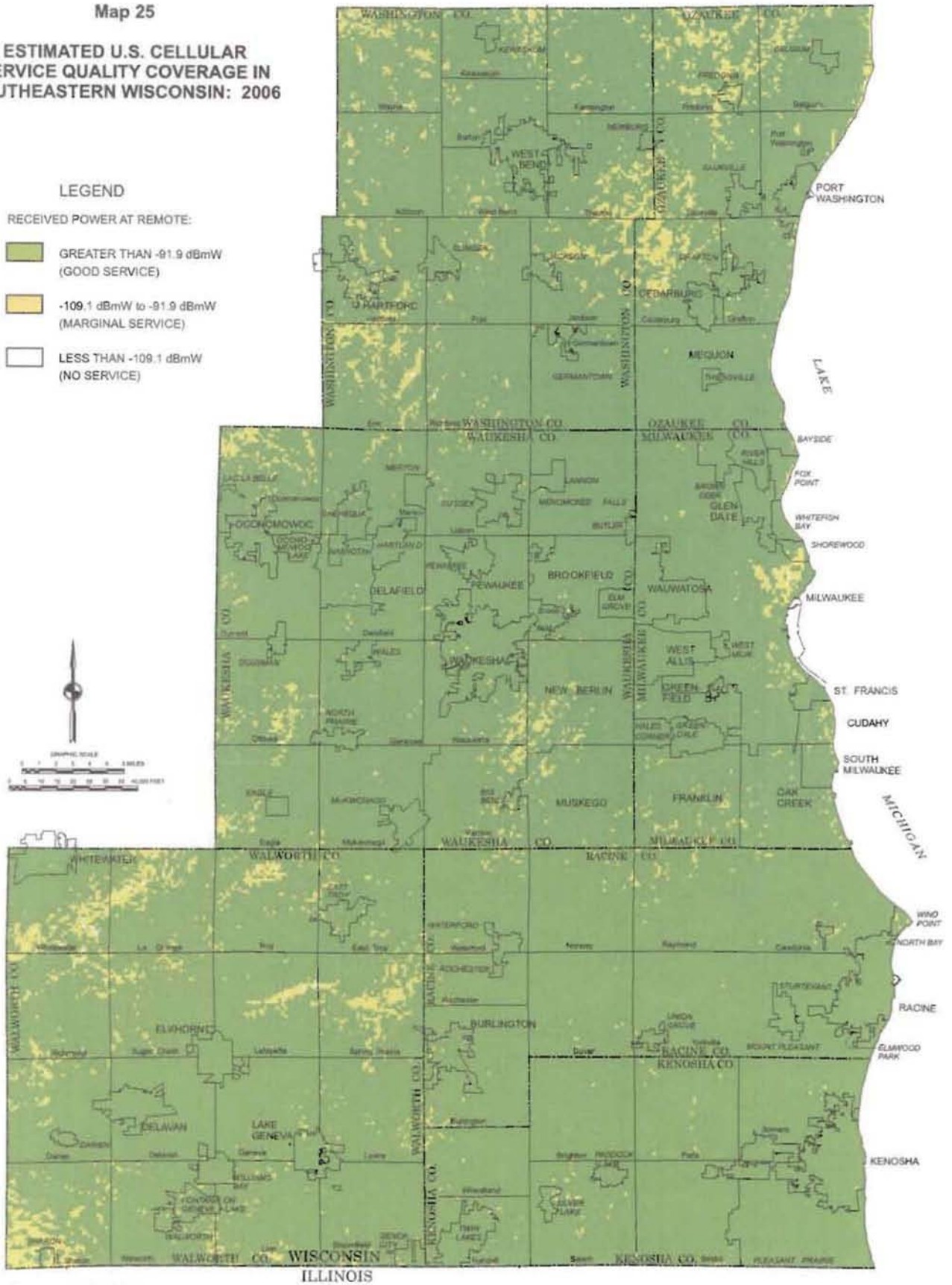
Map 25

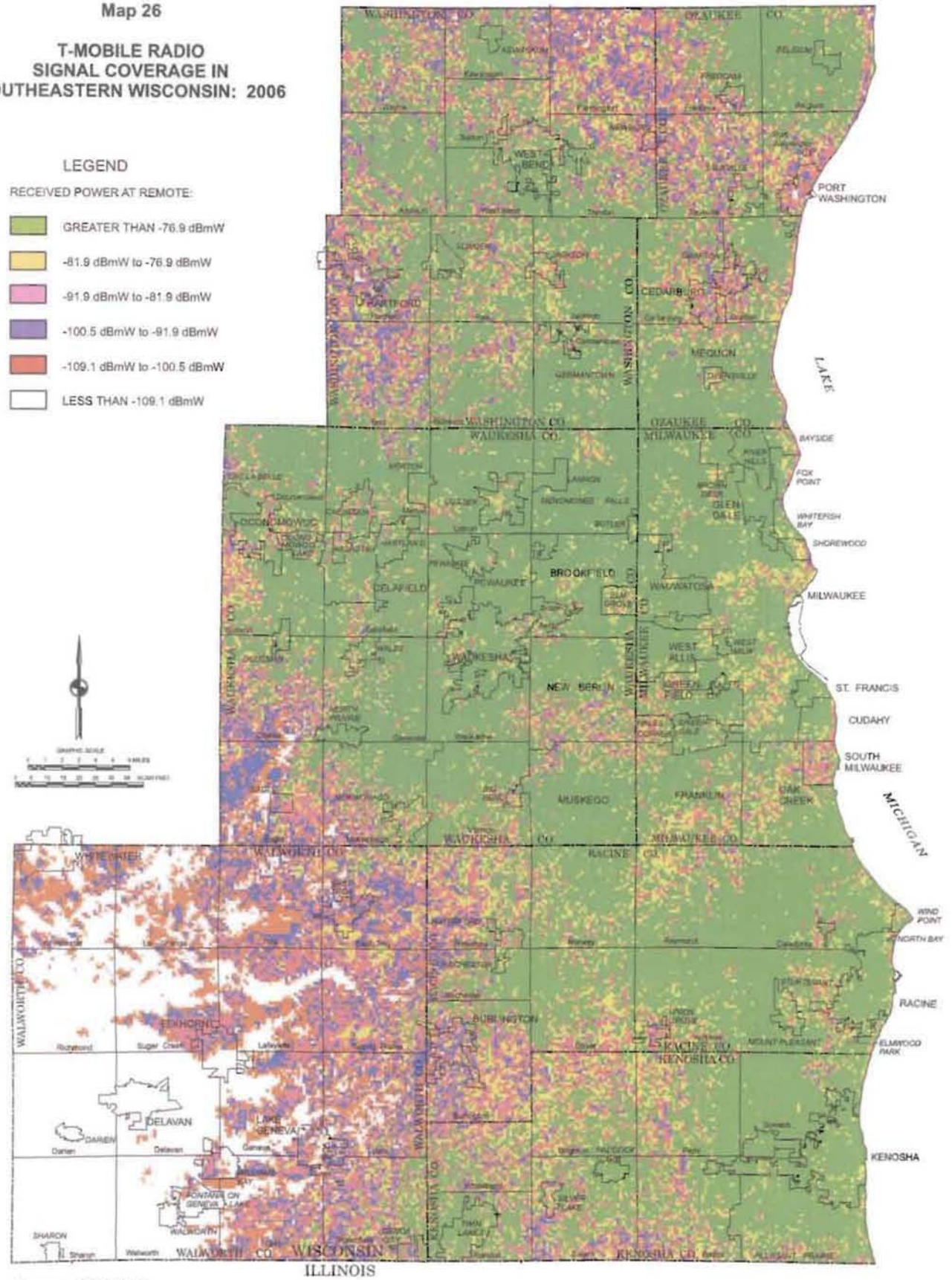
ESTIMATED U.S. CELLULAR SERVICE QUALITY COVERAGE IN SOUTHEASTERN WISCONSIN: 2006



Source: SEWRPC.

