continue and, with the increase of video and other bandwidth-intensive applications, the growth rate of capacity used could increase. Data concerning the highest capacity backbone routes indicates that these critical routes have sufficient capacity at present: the following table indicates that average traffic and peak traffic volumes on major routes are below the amount of available bandwidth:

Table 2: 20 Highest Capacity U.S. Domestic Internet Routes. 2007–2009 (Gbps)

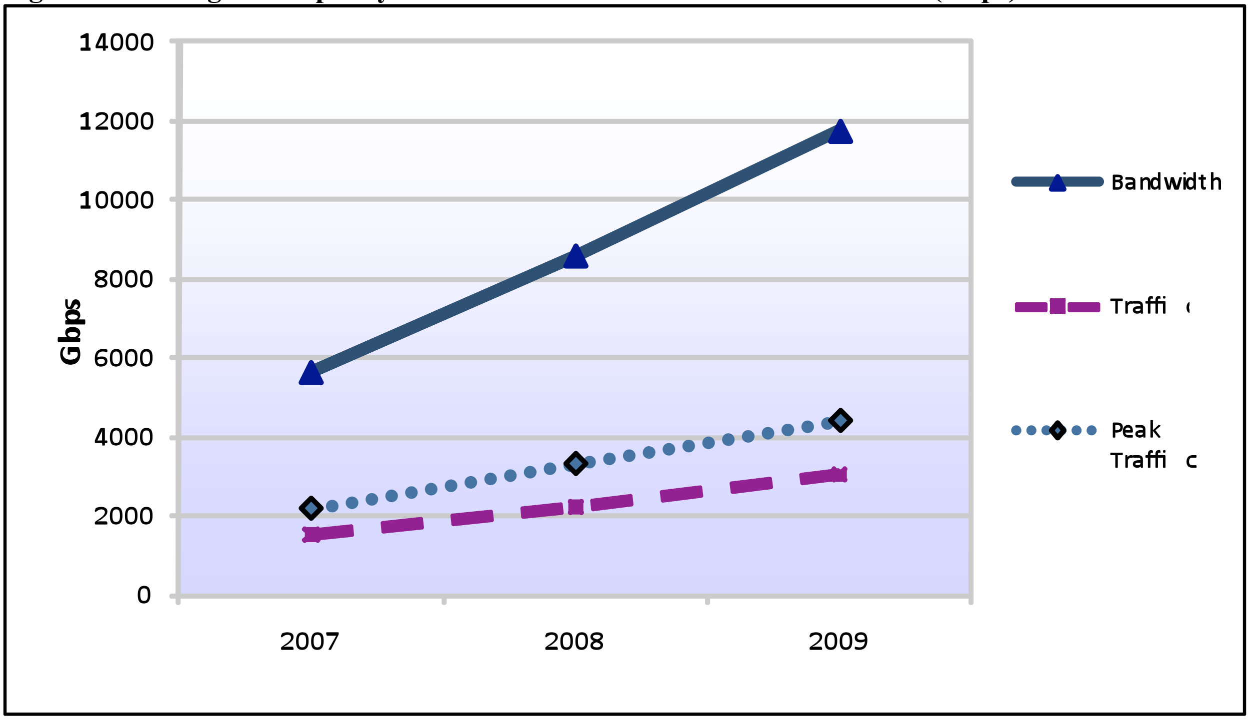
2007			2008			2009		
Band-width	Average Traffic	Peak Traffic	Band-width	Average Traffic	Peak Traffic	Band-width	Average Traffic	Peak Traffic
5,650	*1,525*	*2,182*	*8,608*	*2,227*	*3,308*	*11,767*	*3,039*	*4,393*

Source: TeleGeography Research, 2009

As illustrated below, in the aggregate, peak traffic (in 2009) was 37% of total available bandwidth on the 20 highest capacity U.S. routes, implying sufficient growth capacity in the near term.

[87] TeleGeography Research, "Global Internet Geography United States," PriMetrica Inc., 2009, http://www.telegeography.com/ee/dm/gig2010/42148.php.

Figure 13: 20 Highest Capacity U.S. Domestic Internet Routes. 2007–2009 (Gbps)



Adapted from: TeleGeography Research, 2009

Furthermore, from 2007-2009, according to the research firm, available backbone bandwidth grew at a CAGR of 44%, slightly exceeding the growth rate of traffic (41%) and peak traffic (42%). As summarized below, a review of the upgrade and deployment plans of various backbone operators indicates that additional backbone capacity will be brought on-line during the next few years.

AT&T finished a backbone network upgrade to OC-768 in 2008. That implies a transmission speed of 40 gbps in 80,000 miles of its network infrastructure. The company is testing data transmissions at rates of 100 gbps, which will be the next stage of network upgrade.[88]

Global Crossing operates approximately 18,000 miles of fiber optic Internet backbone in North America (including Canada). It provides transfer speeds between 2.5 and 10 gbps.[89] The company says that it plans to invest most of its capital expenditure into the extension and

[88] AT&T Media Relations, "AT&T Completes Next-Generation IP/MPLS Backbone Network, World's Largest Deployment of 40-Gigabit Connectivity-Company Researchers Continue to Drive Future Network Evolution with Record-Setting 17 Terabit-Per-Second Capacity Test," AT&T Inc., 2008, http://www.att.com/gen/press-room?pid=4800&cdvn=news&newsarticleid=26230.

[89] Global Crossing, "Annual Report 2008," Global Crossing, 2009, http://files.shareholder.com/downloads/GLBC/735860427x0x286672/6EDF05BF-0783-4433-B21C-5D97DFDD1F85/GLBC_2008_AR.pdf at 21.

upgrade of its existing network.[90] The capital expenditures in 2008 were mainly driven by acquisitions of other companies ($192 million).[91]

Level 3 invested $155 million into network upgrades in the first half of 2009.[92] The company plans to focus its capital expenditure on new equipment in the future. Recent upgrades and deployments were made in New York, Seattle, and Tennessee.[93] The company operates 27,000 route miles of cable with its newest deployments operating at 40 gbps.[94]

Qwest is one of the largest backbone operators as well as one of the largest regional telephone companies providing telephone service in much of the West other than California. Its backbone reaches across the U.S. and is available in almost every state. Currently its backbone operates at transmission rates of 40 gbps but the speed will be upgraded to 100 gbps during 2009 and 2010.[95]

Verizon currently operates its backbone at 40 gbps and is planning to upgrade to 100 gbps beginning in 2009.[96]

XO is currently operating a backbone network of 18,000 miles operating at 10 gbps.[97] It is currently undertaking many enhancement projects including a deployment of 1.6 terabits - capable systems on selected inter-city routes.[98] Recent investment in network upgrades and new deployments totaled $450 million.[99]

From the backbone developments described above, it would be reasonable to conclude that the internet backbone in the U.S. is expanding at a pace that should keep up with expected demand over the next few years, provided that there is no huge and unexpected increase in usage

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[90] Global Crossing, "Annual Report 2008," Global Crossing, 2009, http://files.shareholder.com/downloads/GLBC/735860427x0x286672/6EDF05BF-0783-4433-B21C-5D97DFDD1F85/GLBC_2008_AR.pdf at. 24.
[91] Ibid.
[92] Level 3 Communications Public Relations, "Quarterly Report," Level 3 Communications LLC., 2009, http://files.shareholder.com/downloads/LVLT/740502237x0xS1104659-09-48275/794323/filing.pdf at 26.
[93] Level 3 Communications Public Relations, "Level 3 Expands Operations in Upstate New York," Level 3 Communications LLC., 2009, http://www.level3.com/index.cfm?pageID=491&PR=772.
[94] Level 3 Communications Public Relations, "Our Network," Level 3 Communications LLC. , 2009, http://www.level3.com/index.cfm?pageID=242.
[95] C. A. Tyler, "Qwest Positions its National Network for Fastest-Available Ethernet Technology," Qwest Communications International Inc., 2009, http://news.qwest.com/QwestNetworkEnhancements.
[96] Verizon Investor Relations, "Global Network," Verizon Communications Inc., 2009, http://www.verizonbusiness.com/about/network.
[97] XO Communications, "Network Details," XO Communications, 2009 http://www.xo.com/about/network/Pages/details.aspx.
[98] XO Communications, "Annual Report (2008)," XO Communications, 2009, http://www.xo.com/SiteCollectionDocuments/about-xo/investor-relations/Annual_Reports/XO_2008_10K.pdf at 3.
[99] XO Communications, "About XO Overview," XO Communications, 2009 http://www.xo.com/about/Pages/overview.aspx.

patterns. With 78% of backbone traffic consisting of peer-to-peer connections and video streaming,[100] increasing video traffic should not be an unanticipated development.

Wireless traffic is also likely to place increased demand on the backbones. For example, AT&T has reported explosive growth (nearly 5,000% in the past 3 years) in its wireless data traffic, presumably due to the iPhone,[101] and wireless carriers have asked for bids to provide fiber optic connections to 7,500 of 17,000 cell sites in Qwest's operating area.[102] On the other hand, wireless traffic will be at least partly a substitute for wired traffic rather than being completely additive.

As upgrading backbone facilities requires 6-18 months,[103] the backbone providers should be able to react reasonably quickly to accommodate unexpected demand.

Towers: A discussion of "towers" was not included in the original First Report but, because towers are an essential part of the telecommunications infrastructure, that oversight is being corrected in this Second Report.

Tower companies provide essential elements of infrastructure needed to deliver wireless broadband signals throughout the United States: towers and distributed antenna systems (DAS). Towers are the large structures (including roof-tops) upon which wireless service providers install their transmitter/receiver equipment. DAS are collections of small antennas spread over a limited geographic area and are connected, usually by fiber, to a central location, usually a base station"[104]

According to an analyst, "[DAS] is used to fill in gaps where the big cells may not reach, but going forward it will probably replace a lot of big cells in a lot of situations where they need high capacity."[105] Therefore, although distributed antenna systems have usually been used to solve specific coverage problems, DAS are becoming more central to 4G network deployment plans.

Tower companies such as American Tower, Crown Castle International, and SBA Communication Co. have established both tower and DAS infrastructure lines of business. However, there are

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[100] See the first chart in this Section 3. See also, G. Kim, "Wireless is Key for Broadband Access Demand and Supply," Technology Marketing Corporation, 2009, http://4g-wirelessevolution.tmcnet.com/wimax/topics/wimax/articles/55281-wireless-key-broadband-access-demand-supply.htm.

[101] Morgan Stanley Research, "Economy + Internet Trends," Morgan Stanley, 2009, http://www.morganstanley.com/institutional/techresearch/pdfs/MS_Economy_Internet_Trends_102009_FINAL.pdf at 57.

[102] S. Carew, "Rpt-Update 2-Interview: Qwest 2010 capex flat, fiber as bigger pa," Reuters, 2009, http://www.reuters.com/article/technology-media-telco-SP/idUSN2046085120091021?pageNumber=2&virtualBrandChannel=11604.

[103] K. Papagiannaki, N. Taft et al., "Long-Term Forecasting of Internet Backbone Traffic," IEEE Transactions on neural networks, 2005, http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=01510713.

[104] "Distributed antenna systems: From niche to necessity" March 4th 2010, FierceWireless http://www.fiercewireless.com/story/distributed-antenna-systems-niche-necessity/2010-03-04#ixzz0vm5VUXSL

[105] Ibid Allen Nogee, analyst at In-Stat

also companies who construct only DAS systems such as ExteNet Systems Inc., NextG Networks and NewPath Networks.[106]

1.2 Timeline for Broadband Plans

For competitive reasons and to avoid complications with securities laws dealing with disclosures of material information, most broadband service companies are reticent about releasing details of the timing of their future broadband deployment plans. Where investment analysts have made forecasts for the major companies' deployment plans (since this is a matter of great interest to investors), the companies themselves have not verified the analysts' forecasts. To the extent companies do make announcements, the plans typically do not extend past 2012, and mostly only cover the next year.

Known details of public plans, timelines, and expected coverage are summarized in the following discussion on "Expected Deployment," which has been updated for 2010 in Section 2 of this Report. The Appendix and the discussion of analyst projections in Section 3 of this Report also provide insights into deployment timelines.

1.3 Penetration and Coverage Footprint

Investment analysts and other research firms estimate current (year-end 2010) wireline broadband penetration at approximately 70% of all U.S. households, with 31% by telephone companies and 39% by cable companies.[107] As the following chart illustrates, an estimated 19% of U.S. households do not access the Internet at all and 12% access the Internet with dial-up telephone service. (It is worth noting that some of the households that are not accessing the Internet do not have the essential prerequisite for using the Internet: a personal computer. According to analysts, "Penetration of consumer Internet access in total (including dial-up) is estimated at ~87% of PC Households"[108]).

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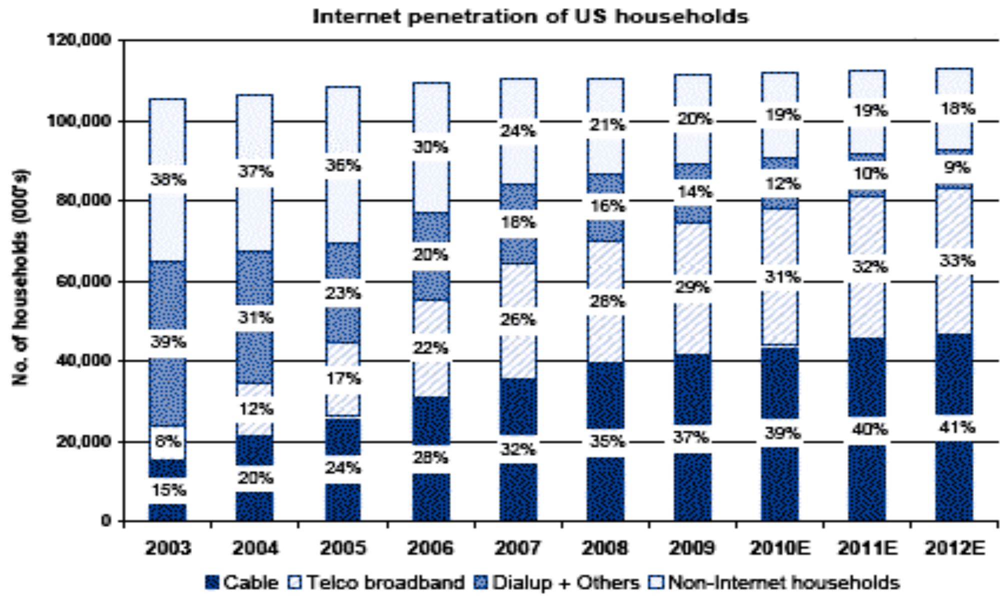
[106] Ford, Tracy, "DAS Networks gain traction among carriers," RCR Wireless News, October 2009, http://www.rcrwireless.com/ARTICLE/20091028/WIRELESS_NETWORKS/910289999/das-networks-gain-traction-among-carriers

[107] Leichtman Research Group, "Under 650,000 add broadband in the second quarter of 2009," Leichtman Research Group Inc, 2009, at 2, http://www.leichtmanresearch.com/press/081709release.pdf. Leichtman estimates 69,902,289 total broadband subscribers at end of 2Q 2009, which is roughly 60% of U.S. households.

[108] BofA Merrill Lynch Global Research, Telecom Services/Cable, May 24, 2010

Figure 14: Internet Penetration Forecast



Source: Goldman Sachs, "1Q2010 US Communication Service Review," May 2010

Since the First Report, wireline broadband penetration of all households has increased by 4%. The number of non-internet households, however, has only decreased by 1%. This implies more of a shift of Internet users from dial-up to broadband high-speed Internet access than households accessing Internet service for the first time.

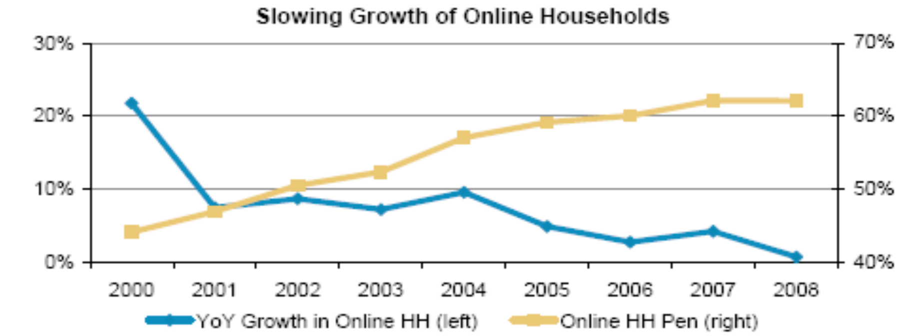
As one analyst observed, "Internet penetration is now entering the later stages of adoption, where the growth curve flattens out as the incremental 'hold-out' subscriber is harder to add."[109] Some analysts expect overall penetration of US Internet households will increase by about 1% per year, as supported by the previous graph, driven largely by gains in the penetration of personal computers.[110]

The maturation of the broadband market, as evidenced by the slowing annual growth in total Internet households, can be observed as far back as 2004:

[109] BofA Merrill Lynch Global Research, Telecom Services/Cable, May 24, 2010

[110] Morgan Stanley Research, "Cable/Satellite: After Years of Deflation, Broadband Pricing Set to Rise" October 20, 2009.

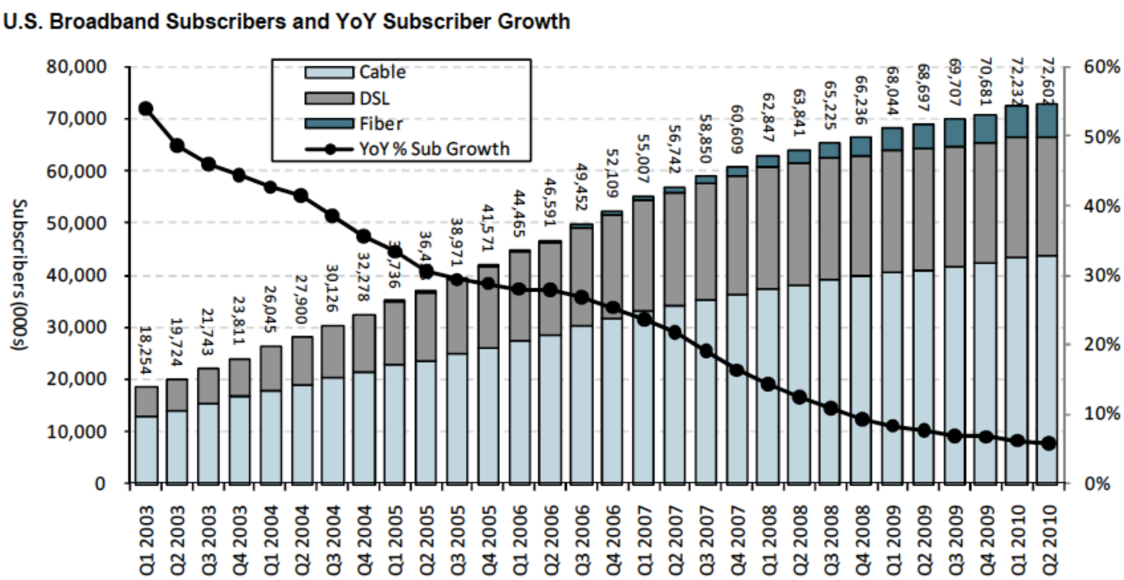
Figure 15: Growth in Online Households



Source: Morgan Stanley Research, Industry View Cable/Satellite, October 20, 2009

While the number of cable and fiber subscriptions is growing, overall subscriber growth is rapidly declining, as shown below.

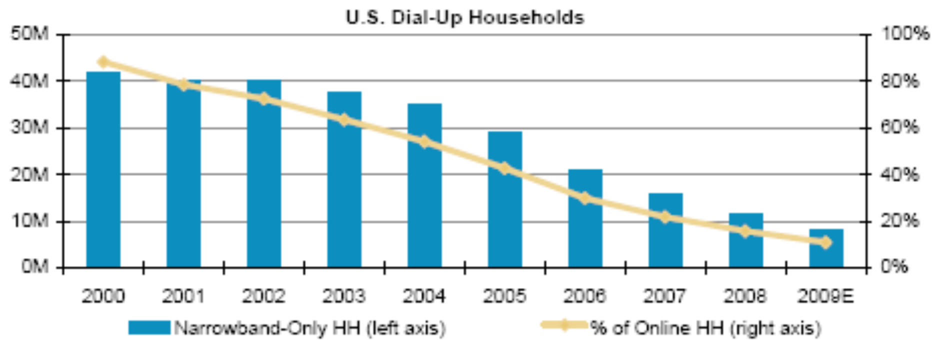
Figure 16: Broadband Subscribers and Growth



Source: Bernstein Research, US Telecommunications and US Cable, October 18, 2010

The dial-up market is quickly dissipating as seen in the following graph.

Figure 17: Households with Dial-Up Service



Source: Morgan Stanley Research, Industry View Cable/Satellite, October 20, 2009

1.4 Capital Expenditures

Overall Capex

In 2009, the telecommunications service providers, including telephone, wireless and cable companies invested about $56.2 billion, down about $6 billion from the prior year.[111] The following table illustrates the breakdown of this total among six industry sectors:

Table 3: Aggregate CapEx 2009 - $56.2 B

	$ Billion	Percent
RBOC Wireline	21.7	38.6%
Other Telco Wireline	1.1	2%
Cable MSOs	11.9	21%
CLECs	1.1	2%
Tower Companies	0.65	1.2%
Wireless	19.8	31.6%
Total	56.2	100%

Source: Average of analyst data provided to CITI, with adjustments as described in the accompanying text. *Telco*: AT&T (excluding wireless), Verizon (excluding wireless), Qwest; *Cable*: Comcast, Time Warner, Cox, Cablevision, Charter, Mediacom, and Insight; *Wireless*: AT&T, Verizon, Sprint, T-Mobile.

Since last year, cable and wireless (including telco wireless) companies have increased capex, while traditional telephone operations (both RBOC and other telco) have decreased capex. In 2010, total company capital expenditures for the major telcos, major cable companies, and major wireless companies, of which broadband capital is only a part, are as follows:

[111] See "Capex 2006-2015". Source: Data reported by companies and analyst estimates provided to CITI.

Table 4: Total Capital Expenditures of Largest Companies ($ billions)

	2009	2010
Telco	22,502	21,230
Cable	11,892	11,509
Wireless	19,765	23,328
Total	**54,159**	**55,067**

Source: See Table 15: Total Capex and Broadband Capex by Sector

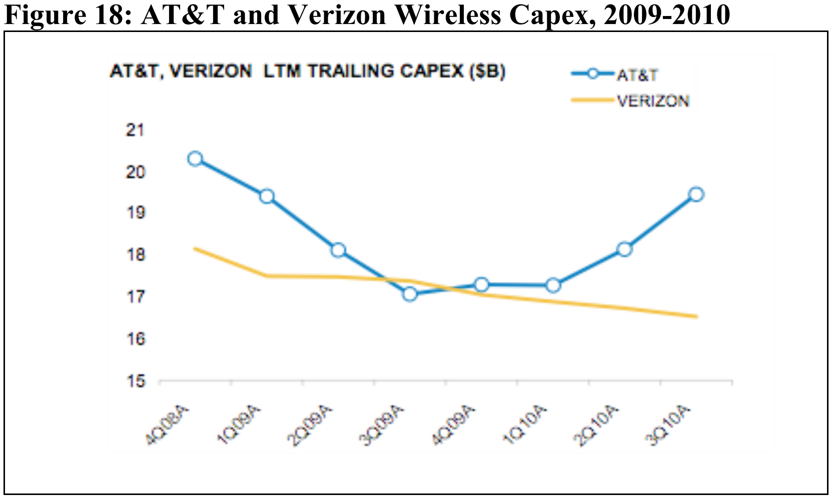
(Since these figures are for the major public companies covered by investment analysts, they need to be increased by 6-18%, depending on the sector, to account for the smaller companies not included in the analysts' coverage. See Section 3 of this report.)

Telco: In 2009, telco companies covered by analysts had total capital expenditures of about $22 billion. In 2010, the wireline capital expenditures are forecast to be about $21 billion, a reduction of about $1.2 billion.

Cable: Covered cable companies had total capital expenditures of $11.9 billion in 2009. The figure is forecast to decrease slightly to about $11.5 billion for 2010.[112]

Wireless: Wireless companies spent $19.7 billion in 2009 and are forecast to spend $23.3 billion in 2010. These totals do not include spectrum license fees. AT&T and Verizon alone are expected to spend $16.4 billion in 2010. Clearwire spent $2.7 on its 4G network in 2010.[113]

Figure 18: AT&T and Verizon Wireless Capex, 2009-2010

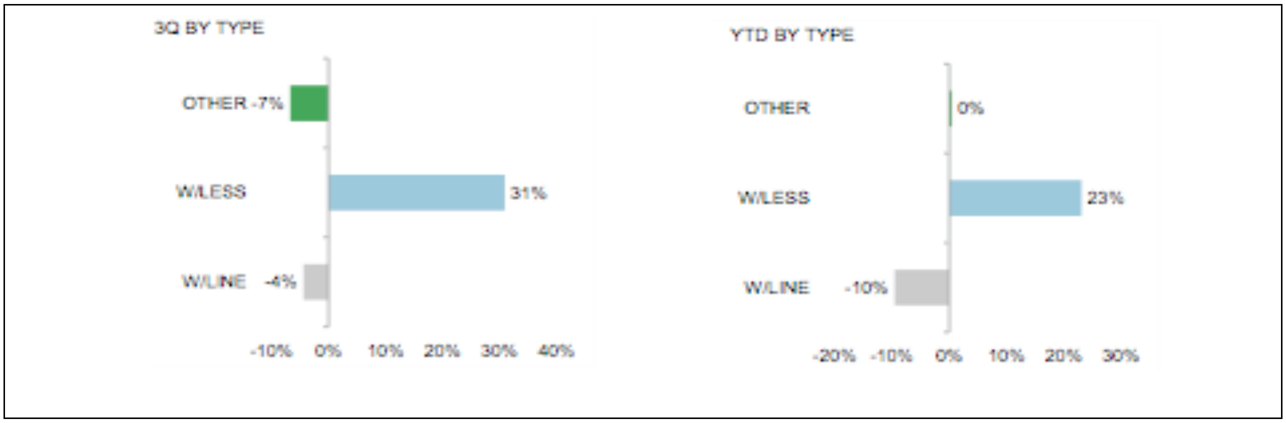


Source: Morgan Stanley Research, November 11, 2010 at 12.

[112] See "Review of Publicly Announced Broadband Plans" Section 2; see also "Appendix 1: Listing of All Publicly Announced Broadband Plans"
[113] Wireless Week, "Clearwire Defies Skeptics, Plans Hefty Capex in 2009" http://www.wirelessweek.com/News/2009/03/Clearwire-Defies-Skeptics,-Plans-Hefty-CapEx-in-2009/

In the 3rd Quarter, as with the rest of 2010, wireless capex spending, which almost entirely driven by "broadband", has clearly outstripped spending on other types of broadband services. In 2010, wireless spending increased 23%, while wireline decreased 10%.[114]

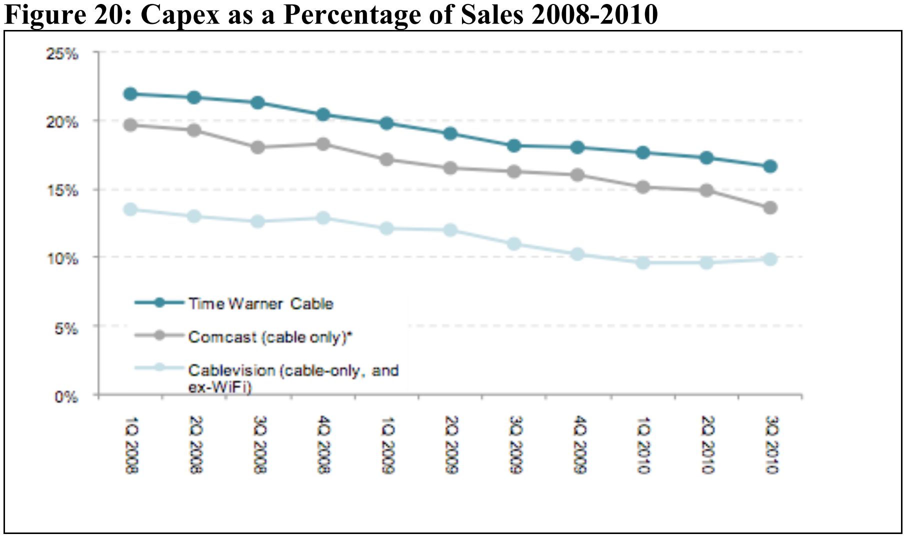
Figure 19: Broadband Capex by type, 3Q and YTD 2010



Source: Morgan Stanley Research, November 11, 2010 at 12.

From 2008 to the third quarter of 2010, cable capex as a percentage of sales decreased. As one analyst noted, "The decade-long digitization of the physical plant is finally coming to a close. And the generation-long set top box duopoly is starting to show some cracks."[115]

Figure 20: Capex as a Percentage of Sales 2008-2010



Source: Bernstein Research, November 11, 2010 at 3.

[114] Morgan Stanley Research, "Telecom Services: 3Q10 Takeaways – Metrics Show Improvement; Wireless Capex
Climbs," November 2010.
[115] Bernstein Research, "Quick Take -U.S. Cable: Cisco's Pain Is Cable's Gain... the Read Across for Cable Capex," Bernstein, November 2010.

Broadband Capex

How much of this total capital investment goes towards broadband? Since much of the capex is for general-purpose digital networks that can carry voice, data and video, the answer is largely based on allocating the capital among a variety of services. One 2009 estimate was that:

> "Approximately two-thirds of AT&T's 2009 investment will extend and enhance the company's wireless and wired broadband networks to provide more coverage, speed and capacity."[116]

It is clear that the major telephone companies have shifted wireline capital from their "legacy" telephone networks to wired broadband, with broadband capex expected to reach nearly 60% of total wireline capex in 2011.

Table 5: RBOC Wired Broadband Capex ($ billion)

Network	2006	2007	2008	2009E	2010E	2011E
Legacy	16.3	15.2	13.0	10.5	10.5	10.0
Broadband	7.2	10.7	11.9	11.5	12.5	14.0
Total	23.5	25.9	24.9	22.0	23.0	24.0
% broadband	*30.6%*	*41.3%*	*47.8%*	*52.3%*	*54.3%*	*58.3%*

Adapted from: Skyline Marketing Group, Capex Report: 2008 Annual Report, at Exhibit 14 and text at 18, 20, 23.

The Appendix includes information on broadband-related capital expenditures, updated for 2010. The following are examples by technology:

Fiber: AT&T expects "full year capital investment in the $18 billion to $19 billion range" for 2010. Capital expenditures in the wireline segment represented 64.3% of the company's capital expenditures, as the company completes its delayed deployment of U-Verse fiber to 30 million living units by the end of 2011.[117] Analyst data provided to CITI projected Verizon's wireline capital spending to be around $7.5 billion 2010; this would support the expansion of FiOS fiber to 70% of the company's wireline footprint.

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[116] AT&T, "AT&T to Invest More Than $17 Billion in 2009 to Drive Economic Growth," AT&T Inc., 2009, http://www.att.com/gen/press-room?pid=4800&cdvn=news&newsarticleid=26597. AT&T's estimate of two-thirds is consistent with the observation of a market research firm that "broadband remains the primary capex driver" for 2008-09 because,

> "Wireline and wireless carriers alike are stepping up their network investments to make high speed Internet connections, and associated triple-play bundles, available to a greater portion of their customers."

The firm added that, "…there has been a pronounced shift in capex towards new, broadband platforms, and away from narrowband systems." Skyline Marketing Group, CapEx Report–2008 Annual Report at 1.

[117] AT&T 2009 Annual Report, Form 10-K

Cable: Comcast's 2010 total capital expenditures were lower in "both absolute dollars and as a percentage of revenue" compared with 2009's $5.1 billion expenditures.[118] Time Warner Cable's total capital expenditures for 2009 were $3.2 billion, supporting the company's expansion of DOCSIS 3.0 cable.[119]

Wireless: Verizon spent $8 billion in 2010 to expand and maintain its wireless network.[120] Clearwire, in its efforts to cover 120 million POPs by the end of 2010, expects to spend between $2.8 billion and $3.2 billion "in total cash".[121] Two-thirds of AT&T's aforementioned "$18 to $19 billion" of capital spending will go to broadband and wireless, with analysts estimating a total of 7.7 to 8 billion in wireless capex for the full year.[122]

Satellite: Satellite communication companies such as ViaSat Inc. (ViaSat-1) and Hughes Communications, Inc. (Jupiter) are planning to launch new satellites in 2011 (ViaSat-1) and 2012 (Jupiter), respectively. Satellite construction, launch and insurance can cost upwards of $400 million per satellite.[123]

Tower: American Tower expects to spend $515 to $605 million on capital expenditures in 2010.[124] SBA Communications expects to incur discretionary cash capital expenditures of $190 million to $210 million.[125]

1.5 Expected Broadband Performance/Quality

Most broadband service providers describe their broadband performance in terms of upstream and downstream speed. Speed claims, however, are difficult to verify and companies have different numbers in terms of advertised, actual, throughput, and average speeds. Generally, a consumer's "actual speed" is likely to vary, particularly on cable and wireless systems where capacity is shared, and in most cases is substantially less than the advertised "up to" speed. The advertised and theoretical speed capabilities of the various technologies have been broadly described in the previous discussion of each technology. Complete company speed information may be found in the Appendix.

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[118] Comcast Q2 2010 Earnings Call Transcript, http://seekingalpha.com/article/217044-comcast-corporation-q2-2010-earnings-call-transcript?source=thestreet

[119] http://www.timewarnercable.com/MediaLibrary/1/1/about/pressrelease/twc_4Q09_earnings_announcement.pdf

[120] Goldman Sachs. "The Quarter in pictures, 1Q2010 US Communication Services Review"

[121] Clearwire Q1 2010 Earnings Call, http://seekingalpha.com/article/203243-clearwire-q1-2010-earnings-call-transcript

[122] Bank of America, "1Q10 telecom and cable scorecards"

[123] P. B. Selding, "ViaSat to Buy WildBlue for $568 Million," Space News, 2009, http://www.spacenews.com/archive/archive08/kabandside_0114.html.

[124] American Tower, Form 10-Q, Q1 2010, http://phx.corporate-ir.net/phoenix.zhtml?c=98586&p=irol-SECText&TEXT=aHR0cDovL2lyLmludC53ZXN0bGF3YnVzaW5lc3MuY29tL2RvY3VtZW50L3YxLzAwMDExOTMxMjUtMTAtMTExMDUyL3htbA%3d%3d

[125] SBA Communications Corporation Form 10-Q, Q1 2010, http://www.sec.gov/Archives/edgar/data/1034054/000119312510112092/d10q.htm

Overall, downstream broadband speeds on average in the US are at 9.98 Mbps with upstream speeds at an average of 2.18 Mbps.[126] The top average broadband speeds actually experienced in the residential U.S. are listed as follows:

Average US Download Speeds:

Table 6: Average Download Speeds of ISPs (Top Ten)

	Top ISP's	Average Speedtests	Total IP Addresses
1	Westnet	25.62 Mbps	12,016
2	Psinet	22.52 Mbps	13,214
3	Iowa Network Services	16.76 Mbps	33,206
4	Comcast Cable	16.10 Mbps	6,919,468
5	Midcontinent Communications	14.99 Mbps	48,636
6	Charter Communications	14.86 Mbps	1,748,148
7	Insight Communications Company	14.14 Mbps	219,955
8	Cox Communications	13.96 Mbps	1,727,342
9	Time Warner Road Runner	13.57 Mbps	4,337,530
10	Optimum Online	13.36 Mbps	193,786

Table 7: Average Upload Speed of ISPs (Top Ten)

	Top ISP's	Average Speedtests	Total IP Addresses
1	Westnet	19.73 Mbps	12,016
2	Psinet	13.98 Mbps	13,214
3	Iowa Network Services	11.43 Mbps	33,206
4	Surewest Broadband	8.65 Mbps	25,555
5	AT&T Services	6.53 Mbps	23,930
6	Verizon Internet Services	6.19 Mbps	4,118,703

[126] Net Index, July 28, 2010 <http://www.netindex.com/upload/2,1/United-States/>

7	TW Telecom Holdings	5.98 Mbps	14,749
8	Apogee Telecom	4.39 Mbps	13,831
9	Cox Communications	3.57 Mbps	1,727,342
10	Cbeyond Communications	3.55 Mbps	32,213

Source: Adapted from, Ookla. http://www.netindex.com/download/2,1/United-States/

Cable: Speeds being delivered by DOCSIS 3.0 are currently reaching as high as 100+Mbps and even 200Mbps by some companies.[127] Speeds vary, however, throughout the cable market with some providers delivering top speeds as low as 20 Mbps and many delivering around 50 Mbps. Upstream speeds are still significantly lower with most peaking around 10-12 Mbps. See the Appendix for more detail.

Telco: FTTH and FTTN-DSL providers are delivering speeds to keep up with cable's DOCSIS 3.0 rollout. AT&T U-verse is planning to cover its 120 U-verse markets with 24Mbps downstream and 3 Mbps upstream,[128]while Verizon if offering 50 Mbps downstream/20Mbps upstream with FiOS. [129] Smaller telephone companies offer a wide range of speeds, from very low to speeds that match or exceed those of the large telcos and cable companies. For instance, Rural Telephone/Nex-Tech, in Kansas, will use a combination of fiber and WiMAX technology to 23,000 households that is capable of delivering 100 Mbps speeds.[130] NITCO, a small Indiana Telephone company, said it "will be working diligently to utilize the latest versions of DSL, fiber, and WiMax technologies to achieve and exceed these upload and download speed standards."[131]

Satellite: Download speeds are typically five to six times faster than satellite upload speeds and currently range from 512kbps to 1.5 mbps downstream and 100kbps – 300kbps upstream.[132] Overcoming latency and signal loss due to precipitation have been major performance and quality obstacles for satellite providers. Geostationary satellite communications experience

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[127] Fiercewireless, "Comcast Nears National DOCSIS 3.0 Rollout" February 22, 2010. < http://www.fiercetelecom.com/story/comcast-nears-national-docsis-3-0-rollout/2010-02-22>

[128] "AT&T extends 24 Mbps broadband service to entire customer base" - FierceTelecom, March 30, 2010 < http://www.fiercetelecom.com/story/t-extends-24-mbps-broadband-service-entire-customer-base/2010-03-30#ixzz0v53DVItJ >
Subscribe: http://www.fiercetelecom.com/signup?sourceform=Viral-Tynt-FierceTelecom-FierceTelecom

[129] Verizon Investor Relations, "2008 Annual Report," Verizon Communications Inc., 2009, http://investor.verizon.com/financial/annual/2008/downloads/08_vz_ar.pdf at 9.

[130] Rural Telephone/Nex-Tech Selects Occam Networks as Broadband Access Supplier in $101 Million Broadband Stimulus Project - FierceWireless http://www.fiercewireless.com/press-releases/rural-telephone-nex-tech-selects-occam-networks-broadband-access-supplier-101-million#ixzz0v5FPALRW

[131]NITCO to Achieve Federal Government's National Broadband Mandate Within 1 Year, 3 Years Earlier Than Required Deadline - FierceTelecom May 26, 2010. http://www.fiercetelecom.com/press_releases/nitco-achieve-federal-governments-national-broadband-mandate-within-1-year-3-years-ea#ixzz0v5QEpzkO

latency due to the long distances the signal must travel to geostationary orbit and back to earth. The total signal delay, including latency in the connecting terrestrial networks, can be as much as 500-900 milliseconds or more, making some applications unusable (interactive gaming) or difficult (two-way voice or video conference conversation). However, latency is typically not noticed by the user during basic Internet use (web browsing, E-mail).

1.6 ARPU (Average Revenue per User)

The Appendix notes ARPU across various providers. Those figures are summarized by market segment below. As representatives from major wireless providers have stated, ARPU is becoming an increasingly inaccurate metric for their business.[133] The growing pool of users who own multiple connected devices is not represented in a metric traditionally used for voice service, and companies such as Verizon have stopped providing ARPU for some segments.[134] Analysts have proposed RHP (Revenue per Homes Passed) for cable and Lifetime Revenue per Net Add as more effective metrics, and we provide ARPU here primarily to illustrate the information most major companies currently report.[135]

Telco: Neither AT&T's U-Verse nor Verizon's FiOS fiber services has reported ARPU beyond the overall figures provided by the companies.

Cable: For broadband service over cable networks the average ARPU is approximately $42.5. There is very little variation in this figure among cable companies, with Time Warner Cable, Comcast and Charter all releasing similar figures. Cable ARPU has trended upwards over the past two years, as seen below.

