Forecasts for the US Telecommunications Network

LAWRENCE K. VANSTON, RAY L. HODGES

Although not the leader in all telecommunications areas, the US is still a large diverse market of considerable economic interest. This article provides an overview of TFI's latest quantitative forecasts of the US telecommunications network in terms of competition, broadband data rates, Internet video, HDTV, fiber in the loop deployment, wireless broadband, and VoIP. Between now and 2016, the US is forecast to convert most of its telecommunications infrastructure to all-fiber and 4G wireless transmission and all IP-switching. However, different operators will follow different paths to get there and new players are emerging as the telephony, cable television, and Internet paradigms converge.

Lawrence K. Vanston is President of Technology Futures, Inc., Austin, Texas

Ray L. Hodges is a Senior Consultant with Technology Futures, Inc., Austin, Texas

Introduction and Summary

The US telephone network was built to provide narrowband voice service to essentially every home and office. This massive, dedicated network required hundreds of billions of dollars of investment in telephone plant comprised of metallic and fiber cable, switching equipment, and various types of circuit equipment, not to mention buildings, poles, conduit, etc. Through most of the industry's history market share was almost 100 %, quality of service was high, revenue kept growing, investment was continuous, profits were dependable, equipment lives were long, and employment was lifelong and secure. This network is still in place, and will be for a few years longer, but the world in which it thrived is rapidly disappearing.

The reasons include:

- The dramatic decline in narrowband access lines, starting in 2000, due to competition from cellular, cable telephony, and VoIP (voice over Internet protocol), as well as broadband replacing dialup Internet access.

- The resulting imperative by telephone companies to offer bundled phone, television, and broadband service (the triple-play), often combined with wireless (the quadruple play), to compete with their rivals from the cable television industry.

- The demand for new interactive video and television services, and the demand for much higher broadband data rates than DSL and cable modems can provide.

- The rapid rollout of access networks which meet these demands via state-of-the-art fiber optics technology.

- The emergence of mobile wireless broadband as a serious competitor to DSL and cable modems for existing Internet applications.

- The absorption of voice into integrated Internet applications, so that voice becomes less of a stand-alone service.

Research and forecasts from recent TFI studies for the telecommunications industry quantify these trends[1] and indicate that these changes are happening very rapidly as discussed herein. Much of this research was sponsored by the Telecommunications Technology Forecasting Group (TTFG) comprised of AT&T, Verizon, Qwest and Bell Canada. These are the major traditional North American local telephone operators, referred to in the US as incumbent local exchange carriers (ILECs).[2]

Convergence

Convergence is happening in so many ways and so fast that it is hard to keep track of. Figure 1 shows three important types of convergence impacting telecommunications companies. First, there is the convergence of voice, data, and video. This is more than carrying all three on the same facilities or putting them on the same bill; ultimately, it involves all three becoming simply integrated applications on the broadband Internet. The boundaries between wireless and wireline are also beginning to dissolve, with the use of wireless broadband to access the same Internet content regardless of location or device. Third, computers, handsets, and consumer electronics (TVs, VCRs, CD players, etc.) were once distinct

[1] *The most recent studies are L.K. Vanston and R.L. Hodges,* Transforming the Local Exchange Network: Fourth Edition *(Austin, TX: Technology Futures, Inc., 2008) and L.K. Vanston and R.L. Hodges,* Forecasts of Access Line Competition in the Local Exchange: Fourth Edition *(Austin, TX: Technology Futures, Inc., 2008).*

[2] *AT&T is the largest ILEC, operating in California, the South and much of the Midwest. Verizon is second serving much of the East. AT&T and Verizon are the largest long distance and cellular operators as well. Qwest is the ILEC serving most of the West, except California; it sold its cellular operation, but operates a major nationwide fiber optic network. The third major cellular operator, Sprint Nextel, still provides long distance service, but recently spun off its ILEC operations.*

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devices in their own right. Now, people watch TV or listen to music on their computers or their cell phones, with the Internet, or at least Internet technology, playing the key communications role. In summary, the common convergence point for voice, data, and video, wireless, or wireline, regardless of device, is the broadband Internet.

The significance of convergence is clear when we consider the convergence of content from specialized analog formats (photos, records, VCR tapes, brochures, etc) to generalized digital formats (.jpg, .mp3, .mpg, .pdf, etc) that are stored, manipulated, and transmitted as if they were just data. (See Figure 2 for a longer list.)

The Dramatic Decline in Narrowband Access Lines

The loss of ILEC narrowband access lines due to competition from wireless, broadband, cable telephony, and VoIP has been dramatic. As illustrated in Figure 3, since the peak in 2000, total ILEC access lines have fallen 20 % by mid-2007.[3] We forecast this number to continue to fall, reaching about 25 % of the peak in 2015. The ILEC total includes both retail access lines and facilities provided to CLECs[4] on a wholesale basis. The figure shows the decline has two main components:

- The substitution of wireline narrowband access (both ILEC and CLEC) by wireless, broadband[5] and non-carrier VoIP.
- Facilities-based CLECs, primarily cable television companies capturing wireline market share from ILECs.

Each of these components is discussed below.

Substitution by Wireless, Broadband, and VoIP

The part of the decline of ILEC narrowband access lines caused by wireless, broadband and VoIP is isolated in Figure 4 for the residential market. The figure plots the percentage of access lines captured by these technologies, both historical and forecast. The forecast is based on a standard S-shaped substitution

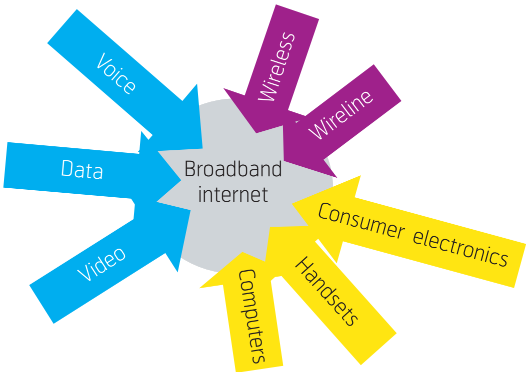

Figure 1 Telecom convergence

model of how a new technology (in this case, several new technologies together) replaces an old technology in the market.[6]

The most important replacement technology currently is wireless, that is, cellular telephony. Cellular continues its rapid penetration as shown in Figure 5, reaching-