Map 26

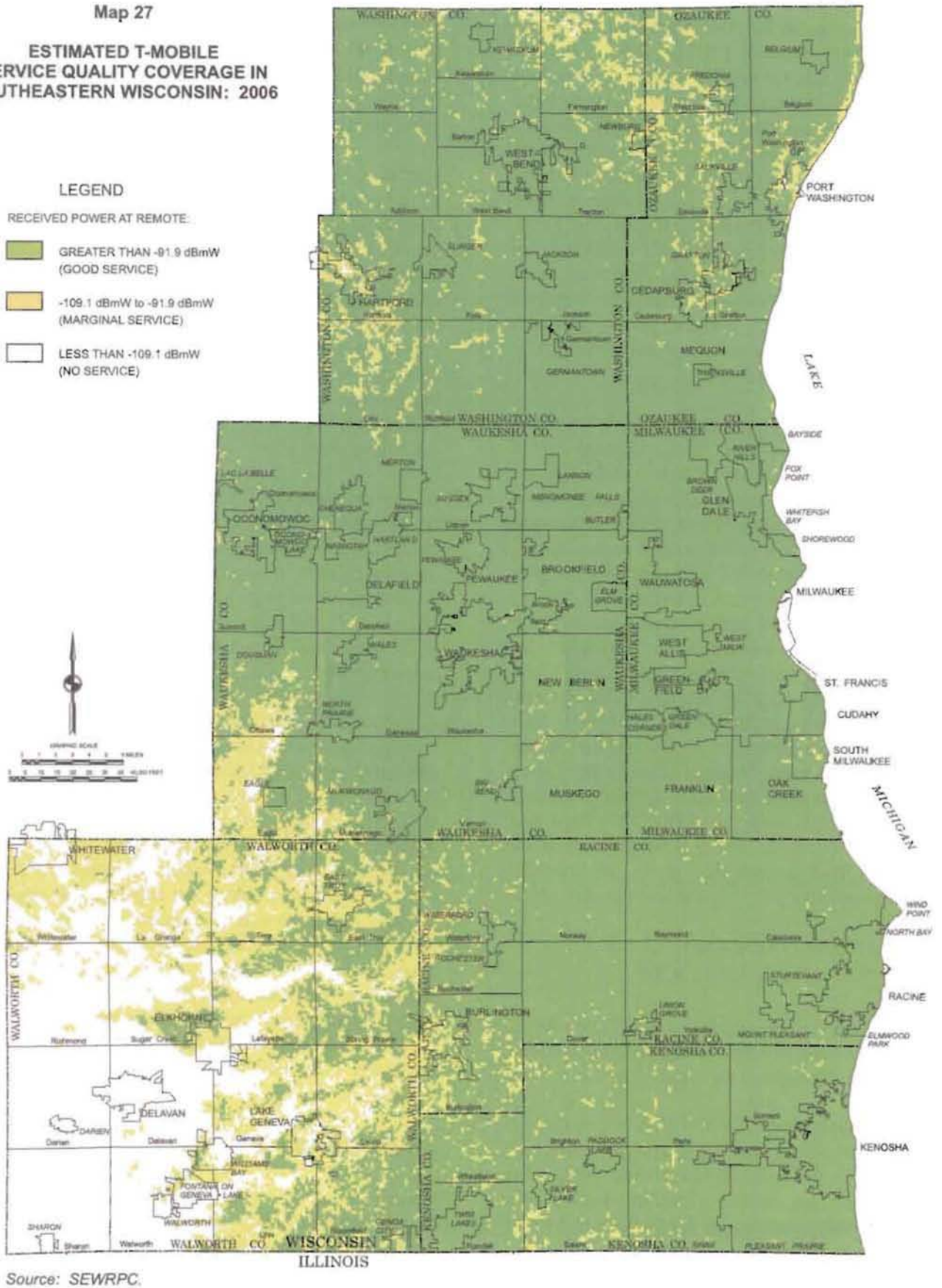
T-MOBILE RADIO SIGNAL COVERAGE IN SOUTHEASTERN WISCONSIN: 2006



Source: SEWRPC.

Map 27

ESTIMATED T-MOBILE SERVICE QUALITY COVERAGE IN SOUTHEASTERN WISCONSIN: 2006



Source: SEWRPC.

to the Internet. There are numerous broadband fiber optic core networks in the Region with each having its own POP locations for interconnection with other networks. Some of these POP point locations are known and available for Internet gateway connection to existing or new broadband wireline or wireless networks. Others are not publicly available and are useable only by special private arrangements with the carrier. For a new broadband communications system to interconnect at a POP point, it must provide a wireline or wireless link to that POP point. Such links, particularly for fiber optic wireline links, can be quite costly. The initial and continuing costs of such links can significantly change the economics of network deployment. For this reason, a search was carried out for an alternative to established POP point Internet gateway access.

One such an alternative is found in the hybrid fiber coaxial networks of the two regional cable companies—Time Warner Cable and Charter Communications. Internet access through these cable networks can be implemented with an average link distance of about one-half mile. For this reason, the concept of a POP gateway has little meaning in fiber coaxial cable networks. Both Time Warner Cable and Charter have literally thousands of "POP points" available wherever their networks are deployed in the Region. One possible key to future new broadband access network deployment, therefore, rests with connection to the hybrid fiber optic coaxial cable networks. Other alternatives for Internet connection may exist in the core fiber optic cable facilities deployed by other service providers within the Region, such as AT&T, Norlight and Time-Warner Telecom. For this reason, a detailed inventory of fiber network POP points for noncable networks as originally envisioned was not pursued.

SATELLITE BROADBAND COMMUNICATION SERVICES

A number of service providers offer broadband satellite based Internet access communications within the Region and throughout the United States.

Download speeds vary from 500 kilobits per second, to 3 megabits per second while upload speeds are much slower in the range of 128 kilobits per second to 1.5 megabits per second. Monthly service fees extend from $50 per month at the low end to $1,000 per month at the high end. Megabit per second performance generally calls for charges exceeding $500 per month. For this reason, broadband satellite services can not compete with other broadband service alternatives when and where they are available. Most current satellite broadband service users reside in rural areas lacking other forms of broadband communications services.

Operating in the super high frequency SHF—2.5 to 22 GHz—bands, satellite communications has the advantage of significant bandwidth allocation which generally allow for high throughput rates. This bandwidth must be shared, however, with a large body of other users to support the costs of launching and maintaining communications satellites in orbit. These low earth orbiting satellites to be effective on a 24-hour basis, must be continuously available on a line-of-sight basis throughout the service area. Such availability requires a large fleet of satellites for continuing coverage.

A geosynchrous (GEO) satellite is a satellite whose orbital track on the Earth repeats regularly over points on the Earth over time. If such a satellite's orbit lies over the equator, it is called a geostationary satellite. Such satellites to be geosynchronous must orbit at an altitude of 22,369 miles so as to have an orbital period of 23 hours and 56 minutes, the same as the Earth's rotation period.

A geostationary satellite appears to be fixed in one location above the equator. Other GEO satellites are stationary over other locations on the earth's surface. All GEO satellites have an inherent time delay of about 0.25 seconds for a round trip to and from the satellite. Such delays preclude their use in voice communications. GEO systems also require the use of expensive, bulky directional antennas that must be pointed and calibrated to acquire a satellite. Low earth orbit (LEO) satellites, in contrast, use small omnidirectional antennas that do not require calibration. GEO satellites also do not interface well with the Internet and its TCP/IP protocol. For all of these reasons, GEO satellites are best used for television broadcasting and high-speed data transmission.

ENTERPRISE NETWORKS

Modern communications networks in the United States and worldwide take two forms by way of organizational structure and clientele served; utility

networks and enterprise networks. Utility networks such as those operated by AT&T, Verizon, Time-Warner Cable and Charter Communications are organized to serve the general public. These networks are owned and managed by the private service providers and offer a wide range of voice, video and data communications services to consumers, businesses, government entities and other organizations. Enterprise networks, in contrast, are owned and operated by individual enterprises to serve the needs of the enterprise. Enterprise networks do not typically offer communications services to the general public. Enterprise networks serve medium and large businesses, government, health care and educational institutions and other private and public enterprises. In developing and deploying their enterprise networks, organizations may lease facilities, particularly land line facilities, from service providers in lieu of constructing all elements of their networks. They also typically purchase other network equipment such as switches, routers and multiplexers for their exclusive network use. The key difference, however, is that enterprise networks are owned and operated by the enterprise to serve enterprise functions.

The regional telecommunications planning program was originally envisioned to address only telecommunications networks that either performed governmental functions, such as public safety, or offered services to the general public. Enterprise networks were not intended to be addressed except peripherally. Maintaining the economic viability and competitiveness of the Southeastern Wisconsin Region, however, was a major objective of the planning program. And, the availability of fiber optic cable core network facilities is an important factor in regional economic development. For this reason, an attempt was made in the planning program to map the location and geographic availability of the existing fiber optic cable core network serving in the Region.

In this respect, it is important to note the somewhat divergent needs of small, medium and large scale businesses and industries within the Region. Small businesses generally rely on residential telecommunications networks for reasons of cost, scale and geographic availability. For this reason, universal geographic availability of broadband communications is an important factor in regional economic development. Data published by the U.S. Small Business Administration (SBA) indicate that over 50 percent of all small businesses may be expected to be home-based and therefore widely distributed geographically. Other small business enterprises also tend to be similarly widely dispersed geographically throughout an urban region. Small businesses play a vital role in the growth of the regional economies. Data published by the SBA indicate that from 1996 to 2006, 60 to 80 percent of net new jobs created annually at the national level were created by small business enterprises. Many of these businesses are based on new technologies. SBA data also indicate that small businesses produce 13 to 14 times more patents per employee than larger businesses that are active in patenting. An increasing number of these small businesses are information-oriented, and have need for high performance broadband communications. Given their home-based, or small facility-based, nature and their wide dispersion throughout an urban region, small businesses may be expected to benefit from broadband communications networks that cover the entire Region. Accordingly, the Commission telecommunications planning effort focused on services provided to the general public.

The importance of small business enterprises to economic development within the Region is confirmed by the following excerpts from the *Jobs in the New Millennium* report of the Wisconsin Policy Research Institute for the period 1999 through 2003.

1. Small Business
   In the Metropolitan Milwaukee area—Milwaukee Waukesha, Ozaukee and Washington Counties—small business employs 76.6 percent of all of the 799,690 private sector employees in the area. In Racine and Kenosha counties, the corresponding small business percentages are 78.7 percent, and 83.9 percent respectively. Nationally, small business provides about 50 percent of all private sector jobs.

2. Employment gains from 1999 through 2003 were confined to establishments with under 100 employees. Large businesses—over 500 employees—accounted for 60 percent of the employment losses even though they represented only 21.3 percent of the workforce.

The relatively higher percentage of small business employees in Southeastern Wisconsin along with their

leading cable services provider, Time-Warner Cable. Other incumbent telephone companies, such as Century Tel and Verizon North also offer broadband communications services in some parts of the Region. Charter Communications, the other regional cable services provider, has deployed broadband cable networks in areas of Washington and Walworth counties and in the City of Oconomowoc in Waukesha County.

Telephone-based service providers utilize a technology known as DSL—digital subscriber line—which transmits high speed data over twisted pair copper wires originally used for voice communications. Cable companies employ a hybrid communications technology that combines fiber optic cable links with traditional coaxial cable connections to deliver high speed data services.

None of the existing wireline broadband services networks in the Region offer throughput data rates that meet the Commission recommended performance standard of 20 megabits per second. All of the current wireline services are extremely asymmetrical, with upload speeds of 20 percent or less of download speeds. AT&T, the leading DSL service provider, is in the process of deploying a Fiber-to-the-Node technology (FTTN) that is designed to achieve the Commission recommended broadband service standard of 20 megabits per second. Advanced broadband service plans of the two cable service providers, Time-Warner Cable and Charter Communications, have not been revealed at this time. Similarly, the other DSL service providers have not announced plans for technologies designed to meet the 20 megabits per second throughput standard.

None of the major current wireline broadband service providers offer the universal geographic coverage objective recommended by the Commission. Cable services in many communities serve the large majority of the population, but there are still areas of the Region that do not meet the Commission recommended standards for extension of broadband cable services. DSL broadband services from telephone service providers are also not universally available from the wireline carriers in the Region. Furthermore, as of the date of publication of this report, AT&T's plans for expanded broadband services target only 44 of the 116 local municipalities within Southeastern Wisconsin that AT&T serves. Although AT&T's post-2008 plans may expand this number, there was no information available on these plans at the time of publication of this report.

recent position as the only source of job growth, make wide coverage regional broadband communications a high economic priority.