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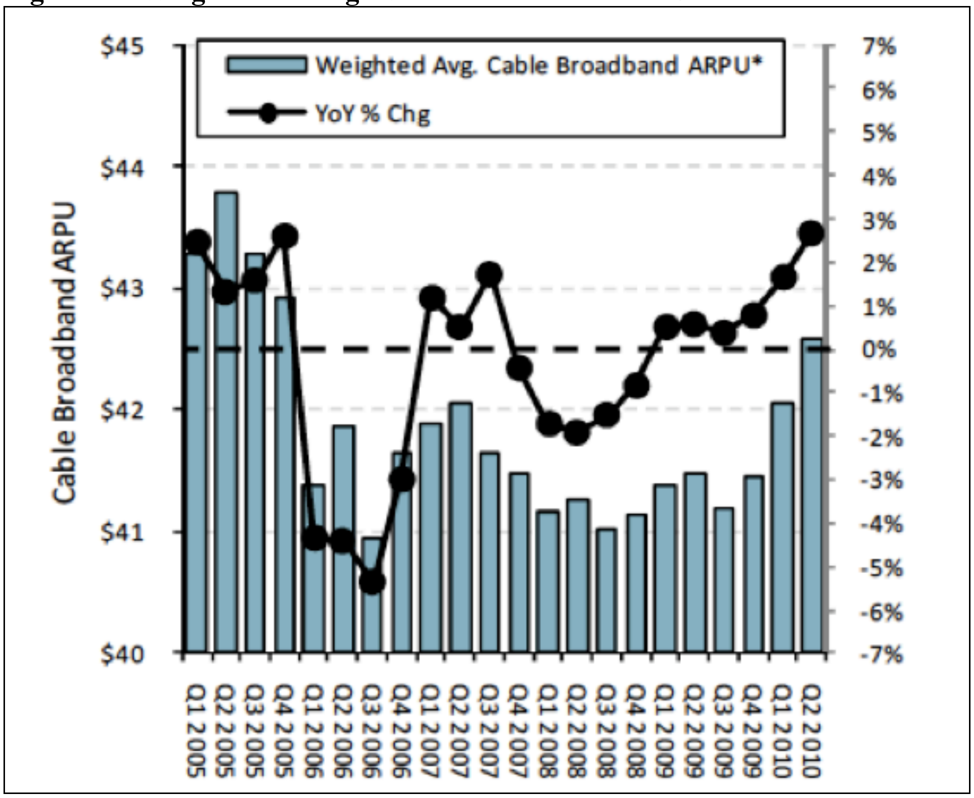
[133] http://www.lightreading.com/blog.asp?blog_sectionid=958&doc_id=193340

[134] http://www.martinsuter.net/blog/2010/03/of-churn-arpu-and-the-value-of-a-net-add.html; See also, Appendix

[135] Moffet, Craig, et al., Bernstein Research, Feb 16, 2010, "The Long View: Beyond Video... Taking the Measure of the Broadband-Centric Cable MSO."

Figure 21: Weighted Average Cable Broadband ARPU



Source: Bernstein Research, US Telecommunications and US Cable, October 18, 2010. Includes Comcast, Time Warner Cable, Cablevision, and Charter Communications.

Wireless: According to analyst estimates and CITI data, the average wireless data ARPU in Q1 2010 was $14.46, ranging from T-Mobile's $10.20 to AT&T and Verizon in the mid-$16s. The average total wireless revenue (voice and data) per month per user was $45.30, with AT&T the highest of $50.15 and MetroPCS at the low end with $39.83.

We estimate that the smaller rural independent WISPs generate an ARPU of approximately $30 per month. This estimate was derived through a combination of telephone interviews with two WISPs in 2009, pricing available on the websites of a few other WISPs, and a calculation based upon the reported margin of one such provider, which tended to support our other assumptions.

In addition to a monthly subscription price, some wireless broadband pricing plans sometimes include a usage limit or "cap" which, if exceeded, leads to additional usage charges.

Bundles: It is worth noting that many broadband services are sold in “bundles” along with voice and television (the so-called “Triple Play”). Examples of bundles are illustrated in the following Pricing Appendix.

Pricing Appendix

Table 8: Typical Wireless Broadband Pricing plans

	Clearwire	Comcast (CLWR network)	Verizon	AT&T	Sprint	T-Mobile
Advertised Service	4G WiMAX 3-6mbps (local) 1.4 Mbps (National)	4G WiMAX 3-6mbps (local) 1.4 Mbps (National)	3G National (CDMA) 0.6 - 1.4 Mbps	3G National (GSM) 0.7-1.7 Mbps	3G National (CDMA) 4G Select Cities 0.6 - 1.4 Mbps	3G National (GSM) 0.7-1.7 Mbps
Basic Plan	$40/month 4G local, no cap	~$40/month (bundled price) 4G Local, no cap	$39.99 / mo Includes 250MB	$35 / mo Includes 200MB		$29.99/mo includes 200 Mbps
Advanced Plan	$40/month Unlimited Use	~$55 / mo (bundled price) 4G/3G Nat, no cap	$59.99 / mo Includes 5GB	$60 / mo Includes 5GB	$59.99 Unlimited 4G 5GB, 3G	$59.99 Includes 5GB

Source: Company data, Morgan Stanley Research estimates, "Cable and Satellite Led by Broadband & in line with Thesis, Pricing Trends Improving," April 20, 2010

Compared to wireless broadband pricing plans in 2009, most prices increased in 2010 across basic and advanced service plans without much change in advertised speeds. For basic plans, both Clearwire and Comcast raised monthly rates, while Verizon stayed the same and AT&T dropped its rate by $5. The situation was similar in advanced plans, with Clearwire and Comcast raising rates. The remaining telcos all kept their advanced plans priced at the same rate.

Table 9: Broadband Pricing Changes (DSL)

		Voice (Bundled Local+LD)		DSL		Satellite Video		Triple Play
Company	**Offering**	**Q/Q**	**Comments**	**Q/Q**	**Comments**	**Q/Q**	**Comments**	
AT&T	Entry Level				Almost unchanged at $25	↑	Sequential MRC moved up to $63.99 with $24 bill credit and $5 instant bundle discount. $50 AT&T reward card offered Choice Extra or higher package	↑
	Comparable Speed				Almost unchanged at $25			↑
BLS	Entry Level	↓	Basic unlimited local services back to 4Q09 levels ($17.45)			↑		↑
	Comparable Speed							↑
VZ	Entry Level							
	Comparable Speed	↑	Double bundle discount down ~17%	↑	Double bundle discount down ~17%			↑
Qwest	Entry Level			↑	MRC move up to $19.99 (Q409 levels). No more $50 Qwest Visa Prepaid Card.	↑	New price $29.99 reflects $24 bill credits for 12 months and $5 discount	↑
	Comparable Speed			↓	Effective MRC moved down ($11.66 vs $12.5) on $100 Visa prepaid card.			↑

Source: Bank of America Merrill Lynch, Battle for the Bundle, July 20, 2010 at 8.

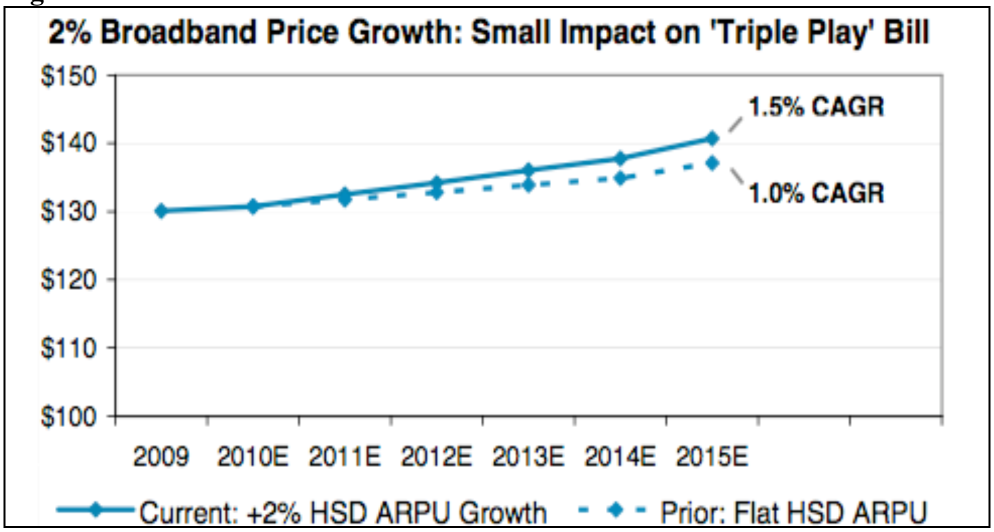
AT&T made little to no change in its DSL prices over the second quarter, while Verizon raised its entry-level broadband price to $20, up from $18 in the first quarter of 2010. On average, the Bell companies lowered their bundled pricing by 5.6% year over year for 2010.[136]

Analysts' reports are covering bundled prices more than prices for broadband, video, and telephone separately, perhaps reflecting companies' push to sell multiple products to customers. For changes

[136] Bank of America Merrill Lynch, Battle for the Bundle, July 20, 2010 at 8.

due to broadband, one analyst noted that he was adding a 2% pricing increase to the residential broadband model in 2010.

Figure 22: Broadband Price Growth



Source: Morgan Stanley Research, US Cable, Satellite, Telecom 1Q10 Outlook, April 20, 2010 at 10.

Section 2: Comparison of All Publicly Announced Plans of Network Enhancement

After the preparation the List of Announced Broadband Plans (now the Appendix), the FCC asked for the First Report to include,

> "… a document that compares what was projected at the time of a plan to what has resulted to date for each of the publicly announced broadband plans across the identified variables. This should look backwards at what was said at the time the plan was established to be compared against the outcomes of completed plans and the current status for those plans still in progress."

To prepare the requested document, CITI researchers examined each of the announced plans project-by-project to establish the first time that each project was announced and the time(s) that the original announcement was modified or updated. They then checked for information about the status of each announcement, particularly about completion or the degree of progress if still incomplete. They searched for information in the same manner as described in Section 1, which was by checking companies' websites, investment analyst and consultant reports and by conducting searches on the Thomson One database and the internet. The researchers also used news publications as a source for developments on broadband deployment announcements.

While this methodology may provide some insights about the credibility of companies' deployment announcements and a means for judging the probability of on-time completion of similar projects, the type of project is probably the chief factor in predicting if it is likely to be completed on time or not. This shouldn't be a surprising conclusion: small, easy projects are obviously more likely than difficult, complex ones to be completed as initially scheduled.

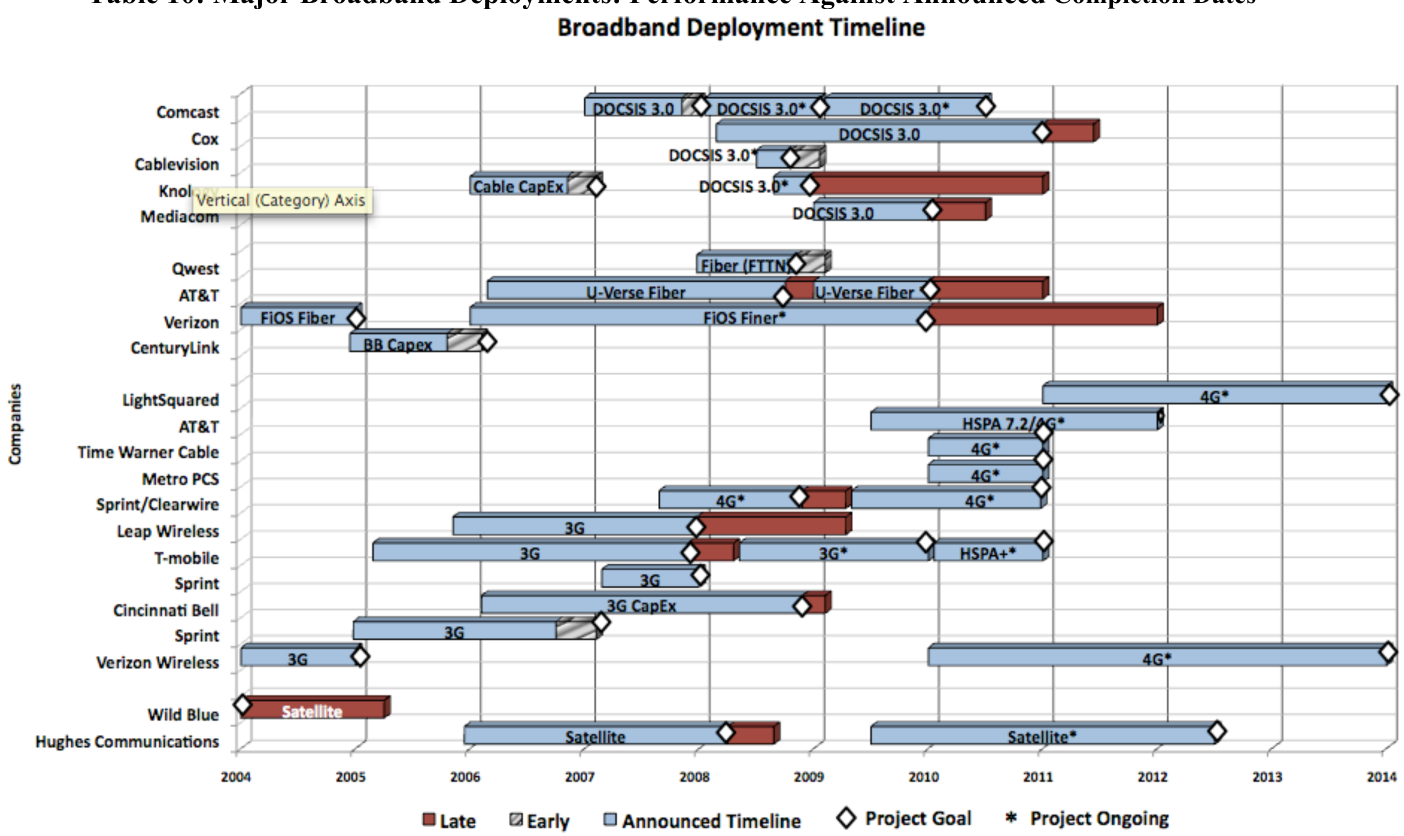
Thus, for example, the cable industry's upgrade from DOCSIS 2.0 to DOCSIS 3.0 is not a major physical construction project, does not require substantial deployment of new cables and the variables affecting the deployment are much more controllable by the cable company. In contrast, deployment of entirely new infrastructures is largely an outside construction project, heavily dependent on digging trenches for conduits, stringing cable on poles, or erecting towers (for wireless systems), tasks that are in turn dependent on government permits, topography, weather and all the uncertainties associated with construction programs.

Broadly, the review of the various broadband project announcements indicates that projects that were predominantly an "upgrade" were generally completed on or even ahead of the announced date, while projects predominantly of a new construction character tended to lag behind the completion dates predicted when the project was announced.

What's New:
CITI research assistants examined announcements from the second half of 2009 through mid-2010 to update the companies' progress on broadband deployment. The past year saw notable changes and new announcements for the deployment plans of many broadband providers.

Wireless deployments of HSPA7.2, WiMAX, and LTE were the most prominent in company announcements. The end of 2009 brought LTE announcements from AT&T, Verizon, and Metro PCS. Sprint/Clearwire announced the launch of their 4G WiMAX service, and T-Mobile announced plans to upgrade its 3G network to HSPA21+. LightSquared announced its plans to cover 92% of the US with LTE wireless broadband by 2015. In addition to this, the company will also offer nationwide wireless satellite service.[137] Cable companies were also active, with Comcast, Knology, and Mediacom announcing new goals for DOCSIS 3.0 deployments. Details of the plans and their progress can be seen in the figure and text below.

Table 10: Major Broadband Deployments: Performance Against Announced Completion Dates



Source: Report Appendix

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[137] LightSquared, Inc, About Lightsquared,
http://www.lightsquared.com/pdf/LightSquared_Backgrounder.pdf

The focus of the analysis is to understand whether telecommunication companies are generally able to meet the goals outlined in their own statements, or not. The review focused on the timeframe beginning in 2004-05 based on the judgment that those years marked "the beginning of modern era" of broadband in terms of industry structure: the internet "bubble and bust" had passed and the AT&T-SBC and MCI-Verizon mergers and consolidation in the cable industry had largely been completed. Those years also mark the beginning of wireless companies as significant providers of "broadband data" service.

Yearly Deployment Announcements

2004

Verizon announced at the end of 2003 that it planned to begin implementation of its new FiOS fiber to the home network in 2004 and pass one million homes by yearend. The company predicted that by 2005 it could increase that number to three million.[138] In 2005 Verizon reported that they reached that number.[139]

At the beginning of 2004 Verizon also announced that it would implement wireless broadband access in two-thirds of its network, covering about 75 million people by the end of the year.[140] By December 2004, Verizon's 3G service was available to 75 million people including 20 major cities in the US.[141] [142]

CenturyLink (Century Tel, prior to the recent merger with Embarq in July 2009)[143] at the end of 2004 said it would invest heavily in its IP capabilities, announcing a $350m investment for the following year.[144] It surpassed that amount, investing $415m in 2005 and $314m in 2006.[145]

Sprint in its 2004 annual report announced that it would rollout EV-DO wireless 3G technology in the subsequent two years,[146] with coverage of major metropolitan areas in the US by the end

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[138] http://investor.verizon.com/news/view.aspx?NewsID=469
[139] Verizon Press Release, "Verizon Communications Reports Strong 4Q 2005 Results, Driven by Continued Growth in Wireless and Broadband", Verizon, 2006, http://investor.verizon.com/news/view.aspx?NewsID=718
[140] Verizon Press Release, "Verizon Wireless Makes Strides With Planned Broadband Access 3G Network Expansion", Verizon, 2004, http://investor.verizon.com/news/view.aspx?NewsID=498
[141] Ben Charny, "Sprint begins $3 billion march to 3G", CNET News, 2004, http://news.cnet.com/Sprint-begins-3-billion-march-to-3G/2100-1039_3-5480249.html?tag=lia;rcol
[142] http://www.manifest-tech.com/ce_wireless/wireless_vcast.htm
[143] http://gigaom.com/2009/07/01/embarq-and-centurytel-merge-become-centurylink/
[144] http://media.corporate-ir.net/media_files/irol/11/112635/annreports/04_annual_report.pdf
[145] Verizon, "Annual Review 2006", Verizon, 2006, p.4, http://library.corporate-ir.net/library/11/112/112635/items/239821/CTLAnnualReview2006.pdf
[146] Annual Report 2004

of 2005.[147] In its 2005 annual report Sprint confirmed capital expenditures of nearly $ 1 billion for EV-DO deployment.[148] The coverage in September 2006 was 69 cities in the US including major metropolitan areas, most of which were not publicly announced by Sprint before.[149]

WildBlue Communications Inc. announced in April 2004[150] that its satellite broadband Internet service would roll out in June of 2005. This was the second time they made this announcement: it was originally made in 2001 and service was supposed to have been available by mid-2002. [151] Various issues caused them to delay the service, particularly the loss of funding which was influenced by the attacks on September 11, 2001[152] as well as defects on the WildBlue-1 satellite[153]. In June 2005 WildBlue unveiled its satellite broadband Internet service three years late[154]

2005

Hughes Communications Inc. announced in December 2005 that the SPACEWAY-3 satellite would be launched in early 2007[155] and be ready for service in early 2008.[156] The satellite was launched in mid-2007 and became operational on April 8, 2008. The delay was due to an unrelated launch failure of another satellite that forced Hughes to find an alternate launch service.

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[147] Amy Schiska-Lombard (Sprint), “Sprint Begins Offering EV-DO-Ready Sprint PCS Connection Card(TM) by Sierra Wireless to Business Customers”, Sprint, 2005, http://newsreleases.sprint.com/phoenix.zhtml?c=127149&p=irol-newsArticle_newsroom&ID=681282&highlight=

[148] Annual Report 2005

[149] EVDO Forums, “Sprint EVDO Rev A Coverage Sightings”, EVDO-Forums.com, 2006, http://www.evdoforums.com/thread3234.html

[150] WildBlue.cc, WildBlue Ready To Roll Out Its Satellite Internet Service In June, http://www.wildblue.cc/wildbluenews.html, April 25, 2004

[151]WildBlue.cc, WildBlue Secures Low Cost, Fixed Price Contracts For Customer Premises Equipment, http://www.wildblue.cc/2001pr.html, July 16, 2001

[152] WildBlue History, http://satjournal.tcom.ohiou.edu/issue13/pdf/David_Brown_WildBlue.pdf, November 2007

[153]Dsl Reports, “Wild Blue Yonder”, dslreports.com, 2004, http://www.dslreports.com/shownews/58219

[154] Paul, Weiss, Rifkind, Wharton & Garrison LLP, Against WildBlue Debut, ISCe Participants Debate Future of Satellite Broadband,, http://www.paulweiss.com/files/Publication/a4182527-a24f-4827-9e73-0c4403ded807/Presentation/PublicationAttachment/4490c85f-7055-4250-b5a9-34eaa04bde01/6-3-05.pdf, , June 3, 2005

[155]SpaceDaily.com, Sea Launch Awarded Spaceway 3 Contract By Hughes Network Systems, http://www.spacedaily.com/reports/Sea_Launch_Awarded_Spaceway_3_Contract_By_Hughes_Network_Systems.html, December 12, 2005

[156]Bbwexchange.com, Hughes Initiates SPACEWAY 3 Satellite with First Commercial On-board Satellite Broadband Wireless Internet Traffic Switching and Routing, http://www.bbwexchange.com/pubs/2008/04/08/page1405-1664513.asp, April 8, 2008

Knology announced that it would invest $7.5m to upgrade its cable systems in Florida to support broadband services.[157] In 2006 the company had capital expenditures for new deployment and enhancements of equipment of more than $12.5m.[158]

T-Mobile announced in May 2005 that it would roll out 3G networks in the second half on 2006 and serve its first customers in 2007.[159] T-Mobile planned to continue the rollout in 2008 and have the rollout completed by 2009.[160] The company's actual rollout of 3G only began in May 2008, which was at least 5 months behind the scheduled year-end 2007.[161] According to T-Mobile's latest announcement, the plan to have full 3G deployment by the end of 2009 is currently on track.[162]

Leap Wireless announced in September 2005 that it planned to implement EV-DO 3G technology in 2006 investing about $475m.[163] In the 2006 annual report it confirmed the roll-out of this technology with a completion goal of 2007.[164] In the company's annual report for 2008, it indicated that the rollout was not entirely completed.[165] In June 2009 the company successfully completed the 3G rollout throughout their entire service area.[166]

2006

AT&T announced in June 2006 that it planned to reach 19 million households with its U-Verse FTTN-DSL system by the year 2008.[167] By the end of 2007 the company reduced its goal to 18

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[157] Knology, "Annual Report 2005", Knology, 2005, p. 26, http://phx.corporate-ir.net/phoenix.zhtml?c=130221&p=irol-sec

[158] Knology, "Annual Report 2006", Knology, 2005, p. , http://phx.corporate-ir.net/phoenix.zhtml?c=130221&p=irol-sec

[159] Joel, "T-Mobile 3G: Not Until 2007", Gizmodo.com, 2005, http://gizmodo.com/105518/t+mobile-3g-not-until-2007

[160] Mobile-Commons, "T-Mobile USA 3G Network, USA", mobile-commons.com, 2006, http://www.mobilecomms-technology.com/projects/tmobileusa/

[161] Om Malik, "Finally, T-Mobile Launches a U.S. 3G Network", The GigaOM Network, 2008, http://gigaom.com/2008/05/05/t-mobile-launches-us-3g-network/

[162] Ronen Halevy, "T-Mobile Forges Ahead With 3G Rollout – Still No 3G BlackBerry…", Berry Review, 2009, http://moconews.net/article/419-t-mobile-usa-rolls-out-super-fast-3g-in-parts-of-philadelphia/

[163] Kristin Atkins – Lead Media Relations, "Leap Unveils Mobile Data Strategy for Cricket and Jump Mobile at CTIA Wireless I.T. & Entertainment", Leap Wireless, 2005, http://phx.corporate-ir.net/phoenix.zhtml?c=191722&p=irol-newsArticle&ID=760669&highlight=

[164] Leap Wireless, "Annual Report 2006", Leap Wireless, 2007, p.29, http://investor.leapwireless.com/phoenix.zhtml?c=95536&p=irol-sec

[165] Leap Wireless, "Annual Report 2008", Leap Wireless, 2009, p.4, http://investor.leapwireless.com/phoenix.zhtml?c=95536&p=irol-sec

[166] Greg Lund - Media Relations, "Second Quarter Results", Leap Wireless, 2009, http://phx.corporate-ir.net/External.File?item=UGFyZW50SUQ9MTI1MjV8Q2hpbGRJRD0tMXxUeXBlPTM=&t=1

[167] AT&T Press Release, "Company's Extensive DSL Network Expanded to Reach 95 Percent of State", AT&T, 2006, http://www.att.com/gen/press-room?pid=4800&cdvn=news&newsarticleid=22361

million homes passed by the end of 2008.[168] In January 2009 the company said that 17 million households were passed,[169] indicating that AT&T was behind the revised target by at least 1 million households.

Cincinnati Bell announced in its 2006 annual report that it would invest about $30 million in 2007 to build up its 3G wireless network and to have 3G service operational in 2008.[170] The company spent $11 million in 2007, maintaining the date for operational launch as 2008. Cincinnati Bell planned to spend an additional $19 million in 2008 to complete the project.[171] The actual spending on the 3G network in 2008 was $16 m.[172] The 3G wireless network was deployed in the fourth quarter of 2008.[173] Apparently Cincinnati Bell managed to launch the 3G overlay within their schedule.

Knology stated in its 2006 annual report that it expected to invest $30.4 million in 2007, of which $7.3 million would be for new deployments and enhancements of infrastructure.[174] Investment came in below, as $28.8 million was spent of which $9.1 million was plant extensions and enhancements.[175]

Verizon announced in early 2006 that it would have 3-4 million premises passed by the FiOS fiber optic service by the end of that year.[176] It also announced that it would have 18 million premises passed with fiber by the end of 2010.[177] In the second quarter of 2009 Verizon's fiber optic systems passed 13.4 million homes,[178] meaning that the company will have to pass

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[168] Peter D. Shapiro, "AT&T U-verse by the Numbers", CableFAX Magazine, 2007, http://www.cable360.net/cablefaxmag/business/competition/telcos/26065.html

[169] DSL Reports, "AT&T Slows U-Verse Build Out", dslreports.com, 2009, http://www.dslreports.com/shownews/ATT-Slows-UVerse-Build-Out-100539

[170] Cincinnati Bell, "Annual Report 2006", Cincinnati Bell, 2007, p. 115, http://library.corporate-ir.net/library/11/111/111332/items/246974/2006AnnualReport.pdf

[171] Cincinnati Bell, "Annual Report 2007", Cincinnati Bell, 2008, p. 86, http://library.corporate-ir.net/library/11/111/111332/items/294111/CincinnatiBellNPS10KWrap1.pdf

[172] Cincinnati Bell, "Annual Report 2008", Cincinnati Bell, 2009, p. 5, http://library.corporate-ir.net/library/11/111/111332/items/294111/CincinnatiBellNPS10KWrap1.pdf

[173] Cincinnati Bell, "Annual Report 2008", Cincinnati Bell, 2009, p. 3, http://library.corporate-ir.net/library/11/111/111332/items/294111/CincinnatiBellNPS10KWrap1.pdf

[174] Knology, "Annual Report 2005", Knology Inc, 2006, p.52, http://phx.corporate-ir.net/phoenix.zhtml?c=130221&p=irol-sec

[175] Knology, "Annual Report 2006", Knology Inc, 2007, p.52, http://phx.corporate-ir.net/phoenix.zhtml?c=130221&p=irol-sec

[176] Verizon Press Release, "Verizon Vice Chairman Says Fast MCI Integration", Verizon, 2006, http://investor.verizon.com/news/view.aspx?NewsID=726

[177] Verizon, "Verizon Provides New Financial and Operational Details on its Fiber Network as Deployment Gains Momentum", Verizon, 2006, http://investor.verizon.com/news/view.aspx?NewsID=773

[178] Seeking Alpha, "Verizon Communications Inc. Q2 2009 Earnings Call Transcript", seekingalpha.com, 2009, http://seekingalpha.com/article/151577-verizon-communications-inc-q2-2009-earnings-call-transcript?page=-1

another 4.6 million in the subsequent 18 months to hit the year end 2010 goal.[179] Verizon has stated that it is on track with the announced deployment schedule.

2007

Sprint and Clearwire announced in July 2007 that they together planned to cover 100 million people with the joint-use WiMax service by the end of 2008.[180] (Sprint provides its 4G services over Clearwire's network; Sprint's coverage is therefore based on Clearwire's deployments). Thus far, this goal was missed by at least one year: at the end of the fourth quarter 2008 Sprint claimed to cover 49 million people[181] meaning that the companies' coverage was about 50% short of their original announcement. Clearwire also stated in the annual report of 2007 that they would have about 530,000 customers by the end of year 2008. That goal was also not reached as the company reported 475,000 customers in its 2008 annual report.

Sprint announced in early 2007 that it would have a majority of its footprint covered with EV-DO Rev. A by the end of 2007[182] In the 2008 annual report, the company said that it had EV-DO Rev. A employed in 82% of their footprint, meeting the goal.[183]

Comcast announced in 2007 that it would have DOCSIS 3.0 deployed in 20% of its footprint by the end of 2008.[184] Apparently it hit its target in 2008.

Qwest announced in the end of 2007 that it would have a fiber-to-the-node (FTTN) deployment in 2008. The company planned to pass approximately 1.5 million households that year.[185] According to their annual report in 2008 Qwest exceeded their goal of fiber-to-the-node deployment, covering 1.9 million potential customers.[186]

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[179]Verizon, "FiOS at Five: Continuing Rapid Growth, Leadership in Technology and Innovation", Verizon, 2009, http://newscenter.verizon.com/press-releases/verizon/2009/fios-at-five-continuing.html
[180] Clearwire Press Release, "Sprint Nextel and Clearwire to Partner to Accelerate and Expand the Deployment of the First Nationwide Mobile Broadband Network Using WiMAX Technology", Clearwire, 2007, http://investors.clearwire.com/phoenix.zhtml?c=198722&p=irol-newsArticle&ID=1028160&highlight=
[181] Reuters, "Houston Sprint Customers Enjoy Enhanced Network Coverage and Capacity", Business Wire, 2009, http://www.reuters.com/article/pressRelease/idUS159956+23-Feb-2009+BW20090223
[182] Sprint, "Annual Report 2006", Sprint, 2007, p.2, http://investors.sprint.com/phoenix.zhtml?c=127149&p=irol-sec
[183] Sprint, "Annual Report 2007", Sprint, 2008, p.3, http://investors.sprint.com/phoenix.zhtml?c=127149&p=irol-sec
[184] DSL Reports, "20% of Comcast Users To See DOCSIS 3.0 in 2008", dslreports.com, 2007, http://www.dslreports.com/shownews/20-of-Comcast-Users-To-See-DOCSIS-30-in-2008-89821
[185] Qwest, "Annual Report 2007", Qwest, 2008, p.3, http://ww3.ics.adp.com/streetlink_data/dirq/annual/HTML2/qwest_ar2007_0003.htm
[186] Qwest, "Annual Report 2008", Qwest, 2009, p.3, https://materials.proxyvote.com/Approved/749121/20090316/AR_36466/HTML2/qwest-ar2008_0004.htm

2008

Cablevision announced in mid-2008 that it would have 20% of its network upgraded to DOCSIS 3.0 by the end of that year and complete coverage would be reached by mid- 2010.[187] The plan laid out a budget for the DOCSIS 3.0 and a WiFi rollout for the three-year period at $315m.[188] (WiFi would be a free additional service to Cablevision's cable customers.) The build-out was planned be completed by 2010.[189] At the end of 2008 Cablevision claimed to have 52% of its footprint covered with DOCSIS 3.0[190] meaning that its first goal of deployment was overachieved. By mid-2009 the WiFi service was deployed in New York's Rockland and Orange Counties, which represents approximately one-third of Cablevision's footprint.[191] As of February 2010, the DOCSIS 3.0 rollout was complete, [192] and the WiFi deployment was announced to be complete by early 2010. [193]

Charter announced in November 2008 that it would deploy DOCSIS 3.0 on a small scale within three months.[194] At the end of January 2009, it achieved this goal by deploying DOCSIS 3.0 service in the metropolitan area of St. Louis.[195] Although the scale was small, Charter kept to its original plan.

Cox in March 2008 said that it planned to deploy DOCSIS 3.0 on a small scale by the end of that year. The company stated that its networks would be fully upgraded by the end of 2010.[196] The company had deployed DOCSIS 3.0 in the Arizona communities of Carefree, Rio Verde, Scottsdale and Phoenix by August 2008.[197]

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[187] Jeff Baumgartner, "Cablevision Begins Wideband Assault", lightreading.com, 2008, http://www.lightreading.com/document.asp?doc_id=160511&site=cdn

[188] Seeking Alpha, "Cablevision Q2 2008 Earnings Call Transcript", seekingalpha.com, 2008, http://seekingalpha.com/article/88345-cablevision-q2-2008-earnings-call-transcript?page=-1

[189] TMCnews, "Cablevision plans wireless broadband network", tmcnet.com, 2008, http://www.tmcnet.com/usubmit/2008/05/08/3434956.htm

[190] Multichannel News, "Cablevision To Blast Out 101-Mbps Internet Service", Multichannel News, 2009, http://www.multichannel.com/article/210164-Cablevision_To_Blast_Out_101_Mbps_Internet_Service.php

[191] Cablevision Press Release, "Cablevision's Optimum WiFi Arrives in Rockland and Orange Counties", Cablevision, 2009, http://www.cablevision.com/about/news/article.jsp?d=072209

[192] http://www.lightreading.com/document.asp?doc_id=187600&site=lr_cable

[193] Mutlichannel News, "Cablevision Optimizes Wi-Fi," George Winslow, November 2010. http://www.multichannel.com/article/459591-Cablevision_Optimizes_Wi_Fi.php

[194] DSL Reports, "Charter DOCSIS 3.0 Within Months", dslreports.com, 2008, http://www.dslreports.com/shownews/Charter-DOCSIS-30-Within-Months-98946

[195] Anita Lamont, "Charter Launches Fastest Residential Internet Service", Charter Communications, Inc, 2009, http://phx.corporate-ir.net/phoenix.zhtml?c=112298&p=irol-newsArticle&ID=1249700&highlight=Charter launches

[196] Jeff Baumgartner, " Teeing Up Docsis 3.0", Cable Digital News, 2008, http://www.lightreading.com/document.asp?site=cdn&doc_id=148909&page_number=2

[197] Cox Press Release, "Cox Expands DOCSIS 3.0 Reach to Arizona", Cox Communications, 2009, http://cox.mediaroom.com/index.php?s=43&item=442

Knology announced DOCSIS 3.0 plans in November 2008. It planned to have 20% of its networks upgraded to DOCSIS 3.0 by year-end 2008, 50% by 2009 and full deployment by 2010.[198] In February 2009 the company announced a revised, perhaps more aggressive plan: it planned to have 65% of the network upgraded by the end of 2009, but apparently none of the DOCSIS 3.0 deployment originally expected to occur in 2008 happened.[199] Hence it is behind its original plans, but plans to increase the pace so that it can reach the original goal ahead of schedule.

Time Warner Cable announced in 2008 that it would deploy DOCSIS 3.0 during 2009 selectively.[200] By the end of September 2009 the company had deployed the technology in parts of New York City.[201] In the end of 2009 Time Warner Cable reiterated the idea that it would deploy in more markets but it would be surgical.[202]

ViaSat, Inc. announced in January 2008 plans to build and launch ViaSat-1 as its next generation 100Gbps High Throughput satellite[203] capable of providing users with download speeds of 2-10Mbps or perhaps more.[204] ViaSat announced it had executed the construction contract with Space Systems/Loral on January 7, 2008. The satellite is expected to be launched in early 2011.

2009

AT&T announced in mid-2009 that it would begin to upgrade its network to LTE toward the end of that year.[205] By year-end 2009, it expected to deploy about 2,100 new cell sites nationwide[206] It stated that its migration to LTE was "seamless" and can be assumed to be on track.[207]

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[198] Jeff Baumgartner, "Knology Calls Wideband Play", Cable Digital News, 2008, http://www.lightreading.com/blog.asp?blog_sectionid=419&site=cdn&doc_id=168387

[199] Jeff Baumgartner, "Knology Goes on the Offensive", Cable Digital News, 2009, http://www.lightreading.com/document.asp?site=cdn&doc_id=172415

[200] Nate Anderson, "No data caps, no DOCSIS 3.0? TWC's math doesn't add up", Ars Technica, 2009, http://arstechnica.com/tech-policy/news/2009/04/twc-without-data-caps-internet-upgrades-now-in-doubt.ars

[201] Karl Bode, "Time Warner Cable (Finally) Launches DOCSIS 3.0", DSL Reports, 2009, http://www.dslreports.com/shownews/Time-Warner-Cable-Finally-Launches-DOCSIS-30-104626

[202] Seeking Alpha, TWC Q4 2009 Earnings Call January 28, 2010 http://seekingalpha.com/article/185162-time-warner-cable-inc-q4-2009-earnings-call-transcript>)

[203] Spacemart.com, http://www.spacemart.com/reports/ViaSat_1_To_Transform_North_American_Satellite_Broadband_Market_999.html, January 9th, 2008

[204] ViaSat.com, ViaSat-1 to Transform North American Satellite Broadband Market, http://www.viasat.com/news/viasat1-transform-north-american-satellite-broadband-market, January 7, 2008

[205] "AT&T to Deliver 3G Mobile Broadband Speed Boost", May 27, 2009, http://www.att.com/gen/press-room?pid=4800&cdvn=news&newsarticleid=26835

[206] http://www.att.com/gen/press-room?pid=4800&cdvn=news&newsarticleid=26835

[207] http://seekingalpha.com/article/200029-at-amp-t-inc-q1-2010-earnings-call-transcript

Comcast announced in the beginning of 2009 a new goal of full DOCSIS 3.0 deployment by year-end 2010. Comcast had already deployed to 35% coverage at the beginning of 2009 and aimed for 65% in the end of 2009.[208] In mid-2009 Comcast changed their goal from 65% to close to 80% deployment of its footprint by the end of 2009.[209] By the end of 2009 Comcast had distributed wideband to 75% of its footprint meeting its goal and stated once again that it would have full deployment by early 2010.[210]

Hughes Communication announced in June 2009 that it plans to launch a 100Gbps throughput satellite Jupiter in first quarter of 2012.[211] As of May 2010 Hughes signed an order with Arianespace for the launch of Jupiter in the first half of 2012.[212]

Knology announced in February 2009 a revised, perhaps more aggressive plan: it planned to have 65% of the network upgraded by the end of 2009, but apparently none of the DOCSIS 3.0 deployment originally expected to occur in 2008 happened.[213] Hence it is behind its original plans, but plans to increase the pace so that it can reach the original goal ahead of schedule.