- Photos
- Music
- Text
- Messages
- Images
- Personal video
- Movies
- TV
- Voice
- Location
- Games
- Newspapers
- Magazines
- Books
- Journals
- Brochures
- Documents
- Information
- Sensors
- Transactions

Figure 2 Convergence of Content

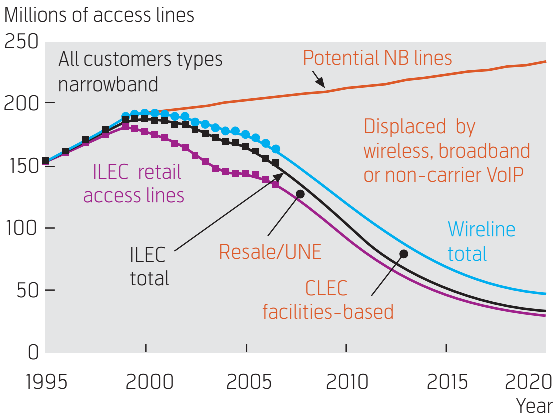

Figure 3 US narrowband access

(Source: Technology Futures, Inc.)

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3) *Much of the historical data used herein is published by the US Federal Communications Commission (FCC) based on data provided by telecommunications operators, especially,* Local Telephone Competition: Status as of June 30, 2007 *and* High-Speed Services for Internet Access: Status as of June 30, 2007. *These two are published semi-annually.*

4) *Competitive local exchange carrier. CLECs include resellers of ILEC services, operators leasing unbundled network elements (UNEs) from the ILECs and facilities-based operators such as cable television companies offering telephone service.*

5) *By broadband competition, we mean the decline in wireline access lines caused by broadband users dropping second lines that were used for dialup Internet access.*

6) *See, for example, our article in* Telektronikk, *vol 100, No. 4, 2004.*

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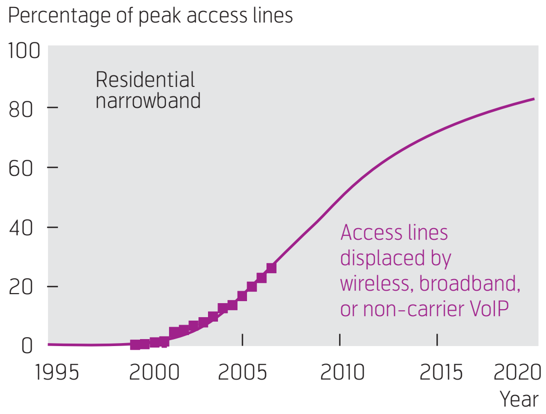

Figure 4 US residential narrowband access lines displaced by wireless, broadband, or non-carrier VoIP
(Source: Technology Futures, Inc.)

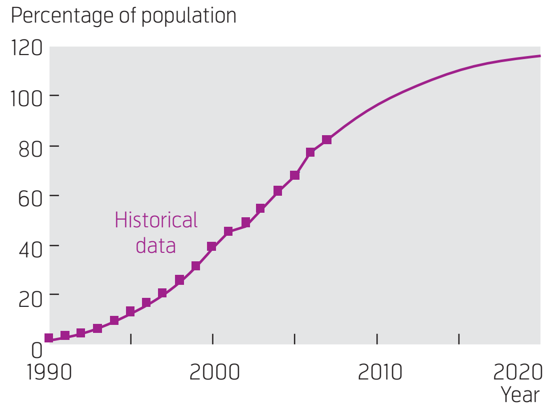

Figure 5 US wireless subscribers
(Source: Technology Futures, Inc.)

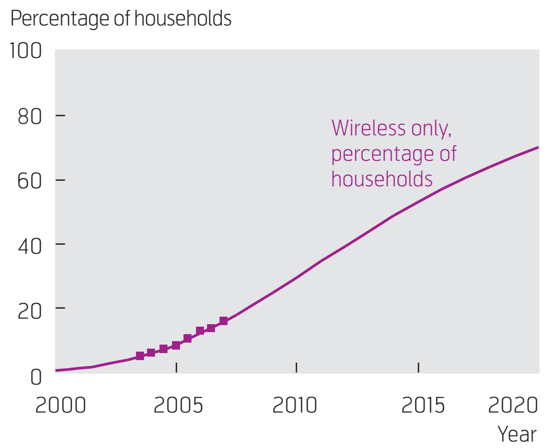

Figure 6 US Wireless-only households
(Source: Technology Futures, Inc.)

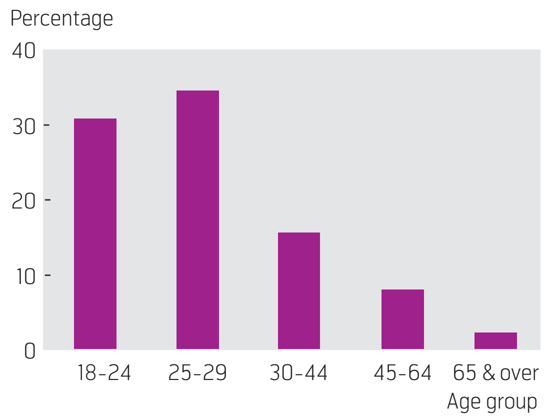

Figure 7 US Wireless-only adults by age group
(Data source: National Health Interview Survey)

ing 80 % of the population in 2007. Flat-rate cellular pricing plans, large buckets of free minutes, large free calling areas, and free long distance plans have encouraged people to rely on their cell phones to the extent that many have abandoned their landline phones. The historical trend is shown in Figure 6. Currently about 16 % of households have only wireless voice service. Younger people are more inclined to use wireless only as shown in Figure 7. About a third of adults under thirty are wireless only. This will support a continued long-term wireless-only trend.

Traditional wireline access lines are also being replaced by VoIP. As noted below, most cable television companies use VoIP instead of traditional circuit switching. Apart from the cable companies, non-carrier VoIP is having an impact. For example, Vonage, which provides phone service over its customers' broadband connections, served 2.2 million customers as of December 2006,[7)] and peer-to-peer VoIP services, such as Skype have been growing rapidly. Originally viewed as a cheap partial substitute for 'real' telephone service, VoIP quality is much improved and, ultimately, may surpass circuit switching's quality.[8)] It will also be infinitely more flexible as voice becomes integrated with the Internet as we discuss later.