Medium and large-scale organizations present a somewhat different set of telecommunication requirements than small businesses. Such medium and large-scale organizations typically design and operate their own enterprise networks. The trend toward enterprise networks began with the breakup of the Bell System in 1984, and accelerated with the growth of large-scale national and international data networks. Although enterprise networks are typically designed and installed in cooperation with communications equipment vendors such as Cisco or Nortel Networks, all such networks have the need for land-line fiber optic cable links that provide the required bandwidth capacity to serve the communication needs concerned. Such core network service is typically arranged with core network carriers such as AT&T, Time Warner Telecom, Norlight Communications, or others within the Region. The capacity of the optical fiber cable network generally is not an issue. Most fiber core networks within the United States and the Region are underutilized. The real issue is geographic availability. Fiber optic cable core facilities do not exist in many parts of the Region. For this reason, a definitive, comprehensive map of the Regional fiber optic core network within the Region would provide a valuable resource.

The acquisition of such network layout information requires the cooperation of the core network providers themselves. At the small business level, broadband communications is synonymous with the residential networks. The telephone system Incumbent Local Exchange Carriers (ILECs), and the two regional cable companies, Time Warner Cable and Charter Communications, own the majority of the fiber optic cable facilities required for broadband connection. Although earlier attempts under the regional planning program to obtain detailed information on the core fiber optic cable networks were unsuccessful, the Commission in February 2007 determined to again seek the cooperation of the core optic cable facility providers in mapping those facilities.

In 2007, the major carriers serving the enterprise network fiber optic core network market within the Region included the following: 1.) AT&T; 2.) Time Warner Telecom; 3.) Norlight Telecommunications; 4.) TDS Metrocom; and 5.) Midwest Fiber Networks. The latter firm provides inactive or "dark", rather than electronically activated fiber optic cable facilities that must be equipped and activated by the user.

The remaining core networks service providers are smaller ILEC carriers that offer core network services only in their own ILEC service areas. These in 2007 included: 1.) Verizon North; 2.) Century Tel; 3.) State Long Distance (Elkhorn); and 4.) Sharon Telephone Company.

An unsuccessful search was made of the Federal Communication Commission, and Wisconsin Public Service Commission data bases to obtain definitive information on the location of the core optic fiber facilities within the Region. The Commission on February 21, 2007, sent letters to all known fiber optic core network carriers operating within the Region requesting definitive information on the cable networks locations. As of March 21, 2007, replies were received only from Verizon, politely declining cooperation. Apparently—barring State legislation—the necessary information will become publicly available only when the carriers see it to be in their own interest to cooperate with public bodies such as the Commission in developing a core network infrastructure inventory.

Lacking comprehensive fiber optic core network location information for the Region, the Commission selected to work with core network providers in plan design and implementation on a project-by-project basis. Such an approach allows for the implementation of specific advanced broadband communications system plans based on core network connections specified for a given geographic area. In such a working relationship, the core network carrier would typically offer a number of possible Internet locations, so that a selection could be made that would maximize the performance versus cost of the new network infrastructure design. To date, two core network carriers, Charter Communications and Time Warner Telecom, have demonstrated a willingness to cooperate in this critical aspect of plan implementation. Attempts will be made to expand this group of carriers so that all parts of the Region will achieve broadband communications coverage.

SUMMARY AND CONCLUSIONS

Broadband wireline communications services in the Region are currently offered primarily by the major incumbent telephone company, AT&T, and the

Chapter VI

TELECOMMUNICATIONS BROADBAND PERFORMANCE INVENTORY FINDINGS

INTRODUCTION

Chapter V presented the findings of an inventory of the current broadband telecommunications infrastructure within the Region expressed in terms of geographic coverage and types and levels of service. This chapter deals with the performance of the existing broadband communications networks, particularly with regard to throughput speed—the primary parameter for evaluating system performance under the regional telecommunications planning program. Performance data were collated from a variety of Internet websites that routinely collect throughput performance data from within the United States and worldwide. Performance data are analyzed and published by country, state or province, local community, down to the postal service zip code area level in the United States. Data are also summarized by technology—DSL, cable, wireless—carrier, and type of connection. Performance data, of course, are more readily available for larger geographic areas such as nations or states than for smaller areas. At the zip code area level, many areas have no recorded data available. For purposes of performance analyses, however, the type of technology and the individual service provider or carrier are of primary interest for planning purposes.

PERFORMANCE MONITORING CATEGORIES

The performance herein reported emphasizes wireline, rather than wireless, networks. This emphasis is based on two major considerations:

1. Wireless performance within the planning area was monitored by the Commission, and the findings were reported in SEWRPC Planning Report No. 51; and

2. The higher levels of performance typically provided by the wireline networks as compared to mobile wireless networks. Fixed wireless networks provide better throughput performance than mobile, but these networks do not serve all areas within the Region.

Broadband wireless performance is, however, herein reported to the extent that data are available for the Region through the Commission's monitoring effort. Also of interest are satellite wireless communications in rural areas. Throughput data rate is the only measure of broadband performance herein considered. Data on the other major performance measure considered in the previous Commission

wireless monitoring—availability—are not readily available for wireline networks. Moreover, availability performance in wireline networks is generally high—approximating 99 percent or more—so that availability is not a useful differentiator in wireline broadband service evaluations.

The performance data as herein reported are limited to data on data transmission rather than voice communications, since broadband capabilities are not generally relevant to circuit-switched voice traffic. Voice over internet protocol (VoIP) communications does share bandwidth with data traffic on packet switched networks, but performance quality is more dependent on network response time—latency—than on bandwidth or throughput. Also, regional use of VoIP is still at a relatively low level within this Region.

Based on website-based performance data, broadband throughput data are herein tabulated and analyzed by the following categories:

1. Technology—with emphasis on hybrid fiber coaxial cable and DSL technologies;

2. Service Provider—with emphasis on the major carriers operating within the Region;

3. Geographic Area—broadband performance data availability becomes limited as the geographic areas concerned are reduced in size, but to the extent feasible, performance information is provided for counties and municipalities as geographic areas.

The end objective of the performance monitoring as herein reported is to determine the status of broadband communications within the Region as the foundation for developing future regional broadband communications systems.

Wireline Performance Data Sources and Parameters

A number of broadband communications websites were searched and evaluated prior to selecting two websites that provided higher quality and quantities of broadband wireline performance data. These two sites and the rationale for their selection are described below.

1. TCP/IQ Line Speed Meter
   This website provides data on download speed, upload speed, and latency—response time—by county, state, community and postal service zip code area; and by service provider, technology and class of service.

2. Bandwidth Place
   This website provides data only by state and technology type, but reports based upon a relatively large number of performance tests, e.g., over 30,000 for Time Warner Cable and over 48,000 for Charter Communications in Wisconsin alone.

The TCP/IQ website provides the most extensive categorization of the data, but sample quantities are low and nonexistent for some categories. The Bandwidth Place website has high sample volume, but categorizations are coarse with no areal categories below the state level.

The TCP/IQ website was developed and is managed by Sigma Solutions, Inc. based in San Antonio, Texas. The company was formed in 1998 and has grown to 85 employees. The company develops database, server and internetworking software for businesses, government and institutional users, typically on a custom basis. The TCP/IQ website for network performance measurement was developed as a promotional tool to attract potential customers to the Company. The primary question relating to the use of the data concerns its accuracy. TCP/IQ line speed data are collected from Internet user volunteers who wish to measure their broadband performance in terms of download and upload throughput and latency time. In return for their cooperation, the volunteers receive free access to the performance data base. TCP/IQ maintains the high accuracy of its Internet performance reporting using the following measures.

1. Multiple Time Series Measurement
   When a user registers and contracts for the free service offered, the user agrees to allow collection of additional performance data which permit the averaging of link performance over time, thereby reducing the standard errors of the applicable means and allowing for measurement of performance variability.

2. Detection of Erroneous Data
   A registered user must specify the service levels received in terms of maximum download and upload speeds. Performance data outside of these service ranges are ignored.

3. Three Month Moving Average
   Each registered user's performance data are maintained as three month moving averages. Such a moving average provides a more accurate estimate of link performance than single readings.

Bandwidth Place is a small website company operating out of Calgary, Alberta, Canada. It differs from TCP/IQ and its sponsor, Sigma Solutions, in that it charges fees for its broadband communications measurement services. Users pay fees from $10 to $220 per year to receive network performance data on a continuing basis. The Version 1 of the program was placed online in early 2000. The data acquisition software system is now in its fourth version, and over 100 million test runs have been compiled.

Bandwidth Place data were used herein only to summarize performance at the State level. All other performance data referenced in this Chapter are from TCP/IQ.

Using a combination of data from these two websites, it is possible to approximate the performance characteristics of the major broadband communications technologies currently operating within the Region. Performance data were collated, tabulated, and analyzed by technology and service providers starting at the national level, and moving down to state, region and community levels as data availability permitted.

Service Specifications

Most broadband communications services are based on a service package offering that states the maximum download and upload speeds permissible on that link connection. For example, a Time Warner Cable service offering of 3000/768 specifies a maximum download speed of 3000 kilobits per second and a maximum upload speed of 768 kilobits per second. These figures represent the results of bandwidth allocations made by the service provider. They do not represent a quality of service guarantee, and they are not typically incorporated in any service agreement. These specifications do, however, represent the maximum throughput possible for a given network service.

National Level Broadband Communications Performance

Since the same broadband wireline and wireless communications technologies are deployed throughout the United States, it was deemed advisable to first review broadband performance at the national level, and then compare it with State and local level performances. The larger sample counts available at the national level also improve the accuracy and reliability of the data.

The current overall performance of broadband communications in the United States is portrayed in Figure 9 which displays the means and standard deviations of the download and upload speeds of all Internet service providers over the time period from January 2003 to November 2006. The disparity between the faster download speeds and the slower upload speeds is quite apparent. Download speeds cover the one to two megabits per second range, while upload speeds are generally no more than 300 kilobits per second.

A display of the performance provided by the two primary wireline technologies used in the United States is provided in Figure 10. Broadband cable and DSL throughput performance for two different service levels are shown.