Mediacom indicated that it would be "in a position" to offer DOCSIS 3.0 to approximately 50% of their footprint by the end of 2009.[214]

MetroPCS announced in its 2009 annual report that it was planning to roll out LTE services to "most" of its covered metropolitan areas by YE 2010.[215]

Sprint/Clearwire announced in March 2009 that the 4G goal was reset to eight 4G equipped metropolitan areas by the end of 2009 and four more in 2010. This would be 60-80 million POPs by the end of 2009.[216] The total covered population was supposed to have reached 120 million by the end of 2010 according to the 2009 revised plan.[217] At the end of 2009 Sprint reported

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[208] Seeking Alpha, "Comcast Corporation Q1 2009 Earnings Call Transcript", seekingalpha.com, 2009, http://seekingalpha.com/article/134349-comcast-corporation-q1-2009-earnings-call-transcript?page=-1
[209] Seeking Alpha, "Comcast Corporation Q2 2009 Earnings Call Transcript", seekingalpha.com, 2009, http://seekingalpha.com/article/154406-comcast-corporation-q2-2009-earnings-call-transcript
[210] Comcast Corporation, CMCSA Q4 2009 Earnings Call Transcript, February 3, 2010
[211] Hughes Communications Inc., "Conference Call to Discuss Launch of 100 Gbps High Throughput Satellite in 2012," June 17, 2009
[212] Hughes Communications, HUGH Q1 2010 Earnings Call Transcript May 5, 2010)
[213] Jeff Baumgartner, "Knology Goes on the Offensive", Cable Digital News, 2009, http://www.lightreading.com/document.asp?site=cdn&doc_id=172415
[214] Mediacom Communications Corporation, Earnings Call Transcript, February 2009.
[215] http://investor.metropcs.com/phoenix.zhtml?c=177745&p=irol-SECText&TEXT=aHR0cDovL2lyLmludC53ZXN0bGF3YnVzaW5lc3MuY29tL2RvY3VtZW50L3YxLzAwMDExOTMxMjUtMTAtMDQ0NzgwL3htbA%3d%3d
[217] eWeek, "Clearwire Sets More WiMax Rollouts", eweek.com, 2009, http://www.eweek.com/c/a/Mobile-and-Wireless/Clearwire-Sets-More-WiMax-Rollouts/

having 13 markets covered on its 4G network surpassing its previous goal.[218] As of April 2010 Sprint had also exceeded its plan for 2010 with 36 4G markets.[219] Sprint's 2010 goal was to cover 120 million POP's by yearend 2010.[220] Clearwire announced in August 2009 that it would launch its CLEAR 4G WiMAX service in September of that year.[221] As of Q1 2010, the company had "launched in the markets…expected" and remained "committed to reach up to 120 million POPs by year end."[222]

T-Mobile USA announced plans to upgrade its 3G network to HSPA21+ and have coverage "nationwide by 2010."[223] This goal was later elaborated upon and as of Q2 2010 the company expected to cover a footprint of 185 million people by year-end 2010.[224]

Verizon announced in December 2009 that it planned to reach 100 million POP's by the end of 2010 in 25 to 30 markets and 285 million POP's by the end of 2013 with its LTE rollout.[225] In early 2010 it confirmed this plan and added that it also planned to have virtually all of its 3G footprint upgraded by the end of 2013.[226]

2010

Comcast announced in the beginning of 2010 that it had reached over 75% of its footprint with DOCSIS 3.0 and plans to complete its deployment in early 2010.[227]

Cox revised its estimate of DOCSIS 3.0 deployment, in May 2009, to two-thirds coverage by year-end 2010.[228] The initial statements predicted full coverage by 2010.[229]

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[218] "Bringing 4G to You" Presentation 11/30/09, http://phx.corporate-ir.net/External.File?item=UGFyZW50SUQ9MjE4MDR8Q2hpbGRJRD0tMXxUeXBlPTM=&t=1>)
[219] "Sprint Turns on 4G Service in Richmond, Salt Lake City and St. Louis" April 2010, < http://investors.sprint.com/phoenix.zhtml?c=127149&p=irol-newsArticle&ID=1441980&highlight=>)
[220] "Bringing 4G to You" Presentation 11/30/09, http://phx.corporate-ir.net/External.File?item=UGFyZW50SUQ9MjE4MDR8Q2hpbGRJRD0tMXxUeXBlPTM=&t=1
[221] http://newsroom.clearwire.com/phoenix.zhtml?c=214419&p=irol-newsArticle&ID=1315679&highlight=
[222] http://seekingalpha.com/article/203243-clearwire-q1-2010-earnings-call-transcript
[223] http://www.fiercewireless.com/story/t-mobiles-ray-promises-national-hspa-deployment-mid-2010/2009-09-18
[224] http://www.tmobile.com/company/PressReleases_Article.aspx?assetName=Prs_Prs_20100524&title=4G%20Speeds%20From%20TMobile%20Now%20Broadly%20Available%20in%20the%20Northeastern%20U.S.%20and%20Other%20Major%20Cities
[225] Verizon at UBS Media & Communications Conference, Dec. 08. 2009, http://investor.verizon.com/news/20091208/20091208_transcript.pdf
[226] Verizon, First Quarter 2010 http://investor.verizon.com/financial/quarterly/vz/1Q2010/1Q10Bulletin.pdf?t=634122024165837858
[227] Comcast, Report for first quarter 2010 results
[228] http://cox.mediaroom.com/index.php?s=43&item=430
[229] http://www.justbroadband.org/shownews/Comcast-80-DOCSIS-30-Coverage-By-Years-End-103824

Hughes Communications Inc. signed an order with Arianespace for the launch of Jupiter in the first half of 2012 as of May 2010.[230]

Knology announced in the beginning of 2010 that it had three markets fully or partially operational with DOCSIS 3.0, two markets were in the equipment deployment phase, and one market would be upgraded in the later part of the year resulting in 65% of their footprint to be covered by year-end for their DOCSIS 3.0 rollout.[231] Therefore, it does not plan to meet its initial goal of full DOCSIS 3.0 deployment by 2010, and have not met their revised plan of 65% deployment by year end 2009. This puts Knology a year behind schedule.

LightSquared recently closed a $7 billion outsourcing deal with Nokia Siemens Networks over eight years[232] and plans to cover 92% of the US with LTE wireless broadband by 2015. LightSquared will also offer nationwide wireless satellite service.[233]

Mediacom announced in May 2010 that DOCSIS 3.0 was available in 25% of its footprint and planned to have 50% of its footprint or 1.4 million customers covered by the second half of the year.[234] Mediacom is thus behind on its initial deployment plan.

Time Warner Cable in January 2010 announced that it had launched 4G/3G mobile broadband in Dallas, Hawaii, San Antonio and parts of the Carolinas.[235] In 2010, 4G network coverage is expected to expand to additional cities including New York, Boston, Washington, D.C., San Francisco Bay Area, Kansas City, Cincinnati, Cleveland, and Los Angeles.[236]

Verizon declared in early 2010 that it would be extending its plans to pass 18 million homes with FiOS fiber several years past its initial 2010 year end objective.[237] Verizon wireless plans to cover 38 markets[238] and 285 million POP's by the end of 2013 with its LTE 4G rollout.[239]

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[230] Hughes Communications, Q1 2010 Earnings Call Transcript May 5, 2010

[231] Knology Inc. 1Q10 Earnings Conference Call, May 5, 2010. "WebCast" <http://www.earnings.com/Company.asp?client=cb&coid=130221&ticker=KNOL#>)

[232] Bank of America Merrill Lynch, "Lightsquared Becoming Tangible for Towers," October 7, 2010.

[233] LightSquared, Inc, About Lightsquared, http://www.lightsquared.com/pdf/LightSquared_Backgrounder.pdf

[234] Mediacom Communications Corporations Earnings 1Q10 Conference Call, May 7, 2010

[235] Time Warner Cable, Inc. Q4 2009 Earnings Call January 28, 2010 < http://seekingalpha.com/article/185162-time-warner-cable-inc-q4-2009-earnings-call-transcript>

[236] Time Warner Cable, "Time Warner Cable Business Class Launches 4G Wireless Data Service for Mobile Professionals," May 28, 2010 <http://ir.timewarnercable.com/phoenix.zhtml?c=207717&p=irol-newsArticle&ID=1419456&highlight=wireless)

[237] Verizon, Investor Quarterly First Quarter 2010 , < http://investor.verizon.com/financial/quarterly/vz/1Q2010/1Q10Bulletin.pdf?t=634122024165837858)

[238] Connected Planet, "CTIA: Verizon Wireless expands its 2010 LTE plans, but still no launch date," October 2010, http://connectedplanetonline.com/3g4g/news/verizon-wireless-expands-2010-LTE-plans-1006/

[239] Dec. 08. 2009 - Verizon at UBS Media & Communications Conference <http://investor.verizon.com/news/20091208/20091208_transcript.pdf>)

ViaSat announced in Q1 2010 that it was on track to launch its 100 Gbps Ka-band satellite, ViaSat-1, in 1H 2011.[241]

[241] http://www.viasat.com/broadband-satellite-networks/viasat-1

Section 3: Future Projections

As a third element of its original request, the FCC National Broadband Plan team asked for a review of situations

> "…where the publicly announced broadband plans yet to be commenced or still in progress will be 3-5 years in the future, including LTE, WiMAX, DOCSIS 3.0, backbone, etc. This should include a summary of analyst projections and a 'lessons learned' component."

This portion of the Report updates the initial response to the FCC's request in five subsections: 1) a review of each company's announced but uncompleted broadband plans; 2) the status of internet "backbones"; 3) the status of broadband satellites; 4) a summary of broadband investment projections; and 5) some observations about "lessons learned."

3.1 Announced But Uncompleted Broadband Plans

America's broadband infrastructure is not yet complete: substantial major deployment projects, each requiring substantial capital investment, are currently underway, as the following table illustrates. Nevertheless, the overall picture of the broadband infrastructure for the next few years is quite clear: most of the current multi-year projects are expected to be completed in the next year or two and, to date, no longer range major deployment projects have been announced. Basically, "what you see is what you get."

Table 11: Uncompleted broadband plans

Company	Technology	Plan
AT&T	U-Verse: Fiber/DSL	Expand to pass 30 million living units by 2011.[242]
Cincinnati Bell	FTTH	Launched in 2009, no additional information
Verizon	FTTH	Plans to have FiOS coverage in about 70% of its telecom footprint subsequent to the Frontier transaction.[243] Declared in early 2010 that it would be extending its plans to pass 18 million homes with FiOS fiber several years past its initial 2010

[242] AT&T Public Relations, "AT&T to Invest More Than $17 Billion in 2009 to Drive Economic Growth," AT&T Inc., 2009, http://www.att.com/gen/press-room?pid=4800&cdvn=news&newsarticleid=26597.
[243] J. Killian, "Verizon at Oppenheimer Conference," Verizon Communications Inc., 2009, http://investor.verizon.com/news/20090811/20090811_transcript.pdf.
[244] Verizon - Investor Quarterly First Quarter 2010 , < http://investor.verizon.com/financial/quarterly/vz/1Q2010/1Q10Bulletin.pdf?t=634122024165837858)

		year end objective[244]
Comcast	DOCSIS 3.0	Announced in the beginning of 2010 that it had reached over 75% of its footprint with DOCSIS 3.0 and plans to complete its deployment in early 2010.[245]
COX	DOCSIS 3.0	Revised its estimate of DOCSIS 3.0 deployment, in May 2009, to two-thirds coverage by year-end 2010[246]
Knology	DOCSIS 3.0	65% of their footprint to be covered by year end for their DOCSIS 3.0 rollout[247]
Mediacom	DOCSIS 3.0	Announced in May 2010 that DOCSIS 3.0 was available in 25% of its footprint and planned to have 50% of its footprint or 1.4 million customers covered by the second half of the year.[248]
Time Warner Cable	DOCSIS 3.0	Remainder of NYC and additional DOCSIS 3.0 markets will be in 2010.[249]
Clearwire	Wireless -- CLEAR™ 4G service: WiMAX	2010: 80 markets, 120 million subscribers; The company is targeting 120m covered POPs by YE2010. [250]
MetroPCS	4G LTE	Planning to roll out LTE services to "most" of its covered metropolitan areas by YE 2010[251]
Sprint	Dual-Mode 3G/4G	120 million POP's to be reached by 2010 year end[252]

[245] COMCAST REPORTS FIRST QUARTER 2010 RESULTS < http://files.shareholder.com/downloads/CMCSA/946629823x0x369471/6e92536a-8c1e-486a-acd4-868e4d70cb2b/Comcast_Q110_Release_4.27.10.pdf>

[246] "Cox Expands DOCSIS® 3.0 Reach to Northern Virginia
Ultimate Internet package allows download @ speeds up to 50 Mbps" Press Release, <http://cox.mediaroom.com/index.php?s=43&item=430>

[247] 1Q10 Knology Inc. Earnings Conference Call, May 5, 2010. "WebCast" <http://www.earnings.com/Company.asp?client=cb&coid=130221&ticker=KNOL#>

[248] Mediacom Communications Corporation Earnings Conference Call May 7, 2010 < http://www.earnings.com/conferencecallhost.asp?event=3040752&client=cb>

[249] K. Bode, "Still Waiting On Time Warner Cable DOCSIS 3.0," dslreports.com, 2009, http://www.dslreports.com/shownews/Still-Waiting-On-Time-Warner-Cable-DOCSIS-30-103220.

[250] Clearwire Media Relations, "Clearwire Transforms Wi-Fi Devices with the CLEAR Spot Personal Hotspot Accessory," Clearwire Corp, 2009, http://newsroom.clearwire.com/phoenix.zhtml?c=214419&p=irol-newsArticle&ID=1271811&highlight.

[251] Metro PCS 10K report.3/01/10, <http://investor.metropcs.com/phoenix.zhtml?c=177745&p=irol-SECText&TEXT=aHR0cDovL2lyLmludC53ZXN0bGF3YnVzaW5lc3MuY29tL2RvY3VtZW50L3YxLzAwMDExOTMxMjUtMTAtMDQ0NzgwL3htbA%3d%3d>

T-Mobile	Enhanced 3G 4G LTE	Announced plans to upgrade its 3G network to HSPA21+ and have coverage "nationwide by 2010."[253] This goal was later elaborated upon and as of Q2 2010 the company expected to cover a footprint of 185 million people by year end.[254] T-Mobile USA estimates provided to CITI in July 2010 confirmed this estimate to be on track. T-Mobile also plans to upgrade to an LTE network in 2-3 years. The company will be finalizing its plans over the next year and is considering either partnering with Clearwire or Lightsquared, or building its own separate LTE network.[255]
AT&T	4G	2010: begin LTE trials 2011: expected completion of upgrades; begin deploying LTE.[256]
Verizon	4G	Announced in December 2009 that it planned to reach 100 million POP's by the end of 2010 38 markets[257] and 285 million POP's by the end of 2013 with its LTE rollout.[258]
OpenRange	4G –WiMAX	Serve 546 rural communities in 17 states. Six million people should be covered when the project is finished (over five years).[259]

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252 "Bringing 4G to You" presentation 11/30/09 < http://phx.corporate-ir.net/External.File?item=UGFyZW50SUQ9MjE4MDR8Q2hpbGRJRD0tMXxUeXBlPTM=&t=1>)

253 Fiercewireless. "T-mobile's Ray Promises National HSPA+ deployment by mid- 2010" September 18, 2009. <http://www.fiercewireless.com/story/t-mobiles-ray-promises-national-hspa-deployment-mid-2010/2009-09-18>

254 "4G Speeds From T-Mobile Now Broadly Available in the Northeastern U.S. and Other Major Cities" May 24, 2010 <http://www.tmobile.com/company/PressReleases_Article.aspx?assetName=Prs_Prs_20100524&title=4G%20Speeds%20From%20TMobile%20Now%20Broadly%20Available%20in%20the%20Northeastern%20U.S.%20and%20Other%20Major%20Cities>

255 Deutsche Bank Global Markets Research, "Takeaways from meetings at PCIA and with T-Mobile USA," October 2010.

256 AT&T Public Relations, "AT&T Sees Significant Rise in Wi-Fi Hotspot Connections during Second Quarter", AT&T Inc., 2009, http://www.att.com/gen/pressroom?pid=4800&cdvn=news&newsarticleid=26975.

257 Connected Planet, "CTIA: Verizon Wireless expands its 2010 LTE plans, but still no launch date," October 2010, http://connectedplanetonline.com/3g4g/news/verizon-wireless-expands-2010-LTE-plans-1006/

258 Dec. 08. 2009 - Verizon at UBS Media & Communications Conference <http://investor.verizon.com/news/20091208/20091208_transcript.pdf>)

259 Open Range, "Open Range Communications Secures $374 Million to Deploy Wireless Broadband Services to 546 Rural Communities," Open Range Communications Inc., 2009, http://www.openrangecomm.com/markets.html.

Time Warner Cable: Road Runner Mobile	3G/4G	In 2010, 4G network coverage of Business Class Mobile, is expected to expand to additional cities including New York, Boston, Washington, D.C., San Francisco Bay Area, Kansas City, Cincinnati, Cleveland, and Los Angeles[260]
LightSquared	4G	In 2010, LightSquared closed a $7 billion outsourcing deal with Nokia Siemens Networks over 8 years261 and plans to cover 92% of the US with LTE wireless broadband by 2015. LightSquared will also offer nationwide wireless satellite service.262

Note: Charter and Insight have plans to expand DOCSIS 3.0 service, but have not announced details

3.2 Broadband Satellite Plans

The future of consumer satellite broadband Internet will be dominated by a new generation of high throughput (HT) satellites that are being built for ViaSat and Hughes Communications. The companies expect to launch these new satellites in the first quarters of 2011 and 2012, respectively. These new satellites are expected to lower the cost per bit of delivering satellite broadband service.[263]

ViaSat expects to offer advertised speeds of 2-10 mbps[264] and have the capacity to serve as many as 2 million homes[265] while Hughes is suggesting that it will offer advertised speeds in the 5-25 mbps range and will presumably be able to serve a similar number of homes. However, the relatively poor broadband performance of the current generation of satellites might suggest that the expectations for the next generation are optimistic until proven otherwise.

3.3 Broadband Investment Projections

Projections about the future of broadband capital expenditures require assumptions about three critical factors that drive investment:

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[260] Time Warner Cable, Inc. (TWC) Q4 2009 Earnings Call January 28, 2010 <http://seekingalpha.com/article/185162-time-warner-cable-inc-q4-2009-earnings-call-transcript>
[261] Bank of America Merrill Lynch, "Lightsquared Becoming Tangible for Towers," October 7, 2010.
[262] LightSquared, Inc, About Lightsquared, http://www.lightsquared.com/pdf/LightSquared_Backgrounder.pdf
[263] Hughes Communications, "Conference Call to Discuss the Launch of 100gbps High Throughput Satellite in 2012," Hughes Communications Inc., 2009, http://www.hughes.com/HUGHES/Doc/0/NIJU69S0U56KJ3381689D3KO47/HUGH_Transcript_20090617.pdf at 5.
[264] ViaSat, "Demo of Next Generation Satellite Broadband Service with Highest Speeds Ever at Satellite," ViaSat Inc, 2009, http://www.viasat.com/news/demo-next-generation-satellite-broadband-service-highest-speeds-ever-satellite-2009.
[265] ViaSat, "ViaSat Conference Call to Discuss ViaSat-1 Contract," ViaSat Inc., 2008, http://www.alacrastore.com/alacra/help/sample_ccbn.pdf.

the extent of wired and wireless broadband infrastructure deployment and an assessment of how much additional deployment is likely;

1) the degree of broadband adoption, in terms of wired broadband households and wireless broadband users, and a forecast of how many new users will utilize broadband services; and,

2) the growth of the broadband capacity utilized by each broadband user.

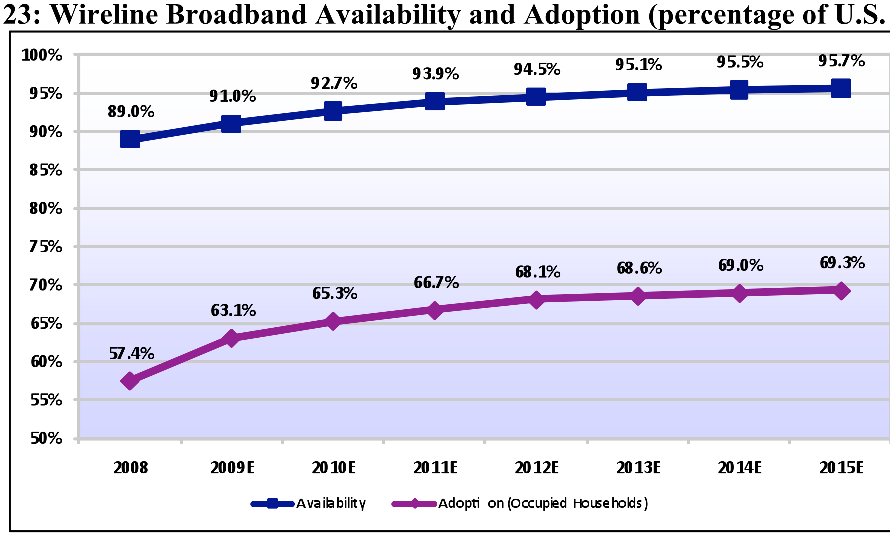
The investment projections will be discussed below. It should be clarified that these figures are those of investment analysts in various financial institutions. The FCC specifically requested CITI to use company data and Wall Street projections as its sources, and not generate its own data or critique company projections.

3.4.1 Broadband Availability

"Availability" is a measure of the deployment of broadband infrastructure: increasing the availability of broadband services requires the capex-intensive deployment of additional physical infrastructure. The data indicates that most (but not all) of the broadband infrastructure has been deployed in geographic markets where it is economically rational for service suppliers to do so, implying that there will be relatively little future investment in infrastructure.

The chart below averages the expectations of a number of investment analysts' forecasts and indicates that the analysts expect that wired broadband internet access availability will plateau and reach about 95% of homes in the United States by 2015 while more than 69% of households will subscribe by 2015.

Figure 23: Wireline Broadband Availability and Adoption (percentage of U.S. households)



Source: Average of analyst data provided to CITI[266]

Industry researchers estimate that fiber to the home (FTTH) was available to about 17 million homes (homes passed) in mid 2009.[267] Verizon announced that it will deploy FTTH systems capable of serving 17 million locations by 2010.[268] A number of other smaller companies, including small rural telephone companies, will be covering additional homes with FTTH. AT&T has announced it will offer DSL from fiber-fed cabinets (fiber to the neighborhood: FTTN-DSL) to 30 million homes by 2011.[269] AT&T currently offers advertised speeds of up to 24 megabits per second downstream[270] (although the actual speed can be much lower), with increases possible as bonding allows doubling total speeds on DSL. Therefore, if just these two largest telecom companies' achieve their goals, at least 50 million homes will be able to receive advertised speeds of 10 megabits per second or more downstream within the next two years. Other telecom companies will be providing additional similar offerings in their service areas.

Broadband service is currently available from cable companies to 92% of households according to a research firm that tracks the cable industry.[271] Cable broadband is being upgraded to the DOCSIS 3.0 standard[272] and is becoming widely available at advertised speeds as high as 50 mbps downstream (with one firm advertising 101 megabit speeds).[273] Comcast, the largest cable company addressing nearly half the United States, expects to cover nearly all its 50.6 million homes passed[274] by the end of 2010. One analyst believes DOCSIS 3.0 will be available by 2013 to "nearly all"[275] the homes covered today by cable modem services.[276] That would be about 92% of 112 million households, or 103 million homes.

A number of wireless broadband service providers expect to deploy Long Term Evolution (LTE) and WiMAX technologies (so-called "4G" wireless services) between 2010 and 2013 and, if successful, bring multi-megabits speeds to a majority of U.S. homes and population.[277] The wireless services offer shared bandwidth, so the speeds obtained by users will be dependent on actual traffic loads at each cell-site, and in particular on how many users are simultaneously

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[266] The number of U.S. Households is based on the most current data from the U.S. Census Bureau. In 2007, there were 112,377,977 households. See: U.S. Census Bureau, America's Families and Living Arrangements: 2007, September 2009. The number of households from 2007 was grown at a rate of approximately 1.00949%. The CAGR is an average of analyst forecasts provided to CITI.

[267] M. C. Render, "North American FTTH/FTTP Status," RVA LLC, 2009, at 2. http://www.ftthcouncil.org/sites/default/files/RVAFTTHPreso092809forrelease.pdf.

[268] See Broadband in America, Section 3: Uncompleted Broadband Plans.

[269] See Broadband in America, Section 3: Uncompleted Broadband Plans.

[270] See Broadband in America, Section 1: 1.1 Technology, p. 21.

[271] See Broadband in America, Section 1: 1.3 Expected Deployment/Coverage Footprint

[272] DOCSIS is a standard developed by Cable Labs and stands for "Data Over Cable Service Interface Specification"

[273] See Broadband in America, Section 1: 1.1 Technology, p.30

[274] See Broadband in America, Appendix A.

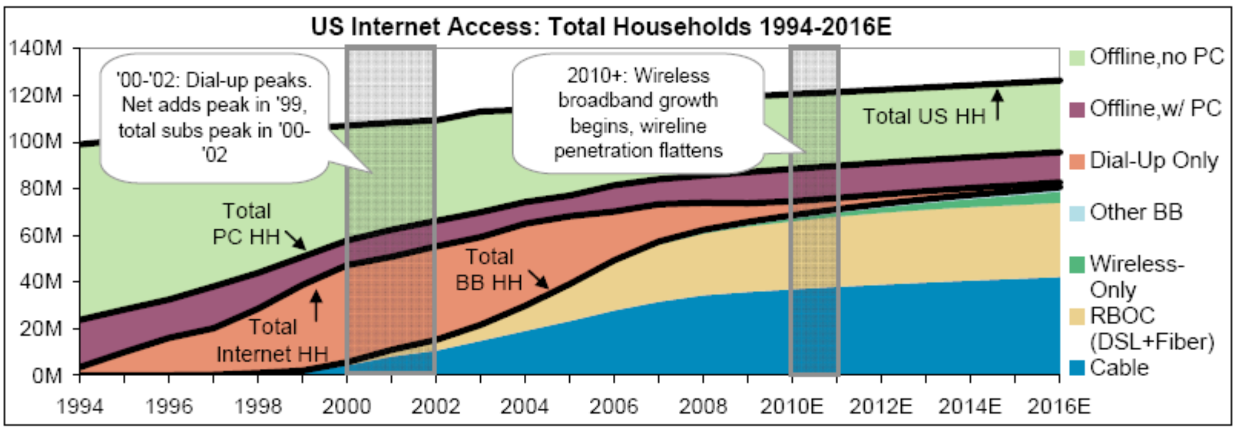
[275] See Broadband in America, Section 1: 1.3 Expected Deployment/Coverage Footprint, p. 36

[276] See Broadband in America, Section 1: 1.3 Expected Deployment/Coverage Footprint, p. 25

[277] See Broadband in America, Section 3, p. 66.

using bandwidth-intensive applications, such as watching video on wireless Internet connections. As one example, by 2013 Verizon expects that LTE will provide subscribers with 5 to 12 mbps downloads in a deployment planned to reach all of its covered population (at the end of 2008, Verizon's network covered 288 million people[278] or 94% of the U.S. population).[279] Other wireless companies cover a smaller share of the population. Entrepreneurial and independent Wireless Internet Service Providers (WISPs) provide WiMAX-type services to at least 2 million customers[280] in rural areas, including many areas not covered by the national wireless companies.

Table 12: US Internet Access by Type of Service



Source: Morgan Stanley Research, Industry View Cable/Satellite, October 20, 2009

In addition, the graph suggests that wireline penetration will continue to flatten in 2010 and beyond, while wireless broadband begins to experience growth. The graph also forecast a very limited number of "wireless only" broadband households, implying that wireless broadband is a complement to wireline broadband and not a replacement, presumably because wireline speeds are expected to greatly exceed wireless speeds.

3.4.2. Broadband Adoption

"Adoption" measures the rate at which customers actually utilize the available broadband infrastructure. Increasing the adoption rate also generally requires some additional capital investment, ranging from physically extending a line to the customer's premises (a capital

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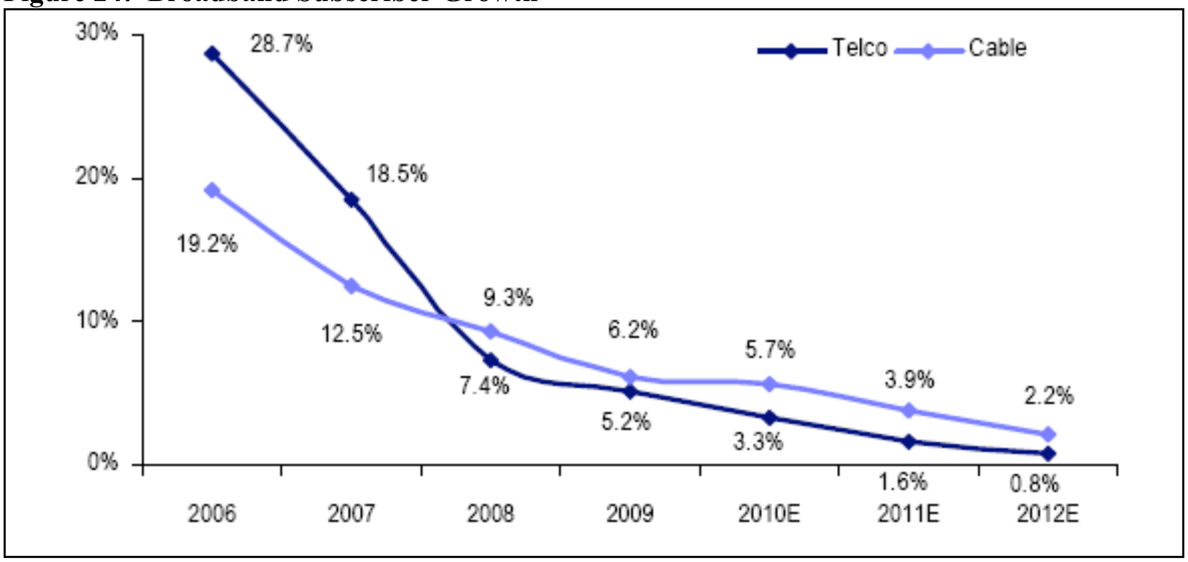
[278] Verizon Communications, "2008 Annual Report," Verizon Communications Inc., 2009, at 9.
[279] See Broadband in America, Section 1: 1.1 Technology, p. 30.
[280] See Broadband in America, Section 1: 1.1 Technology, p. 29.

intensive function) to adding a relatively low cost electronic device to an existing line at the customer's premises.

Data shows that the market for broadband services (particularly wired service) is largely saturated, implying relatively modest future capital expenditure associated with initial adoption. A recent forecast of wired broadband growth predicts that growth will drop as low as 2.2% in Cable subscribers and less than 1% in Telco subscribers by 2012.

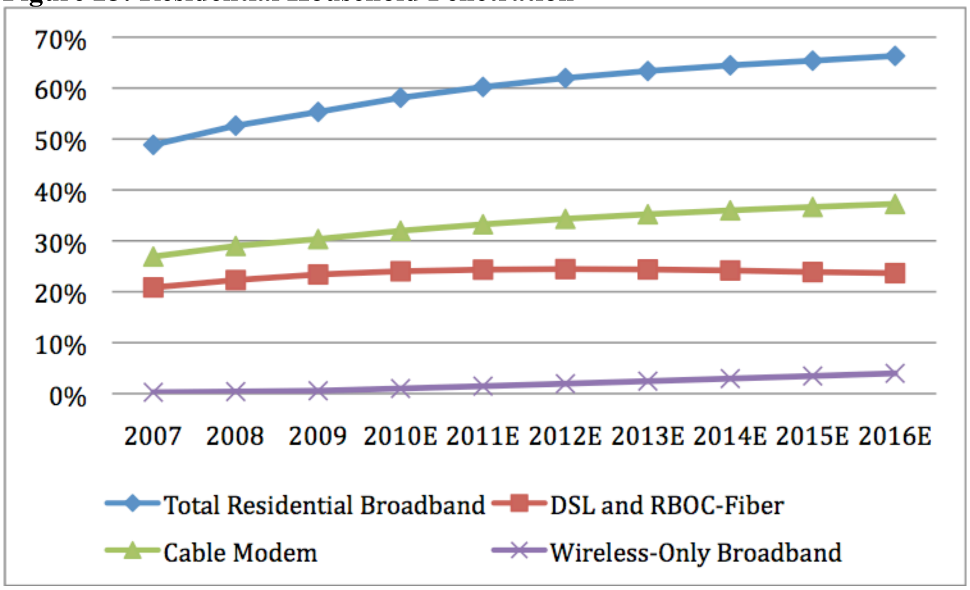
Figure 24: Broadband Subscriber Growth



Adapted from UBS Investment Research Telecommunications "Cable Likely to Extend Lead in Broadband" May 3, 2010

Residential broadband penetration (adoption), including wireless, is expected to reach roughly 66% by 2016, as illustrated in the following graph.

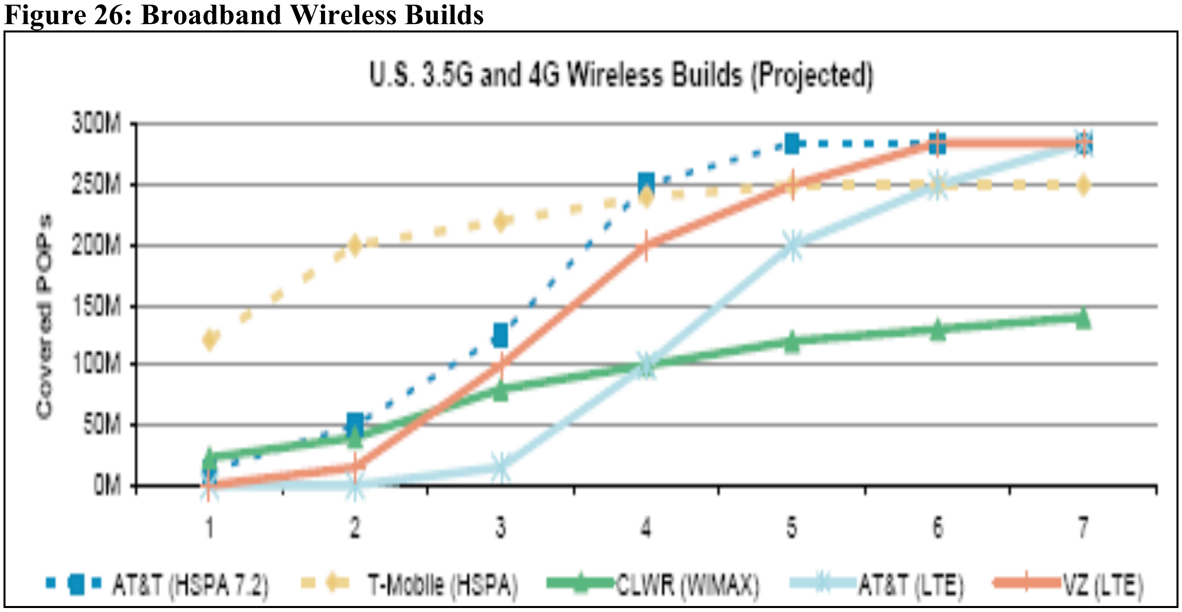
Figure 25: Residential Household Penetration



Source: Analyst data provided to CITI

However, because wireless broadband is currently much lower on the growth curve than wired broadband, analysts expect much stronger growth for wireless broadband and consequently much higher capital investment over the next five years, with continued strong adoption of 3G wireless broadband services and a fast initial ramp-up of 4G as it becomes available. However, it is worth noting that these wireless forecasts predict a traditional "S" curve, with the growth flattening in 5-6 years.

Figure 26: Broadband Wireless Builds



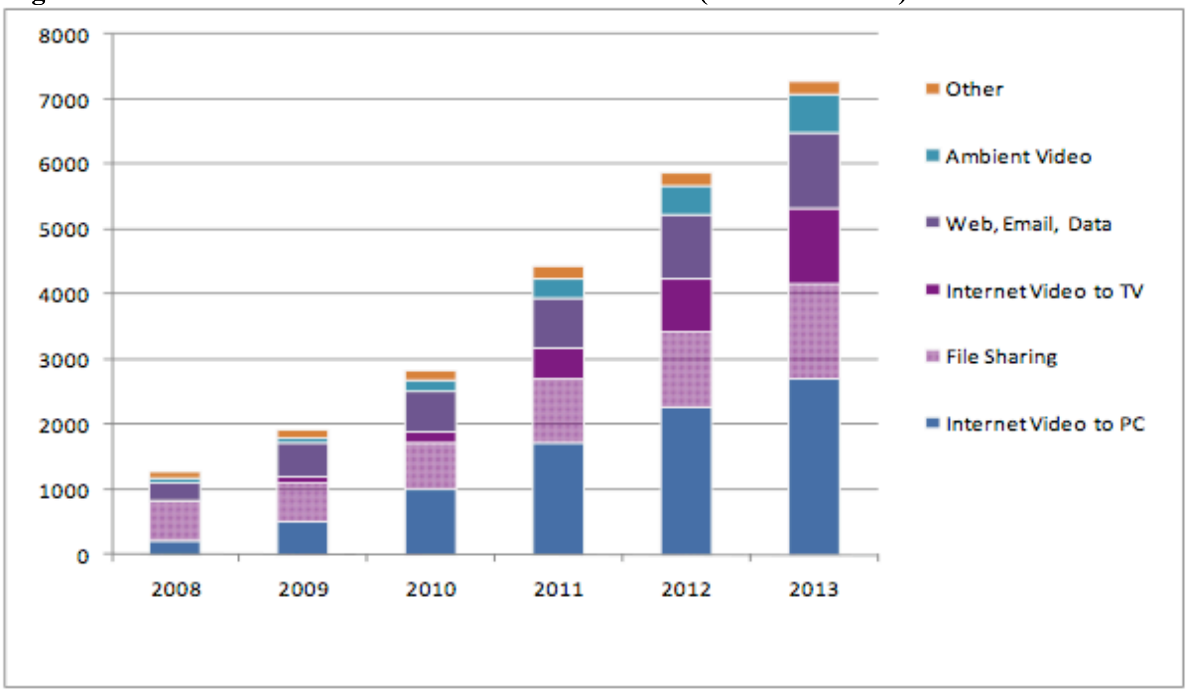
Source: Morgan Stanley "Cable/Satellite: After Years of Deflation, Broadband Pricing Set to Rise" October 20, 2009

3.4.3 Broadband Usage by Customers

Additional capital investment is needed to accommodate growing volumes of traffic generated over broadband services. While some of the additional traffic is a function of new broadband users, the weak growth in additional subscribers (particularly wired services) implies that much of the volume growth is coming from increased usage by current customers. Thus, how consumers will use broadband services and how much capacity they will consume are important factors in forecasting broadband capital expenditures by service providers.

As the following graph illustrates, the most rapid growth in broadband usage is expected in three video-related categories: 1) Internet video to PC; 2) file sharing; and 3) internet video to TV.

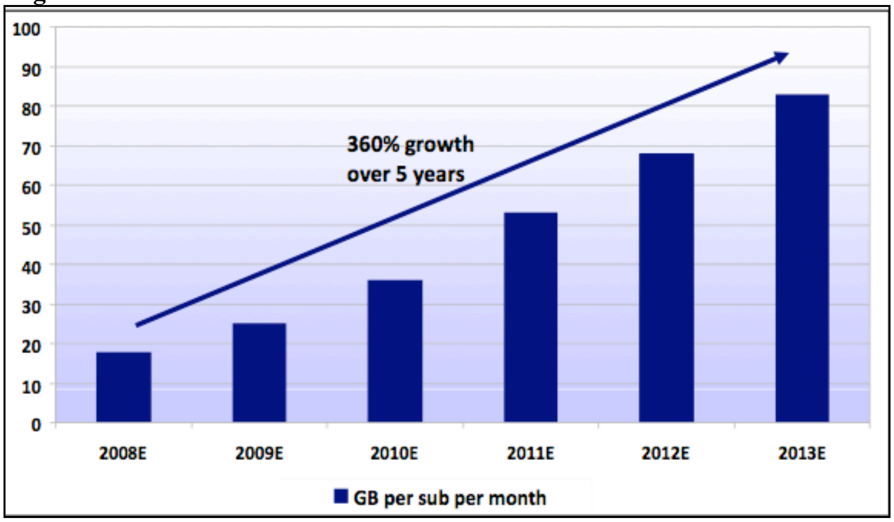
Figure 27: North American Consumer Internet Traffic (Petabits/month)



Source: Cisco Visual Networking Index; Morgan Stanley Research estimates. Note: Data is for North America, limited to non-mobile consumer usage
Adapted from Morgan Stanley Research, U.S. Cable, Satellite, Telecom 3Q09 Outlook, Oct. 21, 2009 at 17.

At a more granular level, with relatively stable numbers of customers these increases in overall internet usage translate into rapidly growing per subscriber volumes, as illustrated by this graph:

Figure 28: Estimated U.S. Consumer Internet Use

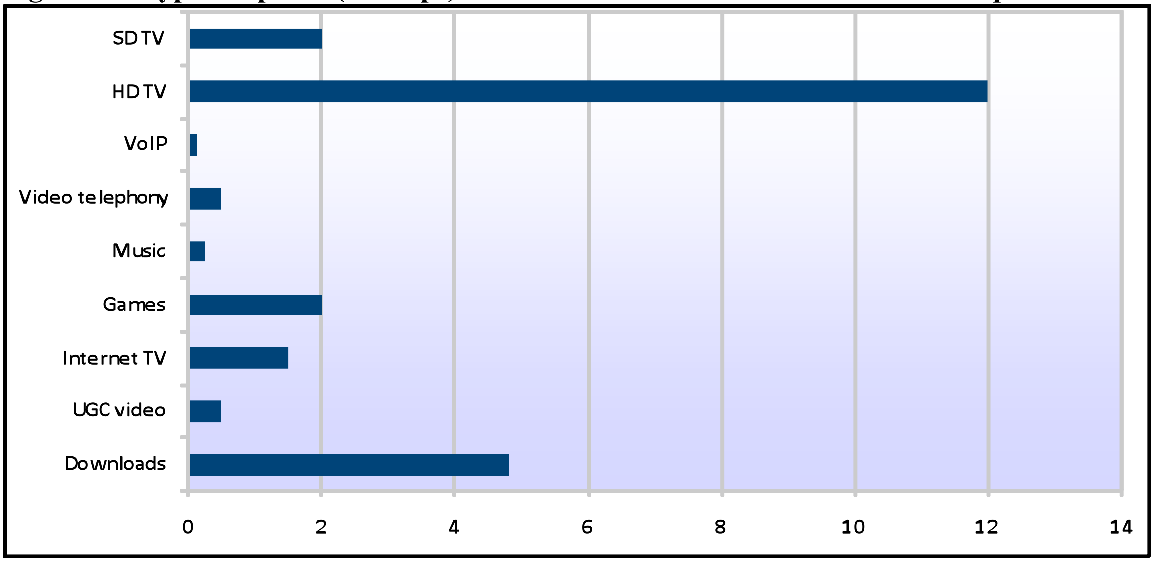


Adapted from Morgan Stanley Research, U.S. Cable, Satellite, Telecom 3Q09 Outlook, Oct. 21, 2009 at 17.