Competition from Cable TV CLECs

The second major component in the decline of ILEC access lines is competition from facilities-based competitors. For the residential market, these are mainly cable television companies such as Cablevision, Comcast, and Time Warner. As shown in Figure 8,

7) *www.vonage.com.*

8) *This is because its bandwidth is virtually unlimited. Superior VoIP quality assumes that any residual technical problems with delay and jitter are overcome or are negligible.*

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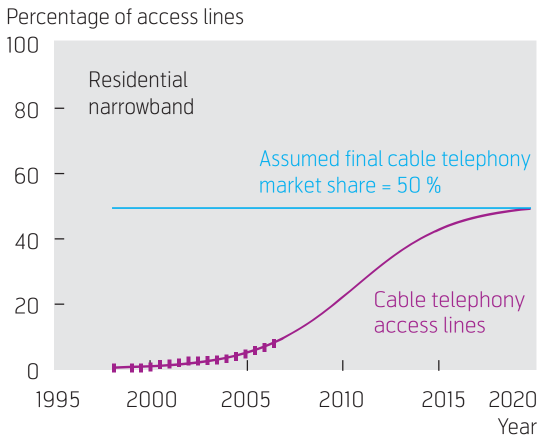

Figure 8 US cable telephony market share

(Source: Technology Futures, Inc.)

cable telephony provided about 10 % of wireline access lines as of June 2007. For the first few years, only a few cable television companies offered voice telephony. These initially used traditional circuit switches. Now, most cable companies are offering voice telephony and are using the much cheaper VoIP technology. Thus, we expect the rate of penetration to increase rapidly as shown in the figure.

Broadband Internet Access

As of June 2007, 60 % of US households subscribed to broadband services.[9)] Our forecast, shown in Figure 9, anticipates continued broadband growth, with broadband following a classical consumer electronics adoption pattern, ultimately achieving ubiquity similar to telephony, radio, and television. (We assume an ultimate 95 % penetration.) This reflects not only the rapid acceptance of broadband so far, but the prospect for it to serve as the basis for landline telephony, entertainment (eg. video, music, and games), home offices, and other Internet applications. Cable modems have a 57 % share of the standard broadband market (10 Mb/s and below), compared with the 41 % share for DSL. As can be seen in Figure 10, cable telephone companies established an early lead in the late 1990s and the ILECs have been closing the gap ever since then. Fixed wireless broadband, including satellite broadband, comprises less than 2 %.[10)]

In the future, we expect mobile wireless to substitute for a significant number of wireline (and fixed wireless) connections, especially as wireless systems, such as WiMax and 4G, that have sufficient capacity to serve household applications on a large scale, are rolled out in the US over the next several years. Thus, our estimated 95 % ultimate household penetration includes wireless substitutes. Of course, there will be many people that will have both, just as many people have both fixed and mobile phones.

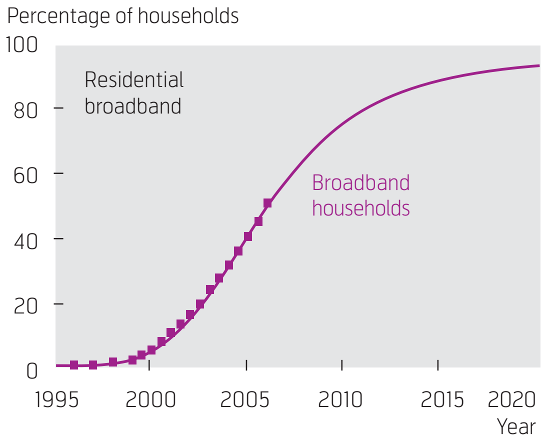

Figure 9 US broadband households

(Source: Technology Futures, Inc.)

Increasing Data Rates

Most US residential broadband customers still use first-generation broadband, nominally 1.5 Mb/s or second-generation broadband in the range of 3 Mb/s to 9 Mb/s mostly via DSL or cable modems. We have also begun the shift to much higher data rates in the neighborhood of 24 Mb/s, which we refer to here as very highspeed (VHS) broadband. The next shift to even higher rates of 50 Mb/s to 100 Mb/s is still a few years off for most people, although there are a few 50 Mb/s offerings to selected fiber customers. TFI's industry forecast for the transition to higher data rates is shown in Figure 11.[11)] Also shown is the

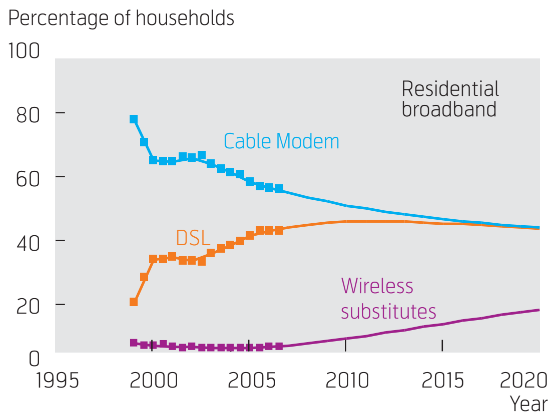

Figure 10 US market shares of DSL, cable modems and fixed wireless for standard broadband

(Source: Technology Futures, Inc.)

9) *FCC. This excludes mobile wireless broadband, which the FCC now reports, but it includes a small percentage of fixed wireless broadband.*

10) *Estimated from FCC,* High-Speed Services for Internet Access: Status as of June 30, 2006 *(Dec 2006), Table 3, Excludes mobile wireless broadband.*

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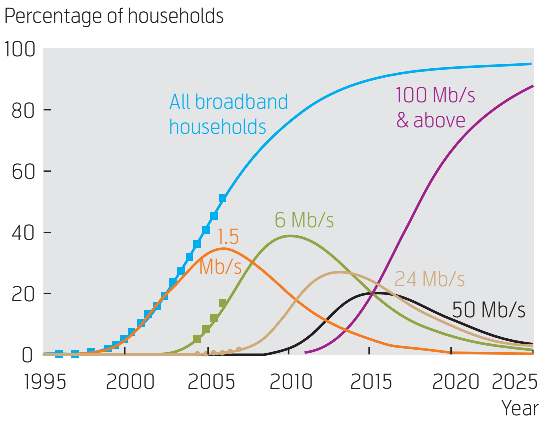

Figure 11 US broadband households by nominal data rate *(Data Source: FCC. Speeds are based on DSL & FTTL data. Excludes mobile wireless broadband) (Source: Technology Futures, Inc.)*