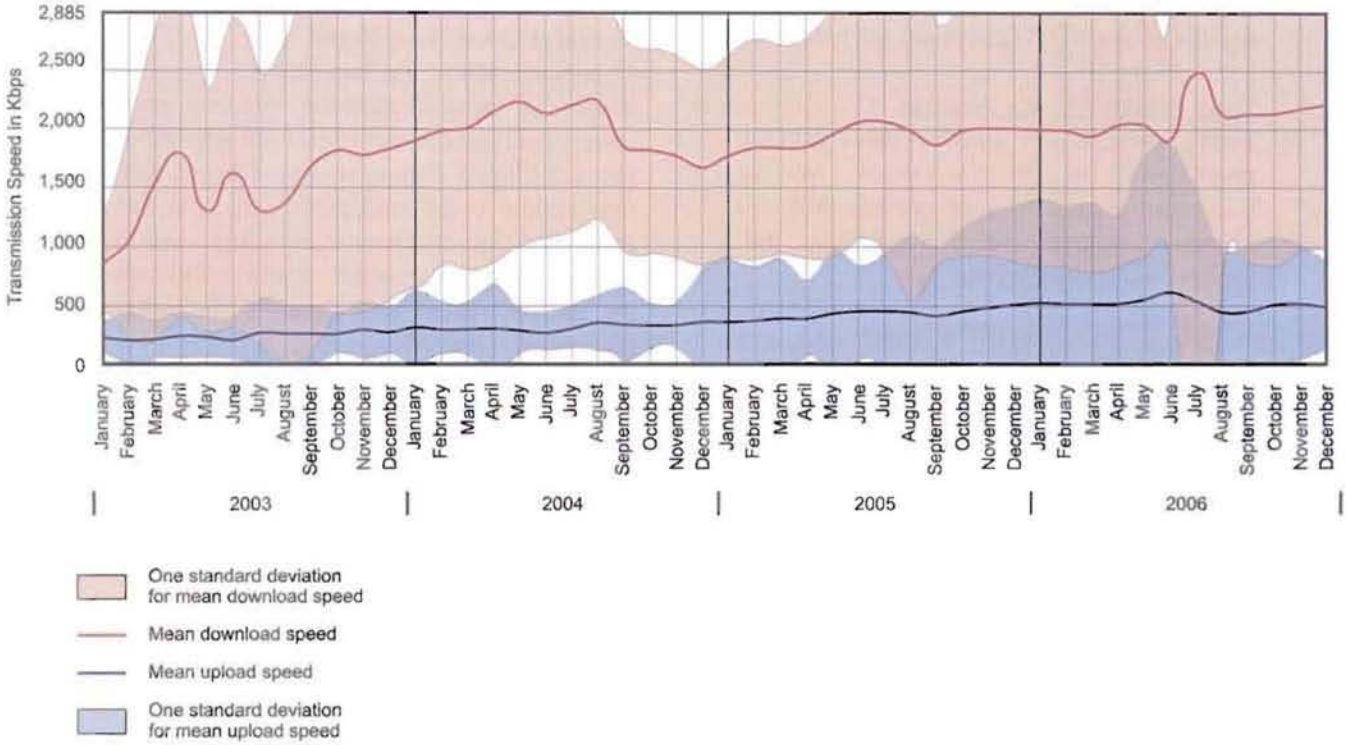
Although Comcast does not operate in Southeastern Wisconsin, its technology is similar to that of Time Warner and Charter, the primary cable service providers in the Region. Again, the slower upload speeds are graphically shown. A higher download throughput level of cable is indicated, but this performance also comes with a higher level of service and an associated higher cost.

The performance of Time Warner Cable is shown in Figures 11, 12 and 13 over the same 2003 through 2006 time period. Variations by the day of the week and hour of the day are also shown. The relatively slow upload speeds are again evident.

Time Warner Cable performance for a higher level of service offering is shown in Figures 14, 15, and 16. The 5000/512 service package promises a higher download speed than the previous 3000/768 service

Figure 9

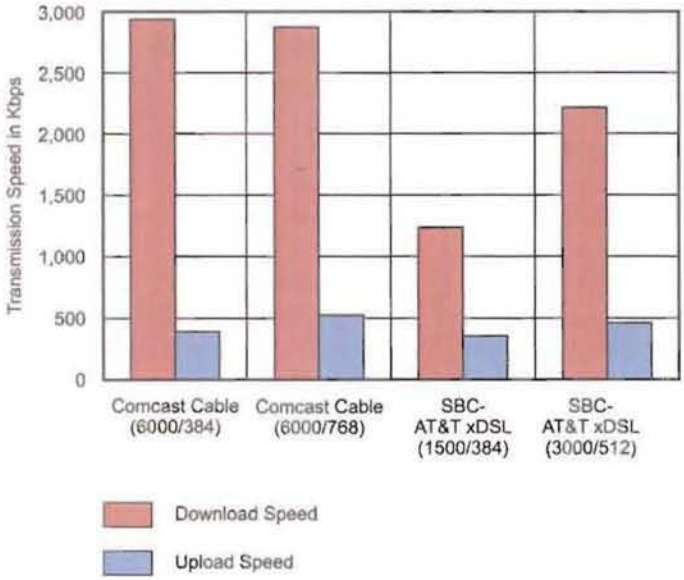
COMPARISON OF DOWNLOAD AND UPLOAD TRANSMISSION RATES FOR ALL INTERNET SERVICE PROVIDERS IN THE UNITED STATES: 2003 - 2006



Source: Sigma Solutions Group, LLC, and SEWRPC.

Figure 10

COMPARISON OF BROADBAND AND DSL PERFORMANCE FOR THE TWO PRIMARY SERVICE PROVIDERS IN THE UNITED STATES



Source: Sigma Solutions Group, LLC, and SEWRPC.

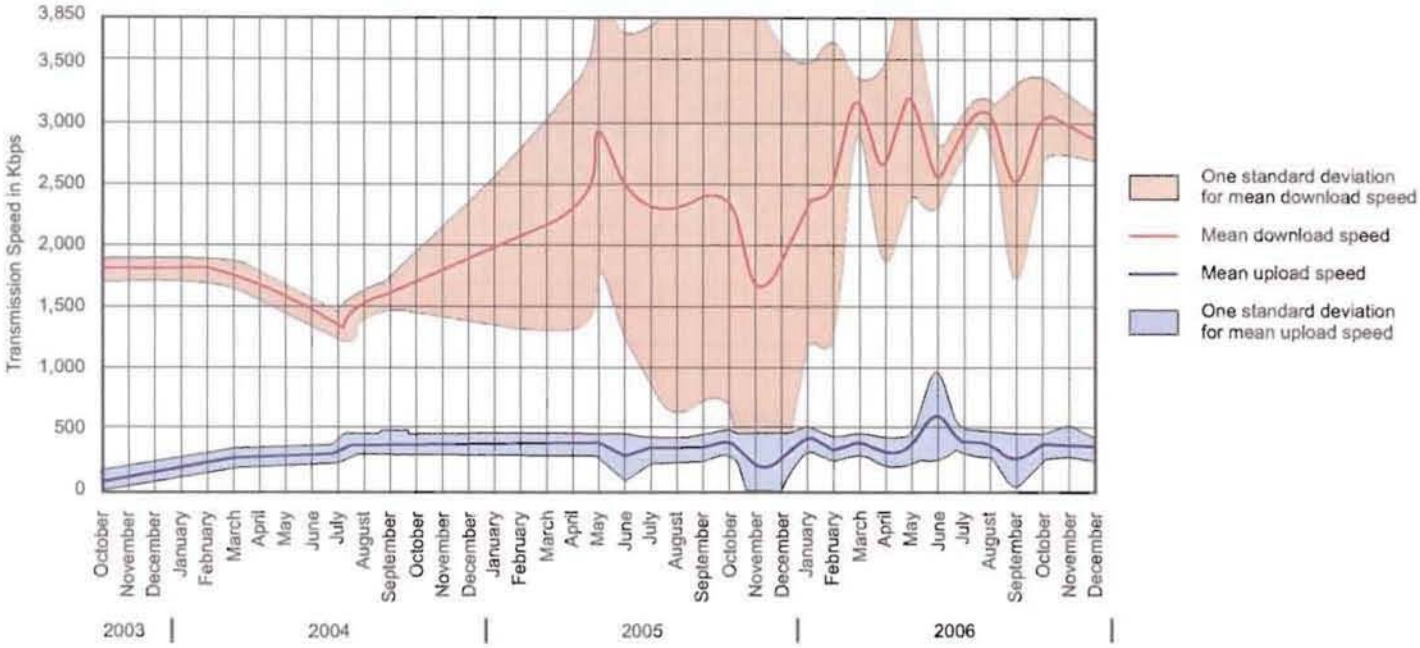
package but with a slower upload speed. The graphs actually indicate a slower download throughput but a slightly higher upload speed performance. Residential service agreements provide no quality of service guarantees. The higher throughput value represents only a maximum throughput speed allowed and not a guaranteed level of service.

An equivalent performance record for Charter Communications, the other regional cable service provider, is shown in Figures 17, 18 and 19. Throughput speeds are significantly slower than the equivalent service offering of Time Warner.