With "video" being a primary driver of volume increases, it is worth noting that different video applications have substantially different requirements. As the following graph demonstrates, television and other real-time video applications will require the highest transmission rates in the future. While there may be improvements in compression codecs over the next years, analysts assume that the typical speed used for standard definition television (SD TV) will be 2 mbps per stream in 2013 while high definition television (HD TV) will require between 9 and 19 mbps with 12 mbps typical. More standard internet activities, including non-real time video, peer-to-peer file sharing, handling e-mail attachments or publishing photos to social networks, do not require a particular high speed level but benefit from ever-higher speeds.[281]

[281] I. Fogg, "Home Broadband Bandwidth Requirements", Forrester Research, 2008, http://www.forrester.com/rb/Research/home_broadband_bandwidth_requirements/q/id/52075/t/2?action=5 at 2.

Figure 29: Typical Speeds (in Mbps) that Internet Activities and IPTV Will Require in 2013



Adapted from Forrester Research, Home Broadband Bandwidth Requirements, Sept. 9, 2008 at 2.

3.4.5 Forecasting Broadband Capital Expenditures

The following table is based on the forecasts of leading investment analysts with respect to overall capex for the leading telecom, cable, and wireless companies (and as such, they represent less than 100% of future capital expenditures in the sectors):

Table 13: Total Capital Expenditures for Major Service Providers ($ billion)

	2009	2010	2011E	2012E	2013E	2014E	2015E
Cable	11,892	11,509	10,951	11,113	11,141	11,112	11,160
Telco	22,502	21,230	18,611	16,778	15,182	13,642	12,284
Wireless	19,765	22,328	22,952	23,570	24,254	24,595	24,870
Total	**54,159**	**55,067**	**52,514**	**51,460**	**50,577**	**49,349**	**48,314**

Source: Average of analyst data provided to CITI, *Telcos*: AT&T (excluding wireless), Verizon (excluding wireless), Qwest; *Cable MSOs*: Comcast, Time Warner, Cox, Cablevision, Charter, Mediacom, and Insight; *Wireless*: AT&T, Verizon, Sprint, T-Mobile, Metro-PCS, Leap.

Note: Investment analysts provide forecasts for telco and wireless up to 2011. Beyond that year, the capex for telco and wireless companies was estimated using averaged growth rates.[282]

[282] A weighted average is used, giving 60% weight to the last year's growth rate, and 20% weight to each of the two earlier years' growth rates.

This data predicts a sharp decrease in total capital expenditures from 2008 to 2011 and smaller declines in the following years. The steepest decline is for telcos, and a smaller decline for cable and wireless companies. After 2012, the investment analysts assume that capex will remain relatively constant. The analysts' forecasts of very slowly declining (relatively flat) capex after 2011 could be too generous for a number of reasons. For example, if the major new infrastructure programs for telcos and cable companies are largely completed by the end of 2011 and there are no similar programs thereafter, there might be an even sharper decline rather than a relatively flat forecast. [283]

There is support for the idea that improvements in DSL technology will keep pace with customer demand for faster transmission speeds in the near to medium term, meaning that telcos currently utilizing a hybrid of FTTN with DSL will not be forced to abandon this architecture for a full-fiber FTTH within the forecast horizon. Recent developments have extended the life of this FTTN-DSL architecture and pushed back the time when operators would need to replace the copper twisted pairs with fiber optics to each customer's premises. First, the steep and steady losses of basic telephone line customers have made more twisted pairs available for DSL services. Second, new technologies that allow "bonding" of the twisted pairs permit much higher transmission speeds, perhaps as high as 50 mbps. In recent test of technology called "DSL Phantom Mode," Alcatel-Lucent and Bell Labs demonstrated downstream transmission speeds of 300Mbps over distances of up to 400 meters . [284] These developments may change the environment for DSL providers and reduce their overall capex requirements.

Deriving Broadband Capex

How much of service providers' total capital will go towards broadband? AT&T estimated that "approximately two-thirds of AT&T's 2009 investment will extend and enhance the company's wireless and wired broadband networks to provide more coverage, speed and capacity."[285]

Since a very high proportion of wireless capex is for broadband (e.g. 3G and 4G deployments), AT&T's comment is broadly consistent with the following table which illustrates how the major

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[283] Therefore, analysts' assumptions for telco and cable companies' capital expenditures in the out years (2012-2015) may be overstated.

[284] Telecom News, "DSL Phantom Model Lab test maximizes the value of existing copper networks by pushing the envelope on DSL capacity," April 21, 2010 http://vartips.com/telecom-equipment/alcatel-lucent/dsl-phantom-mode-lab-test-maximizes-the-value-of-existing-copper-networks-by-pushing-the-envelope-on-dsl-capacity-1174.html

[285] AT&T, "AT&T to Invest More Than $17 Billion in 2009 to Drive Economic Growth," AT&T Inc., 2009, http://www.att.com/gen/press-room?pid=4800&cdvn=news&newsarticleid=26597. AT&T's estimate of two-thirds is consistent with the observation of a market research firm that "broadband remains the primary capex driver" for 2008-09 because,

> "Wireline and wireless carriers alike are stepping up their network investments to make highspeed Internet connections, and associated triple-play bundles, available to a greater portion of their customers."

The firm added that, "…there has been a pronounced shift in capex towards new, broadband platforms, and away from narrowband systems." Skyline Marketing Group, CapEx Report–2008 Annual Report at 1.

telephone companies are shifting wireline capital from their "legacy" telephone networks to wired broadband, with broadband capex expected to reach nearly 60% of total wireline capex in 2011.

Table 14: RBOC Wired Broadband Capex ($ billion)

Network	2006	2007	2008	2009E	2010E	2011E
Legacy	16.3	15.2	13.0	10.5	10.5	10.0
Broadband	7.2	10.7	11.9	11.5	12.5	14.0
Total	23.5	25.9	24.9	22.0	23.0	24.0
% broadband	*30.6%*	*41.3%*	*47.8%*	*52.3%*	*54.3%*	*58.3%*

Adapted from: Skyline Marketing Group, Capex Report: 2008 Annual Report, at Exhibit 14 and text at 18, 20, 23.

Service providers rarely break-out their capex between broadband and other categories of services. Therefore, a broadband capex forecast must be derived from total capital expenditure forecasts. To obtain an estimate for the US broadband investment, several adjustments are required.

First, the analysts' capex numbers have to be adjusted upward because they do not include all of the industry but only the major public companies, typically accounting for about 80-90% of a sector.[286] Second, a certain portion of industry total capex has to be allocated to broadband. These adjustments are described in the footnotes in the following chart.

The First Report did not estimate the capital expenditures for Towers or the CLEC backbone sectors. This update does include these estimates. Therefore, to provide the ability to compare the data in the two reports, the following table clearly identifies the categories not included in the First Report and provides a sub-total that is comparable to the earlier report.

[286] For telcos and wireless companies we used the companies' share of market by subscriber and for cable companies, we used the share by revenue. The large telcos (AT&T, Verizon and Qwest) accounted for 81.4% of subscribers, so the total capex was increased by 18.6% to account for the smaller telcos' capital. Similarly, the 82.4% aggregate share for the seven cable companies (Comcast, Time Warner, Cox, Cablevision, Charter, Mediacom, and Insight) resulted in a 17.6% increase to account for small cable companies' investments. For wireless, the four wireless providers (AT&T, Verizon, Sprint and T-Mobile) and their 94.3% share resulted in a 5.7% adjustment for small companies. See: Eli M. Noam, Media Ownership and Concentration in America, at 72, 236, 247, 2009.

Table 15: Total Capex and Broadband Capex by Sector

BROADBAND CAPEX (in millions)	2008	2009	2010	2011E	2012E	2013E	2014E	2015E
Major Telco Wireline Capex	26,283	22,502	21,230	18,611	16,778	15,182	13,642	12,284
*Gross Up Factor**	*81%*	*81%*	*81%*	*81%*	*81%*	*81%*	*81%*	*81%*
Total Telco Capex	32,289	27,644	26,081	22,864	20,611	18,651	16,760	15,091
*% Broadband***	*48%*	*52%*	*54%*	*58%*	*62%*	*66%*	*70%*	*74%*
Telco Wireline Broadband	**15,499**	**14,375**	**14,084**	**13,261**	**12,779**	**12,310**	**11,732**	**11,167**
Major Cable Capex	13,148	11,892	11,509	10,951	11,113	11,141	11,112	11,160
*Gross Up Factor**	*82%*	*82%*	*82%*	*82%*	*82%*	*82%*	*82%*	*82%*
Total Cable Capex	15956	14432	13967	13290	13487	13521	13485	13544
*% Broadband***	*30%*	*30%*	*30%*	*25%*	*25%*	*25%*	*25%*	*25%*
Cable Broadband	**4,787**	**4,330**	**4,190**	**3,323**	**3,372**	**3,380**	**3,371**	**3,386**
Major Wireless Capex	19,520	19,765	22,328	22,952	23,570	24,254	24,595	24,870
*Gross Up Factor**	*94%*	*97%*	*97%*	*97%*	*97%*	*97%*	*97%*	*97%*
Total Wireless Capex	20,700	20,376	23,019	23,662	24,299	25,004	25,355	25,639
*%Broadband***	*50%*	*60%*	*64%*	*66%*	*69%*	*73%*	*76%*	*79%*
Wireless Broadband	**10,350**	**12,226**	**14,732**	**15,617**	**16,766**	**18,253**	**19,270**	**20,255**
Satellite Broadband	200	200	200	500	300	300	300	200
WISP Broadband	199	219	241	265	292	321	353	388
SUB TOTAL CAPEX	**69,344**	**62,871**	**63,508**	**60,581**	**58,989**	**57,797**	**56,253**	**54,862**
SUB TOTAL BROADBAND CAPEX	**31,035**	**31,349**	**33,447**	**32,965**	**33,509**	**34,564**	**35,026**	**35,396**
Tower Capex	1,320	650	699	782	861	904	931	940
% Broadband **	60%	65%	68%	70%	71%	73%	74%	75%
Tower Broadband	792	423	471	548	613	655	686	705
CLEC Backbone Contributions		650	600	550	500	500	500	500
% Broadband **		80%	80%	80%	80%	80%	80%	80%
Total CLEC Backbone		520	480	440	400	400	400	400
TOTAL CAPEX	**70,664**	**64,171**	**64,806**	**61,913**	**60,349**	**59,201**	**57,684**	**56,302**
TOTAL BROADBAND CAPEX	**31,827**	**32,292**	**34,398**	**33,953**	**34,522**	**35,619**	**36,112**	**36,501**

Source: Average of analyst data provided to CITI, with adjustments as described in the accompanying text. *Telco*: AT&T (excluding wireless), Verizon (excluding wireless), Qwest; *Cable*: Comcast, Time Warner, Cox, Cablevision, Charter, Mediacom, and Insight; *Wireless*: AT&T, Verizon, Sprint, T-Mobile For notes on Table 15 see footnote 287.

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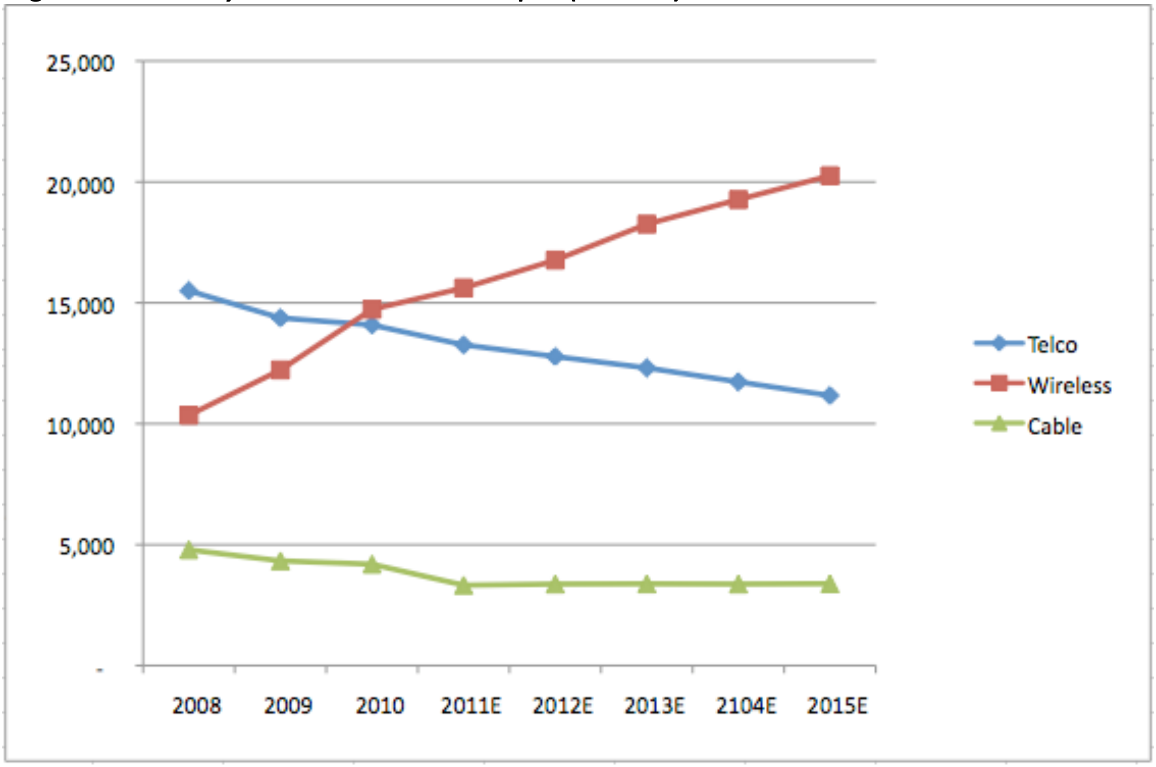
[287] *For telcos and wireless companies we used the companies' share of market by subscriber and for cable companies, we used the share by revenue. The large telcos (AT&T, Verizon and Qwest) accounted for 81.4% of subscribers, so the total capex was increased by 18.6% to account for the smaller telcos' capital. Similarly, the 82.4% aggregate share for the seven cable companies (Comcast, Time Warner, Cox, Cablevision, Charter, Mediacom, and Insight) resulted in a 17.6% increase to account for small cable companies' investments. For wireless, the four wireless providers (AT&T, Verizon, Sprint and T-Mobile) and their 94.3% share resulted in a 5.7% adjustment for small companies. See: Eli M. Noam, Media Ownership and Concentration in America, at 72, 236, 247, 2009.

The following graph is based on the analysts' forecasts, as adjusted, from **Table 15** reflecting the industry investment rationale described above.

Figure 30: Industry Sectors' Broadband Capex (millions)

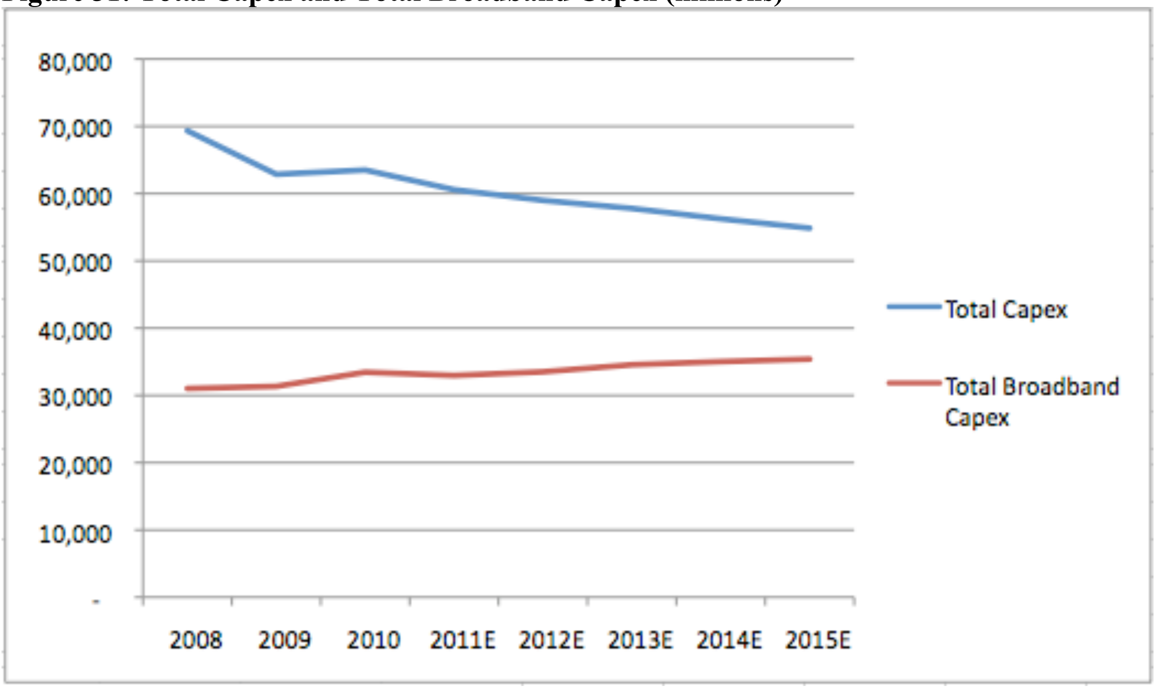


Source: Average of analyst data provided to CITI, *Telco*: AT&T (excluding wireless), Verizon (excluding wireless), Qwest; *Cable*: Comcast, Time Warner, Cox, Cablevision, Charter, Mediacom, and Insight; *Wireless*: AT&T, Verizon, Sprint, T-Mobile.

**Based on costs to upgrade the networks to DOCSIS 3.0 in 2009 at $100 cost per home passed, which includes the cost of DOCSIS 3.0 cable modems, estimate by Pike & Fisher. See the GigaOM Network: http://gigaom.com/2009/04/30/docsis-30-coming-soon-to-an-isp-near-you/
Broadband cable capex has been lowered to 25% and then to 20% to reflect reasonable bottom line numbers as we believe that the investment analysts' overall capex projected numbers may be too high, as explained in the text
***The allocation of wireless broadband capex is estimated at 60% in 2009. This is based on AT&T's statement about 2/3 of investments going to broadband. The increase in subsequent years assumes that 4G investment is for "broadband."
****This estimate is based on $570,000 per system, which the average dollar value of the grants from the Department of Agriculture's RUS 2008 Community Connect Broadband Grants for wireless internet service providers. The number of new systems is assumed to be 10% of the 350 WISPA members, increased 10% per year.

The next graph illustrates the total industry and total broadband investment, based on the totals in Table 15.

Figure 31: Total Capex and Total Broadband Capex (millions)



Source: Average of analyst data provided to CITI, and estimates. *Telco*: AT&T (excluding wireless), Verizon (excluding wireless), Qwest; *Cable*: Comcast, Time Warner, Cox, Cablevision, Charter, Mediacom, and Insight; *Wireless*: AT&T, Verizon, Sprint, T-Mobile, Leap, Metro-PCS.

Towers

Investments by independent companies that lease space on towers for service providers' wireless service radios are logically part of the overall investment in the wireless infrastructure. The initial 2009 report to the FCC did not specifically include an analysis of the "tower companies" or their capital investment. The growth in tower companies reflects the strong growth in demand for wireless services. While demand for data is growing fastest, minutes of use is also increasing due to growth in subscribers and unlimited plans, and in wireless substitution.[288]

Analysts expect wireless data demands to benefit towers. One observed that:

> "The increased network traffic benefits the towers, and 3G and 4G deployment represents additional upside, requiring more equipment on the towers and greater cell

[288] Morgan Stanley Research, "Telecom Services 1Q Tracker", May 27, 2010 at 56.

site density. We believe that the main sources of growth in 2010 will be the rising data demands driven by Clearwire WiMAX build, AT&T and Verizon 3G expansion, and Verizon's LTE build."

"As demand for mobile content grows alongside continued smartphone penetration, we expect wireless carriers in general to continue adding capacity (cell sites that require towers) to support increased usage, network upgrades, and improved coverage."[289]

As the above comments illustrate, most if not all of the new towers are needed to accommodate wireless broadband services so it is therefore appropriate to allocate most -- 68-70% of tower capex to wireless broadband.

ARPU and Pricing Trends

Average revenue Per User (ARPU) and pricing trends are relevant to two issues: the ability of the service providers to finance additional capital investment from current operations and the degree of competition (at least price competition) which is relevant to a determination about whether capex from current operations is likely to be sustainable. If service providers need to raise additional capital from external sources, ARPU and pricing trends are factors which investors study closely so that the trends in these factors affect the cost and availability of capex from external sources. Higher prices and higher ARPUs are therefore "positive" factors for capital, either internal or external, even though such trends might be considered "negative" for consumers.

As an overall measure of broadband revenue, ARPU continues to become a less useful measure because, as the percentage of users who purchase bundled services increases, it becomes increasingly difficult to determine what portion of the overall revenue of services is attributable to broadband and what portion is attributable to other services.

Both telecoms and cable providers have continued to add broadband users, but as market penetration reaches saturation, competition for new users is fierce and most often takes the form of customers shifting from one service provider to another rather than new users entering the market.

Price increases have also reentered the cable broadband market and one investment analyst anticipates 2% annual increases in overall ARPU leading to an overall ARPU growth of 4 – 5% in the next few years.[290] In the DSL market, only Qwest increased prices across its line offering, resulting in an overall increase in DSL pricing of 16% Q/Q as Qwest raised prices 68% Q/Q.[291]

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[289] Bank of America Merrill Lynch, "2Q10 Wrap: In-line Q and guidance raised; maintain Buy," July 30 2009 at 1.

[290] Morgan Stanley Research, "Cable/Satellite led by Broadband and in line with thesis pricing trends improving" Morgan Stanley, 2010, at 8.

[291] Bank of America Merrill Lynch "Battle for the Bundle," Bank of America Merrill Lynch, 2010 at 5.

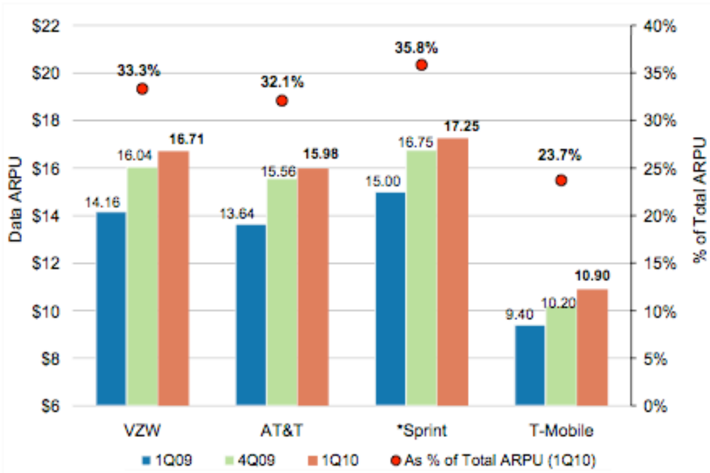
Wireless Broadband ARPU

As many analysts predicted last year, wireless ARPU increased in 2010. Many expect this trend to continue as companies add usage caps or tiered pricing plans to their service plans. Data already represents more than 30% of total wireless ARPU (see Figure below) and demand from smartphone penetration is expected to increase.

Table 16: Wireless Broadband Data ARPU

Exhibit 76

Data Above 30% of Total ARPU for Most



Data growth remains strong across the sector. AT&T's data ARPU exhibited the highest Y/Y growth in the quarter, while Sprint reached the highest percentage of total ARPU in 1Q10. We note that Sprint's data ARPU is not blended but only represents postpaid and that management will no longer disclose data ARPU.

T-Mobile's data ARPU still lags the group at $10.90, compared to its peer's average (T, VZ and S) of $15.80. The company mentioned that there were 5.2 million 3G-capable converged devices on T-Mobile's USA network at the end of 1Q10, an increase of almost 33% from 4Q09. Its 3G network covered 208 million people at the end of 1Q10.

Increased smartphone penetration should keep data revenue climbing.

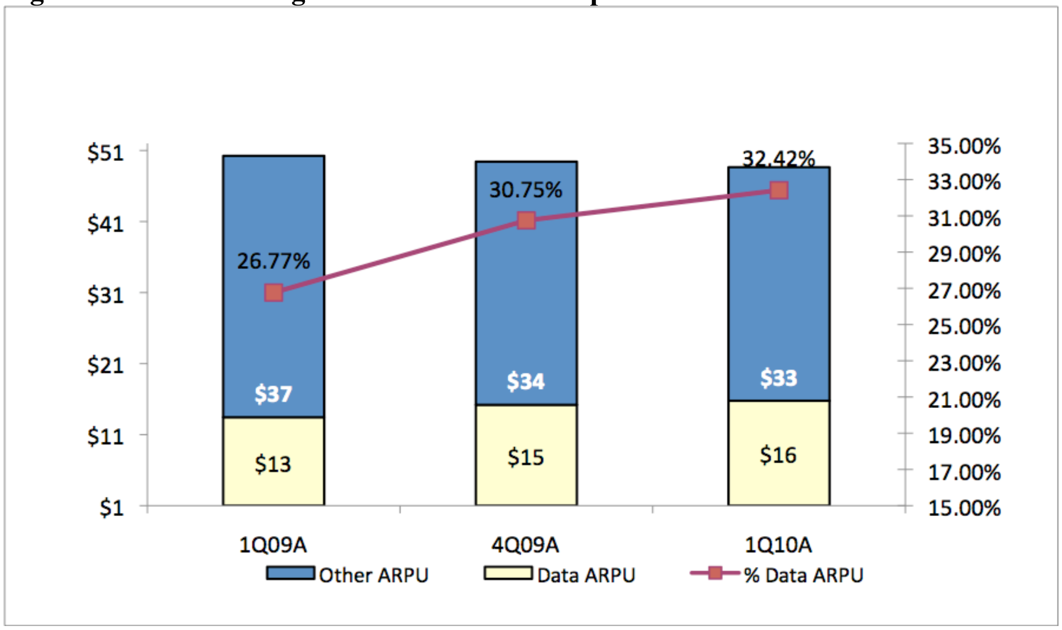
Source: Company data, Morgan Stanley Research. Verizon pro forma for Alltel.
*Sprint data ARPU is for postpaid only and does not include prepaid.

Analysts expect wireless broadband ARPU to increase, one saying, "…we are raising long-term broadband ARPU growth from flat to +2% per annum beginning in 2011."[292]

The percentage of wireless ARPU attributable to wireless broadband has been increasing steadily, and for the four large wireless companies was 32.42% of total ARPU in the first quarter of 2010, up from 26.7% in the same period in 2009.

[292] Morgan Stanley Research, "Cable/Satellite Led by Broadband & In-Line with Thesis, Pricing Trends Improving," Morgan Stanley, April 2010 at 8.

Figure 32: Total Average Wireless ARPU Composition



Source: Company data, Morgan Stanley Research, Telecom Services, May 27, 2010 at 40

Section 4: Guest Essay Contributions

For the second edition of this report, we asked our colleagues who are policy makers, academics, and practitioners for their reactions to and ideas about broadband in America. The contributors are active in the various fields in which they work, and the topics of the essays vary as well. The essays range in scope from examining the National Broadband plan to measuring the economic impact of broadband in rural America. The authors also had the chance to present and debate their views during *The National Broadband Plan – One Year Later* conference, hosted by the Columbia Institute for Tele-Information and Georgetown's Communication, Culture, and Technology program in March, 2011. We are grateful for their contributions to this report.

Section 4 Table of Contents

The Two Ideas Behind the National Broadband Plan

Blair Levin[293]

Aspen Institute, Communications and Society Program

During the last 24 months, the National Broadband Plan catalyzed many discussions about the future of broadband in America and the Plan's role in shaping that future. These discussions have often been productive, but to a surprising extent, the conversations demonstrated a misunderstanding of two critical questions: why have a plan, and what is the animating vision of the Plan? The purpose of this essay is to answer those questions in the hope those answers will lead to more thoughtful conversations about the how our country should approach the challenges and opportunities that the new commons of collaboration—the broadband ecosystem—presents.

First, why have a plan? Properly understood, the plan was an agenda setting, target-clarifying device. The plan was a process whose endpoint was to lay out—particularly for the stakeholders—an agenda for action. Further, it details policy targets to aim *for*--in the sense of policies to adopt--or aim *at*, in the sense of policies to shoot at and propose better alternatives.

A clear agenda, with specific policy targets, sets the stage for a better policy debate.
It does not guarantee great policy. But it increases the odds the policy will be fair, mitigate unforeseen consequences, not contradict other policies and achieve its intended purposes.

Every successful enterprise operates pursuant to a plan. It changes constantly, as markets change. Internal forces often challenge assumptions and suggest new ways to climb the mountain. But there is always a plan, an animating vision, a set of goals and tactics that drive the enterprise upward.

Every successful enterprise knows: *plan beats no plan*.

Without it, we are like those in a sailing race who say, according to my Plan colleague Erik Garr "we're lost, but we're making great time." Government—other than the military in a war setting—only occasionally operates pursuant to a plan. Few government agencies set out a

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long-term agenda, and signal a policy framework long before a final decision. This is unfortunate, as operating pursuant to a plan increases the likelihood an entity can achieve its purpose.

Nothing I have just said should be controversial. It is nonetheless notable because for much talk that government should be run more like a business, it is rare that forces align to empower an agency to do so at the fundamental level by actually developing a plan.

Some have complained that the agenda setting of the plan was too narrow, but they reach that conclusion by ignoring most of the agenda, which included:

- Transforming an outdated $9 billion universal service fund, including repurposing billions that are currently being spent on non-priority public purposes and refocusing funds on unserved areas;
- Getting 100 million Americans who have access but have not adopted on broadband;
- Restructuring billions of dollars of intercarrier compensation whose DNA reflects the world of voice minutes and causes huge inefficiencies;
- Accelerating deployment by removing barriers to the efficient use of poles, rights of ways, conduits, and other essential inputs;
- Transforming public safety by bringing 911, emergency alerts, and a public safety network out of the voice and into the data-rich era;
- Transforming education by removing regulations that make it difficult to move education to the more effective, assessable, accountable and personal digital platform;
- Transforming medicine by removing regulations that make it difficult to take advantage of electronic health records and a data-rich environment;
- Transforming energy to a smart grid by enabling every American to use broadband to track and manage their real-time energy consumption; and
- Creating a foundation for an upgrade to gigabit connectivity by creating a network of community anchor institutions aggregating demand to drive increased speeds.

This list is not exhaustive. The plan also has recommendations for using broadband to improve government performance, civic engagement, job training, and economic development.

In each area, we proposed actions. In each area, there has been action. If this is not a big thing in the eyes of the Plan's critics, the problem is not with the agenda, but with their vision.

But the more important controversies relate to the second question: what is the animating vision of the plan? Before I provide our answer, let me provide some context.

Many, including the President, speak of our country facing a Sputnik moment; a moment in which we collectively recognize other countries have abilities we both lack and need. It is not isolated to a single data point; new data on international leadership in a variety of categories from green energy production to students' math and science scores have caused calls for correcting our deficiencies. A recent Time Magazine cover highlighted the question of whether our nation is in decline.

However described, the challenge is great. A dozen years ago the great business visionary Peter Drucker identified a key element of that challenge: "The most important contribution management needs to make in the 21st century is…to increase the productivity…of knowledge workers…." He then predicted "It is on (the productivity of knowledge work)…that the future prosperity-and indeed the future survival--of developed economies will increasingly depend." Drucker understood knowledge work as the primary driver of the economy and civic society in this century.

In such a world, the core task is knowledge exchange. Knowledge exchange is fundamental to we do. We gather information, analyze it, act on it, and then through a feedback loop, continually revise courses of action.

Three revolutions in the last two decades have transformed knowledge exchange:

- The data revolution--collecting and providing trillions of data points previously unavailable;
- The computing revolution—analyzing that data, making tasks that would have seemed like finding of a needle in a galaxy of haystacks as common as locating the moon in the night sky, and
- The communications revolution--allowing us to transfer data and analysis anywhere, anytime, to anyone at speeds and costs unimaginable when I first arrived at the Commission in 1994.

This knowledge exchange revolution is not an isolated high tech phenomenon. It affects every sector of the economy. It is vital to every construction project, from high-rises to houses, and essential for every farmer on a tractor.

It's how Wal-Mart became the largest retailer, how the largest manufacturing process in the country—Boeing's development of the Dreamliner—is being coordinated across many countries before the final assembly in Everett, Washington.

While knowledge exchange takes many different forms, it inevitably shares a common platform. It is the broadband ecosystem; the combination of networks, devices, applications, and, above all, people who know how to use it.

We've talked for years about broadband causing a convergence of voice, video and data markets; how once sole purpose telephones, televisions and computers are morphing into devices capable of carrying any kind of traffic. Far more important, however, is how that convergence has created a commons of collaboration.

Steven Johnson's book--Where Good Ideas Come From: The Natural History of Innovation—illustrates that throughout history, innovation has been a collaborative art, not a solo science. Thus, the most powerful technology in this broadband ecosystem is not in processors, disk drives or fiber; it is the collaborative brainpower of its users.

This commons of collaboration is the foundation, not just for our economy, but for how we engage each other to create our civic society. Key democratic functions depend on vibrant knowledge exchange. It is how our voluntary associations—as Tocqueville noted, the roots of our democratic culture—assess our needs, how we find out what public officials are doing, and how we hold them accountable.

For the first time in history, the foundation for a strong economy and a strong society depend on the same technology platform. The banker on Wall Street, the teacher in East L.A., the head of a non-profit in Cleveland, the mayor of San Antonio, all depend on broadband to learn from others, to explain to others, and most importantly to together improve how they do what they do.

As broadband is the common collaborative platform for both the economy and our civic society, we need to have a broadband ecosystem that facilitates knowledge exchange in ways that are constantly more robust, more effective and faster. To meet Drucker's challenge of increasing productivity among knowledge workers, our nation requires that a broadband ecosystem that facilitates knowledge exchange in ways that are constantly more robust and effective.

So behind it all, the core idea of the National Broadband Plan: high performance knowledge exchange.

In one sentence, the plan was about assuring that America has a broadband ecosystem that enables high performance knowledge exchange.

Having such an ecosystem does not assure success. Not having it, however, guarantees failure. Without it, there is no possibility of leading in clean energy, improving education, or of responding effectively to international competition.

This understanding led our planning effort to an insight that underlay everything in the plan: as high performance knowledge exchange constitutes table stakes for winning the future, we need a broadband ecosystem that is ubiquitous, diverse and constantly improving.

To move toward this vision, the plan had to focus on more than just networks because it is the interaction of networks, devices, applications, and the people who use them that facilitate high performance knowledge exchange. The ecosystem has to be ubiquitous so all can benefit and all are included in the work of our economy and society.

The ecosystem also had to be diverse in each of its parts. We need multiple, interconnected networks, a full spectrum of applications, all manner of devices, and all manner of persons using it. It is that diversity that drives the innovation we need that leads to the fourth element; constant improvement. Improvements in each element should drive improvements in the others in a constant, virtuous feedback loop: better applications driving more usage driving upgraded networks driving more powerful devices capable of better applications and ever onward; above all, continually improving actual use.

Government is not the primary provider of any part of this ecosystem. It must, however, assure its rules drive, and do not suppress, improvements in this ecosystem. Further, it must rethink how it delivers essential public services in light of new opportunities created by this ecosystem.

It may surprise some but this approach is deeply at odds with prevailing government policies. The idea that dominates current broadband policy is that the primary metric to which our policy should aspire is to maximize the speed of the wireline network to our most rural of residents.

This idea is hurting America. We must end it. It's wrong in almost every respect.

There is no primary metric.

Quick thought experiment. Which would we prefer? Great hammers but no nails or blueprint? Great nails but no hammer or blueprint? Great blueprint but no hammer or nails?

Answer: without all, disaster. How would it profit us to have high speeds if our devices are slow, our applications useless and our users illiterate?

To those who think better networks are the only driver of performance, consider how the iPhone changed our mobile ecosystem. Because the mobile device market is diverse and competitive, Apple was able to enter and catalyze an explosion of use and innovation, and, not coincidentally, an accelerated network upgrade. As the iPhone’s impact demonstrates, the telling measure is the improvement throughout the system, not any single metric.

Which leads to the second problem; the knee-jerk focus on speed. Speed is an input; what matters is output. The data showed that while we need to increase speeds in some areas, the biggest untapped promise has more to do with applications; particularly new ways of delivering education, health care, public safety, job training and other critical public services.

Some critics of the plan have complained that we "pooh-poohed" speed. I find this argument fatuous. We understood speed as an important input but as with any input, the incremental value does not rise in a linear fashion. Going from narrowband to broadband was critical but that does not mean the same increase in speed will again produce the same increase in value, or be commiserate with the incremental cost. Moreover, while speed is an important input, it is not the only one, and what we care most about is the output—high performance knowledge exchange.

A third error is focusing primarily on wireline services. Wireline is important but mobile, wireless services will be every bit as important. In terms of economic growth in the next decade, it may be more important.

Wireless today is a horizon industry, an industry that points to how retail, manufacturing, agriculture, transportation, health care, education, and every other segment of our economy can improve their performance.

One of the points of Johnson's book is that great innovations come from the confluence of different rivers of thought and technology forming a more powerful river.

He describes this as the "adjacent possible." He suggests the "history of life and human culture, then, can be told as the story of a gradual but relentless probing of the adjacent possible, each new innovation opening up new paths to explore." He describes NASA engineers attacking the crisis in getting the endangered Apollo 13 astronauts home by putting everything the astronauts had access to on a table. Many items were not usually considered parts that could work together. But the presence of all parts inspired innovations that saved the day. Johnson writes the "trick to having good ideas is not to sit around in glorious isolation and try to think big thoughts. The trick is to get more parts on the table." Hal Varian of Google makes a similar point when he talks about the importance of "combinatorial innovation."

Mobile is entering its era of the adjacent possible, the combinatorial innovation, as upgraded speeds meet emerging developments in nanotechnology, location awareness applications, and machine-to-machine communications. But blinded by our traditional thinking, some don't see wireless as an essential underpinning of our economic future, and are slow to grasp the potential danger of lack of spectrum.

In just a few years, insufficient spectrum could lead to high prices and bad service, costing our economy billions. The plan identified the urgent need to act and created an innovative but simple solution that has bi-partisan support: allow existing spectrum license holders to participate in an auction, enabling market forces to free up new spectrum.

Lost in the current debate over many complicated spectrum and public safety issues is a simple truth: that the constant reevaluation of how to allocate resources, whether they are financial, human or political capital, is essential to a well functioning enterprise or society. Spectrum may be the most significant asset controlled by government yet our current system does not have any effective way to reallocate spectrum based on changing technologies, markets and consumer preferences. The Plan's proposal addresses that gap in a way that will be important not just for the next few years but for decades to come.

As to rural, it's important to connect all of it. But rural should not be, as it effectively is today, the major focus of our policy effort. The same with residential; indeed most of universal service today is and has been devoted to serving the residential rural market.

Consider how we would prioritize universal service funds to assure a ubiquitous, diverse, constantly improving ecosystem. Then consider how we actually spend it today.

At the beginning of the decade we spent about the same on last mile rural connections as we did on connecting public institutions, such as schools, libraries and rural health clinics. In the last decade, wireless has greatly increased its ability to over broadband, which should result in lowering the cost of deployment of last mile connectivity to rural homes. And the opportunity to improve services in schools, libraries and rural health care should has increased with live video, though that opportunity requires higher bandwidth. From a strategic perspective we should be spending more on institutions and less on homes. But we have kept institutions at the same dollar level while the amount we spent on last mile connectivity to rural homes has massively increased.

This result is a natural consequence of letting our policy be dictated not by strategic analysis but by the interests of those who benefit most from the current thinking. An example of the wrong way to think about the problem was a recent op-ed by the head of the Iowa Telecom Association attacking the reforms proposed in the Plan. It was extremely well written and wrong in almost every way.

It attacks the plan as anti-rural when the plan is the first effort to get broadband to all rural America. Part of the problem today is a rural-rural divide caused by our current system. We subsidize some rural carriers enough to build a Maserati, require them only to produce a Mercedes with enough of a subsidy so they only have to charge for a Corolla. For other rural carriers, we tell their subscribers to walk. The author's solution, not surprisingly, is more government subsidies for his clients and nothing to solve the problem of unserved rural areas.

But the most dangerous part of the editorial was this. After noting that the Plan sets a goal of at least 100 million America homes having access to networks capable of delivering 100 Mbs, he wrote, "(i)t is hard to believe, but the FCC does not believe all Iowans should have access to the same type of broadband speeds."

This is a lovely-sounding idea and a recipe for disaster. It ignores that it is the market, not the government, which sets the speed most Americans receive. It ignores it would require taxing all current subscribers about $30 a month, causing tens of millions to have to drop their service, hardly the result we want from a universal service system.

It ignores that, based on a plethora of data on actual consumer trends, getting 4G wireless to rural is higher priority for consumers than a wireline upgrade. And it defies common sense to think that people whose work is outdoors and mobile don't care about the service they can get on their tractor.