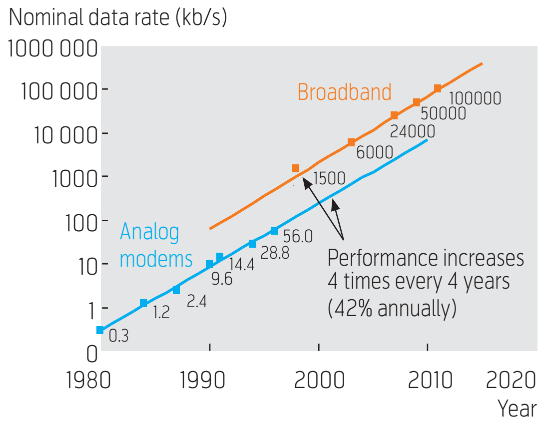

Figure 12 Trend in residential access data rates *(Source: Technology Futures, Inc.)*

early data for the 6 Mb/s and 24 Mb/s categories, based on recent FCC data on broadband technologies.[12]

The forecasts in Figure 11 are for homes subscribing to a service. Subscribership cannot exceed availability (ie. homes passed), and, in fact, there is a minimum availability to support a given level of subscribership.[13] Figure 13 illustrates the estimated required availability for VHS broadband to support the subscriber forecast shown in Figure 11.[14]

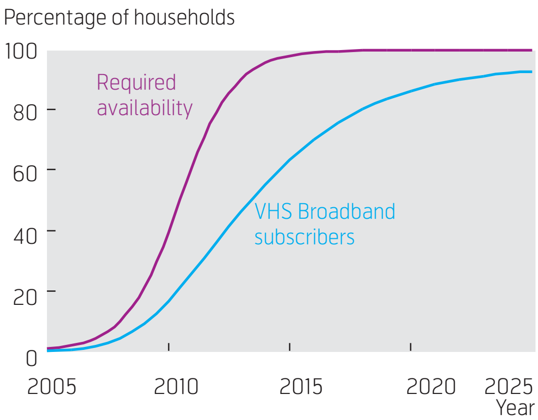

Figure 13 VHS broadband required availability *(Source: Technology Futures, Inc.)*

Forecasts for IP Video

Video services are probably the key driver for the deployment of systems that support increased subscriber bandwidth. We distinguish between three basic types of IP video:

- *Online Video*. Video clips over the open Internet. YouTube is an example of online video. Picture size, resolution, frame rates, quality, and length are limited by bandwidth and other factors.

- *IPTV*. Carrier-provided television service, competitive with cable television, that uses IP technology to deliver programming over a dedicated broadband link to the customer.

- *Internet TV*. Television, either streaming or downloaded, over the open Internet. Like online video, but with TV-like performance and program length. Like IPTV, but the carrier only provides the broadband channel, not the programming.

Online Video

Online video has opened a whole new realm of video communications, production, and distribution. For example, in April 2008, 82.1 million viewers watched 4.1 billion videos on YouTube.com alone.[15] Almost one in three (32 %) of these frequent YouTube users

[11] *The forecast reflects the assumption that the average data rate increases by 42 % per year, the typical rate experienced with analog modems. This is roughly equivalent to quadrupling every four years or doubling every two years. It thus reflects Moore's Law, which implies that computer performance doubles every 18 months to two years (see Figure 12).*

[12] *We excluded cable modems in computing these percentages. Including them would show a higher penetration of the higher data rates. We were not able to confirm how close actual experienced data rates over cable's shared medium are to the advertised rates reported to the FCC. The 24 Mb/s nominal rate corresponds to the FCC range of 10–24 Mb/s.*

[13] *The quantitative relationship is based on analogies to other adoptions, specifically, cable television, pay cable, and pay-per-view. See L.K. Vanston, J.A. Marsh, and S.M. Hinton,* Telecommunications for Television/Advanced Television *(Austin, TX: Technology Futures, Inc., 1992), pp 123-144.*

[14] *The VHS broadband subscribership curve is the sum of the 24 Mb/s, 50 Mb/s and 100 Mb/s curves in Figure 11.*

[15] *comScore Video Metrix, www.comscore.com*

say they are watching less TV as a result of the time they spend there.[16] The left curve in Figure 14 shows the trend in the percentage of Internet users viewing online videos (of any type) at least once a week. The percentage is currently at about 75 % and forecast to rise to 90 % by 2010.

Internet TV

Online video is a precursor for Internet TV. It has shown that people want to acquire TV programming via the Internet. Now, it is a question of bandwidth (ie. quality) and digital rights management. Bandwidth is an issue because quality TV requires considerably higher resolution and duration than online video. Currently, about 25 % of Internet users stream TV shows or segments at least once a week. If it follows the same trend as online video, we would expect the level to reach 60 % by 2010 and 90 % by 2015, as shown in Figure 14. (Movies, being longer, require even more bandwidth, and will lag the TV forecast by a year or two.) Figure 15 compares the Internet TV forecast, put in terms of households, with the forecast for 6 Mb/s and above broadband from Figure 11. Although these were independently derived, they tell a consistent story: rapid development of demand for higher speed broadband services, with over 50 % of US households subscribing to it in 2010.

IPTV

IPTV is a way for ILECs to compete with cable television service using limited bandwidth. It is also a new service that can offer features and performance beyond that of normal cable television. IPTV is most important to those ILECs such as AT&T that are deploying fiber to the node which, unlike fiber to the premises, cannot deliver a standard RF cable television signal.

In the long run we expect the distinction between IPTV and Internet TV to blur, as will the distinction between computers and televisions. Put another way, when people expect to watch TV on their computers and access the Internet on their TVs, they will have similar expectations regarding the delivery channel.

High-Definition Television

High-definition television (HDTV) has now penetrated about 20 % of US households as of yearend 2006 and is forecast to approach 50 % by 2010, as shown in Figure 16. Although HD requires more bandwidth than standard video, it is obviously now a requirement for any competitive television delivery

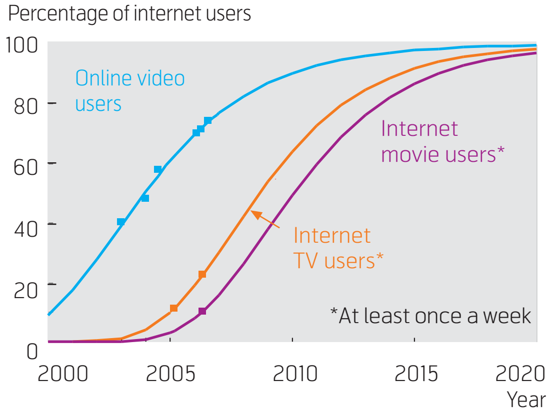

Figure 14 US online video users and Internet TV users (Data source: OL Video: eMarketer, Nov 2006 & Comscore; OL TV: Online Publishers Assn) (Source: Technology Futures, Inc.)