AT&T DSL performance at a higher service level—6,000/608—in the United States is plotted in Figures 20, 21 and 22. The significantly higher level of both download—over four megabits per second—and upload speeds—approximately 500 kilobits per second—is noteworthy. The DSL category, however, is xDSL meaning higher level versions of DSL such as VDSL could be included in the data

Figure 11

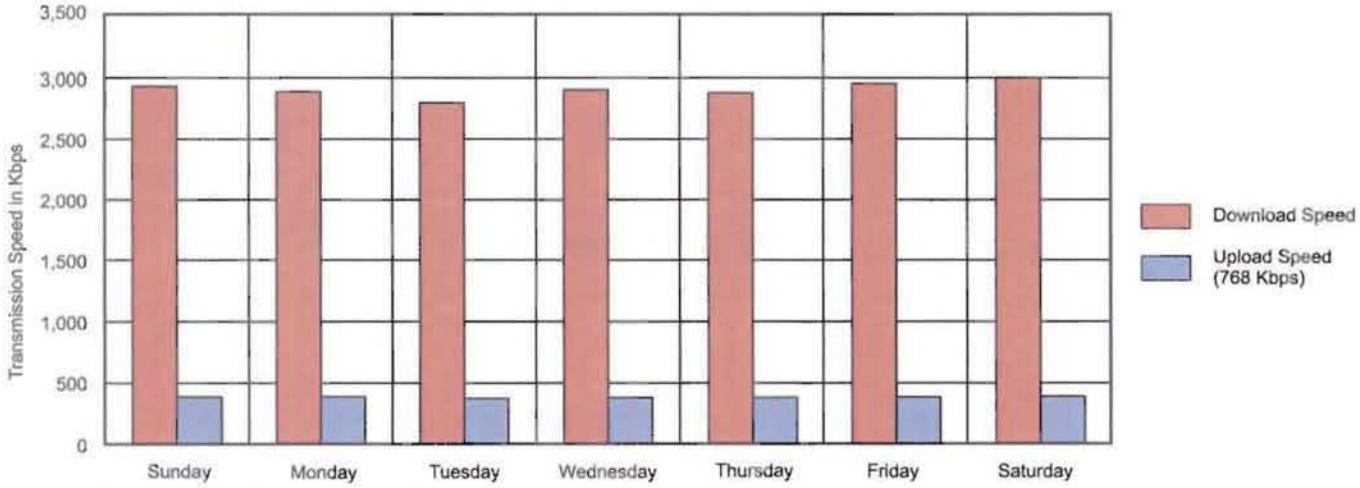
ROAD RUNNER (TIME WARNER CABLE) SERVICE (3000 Kbps/768 Kbps) IN THE UNITED STATES: OCTOBER 2003 THROUGH DECEMBER 2006



Source: Sigma Solutions Group, LLC, and SEWRPC.

Figure 12

UNITED STATES-ROAD RUNNER (TIME WARNER CABLE) CABLE (3000 Kbps/768 Kbps) SPEED VS DAY OF WEEK



Source: Sigma Solutions Group, LLC, and SEWRPC.

summary. Because deployment of VDSL by AT&T in the United States has not been extensive, most of the data in this summary is believed to represent ADSL technology.

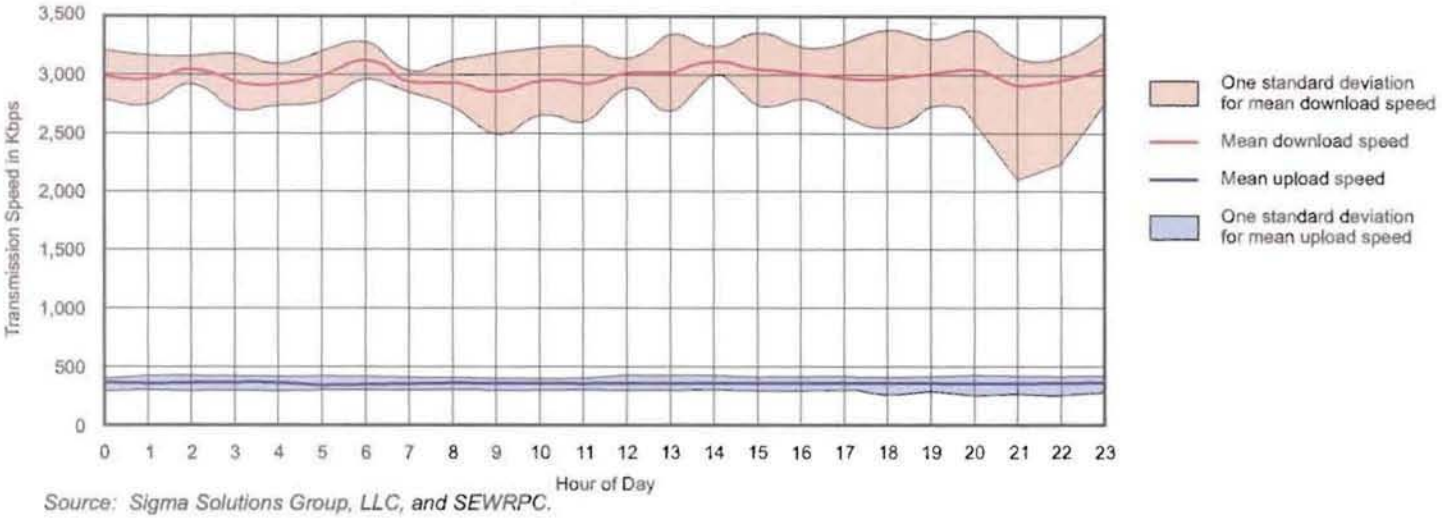
A similar data summary for CenturyTel, a regional DSL service provider is displayed in Figures 23, 24 and 25. The level of service portrayed, however, is much lower at 1,500/256. It is significant that actual performance is very close to the service specified.

Wireless Broadband Performance

Performance data on wireless broadband networks even at the national level are not widely available. The cellular/PCS wireless monitoring data reported in SEWRPC Planning Report No. 51 provided a greater volume of data than most other publicly available reports even at the national level. The data collected by the Commission were for mobile rather than fixed wireless service. Some of the wireless

Figure 13

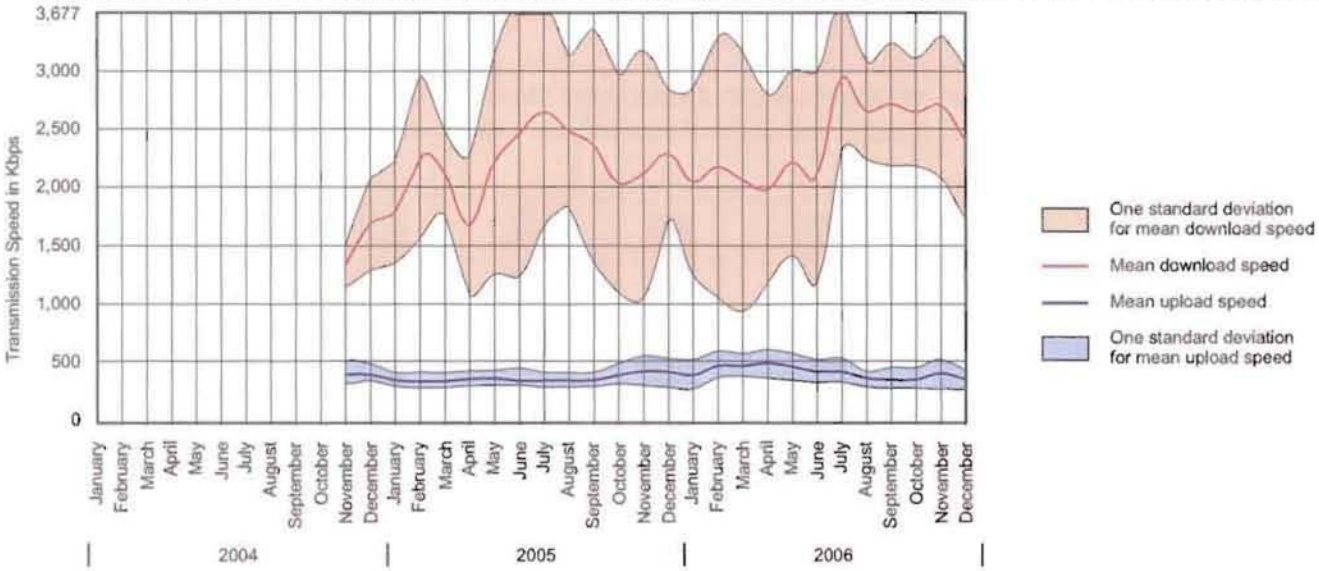
ROAD RUNNER SERVICE (3000 Kbps/768 Kbps) IN THE UNITED STATES VS HOUR OF DAY (+1000)



Source: Sigma Solutions Group, LLC, and SEWRPC.

Figure 14

COMPARISON OF DOWNLOAD (5000 Kbps) AND UPLOAD (512 Kbps) TRANSMISSION RATES BY MONTH FOR TIME WARNER CABLE ROAD RUNNER SERVICE IN THE UNITED STATES: NOVEMBER 2004 THROUGH DECEMBER 2006



Source: Sigma Solutions Group, LLC, and SEWRPC.

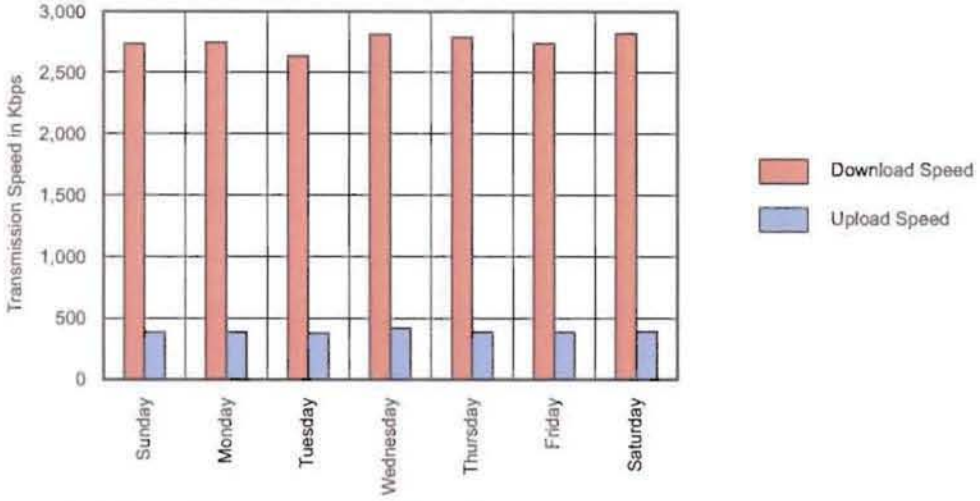
performance data relate to standard technologies such as WiFi (IEEE 802.11), but most relate to a variety of proprietary technologies.

An interesting WiFi performance study is illustrated in Figure 26 for a 3600/3000 service level typical of mesh networks. Initially, upload throughput exceeds download throughput, an unusual situation for any current day broadband network. Although WiFi networks are basically symmetrical, ISPs typically allocate more bandwidth to download traffic than upload traffic because most applications are download oriented.