Most important, it ignores a robust, constantly improving broadband service, a service essential to all the economic engines of this century, requires some sectors to have speeds far higher than they have today, and higher than it would ever make sense for the government to subsidize to others.

For example, if our research institutions— certainly a critical asset for responding to this Sputnik moment—are to remain the best in the world, they need world-leading connectivity. So too, our leading medical centers, and other institutions, public and private, which are key to our international competitiveness.

We need a broadband plan that serves a strategy of economic growth, not a bumper strip that serves embedded interests.

While the arguments of the rural telephone companies have significant logical and economic flaws, they have many supporters who have offered up ways to drive new capital into rural areas. I am all for ways increased capital investment but when we examine the proposals, they suffer from the same unwillingness to consider incremental costs and incremental benefits.

A common criticism is that the Plan we erred by not adopting tax changes to stimulate fiber build-outs. Let's put aside that realistically, they have no chance; they are tax expenditures and we are in an era of cutting budgets. If we had proposed them we would have been laughed at, but not just because they are non-starters: they are bad ideas.

First, tax credits are in this case a very inefficient way to use public powers. During the transition and the plan, we looked at several such proposals. I initially thought them worthy but the economists, demonstrated they would effectively pay for things that would have been done anyway or, like rate of return regulation, cause non-economic investments. I think we have had enough of rules that have the public $17,000 a line per year per house and see no need to create a new incentive for such spending.

Second, it puts the heavy hand of the government on the scale of competition. As a study by CITI showed, we have wire line competition for over 90% of the homes.
But a fiber tax credit effectively only helps one side in that competition. Further, as Verizon has already built significant fiber, it only helps a subset. Why should government policy favor the capital expenditures of Windstream but not Charter?
Why should government decide that one kind of technology solution deserves a tax break but an alternative that performs the same function does not? If we only had a single provider for the lion's share of the population—as other countries have—such a policy might make sense. But where competitive forces are driving upgrades, shouldn't we want that process to play out?

Third, and most profound, we should want the capital allocation decisions of competitive players to reflect markets. That AT&T and Verizon are moving their capital expenditures to mobile reflects the choices of consumers, who increasingly want to take advantage of what smart phones and tablets can do and do not yet see the value of moving their expenditures to paying more for faster wire line service.

Tax credits in this context have the effect of the government telling the CEOs of AT&T and Verizon, "don't listen to the consumers. We, the government, know better about what is in the consumer interest and we want you to spend your capital on more wire line and less wireless now."

That is a profoundly bad idea. As is the idea, also offered as criticism of the Plan, that we should have proposed more off-tax expenditures—which still require Americans everywhere to pay more for benefits that are highly unlikely to be commensurate with the cost—to drive fiber to areas where the cost per home cannot be justified.

That such deeply flawed arguments have any legs is unfortunate, but frankly, the process by which the public learned of the Plan bears some of the blame. During the rollout of the Plan, one speech—the one that set forth that goal of 100Mbps to 100 million homes—attracted a great deal of attention. I didn't have a problem with the goal. As the Plan explains, goals are an important way of setting a north star on our compass.

That speech garnered so much attention, however, it effectively defined the plan for the mass audience. On one level, it was a great success; but that short-term success has proven costly over the long-term.

It muddied the waters for the universal service debate. As noted above, rural representatives constantly argue that if urban areas have 100 Mbps, they are entitled to exactly the same, whatever the cost.

The speech focused attention on the hortatory part of the Plan—the aspiration—rather than the more important calls for action, diminishing the real power of the Plan.

Further, it focused on the market segment for which government action is least likely—at least in the near-term--to be required. Over the next several years existing market forces are driving upgrades in the mass market for both wireline and wireless.

In contrast, government needs to act in the unserved end—both deployment and adoption—and the high end, by stimulating gigabit communities and aiding key public anchor institutions. The government needs to act throughout the market to improve the way it delivers essential public services, such as education, public safety, job training and health care by taking advantage of broadband ecosystem. The success of the speech, however, hid from view the primary targets for action.

But the most problematic element was how it played into the conventional wisdom that the plan should be about the network speed to homes, rather than the admittedly, harder to digest but more important goal: improving America by using broadband to empower high performance knowledge exchange. It didn't do the hard but essential work of changing the way we look at the problem.

Another Peter Drucker insight is relevant here: "The danger in times of turbulence is not the turbulence. It is to act with yesterday's logic."

Far more important than a hortatory goal regarding network speed is the practical reality that today's policies are based on yesterday's logic and yesterday's realities, locking us into low-performance knowledge exchange.

Consistent with yesterday's logic, our emergency alert system runs on a low-performance knowledge exchange platform most Americans spend most of their time disconnected from—the broadcast system—instead of the high-performance knowledge exchange platform most Americans are connected to 24/7—the mobile communications networks.

Consistent with yesterday's logic, our 911 system is based on voice, not data.

Today's logic should allow us to see that instead of forcing all to offer uniform, low-performance knowledge exchange voice calls, we ought to unleash competition to offer high-performance

911 upgrades that enable sending videos, texts, the health record and blood type of the victim to the ambulance, a peer to peer neighborhood call for help for functions like CPR.

Consistent with yesterday's logic, we deliver educational materials through a low performance technology developed 5 centuries ago—textbooks--instead of high performance eBooks, which are easier to update, assess, improve, which provide students far more diverse and dynamic modes of learning in ways that work best for the individual students, all at a cheaper price.

I could cite similar examples with health care, energy, job training and many others. In short, our public arena is still using the logic of the past; the era of low performance knowledge exchange.

But there is hope.

In the plan we set out an agenda for such actions and today that agenda is central to every major proceeding the FCC is now undertaking. The plan defined the spectrum agenda for Congressional and White House activity in a way unparalleled for an FCC document. The plan's agenda is reflected in the technology plans of numerous agencies, including the Departments of Education and Health and Human Services and the new Consumer Finance Agency. It has stimulated a number of local government and non-profit activities.

If the plan is understood, as it should be, as an agenda-setting, target clarifying device, then that record of setting an agenda and clarifying targets is one to be celebrated, not berated.

As noted in Johnson's book, innovation is collaborative and collaborative efforts with many agencies has lead to a greater push for high-performance knowledge exchange in health care, education, and other areas, with members of our team of our team now playing key roles in the agency with direct mission responsibility.

The nation's CTO, Aneesh Chopra, and the head of NTIA, Larry Strickling, are making sure that the great recommendations are implemented and the merely good are improved and implemented. They understand the importance of high-performance knowledge exchange to the country and the path we need to travel to get there.

We can be pleased but we all know we have a long way to go. Nothing will be done precisely as we envisioned, not should it. As we wrote in the plan, the plan is in beta and always will be.

High Performance Knowledge Exchange is not achieved in a single event; it is a process that is ever ongoing. The Plan did not start or end that process. But I hope, and it appears, the Plan accelerated it.

Which proves a very important point worth repeating: plan beats no plan.

Let Them Eat Wireless

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Last March, the Federal Communications Commission in Washington, with some fanfare, presented its National Broadband Plan (NBP). A year later and well over two years into the new Administration, it is worth looking at the progress in promoting an infrastructure that candidate Obama had declared essential.

I wrote a year ago in the *Financial Times*[295] that while the plan was excellent in its comprehensiveness and direction, it was significantly hobbled by a major restriction– a dismal budget reality which prevents the Administration from providing funds to a project which it declared to be a prime national initiative. Within such constraints the NBP managed to maneuver creatively. But that's not the same as determining how the nation should proceed if it's not trying to do it on the cheap.

I also liked the open-mindedness of the plan, which was described by its authors as a "beta" version ready for improvements. They should be encouraged to maintain such a perspective. The plan is a national asset but it is not doctrine. In the spirit of constructive dialogue, I will address one major issue, the central role that wireless upgrade plays in the NBP.

What has happened in the year since the NBP was unveiled? The good news is that in 2010, homes with fiber passing (or close nearby) increased by about 9.5 million, and cable's fast DOCSIS 3.0 became available to 25 million additional households. But little of that was due to the plan or to stimulus moneys. Actually, in the preceding year, 2009, those upgrades had been still higher, 9.8 million for telecom and 30 million for cable. As CITI's study of projected investment shows[296] they are expected to decline in 2011 and beyond as the upgrade and deployment programs are nearing completion. Basically, the plan's goals on bottom line

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[295] Noam, Eli, "Paying for the American National Broadband Internet Plan" Financial Times, April 5, 2010. http://www.ft.com/intl/cms/s/0/89f0b142-40e3-11df-94c2-00144feabdc0.html

[296] See Atkinson and Schultz "Broadband in America," http://www.broadband.gov/docs/Broadband_in_America.pdf

connectivity seem to be met by regular market forces. The task ahead is more about unserved areas, as the NBP recognized.

The plan's bottom-line goal, proclaimed by the FCC Chairman – 100 million households with an internet connectivity of 100 megabits per second by 2020 – was an uncomfortable bumper-sticker for the NBP's authors whose targets were more complex. But some bottom line is inevitably needed to measure progress, and using such a yardstick the "100 square" target was hardly ambitious. As mentioned, given the rate at which private cable and telecom companies are pushing ahead, the goal would be achieved anyway without government support (though not as equally distributed). Other countries are more ambitious. Korea, which already today has an almost universal service at the level of 100 Mbps, announced a target of 1 gigabit per second to every household. Japan aims to reach a 100% fiber penetration in 2011, up from 50% in 2009. Australia is creating a national fiber to the neighborhood for 93% of the population at 100 Mbps, with last-mile upgrades for gigabit connectivity to follow with demand.

Advocates of the NBP downplay the importance of bit throughput rates ("speed") and stress instead progress in the applications and penetrations of broadband connectivity. Of course, there is a diminishing return for connectivity speed. But has it been established that today's speed in metropolitan areas is the optimum for the future? The environment is highly dynamic. Applications and performance are intertwined in a chicken-and-egg scenario. When a large user base of high-speed users emerges, applications catch up, and vice versa.

Just a short time ago hardly anyone watched video over the internet. Most internet video ventures collapsed because their speed requirements were ahead of the user base. Today, that problem has declined considerably and there is room for YouTube, Hulu, and Netflix. Netflix has overtaken Comcast as the number one video subscriber service in the country. Millions of people access their video entertainment online. Try to take it away and expect a rebellion. Try to deny it to some people and expect a revolt. Yesterday's vision becomes today's commonplace , and tomorrow's entitlement.

The leading edge of an electronic infrastructure is essential for economic progress, just as the concern for the trailing edge is important for social development. Applications are of course important, but historically governments have been more successful in infrastructure with its huge externalities–roads, airports, transmission lines--than in applications –buses, airlines, refrigeration.

And now, the moderate speed goal – in terms of pushing the leading edge of infrastructure--of the national plan has been further lowered by a shift of emphasis, from no less than President Barack Obama. In recent speeches President Obama has selected the wireless part of the NBP for special emphasis. The broadband priorities of the Administration are now publicly focused on the emerging new fourth generation of wireless mobile and fixed phones and devices, also known as 4G.

The idea is to liberate 500 Megahertz of spectrum, to auction it off to providers of 4G--presumably mobile telecom companies, thus more than doubling their spectrum-- and to use the proceeds to create broadband connectivity for unserved areas and people.

Let's look at the elements of this program. Will it happen? Will it do the job of spreading enough broadband? And what are the alternatives?
Will the wireless-based approach work?
Where would the new spectrum come from? First, from several existing allocations and governmental users, though whether this will actually materialize is a good question, because each of these uses has its fierce advocates. In the plan, perhaps wisely, there is no attempt to go after big slices of government spectrum, even where it is largely technologically superseded, such as domestic radar outside of perimeter defenses.[297] A second part of the new spectrum for mobile communications would come from other mobile uses, especially those for satellites, which have tanked.

Most of the remaining spectrum would come from existing TV broadcasters, who would voluntarily give up all or some of their over-the-air spectrum in return for the carrot of an unspecified slice of the auction revenues and the stick of unspecified spectrum user fees. These auctions would raise an estimated 28 billion dollars.

But will this happen? Unless financially imperiled, most broadcasters have no intention to voluntarily surrender what they have come to consider their spectrum patrimony, or be pushed to yet another band, especially if the result is to facilitate the entry of competing video platforms and viewing options. Maybe they will give up a slice of their spectrum, since with digital multicasting they might need less spectrum to stay in the single-channel business. But, the broadcasters most likely to try to sell or lease their spectrum are those of rural TV stations with low audiences and perhaps high debt. But in those areas spectrum is not scarce. In contrast, in the urban areas where 4G use would require a lot of spectrum, broadcasters are less likely to sell.

Broadcasters still service directly about 15% of American households (and many more over cable), and are the primary way in which candidates for Congress reach their constituents. Thus Congress will not easily approve an involuntary displacement of broadcasters unless their rural constituents benefit substantially to make up for loss of part of their free TV.

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[297] Noam, Eli, "Curb in-air delays for free," Financial Times, December 17, 2007.
http://www.ft.com/cms/s/0/1f124c7e-acd8-11dc-b51b-0000779fd2ac.html#axzz1OtCaO3q3

Given the inevitable legislative and legal roadblocks, the process of shifting spectrum from TV broadcasting to telecom will take much time and political capital. In the end, it is likely that much less spectrum will be available for auctioning than envisioned, and hence less money would be generated by the auction than hoped for. Furthermore, in any calculation of net proceeds one needs to subtract the pay-offs to broadcasters for their spectrum, the cost of clearing other spectrum bands for their relocation, the tax deductibility and amortization of the spectrum licenses by their new holders, as well as the requirement to support poor TV viewers when they are forced to move their TV sets to another band, and to cable and satellite subscription TV.

And of these speculative auction revenues, only a part would actually go to broadband infrastructure – a one-time $5 billion for rural 4G. Virtually nothing would go towards fiber upgrade, or to cable-based infrastructure, or to an upgraded traditional copper based DSL. $9.6 billion would go to cut the federal deficit. (This raises another question, though not one of communications policy: should the nation sell off long-term assets in order to fund current consumption?) An additional $10.7billion would go towards a public safety network, of which about one third would pay off the public safety users to vacate their spectrum for 4G use. Only that third could be counted towards broadband. In other words, a major struggle with broadcasters in the name of broadband internet will result in generating only $8.2 billion towards infrastructure, all of it for 4G wireless.

The second question to address is whether the mobile wireless approach will do the job of creating broadband for rural America. And here, too, I am supportive but skeptical whether this is enough.

Basically, the performance of 4G as a broadband platform is modest and will be soon insufficient. My conclusion is not based on lack of knowledge about the wireless medium. Having been a long time wireless enthusiast as a licensed radio amateur, Advanced Class, I've operated mobile radio transmitters and receivers before mobile wireless became a consumer product. Just among my regular *Financial Times* columns there are half a dozen favorable columns on the topic--celebrating the progress of wireless in the US[298] advocating more

[298] Noam, Eli, "The re-assertion of America in ICT," Financial Times, June 19, 2010, http://www.ft.com/intl/cms/s/0/4a453178-7b33-11df-8935-00144feabdc0.html#axzz1OtCaO3q3

government spectrum for civilian usage[299] opening up underutilized spectrum[300] accelerating the move away from analog broadcasting;[301] and identifying the superiority of mobile-based TV.[302]

Moving more spectrum to mobile and fixed wireless users is a laudable goal and deserving support. But it is hardly a national broadband push. It's foremost a mobile enhancement. Its main contribution would be to improve the coverage for every smartphone user in the country to higher data speeds, to make broadband ubiquitous geographically, and to create competitive alternatives to the existing cable-telco duopoly. These are important accomplishments. But they do not solve the rural broadband problem.

4G wireless would reach realistically speeds of only about 3 Mbps –ignore all of those 'up to' speed projections in the press that are generated by corporate PR machines -- once a lot of people use data-intensive applications and share the spectrum. This is only a fraction of the speed of wireline speeds. In comparison, fiber supports today 150 Mbps, and can easily be upgraded to gigabit speeds as demand emerges. Cable's DOCSIS 3.0 modem service runs at over 50 Mbps and can readily reach 200. Even DSL, using slightly improved telephone networks, can reach in newer versions over 20 Mbps. In other words, fiber and cable are 50-100 times as fast, and DSL is about 7 times as fast, and they have a decent headroom to expand speed.

There are many people who do not conceive of the need for more speed than 4G will provide when it reaches rural America. This is short-sighted. First, there is the simple matter of convenience. If it takes one minute to download a movie over cable or fiber, it would take wireless, at a speed that is slower by a factor of 100, one hour and 40 minutes. That is a lot of time.

Second, if millions of people were to stream movies over wireless, the networks would come to a crawl. Unless one would add huge amounts of spectrum – unavailable-- or a very large number of cell sites – expensive and environmentally unsound. Let's do a simple back-of-the envelope calculation. Suppose we succeed in allocating to 4G new spectrum totaling 300 Megahertz. Each cellsite could use one sixth of these frequencies without interfering with its neighbors. Furthermore, duples (2-way) communications would halve the channel in each direction. This would translate -- using a translation of 2 bits per second per each hertz -- to a 2-

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[299] Noam, Eli, "Curb in-air delays for free," Financial Times, December 17, 2007. http://www.ft.com/cms/s/0/1f124c7e-acd8-11dc-b51b-0000779fd2ac.html#axzz1OtCaO3q3
[300] Noam, Eli, "The fourth way for spectrum," Financial Times, May 29, 2003. http://www.elinoam.com/eli/fourth_spectrum.pdf
[301] Noam, Eli, "The other transition: Analog switch-off," Financial Times, January 16, 2009. http://www.elinoam.com/eli/the_other_transition.pdf
[302] Noam, Eli, "Coming soon: mobile, immersive, interactive entertainment," Financial Times, July 17, 2009. http://www.ft.com/intl/cms/s/0/00ab099c-7301-11de-ad98-00144feabdc0.html

way pipe of 50 Megabits per second. Therefore, any time that more than 10 people try to use the cellsite at the same time, the average speeds (combining uploads and downloads) would drop below 5 Mbps (50 Mbps divided by 10.) And, of course, more than 10 people would use the cell site if it is the only or main connectivity to the internet. The only way to counteract this would be by constructing a large number of additional cell sites, so that the number of pops (people) per site would drop. But even if there would be a cellsite for each single user (less than a pop) the speed, by the above calculation, would be only 50 Mbps. This is not a matter of better engineering, it's physics. Engineering might improve spectrum efficiency and other elements a bit, but the headroom is not huge.

Third, applications will continue to rapidly grow in their needs for speed. Let's do another back-of-the-envelope calculation. An HD quality TV has 1080 horizontal lines and 1920 vertical lines, i.e. 2 million pixels, 3 primary colors are required for each pixel at 8 bits/color, and 60 frames per second is the TV standard. This means that such HD TV requires 3 Gbps of speed, plus some for audio. A household will realistically require a second and third channel for other simultaneous uses such as TV watching, games, or channel surfing by other members of the household, or by multi-taskers. This would mean a transmission speed requirement of about 10 Gbps. (Compression reduces this, of course, maybe by a factor aof 100, and one will reduce the frame rate to 30. This would bring down the required bit rate to 50 Mbps, but at the expense of quality and latency. Latency is important for multi-player games.) But the higher number of 10 Gbps is the benchmark.

And this is not the end for speed requirements. None of the above is extravagant. With TV screens becoming flatter, bigger, and cheaper, the pixel density will have to grow just to maintain sharpness. The next generation of TV resolution–4K—has about 8.5 million pixels. There are 3 colors per pixel, and they will require an increase to 16-bits color. The frame rate will remain at 60 frames per second, and more likely 72 or more. This adds up to 44 Gigabits per second. To create three-dimensionality requires a doubling. 2-way interactivity doubles this again. Superior audio such a 5.1 or 7.1 will also require more bandwidth. Adding all this up, back-of-the-envelope style, results in a transmission requirement of about 200 Gigabits per second. Three such channels per households would bring it to over one half of a Terabit. (And this does not even include a future TV of immersion, which would wrap around the viewer and require ten times as much.). This is about 200,000 as much as the speed of 4G under normal utilization, and even more if 4G is heavily utilized and thus slowed down!

Obviously, all of these numbers will be squeezed by compression and other techniques. But this is the reference point from which engineering must artfully whittle bits away to fit the narrower channel. Even if we compress and reduce bandwidth by a factor of 1000, it would still require 600 Mbps per household, 200 times faster than 4G.

Yes, it will take time for such TV to emerge. From today's perspective it might not seem to meet an imminent consumer demand. But that's what people also said when color supplanted black-and-white, or when 1080 lines of HD doubled the 525 lines of NTSC, or when DVDs replaced VCRs, or when cable TV introduced 12 channels instead of the four or five over-the-air signals. Users get used to higher quality and quantity almost immediately and they never go back.

The point is that we should not underestimate the continued push towards superior video quality. The NBP, too, mentions that transmission speeds of broadband have been rising at the rate of 20% per year. This is a good reminder that we should not fashion national policy on assumptions of a static TV but future-proof it instead. And we should not expect rural areas to sit by holding their little 4G laptop screens while their metropolitan brethren enjoy 2-way, 3D, 4K, 5.1 sound, 6 foot screen television.

There are other dimensions, too. First, cost to users. Because of the relative scarcity of spectrum, mobile 4G broadband service would be more expensive than wireline services, as a way to match demand with supply. Satellite-based broadband internet, even in its forthcoming next generation, is still more expensive. And there will be no savings in hardware. It's hard to imagine that rural people would do their taxes or type their resumes on a smartphone, so they would still require a computer or tablet device for meaningful uses.

Second, cost to taxpayers. From a taxpayer's perspective, a 4G wireless coverage would also be more expensive than DSL for large parts of the country. This is shown by the FCC itself in its map depicted below. As can be seen, for the western and northeastern parts of the country, closing the broadband gap by means of DSL would be cheaper than with 4G.[303]

Third, restrictivness on users. The inherent limitations of wireless communications mean that their use would be more restricted and managed by the network operator to keep data flowing. In other words, the openness of the internet, protected through rules of net neutrality which are also a priority to the Obama Administration, would be harder to sustain in the more limited wireless 4G environment.

Would rural areas accept for long the 4G mobile communications as their broadband platform—at a lower speed, higher price, and with less openness? At first, it would of course be an improvement for those who currently have no broadband access at all, and provide competitive alternatives to others. This would be welcomed with open arms. But soon, the reality of a

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[303] The FCC map probably ignores the potential of fixed 4G in rural areas, which could provide higher speeds at a lower cost than DSL, and are often operated by independent companies, so-called WISPs. They often use license-free bands in low density areas where spectrum is more plentiful, thus not requiring the costly relocations of existing users.

second-grade quality of connectivity will sink in. It will lead to alternative market-based or political solutions to upgrade the service level to match that of metropolitan areas, i.e., to wireline. Thus, 4G wireless is only a temporary substitute.

4G as the platform for broadband connectivity might get a bit faster with technology, but absent a huge extra allocation of spectrum or vast array of cell sites – unlikely, costly, and environmentally controversial-- the wireline technologies will leave wireless in the dust. It's basic physics.

And as metropolitan areas acquire wired connectivity speeds of hundreds or thousands of megabit per second, rural areas will not remain satisfied with wireless 4G speeds that are a hundred times slower, any more than their grandparents stayed with party line phone connections. And why should they? It's basic politics.

Already, most rural households are not dependent on wireless for broadband. A majority of such residents are already passed by cable TV which enables much faster speeds, and still more rural households also have a phone connection. In time, these wireline connections will be upgraded and reach most rural households. This does not require a green-fields construction. Even the FCC's own map shows that upgrade to DSL would be cheaper than 4G wireless for much of the low-density regions in the West and Northeast. This leaves out only those relatively few homes that are not connected to any communications network, yet who have electric power. Their problem can be dealt with by fixed wireless, provided by entrepreneurial WISPs, without such a tiny tail wagging the rest of the country.

We are frequently told that the government should not and will not pick platforms. But the NBP's emphasis on funding and clearing the spectrum for 4G is exactly that. Enhanced mobility is important. But it cannot be described as a platform-neutrality for broadband.

Why then not move the national effort to fiber (with possible tails of coax or fixed wireless), which is future-proof, in contrast to wireless? The problem is that the Federal budget deficit does not permit the funding of a national fiber or rural network upgrade initiative. This leaves the government with the fallback to use an off-budget currency – spectrum allocations— to advance its goals, and it shapes its preference to the wireless platform.

But if fiber and other network upgrades are to be pursued, as they should be, we should jointly and constructively brainstorm about how those investments could be generated, rather than put all public eggs in the 4G basket.

Before we do so, let's get some sense of the funding magnitude required.
Can we afford a wireline network upgrade? The plan's advocates present numbers that are so huge as to serve as deal-breakers, about $320 billion of incremental governmental support. This

number, whose derivation is not explained – or could not be found-- in the NBP report or its technical papers[304], is based on a 100% penetration, which is unrealistic. The last few percent account for much of the cost. Even President Obama spoke of a 98% wireless penetration. Second, any government subsidy would not have to cover the entire investment cost, only part of it. Yet by other estimates, the necessary subsidy to subsidize fiber across the country, is much lower. Dave Burstein, editor of *DSL Prime*, estimates $14 billion, based on extrapolating Verizon FiOS's $650 per home passed to 80% of the country, and subtracting homes already reached by fiber. From this should also be subtracted the numerous households which already are reached by cable modem service, and those households for whom premium DSL provides a high speed option. Even if we multiply the lower figure number by three it would mean that an extension of broadband service by a combination of fiber, cable coax, and DSL is not wildly out of reach, especially when such upgrade is spread out over several years.

This does not replace the wireless approach but adds a strong wireline alternative dimension. The most constructive approach here needed, given budget realities, is to creatively generate off-budget strategies, beyond the auctions of broadband spectrum and not excluding it. Just as broadcast auctions, these strategies are “second best” options constrained by realities, just as the financing through broadcast auctions are. Choices are always imperfect. Options include:

1. Tax incentives, through investment credits or for *incremental*
high-speed network upgrades in *low-low-density areas*, and for certain hardware upgrades by low-income end users. Tax incentives are not ideal, but compared to what? Direct government money infusion isn’t likely. The stimulus funding is gone. And funding through spectrum transfers will not be sufficient.

2. *Regulatory incentives*, such as encouragement for cable, telecoms, and other infrastructure providers to share the fiber in low-density areas and thus reduce their cost. This would have to be subject to openness requirements and consumer protections.

3. *Creation of a Federal off-tax funding mechanism*. This already exists through the universal service fund for rural telecom, which is being transformed into a wider connection mechanism for American broadband. That is one of the most positive initiatives of the NBP. It is, in effect, an internal taxing mechanism for telecom and soon for broadband, paid through a levy on communications bills. However, the amounts raised today for high-cost areas is about $4.5 billion, of which maybe a third would go to broadband upgrades, which is not enough. Expanding this mechanism would be the most realistic source of funding, and it might find the

[304] FCC Omnibus Broadband Initiative. Technical Papers: Chapter 3. http://download.broadband.gov/plan/the-broadband-availability-gap-obi-technical-paper-no-1-chapter-3-calculating-the-investment-gap.pdf Last accessed May 2, 2011

approval even of anti-tax Republicans because it is pro-rural and not formally a tax. But it must also be targeted closely to low-density areas, and not be sprinkled as a benefit to all rural telcos.

4. *Local cost sharing*. There should be a much stronger role and responsibility for states and municipalities to support the infrastructure in their states following their own priorities. They could work with private companies, and use tax-free municipal bonds to support these projects. They could support the building of cell towers on their land and of backhaul from those towers, and share them among providers, which would also make environmental sense. This should be promoted by Federal matching contributions, using the broadband fund mentioned above.

5. *Add spectrum,* beyond the proposed reallocation. Institute a "use it or lose it" spectrum policy, and reclaim unused spectrum and re-allocate it to unlicensed users, with a user fee payable to existing licensees.[305]

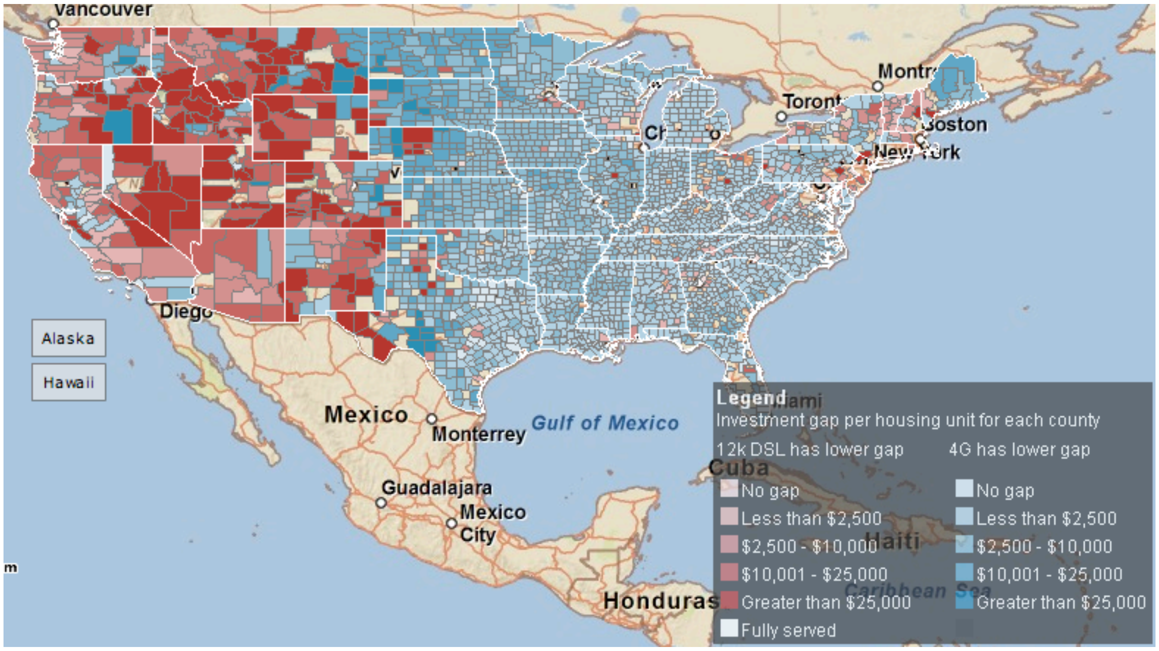
This would include governmental spectrum, which the NBP treats gingerly. And give licensees flexibility in what they can do with the spectrum. (A quasi-economic argument is frequently made is that auctioning off broadcast spectrum will turn such spectrum to its best use, closing the 'value gap'. Well, one would expect such a gap. If one puts one type of usage—mobile communication-- which has an unregulated pricing and subscription model-- against another type of usage – free TV-- that is prohibited from pay models, of course the first platform wins.)

Providing more spectrum for 4G is a laudable goal and should be discussed on its own merits. But such a transfer from one industry to another should not be sold politically as a pro-rural policy when that extra spectrum is mostly important to metro areas. It is not a major broadband initiative if only $5-8 billion are allocated to that purpose, under the best of circumstance. It should not be used as a deficit-reduction policy, when we sell scarce assets to fund current consumption, and where the net contribution to the budget will be probably much lower than hoped for. And it should not be expected to solve rural America's broadband needs when the actual service grade will be significantly inferior, and where wireline alternatives are available.

Thus, wireless as a strategy to spread broadband is a short-term strategy. If we want to address the future we must also address platforms with much greater speeds. Let's start to do so without delay, and without defensiveness. Much work needs to be done. There is no doubt in my mind that within 20 years virtually all American households will use bandwidth well above 200 Mbps. Much of it will be provided on a commercial basis, but some will have to be generated by a variety of public policies. In 20 years there will be fiber connectivity pretty much wherever there is copper today, using the same rights of way, utility poles, and ducts. And

[305] http://www.citi.columbia.edu/elinoam/articles/SPECTRM1.htm

people will then wonder how 20 years earlier we thought that 3 Mpbs would be enough. Just as we wonder today how our parents or grandparents got along on 3 or 4 TV channels.



Economic Impact of Wireless Broadband In Rural America

By Raul L. Katz (*)

ABSTRACT

This study, utilizing federal and state level statistics and relying on econometric analysis, estimates the economic impact that full deployment of rural wireless broadband would have on rural America. This investment will result in the creation and/or retention of 117,000 jobs in the nineteen states that have the lowest broadband availability and penetration in the United States. Jobs will be primarily concentrated in the wholesale trade, health and financial services sectors. Of the total 117,000 jobs, approximately 38,500 will be new jobs created as a result of the economic boost provided by wireless broadband in rural areas. The remaining 78,500 jobs will be saved as a result of the combination of economic growth and increased capabilities resulting from the ability to gain access to broadband services.

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INTRODUCTION:

The broadband supply gap in rural America is significant. Of the 7,035,613 housing units that are either unserved or underserved by broadband highlighted in the National Broadband Plan, a large portion is located in what the census bureau classifies as rural counties. The broadband map estimates that 4,326,299 households that do not have access or can only purchase service with a download speed that is less than 4Mbps are located in rural counties[306].This is no surprise since, as expected, the broadband deployment plans of national carriers do not include in their priorities the construction of either fixed or mobile broadband facilities in these geographies because their lower customer density and/or low socio-economic population do not result in attractive economics of network deployment.

Obviously, supply gap does not equate to broadband penetration in the sense that even under universal coverage conditions it would be expected that a number of these households would not be subscribing to broadband service simply due to issues related to affordability and educational factors[307]. Nevertheless, unless these communities are not given the opportunity to connect to the Internet they will remain permanently marginalized.

It is in this context that the National Broadband Plan identified as a national priority the deployment of broadband technology to address the unserved and underserved communities. In particular, the Plan emphasized that wireless broadband, more specifically the services offered within the 700 MHz frequency band, was one of the primary technologies suited to address these gaps. In addition to the goals outlined in the National Broadband Plan, one of the basic objectives of the Broadband Technology Opportunities Program (BTOP), a stimulus program included in the American Recovery and Reinvestment Act, is to promote deployment of broadband facilities covering what are today unserved or underserved communities.

The objective of this study is to evaluate the employment impact that result from wireless broadband deployment in rural America[308]. First, it reviews evidence from other studies

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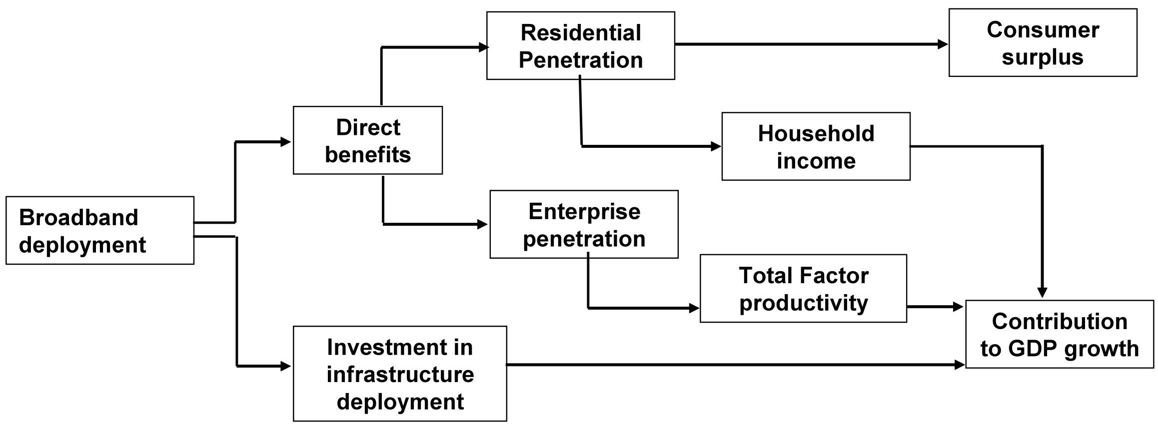
[306] Rural counties denoted by USDA rural-urban continuum codes 4 and up.
[307] See Horrigan (2009).
[308] In a prior study of broadband employment effects in the United States, this author could not reach a precise estimation of the impact of positive externalities (see Katz and Suter, 2009)

regarding the economic impact that broadband has on rural environments. Second, it focuses on Kentucky, a state with a large rural population (which has generated a disaggregated data set of broadband penetration and deployment), and analyzes the economic impact that broadband has had in the past. With this evidence in hand, we project the potential economic impact of deploying broadband in the unserved and underserved areas of Kentucky, and extend the results to 19 states with the lowest broadband penetration in the nation.

RESEARCH EVIDENCE OF THE ECONOMIC IMPACT OF BROADBAND:

The economic impact of broadband comprises four types of effects (see figure 1).

Figure 1. Broadband economic impact



The first effect results from the construction of broadband networks. Like any infrastructure project, the deployment of broadband networks creates jobs and acts over the economy in a way that is encapsulated by multipliers measuring the interrelationship between industrial sectors. The second effect results from calculated gains and "spill-over" externalities, (such as network effects and innovation), which impact both enterprises and consumers. For enterprises, the adoption of broadband within firms leads to a multifactor productivity gain, which in turn contributes to growth of GDP. On the other hand, residential adoption has a multiplier effect that increases real household income. Beyond these direct benefits which contribute to GDP growth, residential users receive a benefit to their consumer surplus, which is defined as the difference between what they would be willing to pay for broadband service and its price. While this last parameter is not captured in the GDP statistics, it can be quite large. Consumers may be willing to pay substantially above the market price for benefits such as enhanced access to information, entertainment and public services.

Broadband research that shows hard evidence of an economic impact falls into three categories:

- Contribution of broadband deployment to employment and output ("countercyclical effect"): Crandall et al. (2003), Katz et al. (2008), Atkinson et al. (2009), Liebenau et al. (2009) Katz et al. (2009), and Katz et al. (2010)

- Impact on GDP growth and employment ("externalities"): Crandall et al (2007), Czernich et al. (2009), Thompson and Garbacz (2009), Koutroumpis (2009), Qiang et al. (2009), Gillett et al. (2006), Shideler et al, (2007)
- Creation of consumer surplus: Crandall and Jackson (2003); Lee and Lee (2006); Greenstein and McDevitt (2009); Greenstein & McDevitt (2010)

In particular, the impact of broadband on rural economies comprises several effects that are specific to the geographic area. On aggregate, the impact of broadband on states with a predominantly rural geography is significant. For example, in a recently published survey of 30,000 households and 70,000 businesses in North Carolina, the Strategic Networks Group (2010) found that:

- 18% of new jobs were created "on direct account of broadband internet" (This included 28% of jobs created at small firms (<20 employees))
- 54% of businesses said they could not operate without broadband
- 45% of North Carolina's broadband households are either running a business from their home (31%) or planning to run (14%) one in the next 12 months
- 65% of households use (42%) or plan to use (21%) broadband to sell things online
- 85% percent of establishments said that broadband was essential to their business

However, while the aggregate impact appears to be significant, it is important to differentiate broadband impact within three distinct regions: metropolitan areas, rural environments that are adjacent to metropolitan areas ("rural peripheries") and remote rural areas. Each of these areas has geographic and economic specificities that condition the economic contribution of broadband. In fact, research suggests that due to the spill-over effects of metro areas on rural peripheries, (e.g., labor arbitrage costs, transportation and warehousing, etc.), the economic impact of broadband on the latter region is significant. On the other hand, the specific features of rural economies (e.g., heavy agricultural sector emphasis with particular production functions), may limit and cause an extended time lag for the impact of broadband in non-metro adjacent areas.

Broadband economic impact in remote rural peripheries:

Rural peripheries, defined as the geographies surrounding metropolitan areas, are subject to a specific set of interrelationship with urban centers. For example, the ease of access to labor pools with some cost differentials facilitates the recruitment of employees resident in the periphery. Similarly, lower real estate costs results in the relocation of certain facilities and functions to adjacent rural areas. In this context, broadband, in a way similar to transportation infrastructure, acts as an enabler of the spatial spill-over, allowing the rural peripheries to benefit from the economic growth of metropolitan centers. Prior research has identified the multiple economic effects that broadband results in:

- Firm relocation with consequent impact on employment and payroll
- Growth in the number of establishments that benefit from lower real estate costs while serving the large metropolitan markets
- Facilitation of telecommuting with consequent reduction in transportation costs and less quantifiable increase of consumer surplus

The research literature has pointed out the direct relationship existing between economic impact of broadband and proximity to urban concentrations. Reasons could range from supply side (e.g. economics of deployment favor early entry of competitive providers) to demand side (e.g. sectoral composition of the economy emphasizing industries with high transaction costs).

In their evaluation of the USDA Broadband Loan Program, Kandilov and Renkow (2010) found that the communities closest to urban centers benefited substantially from loans for broadband deployment[309]. In particular, they determined that the broadband economic impact in metropolitan counties is higher than in those rural counties lying in the periphery of metropolitan areas. Nevertheless, broadband deployment appears to impact employment and, minimally, the number of establishments in rural counties. Why is broadband having some, albeit attenuated, positive effect in rural counties adjacent to metropolitan areas? The analysis the authors perform by industry indicates that the strongest positive contribution of broadband to employment and payroll lies in the transportation and warehousing sector. This would confirm the trend that metro-adjacent rural counties benefit from relocation of firms to the periphery enabled by broadband and related infrastructure.