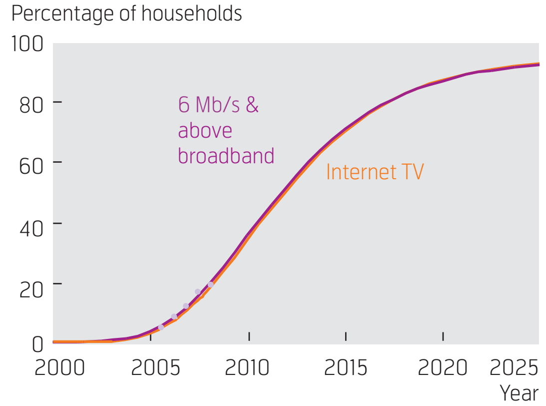

Figure 15 Comparison of Internet TV and 6 Mb/s & above broadband forecasts
(Source: Technology Futures, Inc.)

system. Ultimately, any video application, whether broadcast or online, will need to deliver HD. As entertainment – eg. gaming, pay-per-view movies, and sports – continues to shift from broadcast to online delivery, HD will become as much a computer phenomenon as a television one.

As HDTV becomes prevalent, consumers will want to access HD programming via the Internet. Combining the Internet TV forecast[17] and the HDTV forecast provides a forecast of Internet HDTV, as shown in Figure 17. According to this forecast, about 20 % of households will use Internet HDTV by 2010 and over 60 % by 2015. Figure 18 compares the Internet HDTV forecast with the forecast for 24 Mb/s and above broadband from Figure 13 above. As with Internet TV and 6 Mb/s broadband, they tell a consistent story: rapid development of demand for very

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16) *Harris Interactive,* One-Third of Frequent YouTube Users are Watching Less TV to Watch Videos Online*, Press Release, Rochester, N.Y., January 29, 2007.*

17) *Here the Internet TV forecast is translated from percentage of Internet users to percentage of all households.*

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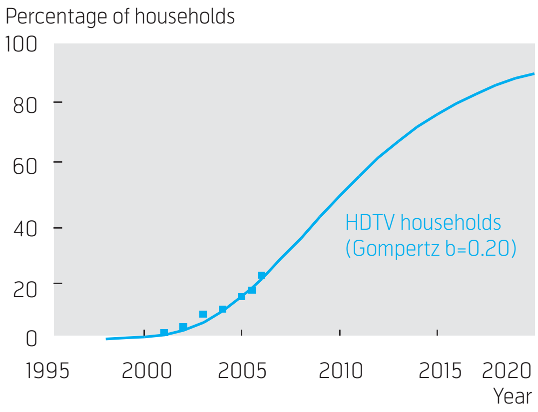

Figure 16 US HDTV households

(Data sources: Various) (Source: Technology Futures, Inc.)

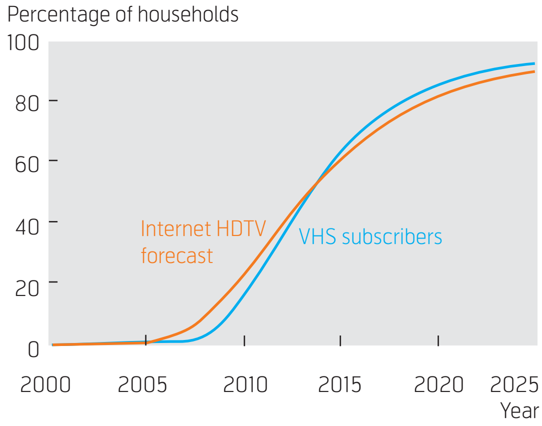

Figure 18 Comparison of Internet HDTV and 24 Mb/s & above broadband forecasts

(Source: Technology Futures, Inc.)

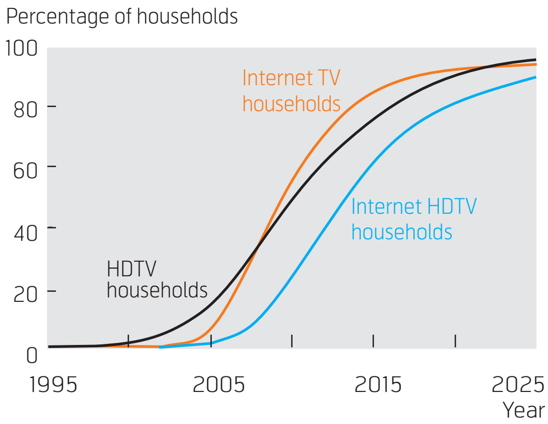

Figure 17 US Internet HDTV households

(Data sources: Various) (Source: Technology Futures, Inc.)

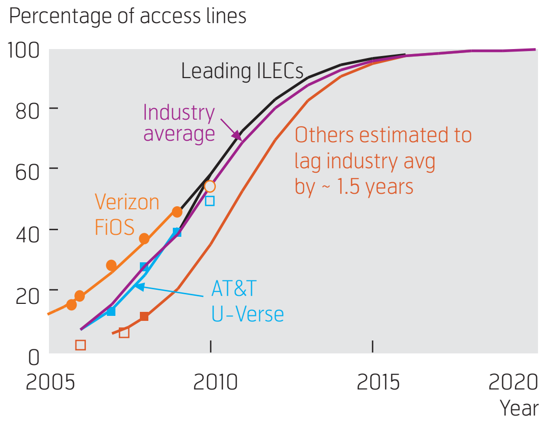

Figure 19 Deployment of very high speed fiber

(Source: Technology Futures, Inc.)

high speed broadband service, with over 50 % of US households subscribing to VHS broadband in 2015.