Some rare data on broadband mobile wireless are shown in Figures 27, 28 and 29. All of the cellular/PCS broadband data collected and presented in SEWRPC Planning Report No. 51 were based on 3G CDMA technology as deployed by Verizon Wireless and Sprint. The new data presented in

Figure 15

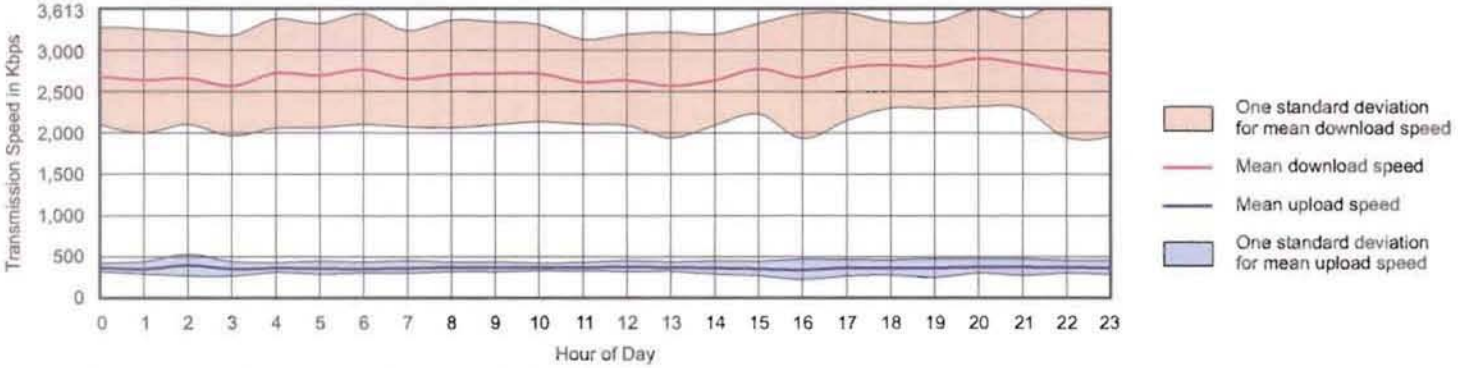
COMPARISON OF DOWNLOAD (5000 Kbps) AND UPLOAD (512 Kbps) TRANSMISSION RATES BY DAY OF WEEK FOR TIME WARNER CABLE ROAD RUNNER SERVICE IN THE UNITED STATES



Source: Sigma Solutions Group, LLC, and SEWRPC.

Figure 16

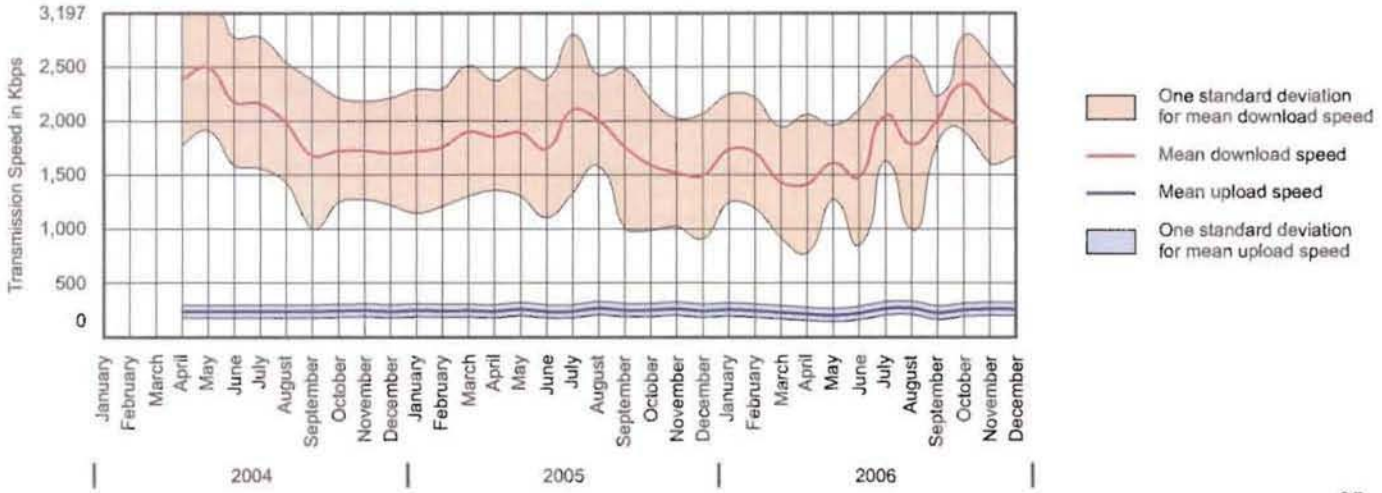
COMPARISON OF DOWNLOAD (5000 Kbps) AND UPLOAD (512 Kbps) TRANSMISSION RATES BY HOUR OF DAY FOR TIME WARNER CABLE ROAD RUNNER SERVICE IN THE UNITED STATES



Source: Sigma Solutions Group, LLC, and SEWRPC.

Figure 17

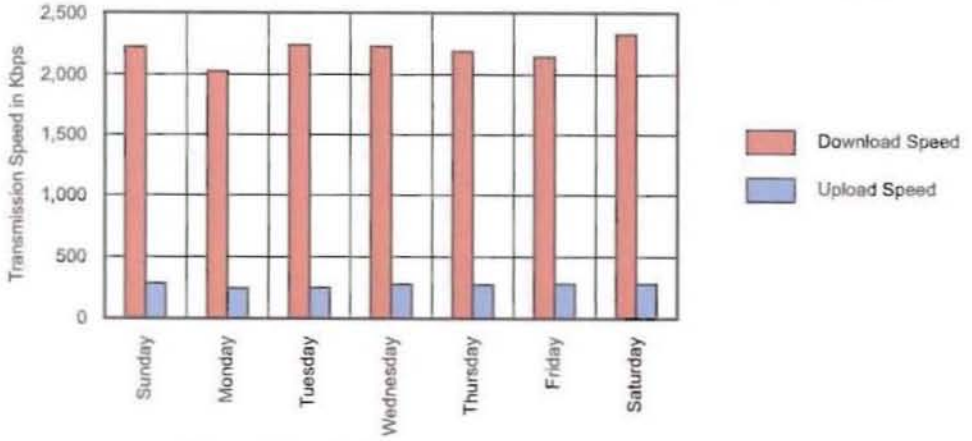
COMPARISON OF DOWNLOAD (3000 Kbps) AND UPLOAD (256 Kbps) TRANSMISSION RATES BY MONTH FOR CHARTER CABLE IN THE UNITED STATES: APRIL 2004 THROUGH DECEMBER 2006



Source: Sigma Solutions Group, LLC, and SEWRPC.

Figure 18

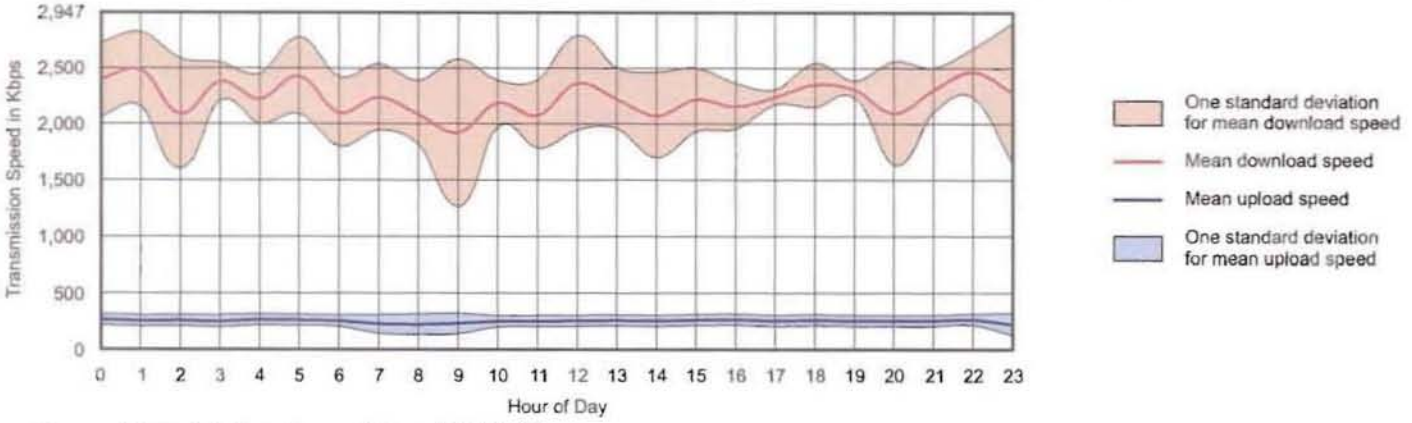
COMPARISON OF DOWNLOAD (3000 Kbps) AND UPLOAD (256 Kbps) TRANSMISSION RATES BY DAY OF WEEK FOR CHARTER CABLE IN THE UNITED STATES



Source: Sigma Solutions Group, LLC, and SEWRPC.

Figure 19

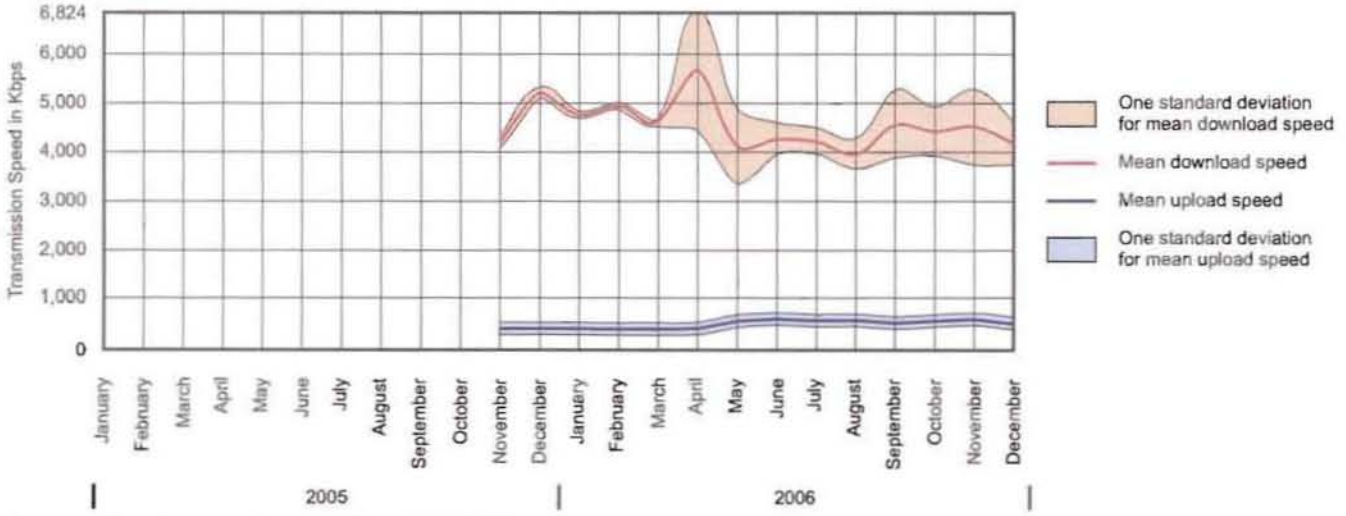
COMPARISON OF DOWNLOAD (3000 kbps) AND UPLOAD (256 Kbps) TRANSMISSION RATES BY HOUR OF DAY FOR CHARTER CABLE IN THE UNITED STATES



Source: Sigma Solutions Group, LLC, and SEWRPC.