A similar finding was reached by Burton and Hicks (2005) in their study of the Central Appalachian region, according to which new businesses are unlikely to locate in areas without broadband. The study concludes that, while broadband is not a significant indicator of firm productivity in general, for firms of the same age, productivity increases 14-17 % if located in a broadband area. As such, there is a “tendency for productive firms to locate in places with broadband”. This finding is also supported by a study of the impact of Iowa’s Municipal Telecommunications Network (2003) on the relative success of the previously “bedroom community” Cedar Falls, IA over the neighboring community of Waterloo[310]:

Shideler et al. (2007) also found that broadband deployment had a statistically significant positive impact on overall employment in Kentucky, accounting for between 0.14% and 5.32% of overall employment growth during the observed period. It also found that additional broadband deployment was most effective at stimulating employment growth in locales that already had an

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[309] The authors mention that, according to a program audit, it was found that between 2005 and 2008, broadband loans were extended to 148 communities within 30 miles for cities with populations greater than 200,000.

[310] As a note, neither of the areas can really be considered rural; Cedar Falls had a population of 36,000 and Waterloo had a population of 69,000, making them much more “small city” or suburban.

average broadband saturation instead of areas with sparse deployment or high saturation, suggesting increasing employment returns to deployment in underserved (likely rural) areas. On an industry-by-industry basis, Shideler et al. (2007) found broadband to be the main driver of increasing employment in the "information" sector (25.27% to 87.07% of growth), the "administrative, support, waste management, and remediation service" sector (23.74% to 84.56% of growth) and the "construction" sector (0.62 to 21.76% of growth)[311].
However, other studies cast some doubt on Shideler et al.'s upbeat picture. Shideler et al. noted broadband deployment was the primary driver of employment in only two areas: the information sector, and the "administrative, support, waste management, and remediation" sector. For the information sector, the study pointed to the necessity of broadband to IT companies and the increased possibility of telecommuting as the likely mechanisms by which broadband supported employment growth. In the "administrative, support, waste management, and remediation," they point to telecommuting and promulgation of call centers in rural areas where business inputs, including labor, become affordable when broadband infrastructure is available. However, although the increased possibility to telecommute is common to both sectors and is cited as a major reason for employment growth, Song (2006) found in its study of broadband impact in Iowa no statistically significant economic benefit to telecommuting as a whole besides the consumer surplus of being able to work from home[312]. In other words, telecommuting cannot yet be proved to create jobs or increase GDP.

On the other hand, regarding the argument that upgraded broadband infrastructure may make it cost-effective for IT companies to do more business and increase employment, and for call center operations to be expanded given generally lower expenses in rural areas once broadband is installed, Greenstein and McDevitt (2010) argue that growth in employment in businesses enabled by broadband may just as easily be "cannibalism" of jobs from elsewhere in the state or

[311] This is unsurprising for the information sector, and the authors point to both technology companies requiring broadband to operate and the increased ability to telecommute as reasons broadband improved employment in the sectors. The authors rationalize broadband helped growth in the "administrative, support, waste management, and remediation service" sector due to telecommuting and because that sector includes the call center business, which requires broadband infrastructure to operate and has been expanding in rural Kentucky. The authors believe that growth in construction employment attributed to broadband was mainly a secondary effect from demand for construction brought about by increased growth in other sectors affected by improved broadband access. Broadband deployment improved (though was not the primary driver of) employment in the "real estate, rental and leasing," "arts, entertainment and recreation," and "other services" segments. "Accommodations and food services" were negatively impacted by increasing broadband penetration, the authors argue, because of the reduced need for travel agencies and the substitution of broadband-enabled technology for otherwise low-wage labor. Broadband's effect on other sectors was either neutral, not statistically significant, or could not be generalized due to too small a sample size.
[312] Song (2006) states that after controlling for endogeneity, returns to rural IT adoption are not significant, implying that the gains from telecommuting are more likely to come from people moving to rural areas instead of enabling existing rural residents to telecommute.

in the country instead of the creation of truly “new” rural jobs. This argument was also raised by this author in his analysis of potential impact of the Broadband Technology Opportunity Program (Katz and Suter, 2009). In the case of call centers in particular, it is easy to imagine a net loss scenario where urban, higher-paying jobs are cannibalized by lower-paying rural jobs made possible by government-sponsored deployment of rural broadband. While obviously difficult to quantify either way, the logic of cannibalism cuts against the economic potential of broadband deployment on both the sector and aggregate level, raising some doubts about the optimistic conclusions of Shideler et al.(2007). However, it has also been indicated that job creation in rural areas could take place not as a result of urban decline, but driven by relocation of enterprises from overseas back to the United States[313].

Broadband economic impact in remote rural areas[314]:

The impact of broadband in remote rural areas comprises the combination of multiple countervailing effects, some impacting economic development and others enhancing consumer surplus:

- Relocation of establishments to rural counties in specific industry sectors, combined with employment losses in other sectors (e.g. retail distribution)
- Productivity gains in selected sectors (e.g. travel, lodging and entertainment) which can result in employment losses
- Improvements in access to health, education, social inclusion and entertainment

A study of residential internet behavior in Shippagan, Canada (Selouani et al., 2007)[315], reveals that primary impact of the technology is in the area of social inclusion, with consequent consumer surplus increase. A similar study to Shipaggan albeit relying on input-output matrices[316], was conducted for South Dundas, a Canadian township located around 150 kilometers away from Montreal and 120 kilometers away from Ottawa (Strategic Network Group, 2003). Between June 2001 and April 2003, the following economic effects can be directly attributed to the deployment of a fiber network in the town:

- $25.22 million increase in GDP for Dundas County and $7.87 million increase for the Province of Ontario

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313 A noted case in point is the attraction of call centers back to this country. Virtual call centers rely on rural population linked to a centrally located supervisor. They have become increasingly popular in the US due to the quality of the labor pool and economics that can get close to matching call centers overseas.
314 It is important to observe that a large portion of research on broadband impact in rural isolated areas has been conducted in Canada. This raises the need to emphasize the development of research in this realm within the United States.
315 The community is extremely rural; it is 255 kilometers from the nearest city of more than 100,000 (Moncton), and is 500 kilometers from Quebec City.
316 The data for the input-output model used in the study was collected from a survey of every business in the Dundas area.

- 207 person years of employment for Dundas County and 64 for the rest of Ontario
- $3.5 million increase in provincial tax revenues and $4.5 million increase in federal tax revenues

Additional findings suggest that there is a correlation between the use of broadband technology and job growth. Nineteen out of 38 (50.0%) businesses with broadband access to the Internet experienced job growth. This number includes 24 organizations using the fiber network, 13 of which (54.2%) experienced job growth. While data suggests that there is a link between job growth and broadband access, a causal link could not be established due to the limited nature of this study, though the correlation appears to hold across industry sectors and organization size.

To summarize, the research results indicate a directionally positive contribution that broadband makes to economic growth and job creation in rural areas. The effects, so far, appear to be most significant in the rural peripheries of metropolitan areas, where broadband operates as an enabler of spatial spill-over, resulting in an expansion of labor markets. However, it is important to emphasize that job creation in the rural peripheries might result from labor displacement from either the metropolitan areas or other regions. In addition, the technology facilitates the redeployment of industries to the rural peripheries to gain access to lower real estate costs, and better link to transportation networks. Finally, while still not significant, the effects of telecommuting appear to be playing a role in economic growth of the rural peripheries.

With regards to isolated rural areas, research results are beginning to yield some insights on the economic impact of broadband. As expected, employment, payroll, and firm relocation appear to be less influenced by broadband in rural peripheries. However, some case studies indicate that broadband can facilitate some job creation, and more importantly, counter rural-urban migration trends by enhancing social inclusion through communications and information access[317].

THE ECONOMIC CONTRIBUTION OF BROADBAND IN KENTUCKY

This section analyzes the impact that broadband has had on the economy of Kentucky. It begins by reviewing the diffusion of broadband technology and related IT platforms in the state. Following this, econometric models estimating the past impact of broadband on employment and other economic indicators are presented. Finally, based on the statistical models, the impact of future broadband adoption is estimated.

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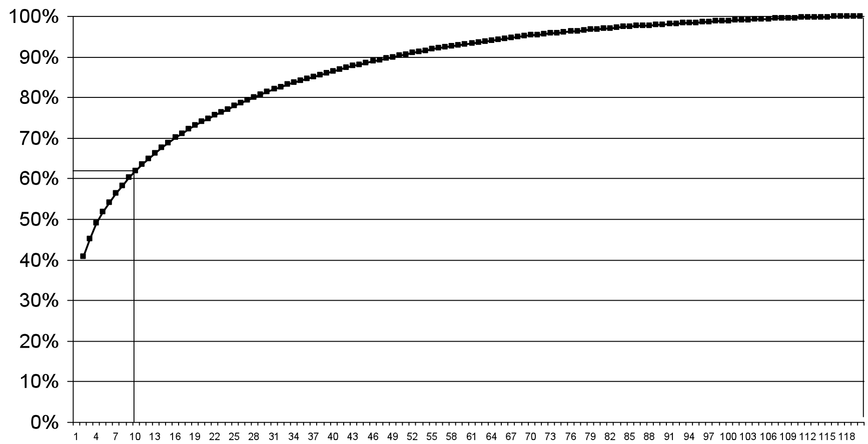
[317] if job transfers occur from the city to rural areas, economists might argue that this is a positive move bringing some equilibrium among labor pools. Finally, sociologists will also argue that job transfers from metro to rural areas help the retention of employment in the latter, which promotes a more viable development path to rural environments threatened by migration and depopulation

The state of Kentucky ranks 44th in the United States in terms of GDP per capita. The growth of Kentucky's GDP since 2000 has averaged 3.7 %, slightly lower than that of the United States, 4.1[318]. In 2009, Kentucky's population was 4,314,113[319], and its income distribution, as measured by the Gini coefficient was 0.464[320], which ranked 36th among US states. From a geographical standpoint, the state's economic activity is very concentrated. Of 120 counties, ten account for 63.45% of the Kentucky's income (see figure 2).

Figure 2. Kentucky: County Distribution of State Income (2009)



County Income is calculated as the number of employees multiplied by average income
Sources: Census Quarterly Workforce Indicators; analysis by the authors

In 2008, there were 92,587 business establishments, employing 1,570,800 residents[321]. In The past eight years, the number of establishments has been fairly stable, while the number of employees had been growing consistently until 2008 when it contracted due to the economic crisis (see figure 3).

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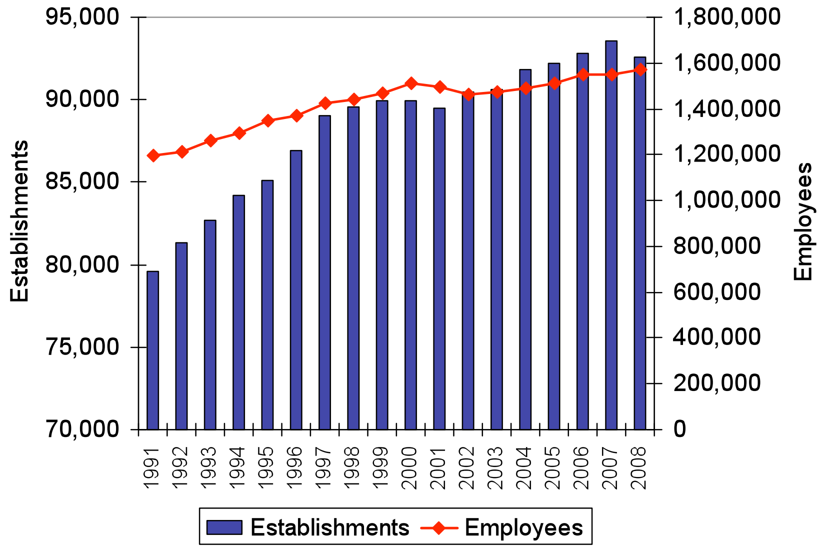
318 Source: Bureau of Economic Analysis, US Department of Commerce.
319 Source: 2010 Census; US Census Bureau, Population Division.
320 The Gini coefficient is a measure of the inequality of a distribution used to measure income inequality; a value of 0 expressing total equality and a value of 1 maximal inequality. Source: 2009 American Community Survey.
321 Source: US Census County Business Patterns

Figure 3. Kentucky: Business Establishments and Employees (1991-2008)

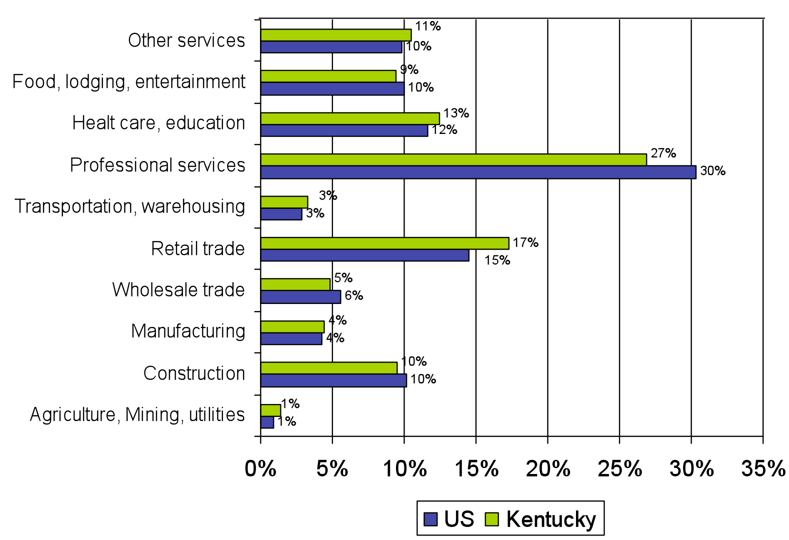


Sources: US Bureau of the Census; County Business Patterns

According to these statistics, the average number of employees per establishment is 20, up from 16 in 1998. In 2008, half of all Kentucky establishments employed fewer than five employees, while 3 % employed more than 100 employees[322].

According to the sector decomposition, professional services comprise the largest share (26.9 %) of business establishments, followed by retail trade (17.3 %) (see figure 4).

Figure 4. Kentucky: Number of establishments by Industry Sector (2008)



Source: US Census Bureau; County Business Patterns

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[322] Source: US Census Bureau Country Business Patterns. (2008)

Relative to national figures, Kentucky has a greater concentration of retail trade establishments (17.3 % to 14.5 %) and a lesser concentration of professional service businesses (26.9 % to 30.3 %). Both sectors are likely beneficiaries of broadband deployment (see Shideler et al., 2007).

Since the advent of the economic crisis, Kentucky has performed weakly. GDP grew by 3.2% from 2007-2008 and by -0.43% from 2008-2009. This is slightly better than the US averages, which were 2.6% and -1.3%, respectively. Unemployment in Kentucky has soared. In 2007 average seasonally adjusted monthly unemployment was steady at 5.5%, but this figure grew to 6.6%, 10.4% and 10.3% in the following years. Unemployment began to grow (year over year) in March of 2008, reached its peak growth rate (77.2 %) in March of 2009, and only started to diminish in May of 2010. However, the unemployment rate has hovered around 10.0% since July 2010[323]. Bankruptcies have grown steadily since 2007. Totals for the 2007, 2008, 2009 and the first three quarters of 2010 are 17,155, 21,468, 25,218 and 19,458, respectively. During the first quarter of 2007 there were 4,294 but in the third quarter of 2010 they had increased by 46 %[324]. In this context, it is critical to consider all policy initiatives likely to have a positive impact on economic growth and job creation.

Broadband deployment in Kentucky:

According to the FCC[325], there are 1,221,000 broadband lines in Kentucky (see table 1).

Table 1. Kentucky: Breakdown of Broadband Lines

Technology	Number of lines
DSL	431,000
FTTx	4,000
Cable modem	483,000
Satellite	---
Mobile broadband (WiMax, 3G, etc.)	303,000
Total	1,221,000

Source: FCC; Operator Reports

[323] Source: Bureau of Labor Statistics. (2010)
[324] Source: American Bankruptcy Institute (2010)
[325] Source: FCC's report "Internet Access Services: Status as of June 30, 2009. (2010)

The growth of broadband lines has increased at an average rate of 57 % over the past ten years, reaching a penetration of 20 % of the population, and 52 % of households[326] (see table 2).

Table 2. Kentucky: Growth in Broadband Lines and Household Penetration (2000-2009)

Year	Total Lines	Residential	Business	Population	Households	Penetration per pop.	Household Penetration
1999	23570						
2000	32,731	12,443 (*)	20,288	4,048,903	1,590,647	0%	1%
2001	67,870	47,060 (*)	20,810	4,069,191	1,604,851	1%	3%
2002	99,265	78,890 (*)	20,375	4,091,330	1,619,056	2%	5%
2003	243,005	211,719 (*)	31,286	4,118,627	1,633,260	5%	13%
2004	360,903	323,532 (*)	37,371	4,147,970	1,647,464	8%	20%
2005	319,160	257,204	61,956	4,182,293	1,653,898	6%	16%
2006	774,736	612,529	162,207	4,219,374	1,651,911	15%	37%
2007	1,161,667	843,641	318,026	4,256,278	1,655,767	20%	51%
2008	1,154,000	829,000	325,000	4,287,931	1,686,277	19%	49%
2009	1,221,000	876,000	345,000	4,314,113	1,690,237	20%	52%

(*) Includes small businesses

Source: FCC; US Census Bureau, American Community Survey

According to Connect Kentucky, fixed line broadband currently covers 95 % of households, which amounts to 57 % growth in broadband availability since 2002. The FCC estimates that the underserved supply gap of broadband (<4 Mbps) in Kentucky amounts to 266,000 households.

In 2006, 56 % of business reported actively using the internet to handle business functions, up from 36 % in 2002. Of these businesses, 85 % access the Internet via broadband. This has risen from 50% in 2002. Of these, DSL comprises 54 % of business access lines, while the rest are cable or fixed wireless access[327]. Broadband adoption is fairly homogeneous across industry sectors. The most recent enterprise survey, (which was conducted in 2006), showed that, with the exception of Health Care, most sectors relied on broadband for Internet access. According to the research reviewed above, these adoption trends should have had an important impact on the economy. This will be assessed in the next section.

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[326] The study recently published by the Economics and Statistics Administration and National Telecommunications and Information Administration (2010) estimates broadband penetration at 54%.

[327] Only 4% relied on satellite technology.

Economic impact of broadband in Kentucky:

In order to ascertain the economic impact that broadband has had in Kentucky two approaches were implemented: 1) a panel regression that measured the impact of broadband availability on county employment and county median income, and 2) a cross-sectional regression that measured the impact of broadband by industry sector. The following section reviews methodology and results[328].

Methodology:

Several studies (Katz et al., 2010; Katz, 2010; Koutroumpis, 2009; Gillett et al., 2005) demonstrated that broadband has a lagged effect on the economy. Thus, the growth of unemployment and income from year *t* to year *t+1* was modeled as a function of average broadband availability, (the percentage of homes passed), between year *t-1* and year *t*. Controls for each of the factors that determine broadband availability (in accordance with the literature) were also included. These are median income, unemployment, ethnicity, the percentage of young population (aged 15 to 25), population density and the growth rate in labor force. There are also other variables that may affect broadband availability such as education and the number of schools in an area, and the percentage of a county that is rural. These other variables were accounted for by including fixed effects in the model (over a period of four years it is expected that they will not change significantly.) Controlling for the effect of the variables that influence broadband availability removes selection bias. Finally, dummy variables were included to control for the economic recession. Hence, the specified model is:

$$Econ_{t+1}/Econ_{t} - 1 = \alpha + \beta_1 (Bb_{t-1} + Bb_{t})/2 + \beta_2 X_t$$

Where Econ is the economic indicator of interest-unemployment or income-, Bb is broadband availability, X is the set of controls, and t is from 2005-2008. Moreover, note that we do not control for median income in our unemployment growth rate regression and vice versa (we do not control for unemployment in our median income growth rate regression.) This is because there should not be a relationship between these variables. Preliminary regressions confirmed that the relationship was insignificant, while not significantly altering any other coefficients.

As discussed above, prior research suggests that the impact of broadband may be area specific, (i.e., it may differ for rural and urban communities.) As reviewed, Kandilov et al. (2010) identified three areas that experienced very different effects[329]. Accordingly, our models were

[328] Data utilized and most regression tables are included in appendix

[329] Though the Kandilov et al. (2010) study is specific to the USDA's Broadband Loan Program, we suspect that the impact of broadband availability may act upon similar lines.

tested for the following sub-samples: metro counties, (rural-urban continuum codes 1-3)[330], rural counties adjacent to metro counties (rural-urban continuum codes 4, 6 and 8), and isolated rural counties (rural-urban continuum codes 5, 7 and 9.)

In order to assess the impact of broadband on specific industry sectors of Kentucky, a similar methodology to that of Shideler et al. (2007) was used. The model establishes a relationship between the current growth rate of employment and its lagged values, controlling for variables that affect the economic activity and also variables that explain differences with other observations, (i.e., other counties). The econometric model used in the estimations is:

$$Ln(Empl_{t+1}/Empl_{t-1}) = \alpha + \beta_1 (Bb_{t-1} + Bb_{t})/2 + \beta_2 X_t$$

This equation states that the employment growth rate is a function of the average broadband penetration, some explanatory variables (X), and an error term, ε, (which has a log-normal distribution). Because there is not county-level time-series available for broadband adoption, the model relies on a cross-sectional analysis rather than a data panel analysis.

Results:

The results of the panel regression models show that broadband availability has a statistically significant positive impact on employment and income. Similarly to Kandilov et al.'s results regarding broadband loans in rural areas, we find that the impact of broadband availability is dependent upon the area of deployment. Though broadband availability impacts rural as well as metropolitan counties, the effect is area-specific (see table 3).

Table 3. Kentucky: Impact of a 1 percent increase in broadband availability on employment and median income

<table>
<tr><th></th><th>Impact on Median Income</th><th>Impact on Employment</th></tr>
<tr><td>Metropolitan Counties</td><td>0.0968*</td><td>0.0303</td></tr>
<tr><td>Rural Counties Adjacent to Metro counties</td><td>0.0704*</td><td rowspan="2">-0.1953*</td></tr>
<tr><td>Rural Counties Isolated from Metro Counties</td><td>0.0800*</td></tr>
</table>

*Significant at 1 % level

Our models show that the impact of broadband on median income is statistically significant for each of the three types of counties. They also suggest that this impact is the highest for metro

[330] See below for further information on rural-urban continuum codes.

counties, followed by isolated rural counties, and lastly rural counties that are adjacent to metro counties. In the regression for metro counties it is estimated that the coefficient of average broadband is about 0.097 percentage points[331] (see Table a.1. in appendix). That is, on average, increasing broadband average availability by one percentage point leads to a 0.097 percent increase in median income over the following year. For example, if average broadband availability between 2006 and 2007 were one percent higher, then one would expect median income to grow an extra 0.097 percentage points between 2007 and 2008[332]. As noted above, the income regressions[333] suggest that the effect of broadband availability is specific to metro, (0.0968), adjacent rural, (0.0704), and isolated rural counties, (0.0800). It is likely that these relationships stem from a combination of productivity and employment effects. We will return to this point after we review the unemployment regressions.

Our results suggest that broadband availability impacts income the most for metro counties, then isolated counties, and finally adjacent counties. As discussed above, there is solid theoretical backing for these estimations. However, it is evident that the interplay of unemployment and productivity effects is complex. For example, the theory offers little in the way of reasons why isolated counties should be impacted more than rural counties that are adjacent to metro areas. However, these complex effects make it unlikely that each type of county experiences the same impact and coefficient. Moreover, it is very likely that metropolitan areas experience the highest income effects.

In the unemployment regressions a slightly different model was used, adding a dummy variable to control for the recession in 2008[334] (See Tables a.4 and a.5). This approach was chosen because the recession affected Kentucky unemployment before it affected the state's median income[335]. While the data shows that the growth rate of unemployment changed markedly from 2006-2005 to 2007-2008 (the average for Kentucky counties changed from -.0394 to .1694), we did not observe the same phenomenon for median income, (which changed from .02755 to .0216). Moreover, two separate dummy variables were used for 2008 and 2009 because

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[331] The number of observations is 140.

[332] Note however, that increasing broadband availability by one percent in 2007 (and not also 2006) would only result in an extra 0.048 percentage points between 2007 and 2008. Because we are dealing in averages, it takes two years to reap the full 0.097 effect of increasing broadband availability by one point.

[333] The number of observation for the adjacent rural regression is 152 and for the isolated rural regression it is 188

[334] Again, the number of observations is 140, 152, and 188 for metro, rural adjacent, and rural isolated respectively.

[335] There are several possible explanations for why this may have happened. For example, it may be that people that have incomes below the median levels had less job security. Then the unemployment rate would grow early, but median income would remain unaffected until later on.

monthly unemployment data showed that the recession did not begin to affect Kentucky counties until half way through 2008[336].

The impact on unemployment is only significant for rural counties[337]. The impact on employment in metropolitan counties is not statistically significant. The interpretation for the broadband coefficient is much the same as above. For example, the regressions show that, on average, increasing broadband average availability by one percentage point in rural counties leads to a -0.1953 percent decrease in unemployment over the following year. For example, if average broadband availability between 2006 and 2007 were one percent higher, then one would expect the unemployment rate to shrink by .19 percent between 2007 and 2008.

Unlike the income regressions, the unemployment regressions show significant broadband effects on job creation solely in rural. This is a reasonable result. One context which provides a strong theoretical backing is the merging of labor markets. In this context, it is to be expected that broadband will have the smallest impact on metro counties. These counties have the lion's share of establishments and employment opportunities so increasing the size of the labor market should have only marginal if any positive effects. However, broadband may extend labor markets to rural areas, e.g., by enabling telecommuting. Of these rural counties, the primary beneficiaries are rural counties that are adjacent to metro areas because the labor force is more technologically skilled (in accordance with the industries that are present). We expect that isolated rural areas will also benefit, but at a lower rate.

Theoretically, we also expect that firms in the services industries can reap greater productivity gains from broadband, (see below for the results on sector-specific broadband effects). Hence it is expected that metro counties, which account for the vast majority of such firms, will experience the largest impact on income. This indicates that the employment opportunities created by broadband in these areas are far more lucrative than the median job. Though the portion of the population that is technologically skilled in these areas may be small, it is likely that the incremental benefits of broadband for this population are quite high. However, it was not possible to identify a statistically significant result for metro counties.

Turning now to assessing the impact of broadband penetration on sector employment, it was found to be statistically significant on the growth in employment in the financial services and insurance, wholesale trade, and health sectors (see table 4).

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[336] We believe that alternate regressions (not shown here) validated our methodological choices. For example, when we included a dummy for the 2008 recession in the income regressions it resulted positive.

[337] The models run for employment impact on rural-adjacent and rural isolated yielded non-significant results.

Table 4. Kentucky: Impact of Broadband Penetration by 1% on Industrial Sector Employment

Industry Sector	All Counties	Rural Counties
Financial Services and Insurance	0.678 (**)	0.517 (***)
Wholesale trade	0.846 (*)	0.836 (*)
Health Services	0.126 (*)	0.122 (**)
Construction	Not significant	Not significant
Retail Trade	Not significant	Not significant
Accommodation	Not significant	Not significant

(*) Significant at 1% level
(**) Significant at 5% level
(***) Significant at 10% level

The industries comprising higher transaction costs and network-based business models appear to benefit more from broadband penetration[338]. Furthermore, as in the models presented above, the impact of broadband in all counties (comprising metro regions) always appears to be higher than in rural counties.

The impact of broadband on the growth of the financial sector was high and significant. According to the model, an increase of 1 percentage point in broadband penetration (from 5% to 6%) would yield an increase of 0.67% in the employment level in the financial sector[339] (see table a.6 in appendix). The impact of broadband on the Finance and Insurance sector declines when metro counties are excluded, although the results are still significant[340] (see table a.7. in appendix). The impact of broadband on the wholesale distribution sector was high and significant. According to the model, an increase of 1% in broadband penetration would yield an increase of 0.84% in employment level in the wholesale distribution sector[341] (see table a.8. in appendix).

The broadband impact remains stable when the metro counties are excluded. The change in impact coefficient is minimal with the prior model (see table a.9. in appendix). In the case of the Health sector, broadband has a smaller impact in comparison to the other two sectors analyzed

338 The conclusions of these results should not be extended to industries that could not been analyzed.
339 The other variable that was significant was the percentage of population between 15 and 25 years old.
340 The other significant variable is the percentage of the population without high school education.
341 Other significant variables include per capita income, population between 15 and 25 years old, employment growth in the preceding period. Unexpected results include the inverse impact of educational attainment in sector employment.

(see table a.10. in appendix). The impact of broadband is slightly lower when the sample is restricted to rural counties, nonetheless the significance remains (see table a.11 in appendix).

The results of the sector impact models are quite illuminating in terms of determining which industries are most benefited by rural broadband. While effects are statistically significant in finance, wholesale trade and health services, the impact is largest in the trade sector, reflecting the value of broadband as an enabler of relocation of warehouses and distribution centers to areas outside the metropolitan counties. Furthermore, while employment is also positively impacted by broadband in finance, its contribution diminishes in rural environments reflecting the difficulty of locating financial back offices in rural areas, primarily due to limits in labor pool availability. On the other hand, the decline in impact of health services for rural areas is not that important revealing both the existence of demand in rural areas and the value of broadband in enabling the redeployment of health facilities.

Estimating the economic impact of filling the broadband supply gap in Kentucky

Based on the historical effect of broadband on Kentucky's county employment and income, the impact of broadband availability on future economic growth and employment is estimated. For this purpose, it is first necessary to assume how broadband availability will evolve over time by county. According to the FCC, as of 2010, broadband was available to 86.2 % of households, ranging from 17% in Elliot County to 100 % in Boone County and others. The benefit of closing this broadband gap by deploying wireless broadband, reaching 100 % availability in all counties throughout the state, is calculated.

Based on the effects analyzed above, the increase in broadband availability to 100 % will drive an augmentation in median income by county and could help reduce the growth rate of unemployment by creating or preserving jobs. According to the models, an increase in broadband availability of 1% would result in a decrease in unemployment of 0.1953% for rural counties. Based on these coefficients and assuming a full deployment in 2011[342], impact on the unemployment rate was estimated for the period 2011-2014. It should be noted that while the model estimates the lagged impact of broadband on unemployment growth, there is obviously no data for the size of the 2011 labor force. Thus, in these estimates the 2010 labor force was used, which is a conservative constraint since it is expected the labor force to be larger in 2011. This resulted in 10,235 jobs created or saved from effects of broadband on business expansion (see Table 5).

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[342] This assumption was made for purposes of the estimation of economic impact.

Table 5. Kentucky: Impact of Broadband Availability on Rural Job Creation
Key Figures

County Type	Total Jobs Saved/Created 2011-14	Number of Counties with Supply Gaps
Rural Adjacent to Metro Counties	4,218	33
Rural, Isolated from Metro Counties	6,017	42
Total Rural	10,235	75

This estimate is fairly consistent with the state of Kentucky Occupational Outlook, which projects that the state economy will generate 63,000 job openings per year going forward. Accordingly, based on this estimate, 13% will be enabled/ facilitated by the fulfillment of full broadband availability.

The number of jobs saved/created is limited by the natural unemployment rate. We cannot expect to realize all these jobs if people are already employed. However, as of now the unemployment rate is at 10%, well above the natural rate of 4-5%. In order to account for this phenomenon, we also do not allow the impact of broadband on unemployment to exceed 5% in any year for any county.

While the models do not allow breaking down the total employment number between those jobs that will be created versus those that will be preserved, we utilized the projections of Kentucky's Occupational Outlook which state that the structure of the change in employment for the 2008-2018 period would be new jobs (32%) and replacement jobs (68%). This structure applied to our model helps us to break down the total job impact of broadband in two categories: new jobs created and jobs saved. According to this, it is estimated that of the 10,235 jobs saved or created in Kentucky, 3,254 will be new jobs resulting from new economic activities triggered by wireless broadband deployment in rural counties. Conversely, 6,981 jobs will be saved as a result of the combined impact of economic growth and enhanced capabilities that will be provided to those workers as a result of wireless broadband.

In addition, according to the models, an increase in broadband availability of 1% also drives an area specific effect on income. In metro counties, rural counties adjacent to metro counties, and isolated metro counties broadband causes income to grow by 0.0968%, 0.0704%, and 0.0800%

respectively. Based on these coefficients and assuming a full deployment in 2011[343], impact on each county median income was estimated for 2011-2013[344] (see table 6).

Table 6. Kentucky: Impact of Broadband Availability on Median Income Key Figures

County Type	Average Increase in Median Income 2011-2013	Number of Counties
All Counties	**$914.56**	**120**
With supply gaps	$1,097.48	100
Metro Counties	**$668.97**	**35**
With supply gaps	$936.57	25
Rural	**$1,015.69**	**38**
With supply gaps	$1151.12	33
Rural Adjacent to Metro Counties	$1033.16	47
With supply gaps	$1189.70	42
Rural, Isolated from Metro Counties	$1001.57	85
With supply gaps	$1120.80	75

An increase in broadband availability to 100 % would drive an average increase in median income of $914.56, which represents 2.0 % increase in the median income of Kentucky, $43,765. Though metro counties experience a greater impact per percentage of broadband supplied, rural counties are expected to benefit more from universal coverage. Because the supply gap is so much larger in rural areas, the average growth in median income is $1,015 for rural counties, whereas it is only $668 in metro counties. However, the difference is much smaller between rural counties and metro counties with supply gaps ($1,151 to $936).

[343] This assumption was made for purposes of the estimation of economic impact.
[344] Note that similarly to labor force above, we use current 2010 median income for our estimations, though the impact will be on 2011 median income.

ESTIMATING THE NATIONAL IMPACT IN RURAL STATES

The estimation of economic impact on a national scale was conducted for those states that exhibited the lowest broadband availability. For purposes of the analysis, states with accessibility lower than 90 % according to the National Broadband Plan were selected[345]. The 19 states considered for the analysis are included in table 7.

Table 7. States identified as significantly lagging broadband accessibility

State	Percent of unserved or underserved	Number of Broadband lines	Households	Household penetration	Population	Population Penetration
W. Virginia	26.0 %	442,000	748,517	59%	1,819,777	24%
Arkansas	25.2 %	516,000	1,124,947	46%	2,889,450	18%
Mississippi	23.0 %	447,000	1,095,026	41%	2,951,996	15%
Alaska	20.7 %	162,000	236,597	68%	698,473	23%
S. Dakota	18.7 %	179,000	316,638	57%	812,383	22%
Montana	17.3 %	212,000	375,287	56%	974,989	22%
N. Dakota	16.5 %	155,000	279,014	56%	646,844	24%
Kentucky	15.7 %	876,000	1,694,197	52%	4,314,113	20%
N. Mexico	15.1 %	389,000	742,104	52%	2,009,671	19%
Missouri	13.6 %	1,269,000	2,339,684	54%	5,987,580	21%
Wyoming	13.5 %	122,000	213,571	57%	544,270	22%
Oklahoma	13.1 %	731,000	1,430,019	51%	3,687,050	20%
Louisiana	12.8 %	888,000	1,688,027	53%	4,492,076	20%
N. Carolina	12.3 %	2,172,000	3,646,095	60%	9,380,884	23%
Alabama	12.0 %	901,000	1,848,051	49%	4,708,708	19%
Kansas	11.6 %	659,000	1,104,976	60%	2,818,747	23%
Virginia	11.2 %	1,904,000	2,971,489	64%	7,882,590	24%
Tennessee	10.1 %	1,248,000	2,447,066	51%	6,296,254	20%
Maine	10.0 %	330,000	544,855	61%	1,318,301	25%
Total	14.1 %	13,602,000	24,846,160	55%	64,234,156	21%

Source: US Census Bureau; National Broadband Plan; FCC; analysis by the authors

[345] While we understand this to be an arbitrary number, his approach has the advantage of considering only those geographies that are facing major infrastructure access shortfalls, as opposed to a demand (penetration) problem.

As it can be seen, these states lag the national average broadband penetration: while broadband has been adopted on average by 55 % of households (or 21 % of the population) of these states, the US national average is 61 % (or 23 % of the population). Furthermore, while broadband is accessible on average by 93.8 % of US households, in the fourteen lowest availability states, the number drops to 85.9 %.

Based on the coefficients utilized in the evaluation of the three states studied in detail above, the impact on employment and median income was estimated for the 19 States (see table 8).

Table 8. Economic impact of full broadband accessibility

State	Jobs created/saved	Increase in median income Per county
W. Virginia	4,793	$ 1,273.61
Arkansas	8,960	$ 1,529.39
Mississippi	13,077	$ 1,222.21
Alaska	1,845	$ 2,427.42
S. Dakota	1,314	$ 1,525.99
Montana	2,280	$ 1,217.33
N. Dakota	660	$ 1,341.89
Kentucky	10,235	$ 911.09
N. Mexico	3,771	$ 1,141.53
Missouri	10,016	$ 1,385.28
Wyoming	996	$ 853.49
Oklahoma	5,855	$ 1,075.93
Louisiana	6,237	$ 954.72
N. Carolina	13,288	$ 1,073.90
Alabama	7,587	$ 905.61
Kansas	3,056	$1,484.67
Virginia	10,163	$1,143.15
Tennessee	11,192	$ 978.80
Maine	1,537	$ 517.98
Total	116,862	$ 1,201.11

Source: Analysis by the authors

In summary, by making broadband accessible to 100% of households in the states with lowest broadband availability, 116,862 jobs could be created and/or saved between 2011 and 2014. Furthermore, the average state median income could increase by $ 1,201.11.

We utilized the projections of each of the States' Occupational Outlook which break down new and replacement jobs to break total employment impact of broadband in two categories: new jobs created as a result of enhanced broadband accessibility in rural areas and jobs saved as a result of the combined effect of economic growth and broadband availability. According to this, it is estimated that of the 116,862 jobs saved or created in the 19 States with lowest broadband accessibility, 38,409 will be new jobs resulting from new economic activities triggered by wireless broadband deployment in rural counties. Conversely, 78,453 jobs will be saved as a result of the combined impact of economic growth and enhanced capabilities that will be provided to those workers as a result of wireless broadband (see table 9)

Table 9. Employment Impact broken down by New Jobs versus Saved Jobs

State	Jobs created/saved	Ratio of Jobs due to growth	New Jobs	Saved Jobs
Alabama	7,587	34.08%	2,585	5,002
Alaska	1,845	27.45%	507	1,338
Arkansas	8,960	41.67%	3,733	5,227
Kansas	3,056	36.45%	1,114	1,942
Kentucky	10,235	31.80%	3,254	6,981
Louisiana	6,237	28.40%	1,771	4,466
Maine	1,537	15.73%	242	1,295
Mississippi	13,077	26.23%	3,430	9,647
Missouri	10,016	19.61%	1,964	8,052
Montana	2,280	32.54%	742	1,538
N. Carolina	13,288	41.69%	5,540	7,748
N. Dakota	660	31.18%	206	454
N. Mexico	3,771	32.52%	1,226	2,545
Oklahoma	5,855	31.00%	1,815	4,040
S. Dakota	1,314	41.02%	539	775
Tennessee	11,192	37.42%	4,188	7,004
Virginia	10,163	40.75%	4,141	6,022
W. Virginia	4,793	18.98%	910	3,883
Wyoming	996	50.40%	502	494
Total	116,862		38,409	78,453

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SUMMARY OF FINDINGS AND POLICY IMPLICATIONS

The current broadband situation in Kentucky indicates that there is still a portion of the population that is either unserved (cannot access broadband service) or underserved (could gain access to broadband service at download speeds under 4 Mbps, which is still the standard for universal service defined in the National Broadband Plan). As expected, a large portion of the supply gap (unserved or underserved households) is concentrated in rural areas (8.8%) compared to the metropolitan counties (5.2%).

The analysis of historical economic impact of broadband in Kentucky (the only state with robust statistical datasets collected between 2004 and 2009) indicates strong effects in terms of job creation and increase of median county income. These effects were used to estimate the economic impact if broadband availability were to be increased to reach 100%[346]. In order to estimate the national impact of providing full broadband availability through wireless technology, the economic impact was estimated for the nineteen states with lowest broadband availability. In this case, the total number of jobs to be created in these states would be 116,862.

In this context, it is critical to generate the policy incentives that will enable the private sector to invest to reach this target. Service deployment in this band is the only choice for unserved and underserved households to gain access to broadband at the service speed stipulated in the National Broadband Plan. In light of these priorities, one could assume that achieving the desired coverage goals would result from a combination of the investment of the private sector, primarily rural carriers, and government stimulus, such as the BTOP program. However, two obstacles have appeared that do not allow this goal to be achieved. First, while rural carriers have acquired 700 MHz spectrum to deliver broadband services, they face the lack of interoperability framework with national service providers operating in other bands. This situation has the potential to hamper the deployment of wireless infrastructure in areas currently unserved by broadband. Second, a portion of the public funds being dedicated to broadband deployment as part of the BTOP program are being assigned to fiber optics infrastructure, which is more suited economically and technically to providing service in urban and suburban environments. Given this situation, it is fair to assume that unless wireless service providers are not supported by the right interoperability framework and supply conditions, the private sector investment of wireless broadband in rural America will be delayed. The negative impact of this state of affairs in terms of job creation and economic growth could be significant.