Fiber in the Loop

The shift to VHS broadband (24 Mb/s and above) requires fiber-based loop architectures. In the US, both fiber to the node (FTTN) and fiber to the premises (FTTP) architectures are being deployed for VHS broadband. Verizon is deploying FTTP in selected service areas under the brand name FiOS and AT&T is deploying FTTN in existing neighborhoods and FTTP in new neighborhoods, both under the brand name U-Verse. (The other major US ILEC, Qwest has announced a strategy similar to AT&T's, but less expansive.) Figure 19 shows the historical data and current plans by Verizon and AT&T for deployment of their VHS fiber alternatives. Both plan to pass about 50 % of the households in their service areas by 2010. The figure also shows our forecast for deployment to the remaining homes by the industry leaders, as well as an estimate of deployment by Qwest and smaller ILECs. As shown in Figure 20, deployment of VHS fiber by the US ILECs meets the estimated availability requirement that was shown in Figure 13.

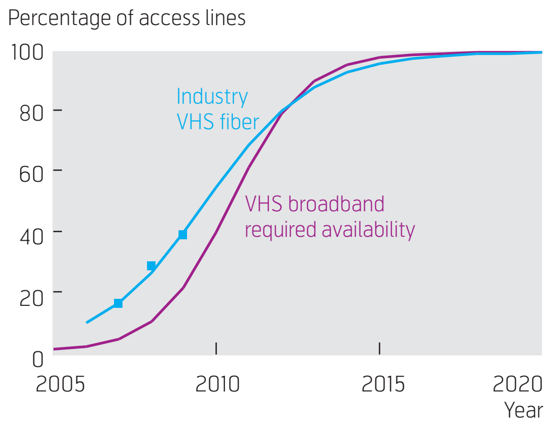

Figure 20 Comparison of deployment of VHS fiber and VHS broadband availability

(Source: Technology Futures, Inc.)

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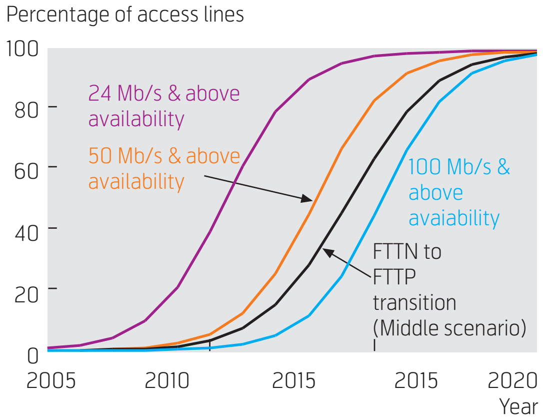

Figure 21 Potential conversion from FTTN to FTTP
(Source: Technology Futures, Inc.)

An interesting question is whether and when the US ILECs that have selected FTTN will convert to FTTP. It is too early to tell for sure, but our best estimate is that the conversion will occur as demand for 50 Mb/s and 100 Mb/s broadband develops as illustrated in Figure 21.

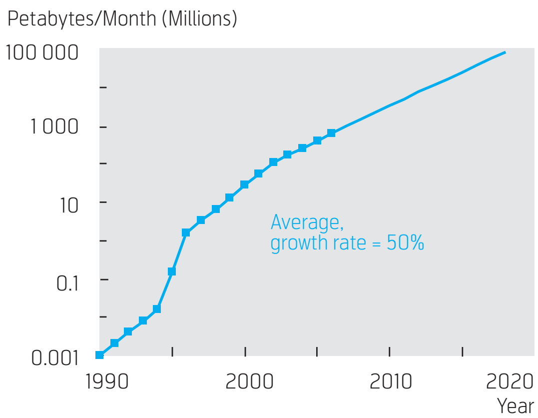

Figure 22 Traffic forecast for the backbone Internet
(Data source: Minnesota Internet Traffic Studies (MINTS)
(Source: Technology Futures, Inc.)

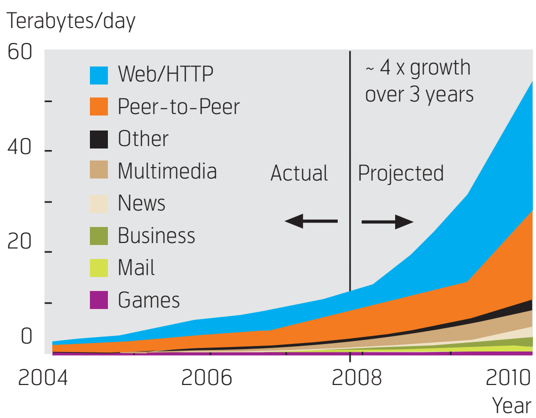

Figure 23 AT&T IP backbone projected traffic growth
(Source: AT&T 2007 Analyst Conference)

Long Distance Transport

Technology change, convergence, and the growth in Internet traffic are also having major impacts on the US long distance network. IP traffic has been growing at an annual rate of between 50 % and 60 % for the last several years.[18] TFI estimates that it will continue to average about 50 % indefinitely, as shown in Figure 22, although there will be years where it is higher or lower. For a specific example, AT&T is projecting about 60 % growth (doubling every year-and-a-half) for its IP backbone, with most of this traffic devoted to Web-based and peer-to-peer applications, as shown in Figure 23.

Long distance operators will have to make nearly continuous upgrades in fiber optic transmission equipment to keep up with the growth in Internet bandwidth and traffic. Most transmission is currently on first and second generation Dense Wavelength Multiplexing (DWDM) systems operating at up to 10 Gb/s per wavelength. Some 40 Gb/s capacity is being installed, but as shown in Figure 24, we expect that 100 Gb/s, not 40 Gb/s, will play the larger role in the future. Most operators will also need to replace fiber optic cable to efficiently provide higher-speed transmission, especially as speeds reach 100 Gb/s per wavelength and above. It is very unlikely that the industry will light more than a fraction of the fiber strands in its long distance fiber optic cable. Long distance operators generally prefer to upgrade transmission equipment rather than light fiber in response to increased demand. This approach is sufficient to keep up with projected traffic growth for most companies. However, the industry may install new fiber to enable the most advanced transmission technologies.

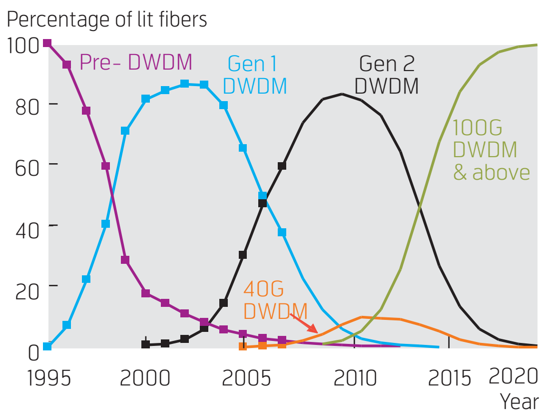

Figure 24 Long distance fiber optic transmission systems by generation, industry average
(Data estimated, based on various sources) (Source: Technology Futures, Inc.)