Figure 20

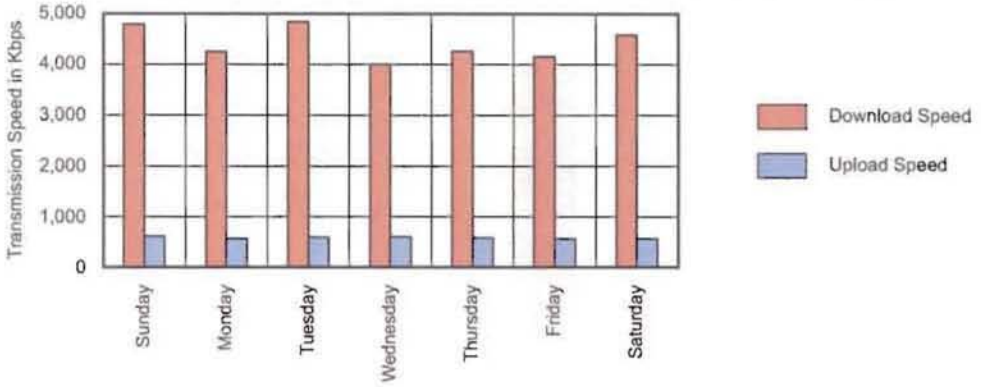
COMPARISON OF DOWNLOAD (6000 Kbps) AND UPLOAD (608 Kbps) TRANSMISSION RATES BY MONTH FOR SBC - AT&T xDSL SERVICE IN THE UNITED STATES: NOVEMBER 2005 THROUGH DECEMBER 2006



Source: Sigma Solutions Group, LLC, and SEWRPC.

Figure 21

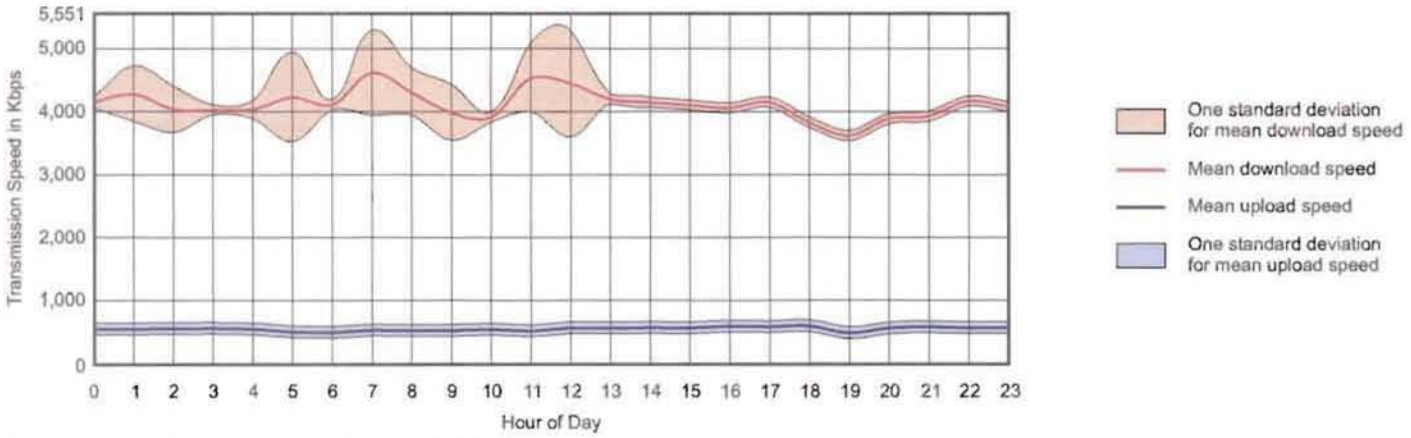
COMPARISON OF DOWNLOAD (6000 Kbps) AND UPLOAD (608 Kbps) TRANSMISSION RATES BY DAY OF WEEK FOR SBC - AT&T xDSL IN THE UNITED STATES



Source: Sigma Solutions Group, LLC, and SEWRPC.

Figure 22

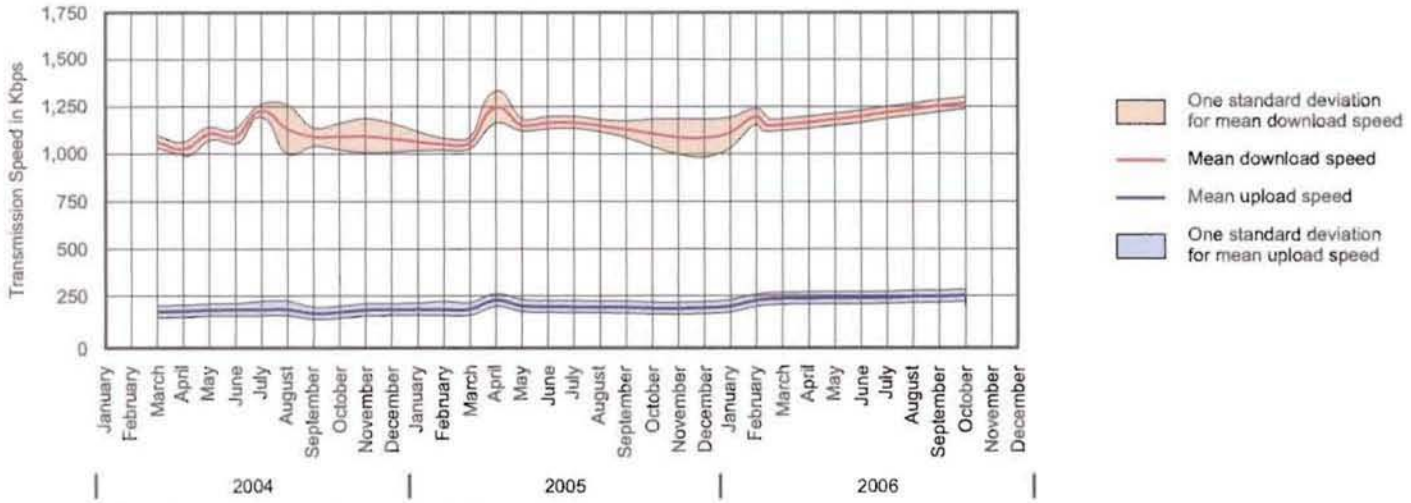
COMPARISON OF DOWNLOAD (6000 Kbps) AND UPLOAD (608 Kbps) TRANSMISSION RATES BY HOUR OF DAY FOR SBC - AT&T xDSL IN THE UNITED STATES



Source: Sigma Solutions Group, LLC, and SEWRPC.

Figure 23

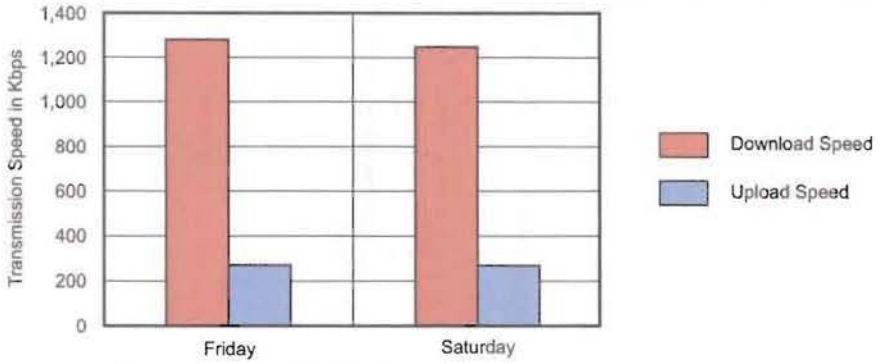
COMPARISON OF DOWNLOAD (1500 Kbps) AND UPLOAD (256 Kbps) TRANSMISSION RATES BY MONTH FOR CENTURYTEL xDSL IN THE UNITED STATES: MARCH 2004 THROUGH OCTOBER 2006



Source: Sigma Solutions Group, LLC, and SEWRPC.

Figure 24

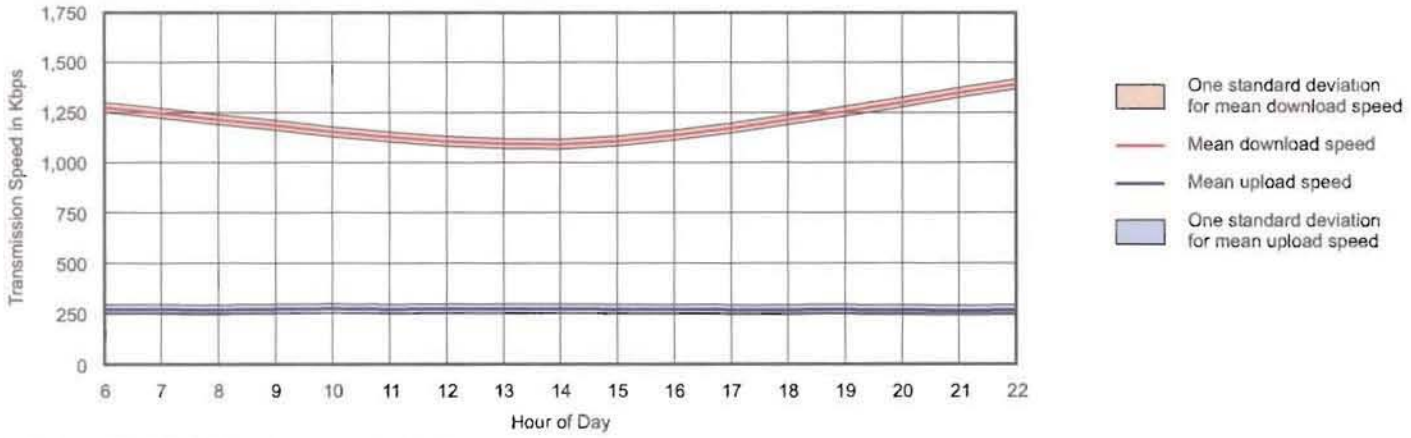
COMPARISON OF DOWNLOAD (1500 Kbps) AND UPLOAD (256 Kbps) TRANSMISSION RATES ON FRIDAYS AND SATURDAYS FOR CENTURYTEL xDSL SERVICE IN THE UNITED STATES



Source: Sigma Solutions Group, LLC, and SEWRPC.