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[346] Because data for the panel regression was only available for Kentucky, projections for Ohio and West Virginia relied on the econometric estimates from the former state. It is considered that Kentucky's estimates can be reliably applied to the other two states due to the rich set of controls and the inclusion of county fixed effects. The only effects not controlled for are state-fixed effects. Therefore, the projections assume that, given the set of controls, (such as income, population density, etc.), rural counties in Ohio and West Virginia respond to broadband in a way that is similar to rural counties in Kentucky. The same assumption applies for metro counties in the three states.

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APPENDICES

Data utilized:

Impact of broadband availability on employment and average income

In the panel regression which measures impact of broadband on employment and income, the data covers the years 2004 to 2009. Broadband availability (2004-2008) is taken from the Connect Kentucky residential survey. Median household income, the percentage of people aged 15 to 25, the percentage of people aged 65 and more, and the population (2005-2009) are taken from the ESRI Business Analyst Sourcebook for County Demographics. Country size, in square km, is gathered from the 2000 Census, while labor force and unemployment data is taken from the Bureau of Labor Statistics.

Rural counties were identified using the classification system of the Department of Agriculture for 2003 (Rural-Urban Continuum code). The codes that denote non-metropolitan areas (4-9) were used to identify rural counties. They comprise both rural counties adjacent to metro counties and isolated rural counties.

Rural Urban Continuum Codes	
Code	**Description**
Metro counties	
1	Counties in metro areas of 1 million population or more
2	Counties in metro areas of 250,000 to 1 million population
3	Counties in metro areas of fewer than 250,000 population
Non-metro counties	
4	Urban population of 20,000 or more, adjacent to a metro area
5	Urban population of 20,000 or more, not adjacent to a metro area
6	Urban population of 2,500 to 19,999, adjacent to a metro area
7	Urban population of 2,500 to 19,999, not adjacent to a metro area
8	Completely rural or less than 2,500 urban population, adjacent to a metro area
9	Completely rural or less than 2,500 urban population, not adjacent to a metro area

The distribution of Kentucky counties according to the Rural-Urban Continuum codes is as follows:

Code	Kentucky
1	16
2	10
3	9
4	3

5	2
6	22
7	24
8	13
9	21
Total	**120**

Impact of broadband by industry sector

For the cross-sectional analysis of broadband impact on industrial sectors, the U.S. Census Bureau's county business patterns data series for 2004, 2005, 2006 and 2007 was used. It provides both total and sectoral employment at the two-digit North American Industrial Classification System (NAICS) level. This dataset contains private, non-agriculture production employment data measured annually as of the week of March 12.

Using this data, employment growth rates for the periods 2004-05 and 2005-07 were estimated for each of the two-digit NAICS codes. A combination of zero employment levels in rural counties and suppressed data due to Census disclosure rules led to missing values in the data and reduced the number of observations and counties available for analysis. After eliminating industries with this type of problems, only six sectors were available for the study: financial services and insurance, wholesale trade, construction, health, and retail trade and accommodation sectors.

The following explanatory variables were included. Average broadband adoption level of households, calculated with information provided by Connect Kentucky, was used to measure broadband. The percentages of population without a high school degree and with college education were used as measures of the supply of unskilled and skilled labor. These variables were constructed using information from the U.S Census 2000. To measure labor availability several variables were included: growth in employment for 2004-2005, percentage of population between 15-25, percentage of population 65 years old and older for 2005 and the population growth between 2005 and 2007. Age and population growth variables were obtained using the ESRI Business Analyst Sourcebook for County Demographics (2005 and 2007). Finally, the income per capita variable was included as a control variable for the characteristics of the county (2005 ESRI Sourcebook for County Demographics).

Tables

Table a.1. Kentucky: Broadband Impact Median Household Income Growth Rate
- Metropolitan Counties -

Variable	Coefficient	Std. Err.	T Score	P Value	95% Confidence Interval	
Bb	0.096846	0.015821	6.12	0	0.065446	0.128246
mIncome	-6.27E-06	1.38E-06	-4.53	0	-9.01E-06	-3.52E-06
pWhite	-0.0317	0.008379	-3.78	0	-0.04833	-0.01507
pAge15to25	-0.00877	0.004044	-2.17	0.032	-0.0168	-0.00075
pAge65+	0.005607	0.006434	0.87	0.386	-0.00716	0.018377
Density	0.001861	0.000712	2.61	0.01	0.000448	0.003274
Labor Force	-0.09664	0.052553	-1.84	0.069	-0.20095	0.007659
Recession09	-0.03199	0.0041	-7.8	0	-0.04012	-0.02385
constant	3.035282	0.795267	3.82	0	1.456898	4.613666

Table a.2. Kentucky: Broadband Impact on Median Household Income Growth Rate
- Rural Counties Adjacent to Metro Counties-

Variable	Coefficient	Std. Err.	T Score	P Value	95% Confidence Interval	
Bb	0.070443	0.010996	6.41	0	0.048642	0.092244
mIncome	-1.2E-05	1.92E-06	-6.14	0	-1.6E-05	-7.97E-06
pWhite	-0.01316	0.00677	-1.94	0.055	-0.02658	0.000262
pAge15to25	-0.00861	0.003154	-2.73	0.007	-0.01486	-0.00235
pAge65+	-0.00141	0.006511	-0.22	0.829	-0.01431	0.011503
Density	0.006206	0.002069	3	0.003	0.002104	0.010307
Labor Force	-0.05826	0.049348	-1.18	0.24	-0.1561	0.039578
Recession09	-0.01202	0.003525	-3.41	0.001	-0.01901	-0.00503
constant	1.614729	0.654341	2.47	0.015	0.317435	2.912024

Table a.3. Kentucky: Broadband Impact on Median Household Income Growth Rate
- Rural Counties Isolated from Metro Counties-

Variable	Coefficient	Std. Err.	T Score	P Value	95% Confidence Interval	
Bb	0.080035	0.011564	6.92	0	0.057162	0.102908
mIncome	-2.4E-05	2.33E-06	-10.34	0	-2.9E-05	-2E-05
pWhite	-0.03062	0.00792	-3.87	0	-0.04629	-0.01496
pAge15to25	-0.00736	0.003211	-2.29	0.023	-0.01371	-0.00101
pAge65+	0.00227	0.006054	0.37	0.708	-0.0097	0.014244
Density	0.010555	0.003211	3.29	0.001	0.004204	0.016907
Labor Force	-0.05583	0.044519	-1.25	0.212	-0.14388	0.032232
Recession09	-0.00614	0.003664	-1.67	0.096	-0.01338	0.00111
constant	3.382363	0.800888	4.22	0	1.798239	4.966488

Table a.4. Kentucky: Broadband Impact on Unemployment Growth Rate
- Metropolitan Counties -

Variable	Coefficient	Std. Err.	T Score	P Value	95% Confidence Interval	
Bb	0.0303	0.1146	0.26	0.7940	-0.1973	0.2575
Unemployment	-0.1119	0.0233	-4.81	0.0000	-0.1581	-0.0657
pWhite	-0.0215	0.0614	-0.35	0.7270	-0.1434	0.1003
pAge15to25	0.0371	0.0290	1.28	0.2030	-0.0203	0.0946
pAge65+	0.0007	0.0453	0.01	0.9890	-0.0893	0.0906
Density	-0.0006	0.0041	-0.15	0.8770	-0.0087	0.0074
Labor Force	1.2926	0.3954	3.27	0.0010	0.5077	2.0775
Recession09	0.7392	0.0404	18.31	0.0000	0.6590	0.8193
Recession08	0.2370	0.0233	10.19	0.0000	0.1908	0.2832
constant	2.1051	5.6980	0.37	0.7130	-9.2054	13.4157

Table a.5. Kentucky: Broadband Impact on Unemployment Growth Rate
- Rural Counties -

Variable	Coefficient	Std. Err.	T Score	P Value	95% Confidence Interval	
Broadband	-0.1953	0.0808	-2.42	0.0160	-0.3544	-0.0363
Unemployment	-0.0926	0.0118	-7.86	0.0000	-0.1158	-0.0694
pWhite	0.0056	0.0491	0.12	0.9080	-0.0910	0.1023
pAge15to25	-0.0319	0.0222	-1.44	0.1510	-0.0756	0.0118
pAge65+	-0.0814	0.0419	-1.94	0.0530	-0.1640	0.0012
Density	-0.0091	0.0174	-0.52	0.6040	-0.0434	0.0252
Labor Force	-1.3835	0.3201	-4.32	0.0000	-2.0140	-0.7530
Recession09	0.7375	0.0269	27.38	0.0000	0.6845	0.7906
Recession08	0.1526	0.0203	7.52	0.0000	0.1126	0.1926
constant	2.0011	4.7359	0.42	0.6730	-7.3269	11.3291

Table a.6. Kentucky: Broadband Impact on Finance & Insurance Employment Growth (2005-7)
- All Counties -

Variable	Coefficient	Std. Err.	T Score	P Value	95% Confidence Interval	
BB_Penetration 0507	0.6789	0.2939	2.31	0.024	0.0932	1.2646
Income per capita 05	-0.0019	0.0025	-0.74	0.463	-0.0069	0.0032
Age15_25	-3.7938	1.6475	-2.3	0.024	-7.0765	-0.5111
Age65up	-0.5222	1.1855	-0.44	0.661	-2.8844	1.8400
Employment 0405	-0.4734	0.5631	-0.84	0.403	-1.5953	0.6486
High School	-0.4558	1.0031	-0.45	0.651	-2.4546	1.5430
College	0.7516	0.9257	0.81	0.419	-1.0929	2.5960
Population Growth	1.3764	1.0661	1.29	0.201	-0.7479	3.5007
Constant	78.1400	93.8077	0.83	0.408	-108.7760	265.0560

Number of Observations	83
F(8,45)	1.29
Prob>F	0.2605
R^2	0.1317
Root MSE	25.605

Table a.7. Kentucky: Broadband Impact on Finance & Insurance Employment Growth (2005-7) - Rural Counties -

Variable	Coefficient	Std.Err.	T Score	P Value	95% Confidence Interval	
BB_Penetration 0507	0.5172	0.3021	1.71	0.094	-0.0913	1.1256
Income per capita 05	-0.0031	0.0022	-1.41	0.166	-0.0074	0.0013
Age15_25	-2.9850	2.0412	-1.46	0.151	-7.0963	1.1263
Age65up	-3.1947	0.9727	-3.28	0.002	-5.1539	-1.2355
Employment 0405	-0.4356	0.5514	-0.79	0.434	-1.5461	0.6750
High School	-1.4830	0.8319	-1.78	0.081	-3.1585	0.1925
College	-0.2288	1.3765	-0.17	0.869	-3.0012	2.5436
Population Growth	-0.0512	1.2448	-0.04	0.967	-2.5584	2.4560
Constant	179.9645	77.7988	2.31	0.025	23.2697	336.6592

Number of Observations	54
F(8,45)	2.29
Prob>F	0.0377
R^2	0.2153
Root MSE	17.545

Table a.8. Kentucky: Broadband Impact on Wholesale Trade Employment Growth (2005-7) - All Counties -

Variable	Coefficient	Std. Err.	T Score	P value	95% Conf.Interval	
BB_Penetration 0507	0.8460	0.2066	4.090	0.000	0.4328	1.2592
Income per capita 05	0.0395	0.0089	4.420	0.000	0.0216	0.0573
Age15_25	40.2643	7.0237	5.730	0.000	26.2196	54.3090
Age65up	6.1638	4.4070	1.400	0.167	-2.6485	14.9762
Employment 0405	-3.9565	2.3117	-1.710	0.092	-8.5791	0.6661
High School	9.7185	3.1161	3.120	0.003	3.4876	15.9495
College	-18.4412	3.8614	-4.780	0.000	-26.1626	-10.7198
Population Growth	1.4344	4.0535	0.350	0.725	-6.6711	9.5400
Constant	-1492.3740	325.7489	-4.580	0.000	-2143.7500	-840.9990

Number of Observations	70

F(8,61)	8.93
Prob>F	0.0000
R^2	0.5395
Root MSE	70.502

Table a.9. Kentucky: Broadband Impact on Wholesale Trade Employment Growth (2005-7) - Rural Counties -

Variable	Coefficient	Std. Err.	T Score	P value	95% Conf.Interval	
BB_Penetration 0507	0.8363	0.2444	3.42	0.001	0.3421	1.3306
Income per capita 05	0.0332	0.0116	2.87	0.007	0.0098	0.0567
Age15_25	43.0622	8.0558	5.35	0.000	26.7678	59.3567
Age65up	-0.2356	6.6017	-0.04	0.972	-13.5888	13.1176
Employment 0405	-4.8324	2.7257	-1.77	0.084	-10.3457	0.6809
High School	5.7727	4.4967	1.28	0.207	-3.3227	14.8682
College	-22.1127	5.1582	-4.29	0.000	-32.5461	-11.6792
Population Growth	-7.5727	6.0644	-1.25	0.219	-19.8391	4.6937
Constant	-1135.5810	431.2029	-2.63	0.012	-2007.7710	-263.3904

Number of Observations	48
F(8,45)	9.38
Prob>F	0.0000
R^2	0.658
Root MSE	72.852

Table a.10. Kentucky: Broadband Impact on Health Employment Growth (2005-7)
- All Counties -

Variable	Coefficient	Std. Err.	T Score	P Value	95% Conf.Interval	
BB_Penetration 0507	0.1260	0.0427	2.95	0.004	0.0409	0.2110
Income per capita 05	0.0031	0.0017	1.85	0.068	-0.0002	0.0065
Age15_25	4.7554	1.5205	3.13	0.002	1.7305	7.7803
Age65up	0.6802	0.9908	0.69	0.494	-1.2908	2.6513
Employment 0405	-0.7191	0.4313	-1.67	0.099	-1.5771	0.1389
High School	0.2372	0.5824	0.41	0.685	-0.9214	1.3959
College	-1.9197	0.8022	-2.39	0.019	-3.5157	-0.3237
Population Growth	-0.0179	0.8623	-0.02	0.983	-1.7334	1.6976
Constant	-119.7998	61.1014	-1.96	0.053	-241.35	1.7503

Number of Observations	91
F(8,82)	4.10
Prob>F	0.0004
R^2	0.2856
Root MSE	18.144

Table a.11. Kentucky: Broadband Impact on Health Employment Growth (2005-7)
- Rural Counties -

Variable	Coefficient	Std. Err.	T Score	P value	95% Conf.Interval	
BB_Penetration 0507	0.1228	0.0509	2.41	0.02	0.0206	0.2251
Income per capita 05	-0.0006	0.0024	-0.26	0.8	-0.0055	0.0042
Age15_25	6.4617	1.7706	3.65	0.001	2.9085	10.0148
Age65up	-0.0241	1.4481	-0.02	0.987	-2.9299	2.8817
Employment 0405	-0.6067	0.48452	-1.25	0.216	-1.5789	0.3656
High School	-1.7665	0.87062	-2.03	0.048	-3.5136	-0.0195
College	-3.1649	1.1894	-2.66	0.01	-5.5517	-0.7781
Population Growth	-1.8002	1.3589	-1.32	0.191	-4.5272	0.9267
Constant	24.7846	80.752	0.31	0.76	-137.2572	186.8264

Number of Observations	61
F(8,52)	5.91
Prob>F	0.0000
R^2	0.4763
Root MSE	18.736

Organizing to Promote Broadband: Matching Structure to Broadband Policy Goals*

D. Linda Garcia[347] and Tarkan Rosenberg[348]• **

1. Introduction

In April 2010, the US Court of Appeals for the District of Columbia ruled that the Federal Communication Commission (FCC) had overstepped its authority in reprimanding Comcast for having interrupted users of BitTorrent file-sharing services. In a unanimous decision, the Court ruled that the FCC's attempt to use Title I of the Communications Act to execute its policy favoring an Open Internet was blatantly illegal. The consequences of the Court's decision might seriously undermine the FCC's efforts to promote broadband technology. As described by Art Brodsky, the communication director of Public Knowledge: [349]

> It was a pretty strong opinion as these things go. It was crucial because everything the FCC wants to do with its broadband strategy is dependent on questionable legal authority as a result of that court ruling.

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[349] Art Brodsky, "No Houdinis Needed: FCC Should Take Direct Way to Broadband Authority," Public Knowledge, April 26, 2010, 4:41 http://www.publicknowledge.org/node/3025, accessed September 10, 2010.

This is not the first time that opponents of communication-related policies circumvented substantive issues by framing their arguments in jurisdictional terms that focus on the FCC's authority to act. One need only recall, for example, that it took critics only two years after the passage of the 1996 Telecom Act to challenge the FCC's role in implementing it. In this earlier case, the States contested the FCC's Common Carrier docket 96-98 (carrier interconnection order) in court, claiming that the FCC lacked the authority to establish interim proxy prices, or to prescribe specific pricing methodologies that the FCC might use. Agreeing with the States on jurisdictional grounds, the US 8th Circuit Court of Appeals overturned the FCC interconnection order on July 18, 1997. A few months later, the Court of Appeals reiterated its position when the States again brought suit against the FCC—this time claiming the Agency had sought to use section 271 of the Communications Act as a way of evading the Court's earlier ruling on the interconnection order.[350]

What makes the present situation unique and interesting from a policy perspective, therefore, is not just that the Federal Communication Commission and its behavior are at issue, but also—and perhaps more importantly—that the FCC has actually taken a stand in defending its authority. For, over the years, the FCC has often been accused of cow towing to industry's interests, and backing down when politics became too intense. [351]

Before casting judgment, however, we must remember that the challenges entailed in implementing policies, when they go against industry interests, should not be underestimated.[352] One need only recall, for example, the problems that former FCC Chairman Reed Hundt faced when he acted to implement the 1996 Telecom Act. According to Hundt, the Act's failure was due not to the over zealousness of the FCC, but rather to the contentiousness of the American legal culture, and the complexities of the US judicial system. As he described the problem: "When it comes to legislation, between the thought and the deed falls the shadow system. The shadow," he said, "is cast by the millions of lawyers in America".[353] From Hundt's perspective, the FCC needed to have more, not less, authority if it were to successfully

[350] Mark Rockwell, "A Strike Against New Telephone Companies—Court Shoots Down Network Element Plan, Quest" Telepath, November 2, 1997; Mark Rockwell, "Jurisdictional Battle Continues—FCC Tries Again on Pricing Rules," Telepath, October 6, 1997, n. 684; and "States, FCC Insist Relationship is Strong Despite New Lawsuit Challenging FCC's Pricing Authority," Telecommunications Reports, September 22, 1997.
[351] See D. Garcia, D. Linda. (January, 2001). "When Agencies are Captured by Experts: The Irony of Telecom Reform," L'Industria,
[352] See, for instance, Tom Bradley, PC World, "Unveiling the FCC Broadband Plan," PC World Business Center, March 15, 2010, posted at 11:38, accessed September 10, 2010.
[353] As quoted in David Braun, "Communication Czar Hundt Blasts Reform Foot-Dragging, TechWeb News, August 14, 1997.

implement the Telecom Act. Curiously enough, today, Blair Levin, Director of the Omnibus Broadband Initiative, has echoed Chairman Hundt's sentiments. On departing the FCC after the completion of the plan, Levin actually questioned whether, given industry's leverage and the recent decisions of the Court, the Broadband Plan is even implementable.[354]

It is all the more significant, then, that FCC Chairman Genachowski did not simply back down upon hearing the Court's decision, nor in the face of industry protests.[355] Intent on pursing an Open Internet policy, he took a different tack—one might say killing two birds with one stone. Genachowski not only reasserted the FCC's authority to set policy as laid out in the Communications Act; he also acted to bring broadband within the regulatory framework of the FCC by changing broadband's classification from an information service (type 1), which are exempt from regulation, [356] to a communication service (type II), which are subject to regulation.[357] Elaborating on his approach, and asserting his right to pursue it, Chairman Genachowski described his policy as a *third way*—that is to say, an approach that entails only *light* regulation. As he explained, the aim is not to regulate broadband pricing, or to require the owners of broadband infrastructure to share their assets; rather, the intent is to assure that the FCC has the legal authority to carry out its obligations, especially as they relate to broadband.[358]

This set of events, which originated with the 1996 Telecommunication Act (if not before) have generated considerable turbulence in the communications policy arena. Thus, even as some parties in industry call for further constraints on the FCC, others raise questions about whether or not the 1996 Act needs to be revamped to provide the FCC with greater authority.[359] The present situation is not, however, in a state of stalemate. As complexity scientists tell us, chaotic situations, such as the one in which we find ourselves today, can produce major

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354 Matthew Lasar, "The end of analog: Blair Levin on the National Broadband Plan," http://arstechnica.com/telecom/news/2010/03: See also Ed Morrissey, Appeals court rejects FCC authority for Net Neutrality," Hot Air, posted April 6, @ 12:05, accessed September 9, 2010.

355 Kim Hart, "Big phone companies challenge FCC 's right to reclassify broadband," Hillicon Valley, April 29, 2010: posted at 5:03 pm. http://thehill.com/blogs/hillicon-valley/technology/95213-big-phone-companies-challenge-fccs-right-to-reclassify-broad, accessed September 10, 2010.

356 Emma Woollacott, "FCC moves to assert authority over broadband," TG Daily, Friday, June 18, 2010. http://s0.2mdn.net/1833838/tgdaily_hp__toner.html?rfp=http://www.tgdaily.com/business-and-law-features/50263-fcc-moves-to-assert-authority-over-broadband, accessed September 9, 2010.

357 Broadband services were deregulated and reclassified as an "information service" during the Reagan Administration. Cable, which provided equivalent services, was not regulated; so the aim was to provide all ISPs a level playing field. The decision was also in keeping with the deregulatory climate of the day.

358 Margarite Reardon, " FCC details plan to reassert authority over Internet," Signal Strength, MY 6, 2010; posted at 7:59, accessed September 8, 2010.

359 "The FCC's Authority Over Broadband Access: The History and Context of the Debate, VIDEO, Media Berkman, May 27, 2010.

structural changes, in the form of phase transitions.[360] With everything upended, the future is up for grabs, providing a window of opportunity to overcome the legacy of the past, and perhaps even redesign the nation's communication system to better meet the needs of the 21st century. One hopeful sign in this regard is that, shortly after Chairman Genachowski announced that he would exercise his broadband authority, the chairmen of major Congressional committees stated that they were interested in considering these contentious issues in the context of a revised Telecommunications Act.[361] On the other hand, efforts by Congressman Waxman, Chairman of the House Energy and Commerce Committee,[362] to put forward a net neutrality bill was stalled by the Republicans in the house, who subsequently have warned the FCC that it would exceed its authority were it to continue to pursue net neutrality on its own.[363] At the same time, Genachowski has reaffirmed his commitment to proceed.[364] Hence, whether or not changes to the '96 Act might be achieved in today's new political environment, and the form they might take, is subject to considerable question. Nevertheless, in light of the intense bargaining and time required for major policy changes to take place, it is worthwhile to address some possibilities now.

Consider this paper, then, as a thought piece—stimulated by the notion that a new Telecommunications Act might be in the offing at some point in the near future. Focusing on the Broadband Plan, it asks what kinds of organizational capacity will be required to implement it, and where that capacity might best be housed. To address this question, the paper proceeds as follows. First, it examines the FCC Broadband Plan and the kind of goals that it sets out. Based on this discussion, section two argues that broadband should be conceived less as a *deployment problem* (as has traditionally been the case) and more as a *diffusion problem.* The next section examines the criteria for successful diffusion efforts, as laid out by Everett Rogers. Drawing on Rogers's criteria, the following section identifies the types of organizational capacity that will be required to meet these criteria. Section five examines the historical case of the Rural Electrification Administration (REA), which was designed, in effect, around a diffusion model. In concluding, the paper asks whether it is possible to build some of the successful aspects of the REA experience into the organizational arrangements supporting a National Broadband Plan.

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[360] See for one discussion, Mark Buchanan, Small Worlds and The Groundbreaking Theory of Networks, New York, W.W. Norton & Company.

[361] "The FCC's Authority Over Broadband Access: The History and Context of the Debate, Media Berkman, May 27, 2010, video

[362] "Chairman Waxman's Statement on Net Neutrality Proposal. http://www.henrywaxman.house.gov/News/DocumentSingle.aspx?DocumentID=209385

[363] Politico.com, "Sources: FCC Chief to Move on Net Neutrality Proposal. Sources:%20FCC%20chief%20to%20move%20on%20net%20neutrality%20proposal%20-%20Kim%20Hart%20-%20POLITICO.com.webarchive, accessed 11/19/10.

[364] Todd Shields, "Republicans Tell FCC to Set Aside Plans to Set Rules for Web Service," Bloomberg Online. November 19, 2010, posted at 5:37, accessed 11/19/10.

2. The National Broadband Plan

Section 706 of the Telecommunications Act of 1996 calls on the Federal Communication Commission to encourage the deployment of advanced networking capabilities. Acting on the belief that competition would reduce costs and encourage investment, the FCC relied almost entirely on the market to achieve this goal. Hence, it classified Internet services as 'information services,' a classification over which it has little, if any, regulatory authority. [365] While touting the importance of broadband services, subsequent administrations maintained this same approach[366]. Contrary to the expectations associated with this policy, the United States continued to fall behind other countries in providing universal access to broadband services at affordable prices.[367] It now ranks 15th among OECD countries.[368]

Responding to growing concerns lest our lagging infrastructure negatively affect US competitiveness, the Obama Administration took up the broadband torch as part of its stimulus package. In February 17, 2009, a little more than a year after Obama assumed office, Congress passed the American Recovery and Reinvestment Act of 2009, which called on the Federal Communication Commission to develop a National Broadband Plan, or roadmap, for ensuring every American has affordable access to broadband capability[369]. To this end, the Act provided more than $7 billion to promote universal broadband access.

Mirroring the fractionated nature of the US communication policy arena, the American Recovery and Reinvestment Act distributes responsibility for promoting broadband across a number of federal agencies. Thus, NTIA received funding to develop a broadband inventory map; the FCC is called upon to develop a national broadband plan; NTIA, in consultation with the FCC, is charged with establishing a grants program—the Broadband Technology Opportunities program; and RDUP is charged with issuing loans, loan guarantees, and grants to

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365 GAO. Broadband Deployment Plan Should Include Performance Goals and Measures to Guide Federal Investment, May 2009: 1-44.

366 As the GAO has characterized these policies: Officials at OSTP, FCC, and NTIA during the Bush Administration told us that current federal broadband policy was market-based; OSTP told us that the Bush Administration had implemented fiscal, technology, and regulatory policies based on the recognition that a competitive marketplace provides the best environment for achieving the United States' broadband goals, and competitive markets should be deregulated; an official at FCC characterized FCC's broadband policy in recent years as one that reduced barriers to entry, lessened regulation of broadband, and encouraged investment; and NTIA told us that federal broadband policies of the past few years flow from an early speech made by President Bush that emphasized the deployment of broadband, and that NTIA had executed to remove economic disincentives." Ibid. : 14.

367 Ibid.

368 Ibid.

369 CNN News, "Stimulus bill includes $7.2 million for broadband," February 17, 2009, posted at 9:40 am; See also, FCC press release, "FCC Launches Development of National Broadband Plan: Seeks Public Input on Plan to Ensure Every American has Access to Broadband Capability," April 8, 2009.

increase broadband accessibility.[370] Of course, notwithstanding this division of labor, the Act requires cooperation and coordination among the agencies responsible for implementing the Broadband Plan. Thus, for example, the FCC is responsible for evaluating the projects funded by the Act. To do so, it must rely on NTIA's data set to determine what, exactly, is an underserved area[371].

Having been vetted through a number of different venues and arenas throughout the country,[372] the FCC's Broadband Plan was finally released on March 16, 2010. It was an ambitious plan, embodying almost 200 recommendations.[373]

The FCC's National Broadband Plan lays out broad strategies and policy recommendations to Congress on how to provide high speed Internet access to homes and communities across the country. The Plan identifies six major goals that include providing broadband access to 100 million homes by 2020, placing the United States at the international forefront of innovation and speed; providing every American with affordable access and the skills needed to subscribe; providing access to communities to be utilized by non-profit and public institutions; providing a nation-wide public safety network to first responders; and providing Americans the opportunity to trace and manage their energy consumption in real-time[374]

The plan focuses on three major strategy areas that include investment, adoption and utilization for public services such as health care and education. Each section contains numerous recommendations to Congress and other agencies, such as the National Telecommunications and Information Administration (NTIA), which aim to meet the various goals over the next decade. The first section, entitled, "Innovation and Investment," calls on the FCC, the NTIA and Congress to free up wireless spectrum for use by Internet Service Providers. The aim is to encourage wireless/wire line competition at higher speeds. It also calls on the Bureau of Labor

[370] GAO, op. cit.: 17.
[371] GAO, op cit.: 22.
[372] Broadband Initiatives Program, Quarterly Program Status Report, Submitted to the Committee on Appropriations, United States Senate and The Committee on Appropriations, United States House of Representatives, February 17, 2010, Quarterly Program Status Report.
[373] Grant Gross, IDG News, "FCC Officially Releases National Broadband Plan," PC World Business Center, March 16, 2010, 12: 30. http://www.pcworld.com/businesscenter/article/191666/fcc_officially_releases_national_broadband_plan.htm; See also Tony Bradley, PC World, "Unveiling the FCC National Broadband Plan, PC World Business Center, March 15, 2010, posted at 11:38. http://www.pcworld.com/businesscenter/article/191534/unveiling_the_fcc_national_broadband_plan.html?loomia_ow=t0:s0:a38:g2:r3:c0.047330:b31935092:z0, accessed September 7, 2010.

[374] National Broadband Plan Ch.2, pp. 25-27

Statistics to provide detailed data on broadband availability, penetration, and prices.[375] The section also lays out recommendations for lowering infrastructure costs and for government investment in research and development projects.

The Plan also calls for strategies of inclusion and adoption, noting that 100 million American homes are without broadband and that approximately 14 million Americans lack access to broadband infrastructure. While it emphasizes that many lacking access may forego service because they see no need for it in their homes, others either cannot afford service (or computers for that matter) or lack the skills needed to utilize the services effectively. The Plan points to the growing digital exclusion among the most marginalized members of society—ethnic and racial minorities, senior citizens, the disabled and those living on tribal lands. [376] Among a few of the recommendations laid out to combat this phenomenon are projects designed to integrate non-subscribers into the broadband ecosystem, including one providing funding to enable a "universalization target" of 4 Mbps of download and 1 Mbps of upload speeds—the highest in the world.[377] The plan furthermore addresses the need to eliminate cost barriers, as well as lower digital illiteracy by launching a public training service in the form of a National Digital Literacy Program.[378]

The third and last major section of the plan focuses on the "diffusion lag" in the nation's public service sector. The section makes recommendations intended to allow services such as health care, education, first responders, and government to be integrated into an ecosystem and to develop a "digital culture" and more transparency. This section seeks to encourage environmental awareness and civic engagement among citizens by integrating broadband into the smart grid, allowing users to tract their energy consumption in real-time and creating a more transparent government by connecting government and citizens through social media environments. [379] This section also calls for a public safety broadband response network that would allow first responders to send and receive voice, video and other data more efficiently, and the public to access emergency services across a range of communication platforms.[380]

Included in this section also are calls to create incentives for widespread e-care adoption and for ensuring connectivity for health care response locations, such as replacing the Internet Access Fund with a Health Care Broadband Access Fund, and allocating moneys to upgrade the

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[376] Ibid. Part II: 129
[377] Ibid. Ch. 8: 135
[378] Ibid. Ch. 9: 168

[379] Ibid. Ch. 12 and Ch. 14
[380] Ibid. Ch. 16: 313

broadband service for health care providers operating on tribal lands.[381] In the area of education, the plan lays out strategies to promote online learning that include the sharing and licensing of digital educational content, reforming state accreditation organizations to allow for more online credit courses, online teaching across states lines, as well as integrating digital literacy standards into curricula.[382]

The last chapter offers up a statement and guide for the plan's implementation, pointing out that the plan itself is expected to be ever changing. It recommends that the Executive Branch establish a Broadband Strategy Council to coordinate the plan's implementation and allow the FCC to regularly update and publish timetables and status reports on the Plan's development.[383]

While stakeholders have generally applauded the intent of the plan, there are many who question specific aspects of it.[384] For example, some in the high tech community and many others representing minority groups and community-based organizations say the plan doesn't go far enough.[385] Some members of the industry are also ambivalent; they want more details, fearing that—in the end—the Plan might serve to discourage investment. Broadcasters, in particular, are concerned lest the spectrum made available for broadband will come at their expense. At the same time, many public interest groups are disappointed that the plan does not recommend 'open access' rules requiring the big phone and cable TV companies to lease their networks to rivals so they might offer services at their own prices.

A more fundamental criticism of the plan, and the focus of this paper, relates to its underlying rationale. Much in keeping with past telecom policy, the Broadband Plan is in essence a technology deployment strategy, relying on industry to provide the momentum for adoption, by competing and driving prices down so that more people can afford Internet access. The value of this approach is questionable, however, not only because similar efforts in the past appear to have failed to meet their objectives, but also because recent survey data suggest that the present limits to usage do not represent so much of a *real supply problem*, but rather a *significant demand problem.*

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381 Ibid. Ch. 10: 200
382 Ibid. Ch. 11 ; 244
383 Ibid. Ch. 17: 333
384 Matt Richtel and Brian Stelter, "F.C.C. Questioned on Its Far-Reach Plan to Expand Broadband Access, The New York Times, March 16, 2010. broadband/F.C.C.%20Questioned%20on%20Its%20Plan%2; See also Tom Bradley, "FCC Broadband Plan Under Fire From All Sides, Biz Feed, PC World, March 3, 2010. broadband/F.C.C.%20Questioned%20on%20Its%20Plan%2, accessed September 2, 2010.
385 Joelle Tessler, "Critics: Broadband plan doesn't go for enough," MNBC.com, updated 3/22/10, 7:58 pm. broadband/Critics:%20Broadband%20plan%20doesn't%20go%20far%20enough%20-%20Technology%20&%20science%20-%20Tech%20and%20gadgets%20-%20msnbc.com.webarchive, accessed September 2, 2010.

Thus, for example, according to a recent PEW research survey[386] private Internet connectivity has only risen by 3% over the last year, and of those surveyed, 53% do not believe the government should intervene in broadband, or that the issue is of particular importance. The majority of those unconcerned about broadband are non-subscribers, who argue that only those who already have access to high-speed services are concerned about broadband expansion. Another recent survey, conducted by ABI Research, reinforced the PEW study, finding that at the end of 2009, 64% of households had broadband. The study breaks the 35% of non-subscribers into four categories. The largest group (37.8%) claims to have no need for broadband, 26.3 % cite a lack of affordability, and 18.3 % don't own a computer of any kind. The remaining 3.6 % live in rural or wilderness areas lacking infrastructural support for broadband.[387]

Equally doubtful is the Plan's expectation that greater technology deployment will lead to the uptake of innovative approaches to employing technology for public purposes such as healthcare, e-government, education, etc. As Janice Hauge and James Prieger have pointed out, there have been few analytical evaluations of the impact of deployment strategies on technology uptake, much less on the innovative use of technology to achieve public goals. Thus, there is no evidence to guide policy makers about the chain of events—and therefore the points where policy intervention might make have a positive impact—that link the deployment of Internet technologies to innovative outcomes in diverse public settings.[388] Without such research and data, proper evaluation, feedback and restructuring cannot take place—as the Plan, as it is presently laid out, presumes. Under these circumstances, there is a real danger that many of the resources, allocated to the broadband problem, in something of a vacuum, may go to waste. As Ryan Singel has characterized the situation:

> . . .But how do we make sure that the billions aren't spent creating the 21st century equivalent of ditches to nowhere. The question of how to spend that money most effectively is largely unanswerable, since almost no one knows anything about the internet's infrastructure and those that do aren't sharing that information with policymakers or regulators.[389]

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[386] John Horrigan. 2008 Adoption Stalls for Low-income Americans Even as Many Broadband Users Opt for Premium Services that Give Them More Speed. Pew/Internet, Home Broadband Adoption: Washington DC.

[387] Louis E. Frenzel, "Broadband for Everyone," Electronic Design, May 11, 2010, accessed Feb. 10, 2011, http://electronicdesign.com/article/communications/broadband_for_everyone.aspx.

[388] Hauge, Janice A, and Prieger, Names E. (2010) "Demand-Side Programs to Stimulate Adoption of Broadband: What Works? Review of Network Economics: Vol. 9: Iss.3, Article 4. Available at http://www.bepress.com/rnevol9/iss3/4 DOI 10.2202/1446-9022.1234

3. The Need for a Diffusion Perspective

The Broadband Plan laid out by the FCC clearly recognizes that the full benefits of broadband usage in the United States will only be realized when broadband technology is employed not only by individuals seeking their own particular ends, but also—and perhaps more importantly--by groups and social organizations that aim to use technology to address major social and economic needs. As highlighted in the Broadband Plan, these occasions might include, for example—technologies to support education, health care, economic development and emergency services. This is a major shift in emphasis, and it requires new ways of thinking about technology promotion. For example, when the focus of a policy is on individuals, each acting on his or her own, it is possible to pursue a supply-side strategy, which looks to market competition to encourage investment and lower prices, thereby encouraging innovation and greater usage. And, as we have seen, this has been the primary approach followed by the FCC in the past. However, if advanced networking technologies are to operate to pursue social and economic goals, a deployment approach will not suffice. In such cases, policy makers must take account not only of the user, but also of the social context in which the technology is being deployed. In other words, policy makers will need to create the optimal conditions for the productive use of networking technologies and their incorporation into a particular social setting.

To capture the critical variables for success, technology deployment strategies must be linked to diffusion strategies. Whereas technology deployment refers to the physical provision of infrastructure facilities, technology diffusion can be defined as the process by which technologies and technical innovations are extended and adapted over time and space, and integrated into day-to-day social and economic activities. [390] As Hanney et al., have described this process with respect to information technologies:

> . . .diffusion involves more than acquiring computerized equipment and micro-electronics-based products and related know-how. It involves the development of technical change-generating capabilities and the adaptation of a given technology to a wide range of needs[391]

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[389]Ryan Singel, EPICENTER, December 24, 2008; 10:28. file:///Users/garciadl/Desktop/broadband/Broadband%20Stimulus%20Plan:%20How%20About%20Some%20Data%20First%3F%20%7C%20Epicenter%C2%A0%7C%20Wired.com.webarchive, accessed September 6, 2010.

[390] See Lawrence A. Brown. 1981. Innovation Diffusion: A New Perspective. New York, NY: Methuen.; and Everett Rogers, 1995. Diffusion of Innovations, fourth edition. Free Press.

[391] Hanna, Nagy, Guy, Ken and Rik, Arnold, 1995. The Diffusion of Information Technology: Experience of Industrial countries and Lessons for Developing Countries. Washington DC: World Bank, n. 281.

Ideally, this process is a cumulative, iterative one; once deployed, new technologies continue to evolve, and are "reinvented" in response to changing needs and circumstances. Hence, the course that the diffusion process takes is determined not only by technical and economic factors, such as technology advances and declining costs, but also by social and institutional factors, such as the availability of mechanisms for information learning and information exchange.

Notwithstanding the critical relationship between deployment and diffusion, these two strategies are rarely combined. In fact, all too often, supply driven deployment strategies—focusing almost exclusively on the problem of access—work to undermine the very socioeconomic conditions that are required to encourage widespread and sustainable usage.[392] Unfortunately, changing course and designing and implementing technology diffusion strategies is especially challenging in today's deregulated, economic environment, in which the political and economic modus operandi is to let markets take their course.

4. Criteria for Executing a Successful Diffusion Strategy

To fully appreciate what is entailed in carrying out such a strategy, we must look more closely at Everett Rogers' well-known diffusion model. According to Rogers, diffusion is less a market process and more a communication process. To be exact, diffusion is "the process by which innovations are communicated through certain channels over time among the members of the social system."[393] Accordingly, policy strategies designed to promote the goals outlined in the FCC Broadband Plan must be grounded in a solid understanding of how these communication processes work.

According to Rogers, innovations are not adopted all at one stroke. To the contrary, adoption is a process that takes place over time, and in the course of five different stages, each of which is a separate, and unique, social process that involves actors interacting with others. In *phase one*, for example, actors learn from others about an innovation, gaining some initial information about what it is and how it works. In *phase two*, actors are either persuaded by others of the benefits of the innovation or not, depending on the attitudes that they develop in the course of their experiencing the innovation. The *third phase* occurs when actors make a decision as to whether or not to accept or reject the innovation. *Phase four,* in Roger's model, entails the decision by actors to implement an innovation—that is, to put it into practice. In the final phase, *phase five*, actors will either confirm or reverse a previous decision. [394]

[392] Garcia, D. Linda, and Gorenflo, Neil. September 1997. "Best Practices for Rural Internet Deployment: The Implications for Universal Service Policy." Paper presented to the Telecommunications Policy Research Conference. Alexandria, Virginia. See also, 1991. OTA, Rural America At the Crossroads: Networking for the Future. Washington DC: U.S. Government Printing Office.
[393] Everett Rogers. Op cit., p. 10.
[394] Ibid. 161.