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[18] *Although this is less than the 100 % annual growth rate the Internet was experiencing at the turn of the century, and still less than the 900 % growth rate that was reported in the mid-1990s, it is still quite high.*

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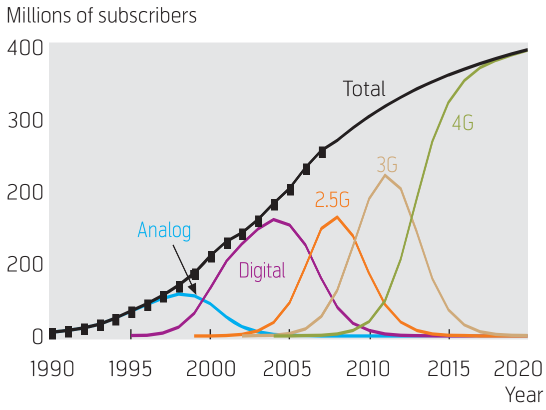

Figure 25 US wireless generations
(Historical data source: CTIA & ITU) (Source: Technology Futures, Inc.)

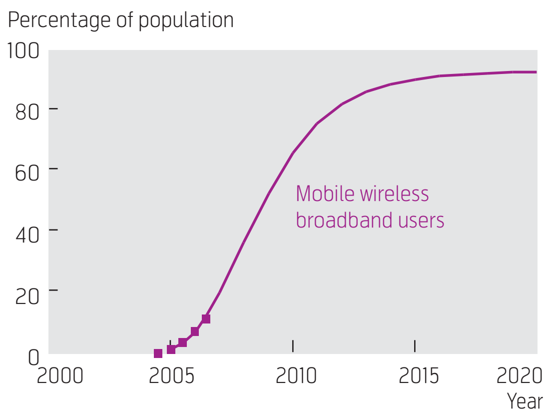

Figure 26 US wireless mobile broadband
(Source: Technology Futures, Inc.)

Regarding switching, the traditional long distance carriers (AT&T, Verizon, and Sprint) have begun a transition from a circuit-oriented architecture based on SONET, ATM, and circuit switches to a packet-oriented network based on IP MPLS technology. This transition will largely be complete by about 2015. The nontraditional carriers (Qwest and Level 3) started with IP technology, but they, as well, face continued requirements for modernization.

Wireless Broadband

Wireless broadband allows users to connect to the Internet at speeds comparable to the first generation of DSL and cable modems. It is coming primarily from two directions: the cellular telephone world and the data communications world.

Cellular 3G and 4G

For the last decade, the cellular industry has been steadily upgrading from a voice-only network to a voice and data network with increasing bandwidth. Over this period, the cell phone has evolved from being a wireless telephone to a universal device for talking, texting, photos, videos, music, games, calculating, etc. As shown in Figure 25, there have been four major generations of equipment, with the most advanced generation being 3G. The previous generation, 2.5G, enabled narrowband applications like picture sharing and downloading tunes, whereas 3G offers enough bandwidth (400 to 700 kb/s) to handle broadband applications. However, system capacity is much less than DSL and cable modems, meaning that it cannot handle lots of customers using data intensive applications without bogging down. It also costs more – $ 60 per month, but it is mobile with lots of coverage, explaining its rapidly growing popularity (see Figure 26). For example, mobile wireless data users increased from below one million in June 2005 to over 35 million in June 2007.[19)]

The next cellular generation, 4G, will operate at much higher capacity and provide much more bandwidth per user owing the greater spectral efficiency of the underlying technologies. As with previous generations there are competing standards, namely LTE from the GSM world and UMB from the CDMA world, not to mention WiMAX, discussed next. Whichever standard, 4G puts wireless broadband in direct competition with cable modems and DSL, but with the added advantage of mobility. As shown in Figure 24, we forecast that most users will have 4G by 2015, about the same time wireline broadband will have completed its move to VHS broadband (which has significantly higher capacity than 4G).

WiMAX

WiMAX was originally promoted by the data communications industry as an alternative way to provide broadband to stationary computer users.[20)] Clearwire, founded in 2003, offers service in dozens of mostly smaller markets providing up to 1.5 Mb/s and competing directly with DSL and cable modem service. However, the third largest U.S. cellular provider, Sprint Nextel, controls the lion's share of the currently available WiMAX spectrum in the major metropolitan areas (85 % of pops in the top 100 BTAs). In 2007 Sprint Nextel chose the mobile version of WiMAX, called 802.16e, making it competitive with 3G cellular. With its large amount of spectrum (120 MHz in most population centers) and high spectral efficiency,

[19)] *FCC,* Local Telephone Competition: Status as of June 30, 2007.

[20)] *For an analysis of the capacity and costs of WiMAX, see L.K. Vanston,* Assessment of Wireless Broadband as a Competitor to Wireline Broadband *(Austin, TX: Technology Futures, Inc., 2006)* the network will have much larger capacity than 3G and, in fact, the company is referring to it as 4G.

In May 2008, a consortium was formed to build and operate a national WiMAX network combining Clearwire and Sprint Nextel operations. The other members are Comcast and Time-Warner (two of the largest US cable television operators), Intel, and Google. They plan to complete the network in about two years. The strategic motivations are clear: Sprint Nextel gets a head start on its larger cellular rivals, AT&T and Verizon, plus the ability to compete with their broadband services. The cable companies get the fourth part of their quadruple play, plus mobile access for online video. Intel will sell a lot of chips. And, as discussed below, Google gets access to its users, wherever they happen to be, via a mobile broadband interface over which it has at least partial control.

Internet Voice (VoIP)

VoIP uses Internet technology (packet switching) instead of traditional telephone technology (circuit switching) to make voice phone calls. There are several forms of VoIP. With one form, VoIP is used internally by the carrier (or carriers) offering what otherwise appears to be standard telephone service. For example, the digital telephone service offered by most cable companies uses VoIP. The carriers use this technology because it is more efficient, cutting the cost of switching by at least half compared to traditional circuit switching. Similarly, many enterprises are also adopting VoIP on their private networks.

With their tremendous imbedded base, ILECs have been slow to abandon their traditional circuit switches in favor of VoIP. Even when they connect a home with VHS fiber, they currently leave the existing metallic cable in place and provide voice service over it and the existing narrowband switch. However, TFI studies[21] indicate that, by 2010, the savings in operations costs achieved by converting these services to VoIP over the broadband link will outweigh the cost of conversion and other constraints. In the meantime, ILECs are promoting VoIP services to their VHS broadband customers.[22] (This is equivalent to a customer-initiated conversion from circuit to packet switching.) Figure 27 shows our forecast for the substitution of packet for circuit switching, based on these two factors, combined with the overall loss of ILEC access lines.

The adoption of VoIP by ILECs will make voice service less expensive and make traditional switching obsolete, but it won't change the business fundamentally. Another form of VoIP, non-carrier VoIP, will change everything. Non-carrier VoIP includes peer-to-peer services like Skype that run directly on the Internet. It also includes voice services tied to instant messaging service such as MSN Messenger, AOL Messenger, Yahoo! Messenger Voice Chat, and Google Talk. Finally, there are a virtually unlimited number of potential integrated applications including interactive games, unified messaging, help desks, net meetings. Although non-carrier VoIP can be used to make cheap calls, the real potential is in these integrated applications where voice is simply an element of a larger experience. VoIP makes voice part of the hyper-dynamic Internet world, subject to all the creativity, new ideas, and danger on an international scale.

Further, this world is not limited to the wireline Internet, but includes wireless as well, especially now that we have wireless broadband. Most wireless voice today goes through the normal voice channel controlled and switched by the cellular operator. However, sophisticated handsets can do VoIP over a wireless broadband connection without the operator's involvement. Given that cellular operators control much of the US handset market, this may take some time. However, with 3G communications already in laptops and PDAs, and with the convergence of devices, it is only that … a matter of time.

A precursor indicating the potential of marrying wireless, voice, and the Internet is an experimental directory assistance service by Google where users dial a

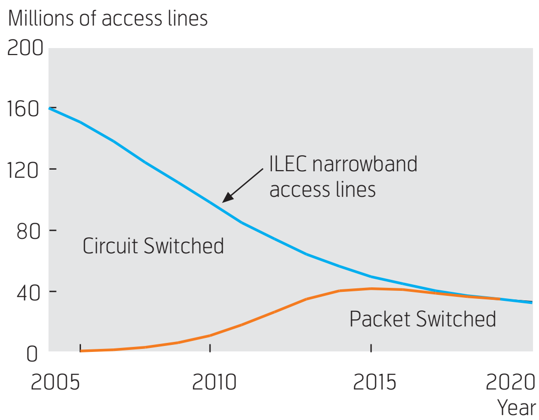

Figure 27 US ILEC narrowband access lines on circuit and packet switching
(Source: Technology Futures, Inc.)

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[21] *L.K. Vanston,* The Conversion of Narrowband Access Lines to VHS Broadband Facilities: Analyses & Forecasts *(Austin, TX: Technology Futures, Inc., 2007)*

[22] *Steve Taylor and Larry Hetlick, AT&T Moves Ahead with IMS, Unveils VoIP Service for its IPTV Customers,* Network World *(January 30, 2008).*

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The Googleplex

- Best guess 450,000 servers spread over at least 25 locations worldwide tied together by a high-capacity fiber network.

Google Data Center at The Dalles

Figure 28 The model for the future of telecom?
(Source: The New York Times)

toll-free number to reach Google, which recognizes what they say and provides information on the businesses in the city that fit their criteria. It's not much of a leap from there to providing maps, directions, Web pages, and especially advertising, or completing the phone call. Eventually, with VoIP on wireless broadband, such a service could bypass the voice network entirely.

Wireless, wireline, voice, data and video converge in this world. Call processing, including switching, is integrated with other Internet functions such as searching, Web browsing, messaging, gaming, etc. With VoIP and the broadband Internet, this can be done anywhere, including the server farms owned by the Yahoos, Microsofts, and Googles (see Figure 28) of the world, which have tremendous processing capacity and, potentially, tremendous VoIP switching capacity.

Review

Let's review some of what we know about the probable telecom future US:

- Narrowband access lines will continue their decline.
- Broadband usage will be almost universal and people will spend a lot of time online.
- People will watch lots of video and TV online, most of it HDTV.
- Users will need more and more bandwidth, which will be provided by VHS fiber and 4G wireless.
- Broadband wireless will become ubiquitous and most people will use wireless handsets for many different activities.
- VoIP will replace circuit switching. Voice will be just another Internet application, integrated with searching, web browsing, messaging, gaming, etc.
- Internet players such as Google will play a large role in telecommunications.

Based on the forecasts reviewed here, we believe this future will largely be reality in the US by 2016.

Dr. Lawrence Vanston is an internationally recognized authority in the use of technology forecasting in the telecommunications and other high-tech industries. As president of Technology Futures, Inc., Dr. Vanston has been monitoring, analyzing and forecasting telecom technologies and services for 25 years. Subject areas include convergence, very high speed broadband, VoIP, fiber optics, IP videos, and wireless broadband. An expert on the impacts of new technologies and competition on telecom networks, he often testifies before government agencies. In addition to enhancing planning and strategy, Dr. Vanston's forecasts are often used for estimating depreciation lives and valuations of telecom assets. Before joining Technology Futures in 1984, Dr. Vanston spent four years with Bell Labs and Bellcore in network planning. His academic achievements include an MS and PhD in operations research and industrial engineering, both from the University of Texas at Austin.

lvanston@tfi.com

A Senior Consultant with Technology Futures, Inc. since 1994, Ray L. Hodges has authored numerous reports on telecommunications, including studies commissioned by the Telecommunications Technology Forecasting Group (TTFG), comprised of AT&T, Bell Canada, Qwest, and Verizon. Topics have included Internet access requirements, xDSL technologies, VoIP, fiber optics, video services, and wireless communications. Mr. Hodges is also an expert witness on telecom depreciation and valuation issues. Prior to joining TFI, Mr. Hodges spent 25 years with GTE Telephone Operations (now Verizon) as a manager of both technical and financial areas. Mr. Hodges is a member of the Institute of Electrical and Electronic Engineers (IEEE) and served as Vice-Chairman of its Technology Forecasting and Assessment Committee. He is also a senior member of the Society of Depreciation Professionals. Mr. Hodges holds a BS from Georgia Southern University in Industrial Management and Technology.

rhodges@tfi.com