In Roger's model, a number of factors play a role in determining whether or not the diffusion of an innovation eventually takes place and the speed at which it occurs. Equally important, the type of impacts that these factors have is related to the phase in the process with which they are associated. Take communication channels, for example. As Roger's points out, whereas mass media channels are effective in the initial 'learning' phase of the process, peer-to-peer ties are more important in the persuasion and decision making phases. Likewise, whereas in the initial phase of awareness, contacts among heteropholous groups[395] are most productive in generating information about an innovation, interactions among homophilous groups are more effective in the later phases of adoption when people develop more emotionally charged attitudes about an innovation.[396]

Rogers also relates the success and speed of the diffusion process to the attributes of innovations and those who advocate and use them. Accordingly, he argues that innovations are more likely to be adopted to the extent that they have a relative advantage; are compatible with existing norms and prior ways of doing things; are not complex; but are trialable and observable.[397] As importantly, he categorizes potential users according to their innovativeness—innovators, early adopters, early majority, late majority, and laggards—with each category being associated with specific social and economic attributes. Thus, according to Rogers, early adopters tend to have higher status, wealth, levels of educational achievement, social mobility and be more cosmopolite than later adopters.[398] Similarly, Rogers describes change agents as being more cosmopolite and educated then the average potential user.

Based on these categories, the criteria for successful diffusion can be summarized as follows:

∗ The innovators in any given social context (or cluster) must have access to sources of information from outside that cluster. This will entail active promotion by outsiders, characterized by Rogers as change agents.[399]

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[395] Homophily is the degree to which pairs of individuals who communicate are similar, whereas heterophily is the degree to which pairs of individuals who interact are different in certain attributes.
[396] Rogers, op. cit.: 169.
[397] Rogers, op. cit.: 207.
[398] Rogers, op. cit.,: 269.
[399] As Rogers describes, Our intimate friends are usually friends of each other's forming a close-knit clique. . . Such an ingrown system is an extremely poor net in which to catch new information from one's environment. Much more useful for gaining such information are the individuals more distant (weaker) acquaintances; they are more likely to possess information that the individual does not already possess. Rogers, op. cit.: 34.

∗ Change agents must identify appropriate opinion leaders who are influential within the target social setting, and with whom change agents are on a relative equal social footing, allowing for mutual engagement and providing a basis for trust and support.

∗ Change agents, and opinion leaders must work together to acquaint less enthusiastic users with the new technology, and to provide assistance to them in using it. The use of the technology should be related to a group's specific goals, so that its compatibility with these goals, and its comparative advantage in achieving them, can be clearly demonstrated. As well, learning about and applying the technology to achieve common goals should be carried out with group participation, which will not only reinforce commitment to the technology but also provide for a platform for mutual support. Shared usage of a technology to achieve a common purpose may also enhance the social capital required to successfully carry out that purpose.

∗ Provision must be made to provide support over time to allow not only for sustainability but also for continued innovation as the technology evolves in context. To this end, active linkages need to be maintained between national policy makers and those operating locally.

5. Meeting the Criteria—The Organizational Capacity Required

Meeting the criteria for promoting technology deployment is far less demanding than meeting the criteria for encouraging technology diffusion—one reason, perhaps, that deployment strategies have typically been preferred over diffusion strategies. Of particular note in this regard is the difference in the organizational capacity required.

With deployment strategies, for example, much of the effort is left to the *invisible hand*. Thus, the Government can invest in infrastructure for the Internet, and then leave it, first to the scientific community, and later to industry, to carry on from there. Similarly, the Government can promote individual usage by enforcing competition law to ensure low prices, and by providing incentives for investment in the form of tax credits, etc. In like fashion, the Government can provide funding to government labs for technology development, without becoming involved in the innovation process itself.

Not so in the case of diffusion strategies! As described above, diffusion is not a straightforward linear process. To the contrary, it is highly complex, taking place over time and in stages, each of which is dependent on all the others. Each of these stages will require its own policy strategy, distinct resources, and engagement with different players. On top of this, each strategy must be flexible enough to incorporate feedback and allow for adjustments along the way. As importantly, unlike deployment strategies, which tend to be top down, diffusion strategies require on-going interaction between government change agents and target populations so that "learning-by-doing" can take place- in both directions and innovative practices can emerge as a result.

Compounding the situation, there is no "one size fits all" diffusion strategy, as is often the case with technology deployment. One need only consider that the government can employ tax credits, for instance, to encourage investment in technology related industries, regardless of the industry in question. Similarly, the government can fund research and development, with wide-ranging spillover effects, as the histories of the computer industry and the Internet attest. In contrast, meeting the societal goals that are outlined in the FCC's Broadband Plan will require diffusion strategies that are targeted not only to specific sectors of activities, such as health care, education, etc., but also to specific places and institutional settings. Designing such strategies will, therefore, require expertise that extends well beyond the traditional law and economics that is to be found in most Federal agencies today. In addition to the need for knowledge of specific subject areas, expertise in the fields of sociology, anthropology, political science, and communication will be required.

Equally challenging, efforts to enhance organizational capacity may very well bring with them greatly increased costs. Even assuming that adequate funding is available in today's depressed economy, budgetary concerns and the need for accountability might require that government take on the additional burden of monitoring progress, and developing and implementing tools to assess outcomes. Political costs may also be greater, not only because—with greater uncertainty—risks are higher, but also because putting together the alliances and resources necessary to carry out a diffusion strategy will give rise to winners and losers, and hence potentially require large amounts of political capital.

The Case of the Rural Telephone Cooperatives & the REA

To get an idea of how such organizational capacity might be brought together, and coordinated, to promote broadband infrastructure in the United States, it is useful to look at the case of the Rural Electrification Administration (REA). In its heyday, the REA—a Federal agency housed in the Department of Agriculture---pursued a combined deployment/diffusion strategy in an effort to deliver both electricity and telephony to un-served rural areas. To this end, the Agency brought together change agents, opinion leaders and local communities in an on-going configuration, which generated increasing returns as well as the social capital so critical for rural development. Employing local capacity together with Federal support, the REA achieved it goals at minimal cost and in a sustainable manner that fostered rural development goals. Given today's challenges in promoting broadband, it is time to revisit the history of the REA to see what lessons it affords.

How did the REA achieve such success? In 1894, when the original Bell Telephone Company patents expired, US rural communities entered the telephone business. Shunned by urban-based telephone companies, rural residents took it upon themselves to provide their own phone service, relying almost exclusively on local capital and labor. In many local villages, doctors and other local professionals took the initiative, whereas in more remote areas it was farmers who set up the first telephone lines.

Rural phone companies organized themselves in a wide variety of ways, depending on their local resources and situations. Some purely private companies, which functioned as intercom systems, consisted of a single line, which was owned and shared by a small group of people. Others were organized on a profit-seeking basis, taking the form of privately owned and commercial stock companies. Mutual stock companies, in contrast, were owned entirely by users. Organized on an informal basis, the members of these organizations paid a prorated share of the capital expenditures, maintenance, and improvement fees. Farmer lines were typically set up as purely private or mutually owned systems.[400] Thus, for example, to join the Liberty Telephone Company in 1910, one had to pay an up-front fee of $25; provide a telephone, a pole, and some labor; as well as pay a flat annual fee of $7 for service.[401]

Rural phone companies were able to make do with such limited resources because they shared what they had and kept their expenses to a minimum. Local farmers, for example, often built networks using their own materials and tools. When necessary, they purchased equipment from independent manufacturers or through mail order catalogues distributed by such firms as Sears and Roebuck and Montgomery Ward. Having built their own networks, these farmers had little trouble maintaining them. Problems did arise, however, when they resorted to very low-quality equipment and poles, which sometimes included barbed wire and fence posts.[402] Overall, however, the model was a great success. By 1920, 39 percent of all farmers had obtained rudimentary service, and in some Midwestern states the number of telephones per person exceeded that in the East.

Despite their initial successes and the important service benefits that they provided, rural telephone companies' fates were inextricably linked to those of the communities they served. With industrialization and the onset of the Great Depression, these companies were no longer able to sustain themselves. Many failed. Because urban-based telephone companies were unwilling to serve these thin, unprofitable markets, service in rural communities continued to

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[400] Dale Hatfield. 1980. Speeding Telephone Services to Rural Areas: Lessons from the Experience in the United Stats. Washington DC. Annenberg Washington Program in Communication Studies, Northwestern University.
[401] C. W. Meyer. November 16, 1912. "How We Built a Home-Owned Farmer's Telephone Line."
[402] Roy A. Atwood. 1984. The Telephone and Its Cultural meaning in Southern Iowa. Iowa City, University of Iowa.

deteriorate. Thus, by 1940, only 25 percent of all farm residencies in the United States had working telephones.[403]

This trend was only reversed when the Federal Government decided to adopt a less market oriented, and more community-based, approach to telephone deployment in rural areas. To promote rural telephony, the Government turned to the Rural Electrification Administration (REA), which had already proven successful in bringing electricity to rural areas. The model advocated by the REA—the cooperative—was designed to address the problem of market failures in rural economies.

As in the case of the telephone, rural residents had greatly lagged behind urban residents in accessing electricity. By 1935, less than 12 percent of all America's farms were served. Private utilities were unwilling to provide service because demand seemed low and the technical problems high. At first, the Federal Government sought to assist and encourage private industry rather than displace it. When industry failed to respond, President Roosevelt created the REA, which bypassed municipal and private industry with its own grass roots, cooperative networks[404] Even though the REA's goals were ambitious—universal high-quality service, rapid deployment, and low rates—the agency was successful in achieving them. Few rural cooperatives defaulted. By 1940, 3 percent of all farmers had electricity; by 1950, 78 percent were receiving service; and by 1959, 96 percent (United States Department of Agriculture, 1989).

Rural electric cooperatives also played an important role in economic development. To this end, they worked not only with REA, which—though its loan program—served to promote deployment, but also with the local extension services, located at near-by land grant collages, who helped to promote economic development and, with it, technology diffusion. Thus, the cooperatives aggressively recruited and served industrial, commercial, and suburban customers, which had the effect of increasing the number of consumers each year, from 5 million in 1960 to 12 million in 1987. In so doing, they greatly facilitated the movement of industrial, commercial and non-farm residences to rural areas.[405]

Looking for a new mission in the late 1940s, REA welcomed the task of helping to deploy telephones to rural areas. With its authority expanded by Congress, the REA helped to achieve high quality, state-of-the art telephone service in rural communities. To serve widely scattered residences, it pioneered technology to reduce the size of wire, its cost of installation, and its vulnerability to lightning and icing. REA borrowers also replaced party lines with one-party

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[403] United States Census, 1949: 1.

[404] John D. Garwood and W. C. Tuthill. 1963. The Rural Electrification Administration: An Evaluation. Washington D.C.: The American Enterprise Institute.

[405] United States Department of Agriculture. Rural Electrification Administration. 1989. A Brief History of Rural Electric and Telephone Programs. Washington DC: USDA, REA.

service. Rates were standardized and comprehensive "area" coverage was provided. Attesting to the program's success, 94 percent of all farms were served by telephones in 1990.[406]

The contribution of the Rural Electrification Administration to rural America was by no means limited to technology deployment, however. By educating and working jointly with rural telephone companies, REA fostered technology transfer without which technical systems could not be upgrade and/or maintained. In addition, by channeling its support to local providers, who relied as much as possible on local resources, the REA helped to reinforce rural economies.

This policy, in turn, had positive cumulative effects. Because the cooperatives and independent telephone companies were socially embedded in local communities, their managers and owners were able to quicken the flow of market information and pass on their technical skills and entrepreneurial expertise. Moreover, in cases where telephone providers were organized as cooperatives—which operated according to democratic rules of the game—the process of managing and administering the provision of telephone services helped to build the social capital that can greatly facilitate economic development in a rural environment.

REA fulfilled many of the goals that were originally assigned to it; but another, and everlasting, value has been REA's successful technology diffusion model for overcoming market failures associated with technology deployment. In fact, in one manner or another, it is a model that policy makers might reconsider today, when developing strategies to promote broadband.

Putting The Horse Before the Cart

Recent surveys have made clear that the demand for broadband is running out of steam, as all but those who Everett Rogers would describe as *late adopters* and *laggards* have by now adopted broadband technology. Drawing on Roger's diffusion model, it would appear that pushing adoption up the diffusion curve at this point requires an entirely new policy strategy that is tailored to this type of user and this stage of the process. In particular, hesitant adopters must be convinced that the technology in question is not only "cool" but also—and much more importantly—meaningful in their lives. Convincing these skeptical users, moreover, will not be easy. Learning about the technology through marketing information and the mass media is not enough; these adopters must be convinced of the benefit of these technologies based on face-to-face interactions with, and support from, their trusted peers.

The REA experience suggests one way of tackling this process; start with a problem such as health care, and emergency preparedness (of which there are many) and build on, and support, local activists, who are also trusted opinion leaders in their communities, to generate broadband-based strategies to deal with these problems. Local activists have a first-hand knowledge of the situation on the ground, so they—far more than national service providers—are likely to structure technological solutions that are tailored to a specific context and hence make sense to hesitant adopters. As importantly, local opinion leaders are likely to have the social capital and network resources required to generate the trust needed to bring reluctant

[406] Ibid.

users on board. A local approach, such as this, also has the advantage of minimizing the organizational capacity required at the Federal level, a benefit that is particularly relevant in today's political environment. As importantly—as the REA case clearly illustrates—it is only by utilizing local capacity that such capacity can grow, generating increasing returns as well as a more general understanding of the way that technology can contribute to local and national goals.

Today's national broadband strategy, as laid out in the Broadband Plan, is a far cry from such an approach. Targeted, for the most part, to the deployment side of the equation, it looks primarily to the availability of technology, and the ability of users to employ it, to drive demand. Not surprisingly, therefore, it focuses on cost-based strategies to promote demand, while placing the responsibility for promoting broadband to agencies that have the prime responsibility for determining telecommunications policies such as the FCC and the NTIA, notwithstanding the fact that these agencies—given the resources available to them--may be ill equipped to grasp the full range of social and economic implications of the technologies over which they oversee.

To move forward with a diffusion-oriented strategy will require not only thinking "outside of the box," but also implementing policies within a new set of organizational arrangements. Recall that organizations are not neutral.[407] Depending on their specific purposes and the circumstances in which they operate, organizations vary according to their resources, organizational structures, normative criteria, operational procedures, and how and to whom they distribute benefits[408] As importantly, organizations are path dependent. Once established, they become locked into their ways, taking on characteristics, or even personalities, of their own.[409] As described by Di Maggio and Powell:

> The constant and repetitive quality of much organized life is explicable, not simply by reference to individuals, as maximizing actors, but rather by a view that locates the persistence of practices in both their taken-for-granted quality and their reproduction of structures that are to some extent self-sustaining[410]

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[407] Harold Seidman, Politics, Position and Power: The Dynamics of Federal Administration, New York, NY: Oxford University Press.

[408]Richard Scott, Institutions and Organizations, 2nd edition. Thousand Oaks, CA: Sage. See also Jeffrey Pfeffer and Gerald Salancik, The External Control of Organizations: A Resource Perspective, Stanford, CA: Stanford University Press.

[409] Douglass North, Institutions, Institutional Change, and Economic Performance. New York, NY: Cambridge University Press. See also Karl Weick. Sensemaking in Organizations, Thousand Oaks, CA: Sage.

[410] Paul DiMaggio and Walter W. Powell. 1991. "The Iron Cage Revisited: Institutional Isomorphism and Collective Rationality in Organizational Fields," in Walter W. Powell. and Paul DiMaggio, The New Institutionalism in Organizational Analysis. Chicago, IL: Chicago University Press.

How To Proceed?

To match organizational structure to broadband policy goals will require the establishment of an organizational capacity specifically designed to pursue an effective diffusion strategy, as laid out above. To be tenable in today's political climate, such a strategy must also—and to the greatest extent possible—require the lowest possible monetary incentives and employ existing organizational capacity. Moreover, given our general lack of understanding about broadband and its diffusion, any set of arrangements should promote learning-by-doing on the part of users and policy makers alike. Although analyzing a variety of organizational options is well beyond the scope this paper, we identify one approach that has strong potential. However, one must keep in mind that this idea is speculative insofar as it is based on the assumption that Congress, in designing a revised Communications Act, specifically grants the authority to implement such a broadband policy.

The proposed idea calls for the creation of an organization capability, inside the Department of Commerce, but apart from the National Telecommunication and Information Administration, allowing it to operate much like a *skunk work*—that is to say, an experimental station where learning-by-doing can take place in an on-going fashion and with representation by parties involved. Although NTIA has responsibility for administering broadband grants under the American Recovery and Reinvestment Act of 2009, its approach is typically linear and top-down, as well as deployment oriented. To shift gears, and take on the responsibilities required to carry out an interactive diffusion strategy would require greatly reorganizing NTIA and enhancing its capacity and breadth of knowledge and experience at considerable expense.

Housed within the Department of Commerce, and separate from NTIA, a Broadband Experimental Station would have the benefit of executive branch support. However, it would not have a legacy favoring deployment grants. Moreover, in contrast to NTIA, it could be organized in a non- bureaucratic way, employing—much like the Rural Electrification Administration—the full range of participants who are engaged in broadband activities—from the local to the national. In keeping with a diffusion strategy, change agents (who might be broadband providers, government workers, NGOs, professionals, academics, etc.) would be brought together with local opinion leaders who are engaged in some type of public services (e.g. health care, emergency services). Interacting together, they might share experiences, gather data and feedback, and work out innovative solutions to recognized problems. It is these solutions that might be tested, adapted and expanded upon in a Broadband Experimental Station.

There are many benefits to such an approach. For example, a Broadband Experimental Station would minimize the need for additional organizational capacity and encourage feedback, learning, and continued innovation. In keeping with the effort's experimental and learning goals, as well as today's significant financial constraints, program participants might be selected through a competitive process based on their project proposals. Projects would be approved based not only on applicants' abilities to put together a committed team of stakeholders and strategies that incorporate all stages of the diffusion process, but also—and as importantly—on the willingness of team members to become part of an on-going participatory learning process. Participants would, thus, not be engaged as members of a permanent staff, but rather on a flexible and temporary basis, corresponding to the nature and time frames of their projects. Rotating participants would both generate new learning while engaging in a project, as well as help to diffuse these practices once their projects come to completion. Alumni of the Broadband Experimental Station might serve as evaluators of future projects, as well as advisors to subsequent participants. Over time, participants in these processes would be linked together in a virtual community of practice.

The approach laid out here is in keeping with the Broadband Plan's notion that the plan is not fixed, but rather evolving in accordance with how successfully it is being implemented. To assure that needed readjustments take place, the Broadband Plan calls for the establishment of a Broadband Strategy Council within the executive branch, which would review broadband strategies and deployment over time. While it is important to have external oversight and a mechanism for readjustment, the Plan does not go far enough. Merely mapping deployment, as is called for in the Plan, fails to provide useful data about impacts and the mechanisms by which they come about. A preferred method for evaluating broadband strategy might be to charge the National Science Foundation, which has a broad base of technical and social science expertise, with the task of soliciting research on this subject. The results from such research could then be directed to the Strategy Council.

One final note about costs and benefits is in order here. Diffusion strategies are far more complex and non-linear than deployment strategies. Requiring the coordination and collective action of multiple stakeholders, participatory strategies can be very uncertain. Nonetheless, collective action can yield very high rewards by generating social capital and stimulating increasing returns. Thus, to the extent that government programs, such as the one outlined above, can provide adequate third party incentives to promote participation and engagement in broadband diffusion, the benefits will likely far exceed the costs.

Advancing Community Broadband: Social Enterprise Solutions to the Problem of the Broadband Digital Divide

Bruce Lincoln[411]

Columbia Engineering

Introduction

Where do we really stand at this moment in time as it relates to the achievement of ubiquitous broadband dissemination in the United States?

The National Broadband Plan provides us with an ambitious framework for an American resurgence in broadband innovation. $7.2 billion in Broadband Stimulus funding has been committed and those projects are in their early stages of development. However, what about those underserved and unserved areas that did not receive any broadband stimulus funding. How do we go about solving the broadband digital divide in those areas?

At the Center for Technology, Innovation and Community Engagement (CTICE) at the Fu Foundation School of Engineering and Applied Science, Columbia University we have developed a social enterprise solution to the problem of the broadband digital divide called **Advancing Community Broadband.**

Advancing Community Broadband

Advancing Community Broadband is a joint collaboration between The Center for Technology, Innovation and Community Engagement (CTICE) at the Fu Foundation School of Engineering and Applied Science, Columbia University; Per Scholas; the Center for Social Inclusion and Data Conversion Laboratory, Inc.

Advancing Community Broadband is a broadband technology strategy dedicated to solving the problems of the broadband digital divide in underserved and unserved communities that did not receive funding from either the BTOP or the BIP programs. For the purposes of submission to the BTOP program, we developed two proposals. Silicon Harlem is designed to address the

[411] Bruce Lincoln is an Entrepreneur-in-Residence at Columbia Engineering and an affiliated scholar at the Columbia Institute for Tele-Information

problems in Upper Manhattan and the South Bronx. Digital Mississippi is designed to address the problems that confront the Mississippi Delta.

Advancing Community Broadband focuses in on two geographically distinct communities: Upper Manhattan and the South Bronx representing our urban catchment area and the Mississippi Delta which represents our rural catchment area. Though these areas are geographically distinct and thus require different technological solutions, they share similarities when looked at from the perspective of cultural and socioeconomic demographics.

Needs Data: Upper Manhattan and the South Bronx

The Upper Manhattan Empowerment Zone encompasses the neighborhoods of Central Harlem, East Harlem, Washington Heights, and Inwood. The 2000 census indicates that the approximately 336,576 people who reside in Upper Manhattan are predominately African-American (48.1%) and Hispanic (37.4%). The median household income in Upper Manhattan is $24,569, compared with the City's overall average of $34,434, and 34.3% of Upper Manhattan residents have incomes below the poverty line. The Furman Center reports that in 2008, before the current economic collapse, average unemployment in Upper Manhattan was 10.87%, compared with 7.1% in New York City as a whole.

Although educational performance is increasing throughout New York City public schools, in the Districts that make up Upper Manhattan, the percentage of students performing at grade level in reading and math consistently lags behind other parts of the City. Furthermore, more than 35% of Upper Manhattan adults (25 years old and over) do not have high school diplomas, compared with 27.7% of all New Yorkers.

The South Bronx is within the poorest Congressional District in the nation, and encompasses the poorest neighborhood in the New York metropolitan area. Nearly 50% of the population lives below the poverty line, and more than half of all Bronx government housing is located there. According to data from 2005-2007, Congressional District 16 (covering most of the South Bronx) was the only congressional district in the United States during those years with a poverty rate over 40%, and in which a majority of children were living below the poverty line. In 2007, the Bronx County child poverty rate of 38.1% was the highest in the Northeast (north of the Ohio River and east of Illinois) and 27.1% of the whole Bronx population was below poverty in 2007, also the highest figure in the Northeast.

According to a 2010 Community District Needs assessment issued by Mayor Bloomberg and the Department of City Planning, Mott Haven and Hunts Point residents are some of New York City's least likely to have completed high school or equivalency degrees, which has lead to staggering unemployment rates. On average these residents earn significantly less than the rest of NYC. In 2007, 55.3% of all residents received some sort of income support.

Compared to NYC as a whole, in Hunt's Point /Mott Haven the percentage of adults 25 years and older without a high school diploma (61% vs. 32%) and the percentage of linguistically isolated households (28% vs. 12%) are substantially higher than other city regions. Approximately 4.1% completed a 2-year or 4 -year college curriculum.

Studies show that in communities of color such as Upper Manhattan and the South Bronx, broadband penetration historically skews towards those who have more education and higher incomes. However, a 2009 Pew Internet and American Life study found that —African Americans experienced their second consecutive year of broadband adoption growth that was below average. In 2009, 46% of African Americans had broadband at home. This compares with 43% in 2008. In 2007, 40% of African Americans had broadband at home.

Needs Data: The Mississippi Delta

Digital Mississippi will cover 51 municipalities in a 34 county area (please see attached list of municipalities and counties in the service area). Census data on the populations of the municipalities served by Digital Mississippi is not available. However, the total population across the impacted counties is 1,262,859 (U.S. Census, Quick Facts).

The Digital Mississippi counties are among the poorest in a poor state. While the percentage of Mississippi residents living in poverty is 19.9%, the corresponding figure for the Digital Mississippi counties is 23%. The Digital Mississippi counties also have a higher percentage of residents of color. Across Mississippi, 39.2% of residents are people of color. However, in the Digital Mississippi counties the 51.7% of residents are non-White. (Analysis of U.S. Census Data, 2000).

Examination of trends in health and education in some of the impacted counties reveals both tremendous need and striking racial disparities. For example, in 2007 the infant mortality rate was a mere 6.6 per 1,000 births for white mothers. For non-whites, however, the rate was 15.5 per 1,000 births. In several of the Digital Mississippi counties, however, the disparities were even greater. For example

- Warren-Yazoo Counties: White 4.2; Non-White 11.5
- Panola-Coahoma Counties: White 6.8; Non-White 15.9
- Washington-Bolivar: White 4.8 ; Non-White 14.8

(American Human Development Project, MS Human Development Report, 2009)

Moreover, the Health Resources Services Administration (HRSA) has designated Quitman, Yazoo, Washington, Tallahatchie, Sunflower, Leflore, Coahoma and Bolivar counties—all of which will be impacted by the Digital Mississippi project--as primary medical care, health professional shortage counties. (MS State Department of Health).

Similarly, educational outcomes in many of the impacted counties lag behind state averages and Black students in those counties fare worse than their White counterparts. For example, 78.5% of Mississippi residents have secured at least a high school diploma. However, while this is true of 83% of whites statewide, it is true of only 70.4% of African Americans in the state. These disparities in high school completion rates are also evident in many of the counties that will be impacted by Digital Mississippi. For example

- Washington-Bolivar Counties: White 31.9%; African American 13.1%
- Leflore-Sunflower Counties: White 19.7% ; African American 8.9%
- Panola-Coahoma Counties: White 15.3% ; African American 8.8%
- Warren-Yazoo Counties: White 24.1% ; African American 10.3%

(American Human Development Project, MS Human Development Report, 2009)

Metroscale Regional Cyberspace Initiatives or the MERCI Model

Advancing Community Broadband is dedicated to bridging the broadband gap in two communities: Upper Manhattan and the South Bronx in New York and the Mississippi Delta. Advancing Community Broadband has developed a model that we believe can be applied to the problems that affect both an urban area and a rural area. That model is called the MERCI model. MERCi stands for Metroscale Regional Cyberspace Initiatives. Silicon Harlem represents our urban or metroscale cyberspace intiative. Digital Mississippi represents our rural or regional cyberspace initiative. The reason we call them cyberspace initiatives is because we want to differentiate these projects from telecommunications initiatives. Our goal is not to compete with the incumbent providers in the provision of telecommunications services but to provide broadband as a life-critical, mission critical infrastructure that is required for participation in the digital economy.

Silicon Harlem

Silicon Harlem will deploy an advanced, community-based wireless broadband internetwork that will blanket the Upper Manhattan Empowerment Zone from 116th Street to 168th Street. The Silicon Harlem Network will develop and run ten telework centers strategically located in community anchor institutions. Each telework center will use the Silicon Harlem portal to give local residents or small business owners a place where, for no charge, they will be able to do the following:

1. Learn how to use a computer and the Internet
2. Gain online job training
3. Engage in tele-employment
4. Access digital services and products

Silicon Harlem will provide education, awareness, training, access, equipment, and support to community anchor institutions, support job creation, and address the needs of vulnerable populations.

Silicon Harlem will support job creation by enabling local residents to take on data conversion work—the conversion of paper documents into optically stored, digitally retrievable documents—which traditionally has been farmed out overseas. To accomplish this, Silicon Harlem is partnering with Data Conversion Laboratory, Inc (www.dclab.com) to provision each telework center as a Center for Excellence in Document Conversion. Data Conversion Laboratory would contract with each telework center to complete data conversion work.

Data Conversion Laboratory will establish training programs and provide their conversion software for use at each telework center. Participants will be trained for positions dependent upon literacy level. Those individuals with the lowest reading levels or the least proficient English language skills, will be trained as Bulk Scanners. These are followed by more advanced positions, as follows: First Proofreader, Second Proofreader, Senior Proofreader, Junior Editor, Senior Editor. Training normally takes six months at which time the teleworker is immediately employable. After editing, Coders convert text documents into HTML, SGML, or XML. In addition, the company employs Managers and Supervisors as well as Customer Service Persons.

The entry-level Bulk Scanner position includes an educational benefit, and as they improve their reading ability employees can advance to become Proofreaders. A direct outcome of this work is that the employees not only learn the value of a home computer and Internet access but also can now afford such necessities because of their job.

Silicon Harlem has five goals:

1. Creating jobs
2. Closing the broadband gap
3. Encouraging demand for broadband
4. Spreading high-speed access to schools, universities, libraries, community centers, job training centers and public safety personnel
5. Jumpstarting the Green Economy in Harlem

Timeline of Implementation

Stage Zero- Preliminary - Consortium Organization

Stage One - Infrastructure Deployment

Stage Two - Creating the Telework Centers)

Stage Three - Operationalizing Silicon Harlem

Stage Four - Providing Distance Education and Tele-Health Services

Stage Five- Sustainability Period

Silicon Harlem as a model is replicable to other settings. The methodology could be applied to other urban settings, such as Newark, New Jersey; Philadelphia, Pennsylvania; Baltimore, Maryland; or Washington. D.C. Silicon Harlem can be applied to rural settings such as Itta Bena, Mississippi or to the entire Delta Region.

<u>Digital Mississippi: A Proposal to Develop the Mississippi Online Neighborhood Electronic Network (MS ONE-Net)</u>

Digital Mississippi is a strategic technology initiative whose goal is to provide the majority of the neediest citizens of Mississippi with affordable broadband by the year 2015. **Digital Mississippi** has five goals:

1. Create jobs
2. Close the broadband gap
3. Stimulate investment in broadband
4. Spread high-speed access to schools, universities, libraries, community centers, job training centers and public safety personnel and
5. Encourage demand for broadband.

Digital Mississippi will cover 51 municipalities in a 34 county area (please see attached list of municipalities and counties in the service area) with a total population across the impacted counties of 1,262,859 (U.S. Census, Quick Facts). This coverage area lacks effective broadband access for the delivery of basic Internet service let alone such critical Information Age services as e-education, e-government, e-employment and e-economic development. The cost per mile for the deployment of wireline infrastructure is cost prohibitive based upon population density and geographic distance. However, the cost to deploy a high speed wireless broadband network is by comparison, non-cost prohibitive and can be rapidly deployed and operationalized.

Digital Mississippi proposes to develop the **Mississippi Online Neighborhood Electronic Network or MS ONE-Net. Digital Mississippi** will be carried out in a set of stages.

In Stage One, the goal is to solve the last ten-mile and the last one-mile problem which prevents the dissemination of fiber to residents of rural Mississippi. Urban Cyberspace will partner with Telepak Networks to utilize their fiber optic network as the backbone for the proposed network, **The Mississippi Online Neighborhood Electronic Network or MS ONE-Net.**

In Stage Two, the goal will be to create telework centers. Telework centers are public access community technology centers which can be located in existing facilities such as schools, libraries, churches, job training facilities and community centers. A telework center does not only give the local citizen a place where she or he can come and learn how to use a computer and the Internet, it also provides online job training and employment at the desktop through a portal. For the purposes of Digital Mississippi, we propose to create jobs by the reverse outsourcing of data conversion work which traditionally has been farmed out overseas.

In Stage Three, the goal will be to extend the reach of the **Mississippi Online Neighborhood Electronic Network (MS ONE-Net)** to include other critical public and municipal facilities, small businesses, community-based organizations, hospitals, first responders, civic and cultural institutions and residences while provisioning the network with life-critical services such as distance learning, tele-health and e-government information.

In Stage Four, the goal is to deliver distance education and tele-health services across the network.

The project will be under the direction of Tugaloo College in partnership with Alcorn State University, Jackson State University, the Jackson Medical Mall, the Delta Health Alliance, Mississippi Public Broadcasting and the BB King Bllues Museum and Delta Educational Resource Center. Full Spectrum South in conjunction with the Urban Cyberspace Company have organized a consortium of technology partners which includes Telepak Networks as the backbone provider; CONXX and Alvarion as the wireless broadband solutions providers; Per Scholas as the provider of IT training and low cost home computers; and Data Conversion labs as the provider of the Document Conversion Specialist training and the telework employment opportunities.

Job Creation Estimate for Digital Mississippi

Over the duration of the Digital Mississippi broadband development initiative it is estimated that the activity of the project will create jobs in a number of areas.

Network Buildout

The buildout of the network will be carried out by three contracting companies:

1. Urban Cyberspace
2. Conxx
3. J and F Labs

Each of these companies have committed to train and employ a number of local workers in the following areas:

- Project Office Administrative Assistants- 3 jobs
- Network Installers- 12 jobs

Telework Center- Development

Per Scholas will train 40 developers who will work on the development of the
20 telework centers.

Once operational, the telework centers will train 25 persons per 2-month cycle as Document Conversion Specialists in the following areas:

- Bulk Scanners
- Proof Readers
- Editors
- Quality Assurance Specialists
- Coders
- Programmers
- Managers
- Salespersons
- Customer Service

Over the course of a year, one telework center will train and employ 150 people in the local data conversion industry. All twenty telework centers will create 3,000 telework positions.

Community Health Houses

Each telework center will double as a Community Health House. Community Health Houses will train and employ Community Health Workers who will be responsible for managing and administering on the local level the tele-diagnostic services. Each Community Health House will train 5 workers per 2-month cycle for a total of 30 workers per year. Across the 20 house network that will amount to 600 new jobs as Community Health Workers.

IT Training

Per Scholas will train IT professionals who will refurbish and service computers as well as install, program and maintain the home computer networks which will be developed in the end users homes. Per Scholas will train and employ 100 IT Project managers.

Educational Associates

Mississippi Public Broadcasting will train in the use of its Read Between the Lions education programs 100 parents who will be employed in HeadStart Centers as Educational Associates.

Digital Mississippi is a $15 million dollar initiative with a five-year timeline which includes the two year deployment and implementation period followed by a three year sustainability period.

<u>Piloting Silicon Harlem and Digital Mississippi</u>

Advancing Community Broadband is an initiative whose objective is to develop a procedural methodology that can be applied to the solution of the broadband digital divide in both an urban
as well as a rural setting. In order to do this, Advancing Community Broadband is in the process of developing a pilot project based upon the motive element behind both Silicon Harlem and Digital Mississippi: the telework center.

The pilot project will develop a proof-of-concept community telework center at Per Scholas' training facility located in the South Bronx. The objective of this project is to demonstrate and evaluate the viability of the telework model for the purpose of replicating it throughout the five boroughs of New York City as well as to other urban centers and rural areas.

Project Description

The goal of this project is to develop a self-sustaining community telework center. The pilot site will be located at the South Bronx facility of the technology non-profit, Per Scholas. Per Scholas' fifteen year mission has been to provide education, awareness, training, access, equipment, and support to community institutions, support job creation, and address the needs of vulnerable local populations.

Per Scholas will support job creation by enabling local residents to take on data conversion work—the conversion of paper documents into optically stored, digitally retrievable documents—which traditionally has outsourced overseas. Per Scholas will partner with Data Conversion Laboratory, Inc. to provision the telework center as a Center for Excellence in Document Conversion. Data Conversion Laboratory would contract with the telework center to complete data conversion work.

Data Conversion Laboratory will establish the training program and provide their conversion software for use at the telework center. Participants will be trained for positions dependent upon literacy level. Those individuals with the lowest reading levels or the least proficient English language skills, will be trained as Bulk Scanners. These are followed by more advanced positions, as follows: First Proofreader, Second Proofreader, Senior Proofreader, Junior Editor, Senior Editor. Training normally takes from three to six months at which time the teleworker is immediately employable. After editing, Coders convert text documents into HTML, SGML, or XML. In addition, the company employs Managers and Supervisors as well as Customer Service Persons.

The entry-level Bulk Scanner position includes an educational benefit, and as they improve their reading ability employees can advance to become Proofreaders. A direct outcome of this work is that the employees not only learn the value of a home computer and Internet access but also can now afford such necessities because of their job.

Skills in Demand

When evaluating job creation programs one has to be cognizant of the types of jobs being created. The jobs being created in this program are readily transferable to the commercial marketplace. Individuals with XML skills are in great demand.
In addition to being very pertinent, some of these jobs can be performed at home enabling populations like single mothers to work from home.

Also, physically challenged and wheelchair bound individuals can be put to work in the process as long as they can read a computer screen and type.

Training

The conversion of Paper to XML is a multi-step process. The steps are:

1. Scanning the Paper
2. OCR (Optical Character Recognition) to extract the text
3. Proofreading the page to ensure accuracy
4. Styling the text into Microsoft Word
5. Converting the Word Documents to XML
6. Viewing the document and correcting any errors
7. Final Quality Check

Training to perform the most complex conversion tasks is completed within 6 months while training for the simpler tasks is completed within weeks allowing the employee to be productive almost immediately.
Also, the different tasks related to document conversion allows individuals with varied levels of skill and aptitude to be employable. For example, the “Scanner” does not have to be as skilled as the Quality Assurance individual who is not as qualified as the Conversion Specialist. Individuals with all levels of talent have a role in this production process.

Timeline of Implementation

Stage Zero- Organization of Project Administration and Preliminary Project Design

During Stage Zero, the collaborating organizations will in essence be in pre-production mode. This will entail the initial establishment of the formal working relationships which includes task assignments and identification of administrative role functions.

Stage One - Infrastructure Deployment

During Stage One, the short-term goal is to have the wide area and the local area network connectivity for the Internet installed and activated in Per Scholas’s facility.

Stage Two - Creating the Telework Center

During Stage Two, the working telework center will be created. The computers and peripheral devices will be connected to the network and provisioned with the appropriate software. The offices and the various working areas will be set up and furnished. The milestone will be the completion of the document conversion center by the end of December.

Stage Three - Operationalizing the Telework Center

During Stage Three, the training program will formally begin. The first cohort of trainees will be comprised of fifteen people drawn from Per Scholas's recruitment pool. The participants will go through the full program of training which will result in their being the first class of document conversion specialists. While the training is underway, the first conversion contracts will be solicited from corporate clients.

Stage Four - Providing Distance Education and Tele-Health Services

During Stage Four, the participants as part of their exposure to digital services, will be offered the opportunity to take advantage of online education courses provided by CUNY and other online learning providers as well as tele-health services provided by different New York based health providers.

Stage Five- Evaluation and Sustainability Period

During Stage Five, the objective will be to conduct evaluations that will inform our thinking as to the design of the project and to our understanding of what is happening in real-time. The ultimate purpose is so that the project can be made sustainable both operationally and fiscally There will be two different types of evaluations carried out during the project. There will be a formative evaluation of the project and there will be an economic analysis of the project.

The formative evaluation will be designed and carried out by The Center for Social Inclusion. The economic analysis will be designed and carried out by Dr. Raul Katz of the Columbia Institute for Tele-Information.

Advancing Community Broadband as a Means to Inform the National Broadband Plan

Advancing Community Broadband has a two-part strategy designed to inform the implementation of the National Broadband Plan. What we explained above is where we intend to influence the NBP through innovative forms of project practice such as Silicon Harlem and Digital Mississippi. Advancing Community Broadband also is organized to inform the NBP through policy innovation.

On December 7th, 2010, we organized a symposium on Capitol Hill entitled, "Advancing Community Broadband: Transforming Community Economics Through Broadband". The symposium brought together a nationally recognized and expert group of panelists to discuss

the current state of broadband deployment strategies, the opportunities and necessity for community-scale approaches to meet these challenges. Our panelists focused on the role that community-scale approaches can play in eliminating the digital divide while empowering communities to create new opportunities in the information economy. Meeting the goal of universal broadband adoption and seizing the new opportunities it enables will require a bold new approach to infrastructure investments that prioritizes equity and recognizes the possibility of community-scale solutions within the context of national priorities. The findings from the symposium will be published in the report **The Promise and Challenge of Community Broadband Models: Lessons from The National Symposium on Community-Scale Broadband.**
To conclude, Advancing Community Broadband believes we are in a period of time that is best characterized by the operating concept of what we call a new localism. This is why we are piloting projects based upon the community-scale model. Whether it is the church or a cooperative, the delivery of content, services and applications over broadband can also return a proportionate stream of revenue that goes back to the community and is reinvested. This will encourage the kind of local innovation that will address community-specific issues but which more so can be expanded incrementally to create regional innovation economies of scale driven by broadband and the green economy.