Figure 25

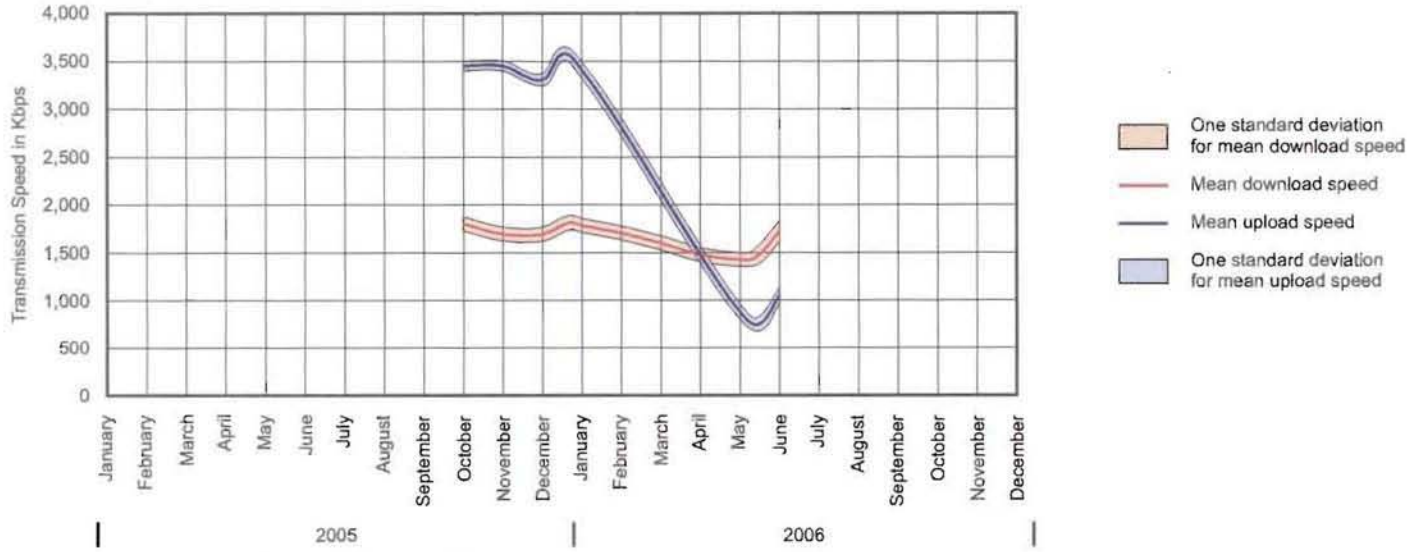
COMPARISON OF DOWNLOAD (1500 Kbps) AND UPLOAD (256 Kbps) TRANSMISSION RATES BY HOUR OF DAY FOR CENTURY TEL xDSL IN THE UNITED STATES



Source: Sigma Solutions Group, LLC, and SEWRPC.

Figure 26

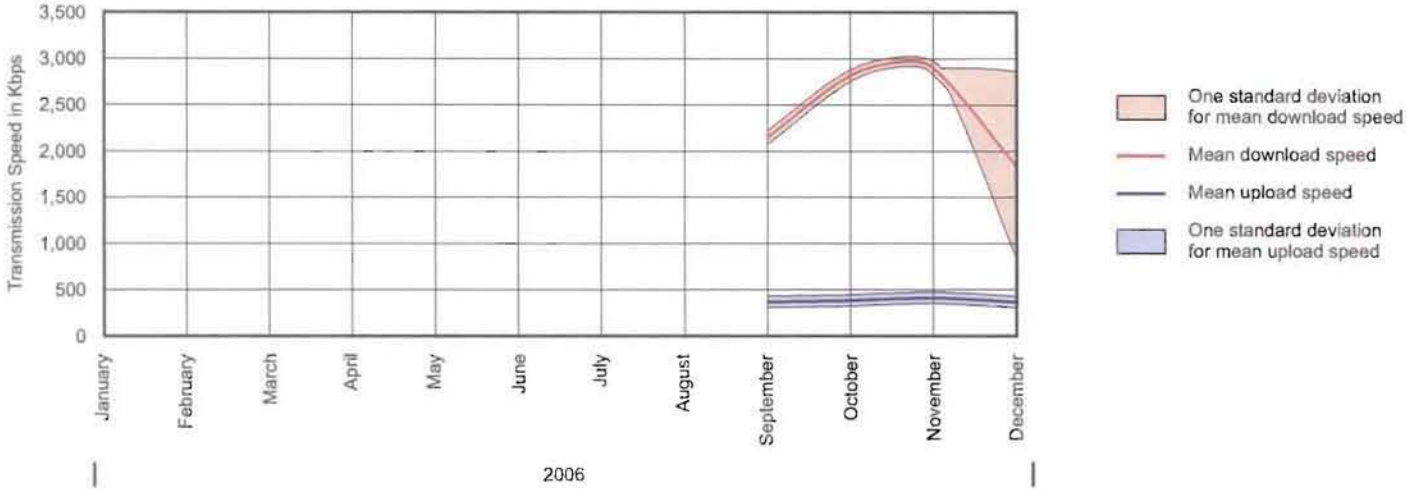
COMPARISON OF DOWNLOAD (3000 Kbps) AND UPLOAD (3000 Kbps) TRANSMISSION RATES BY MONTH FOR WIRELESS BROADBAND INTERNET ACCESS WiFi 802.11a/b/g/n/x IN THE UNITED STATES: OCTOBER 2005 THROUGH JUNE 2006



Source: Sigma Solutions Group, LLC, and SEWRPC.

Figure 27

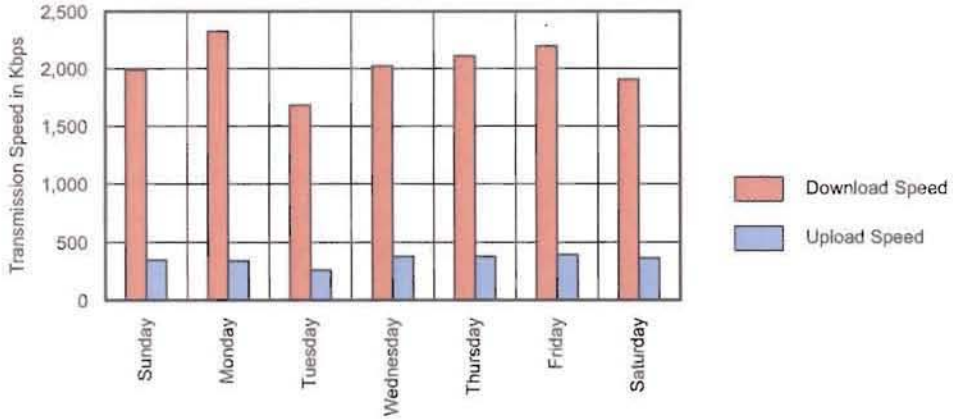
COMPARISON OF DOWNLOAD AND UPLOAD TRANSMISSION RATES BY MONTH FOR CINGULAR WIRELESS GSM GPRS IN THE UNITED STATES: SEPTEMBER 2006 THROUGH DECEMBER 2006



Source: Sigma Solutions Group, LLC, and SEWRPC.

Figure 28

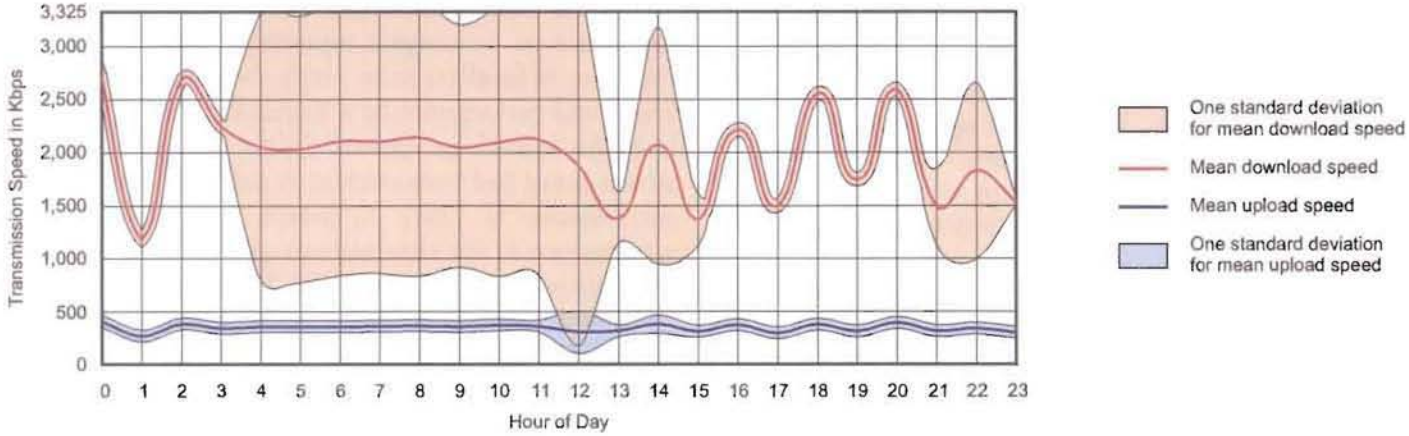
COMPARISON OF DOWNLOAD AND UPLOAD TRANSMISSION RATES BY DAY OF WEEK FOR CINGULAR WIRELESS GSM GPRS IN THE UNITED STATES



Source: Sigma Solutions Group, LLC, and SEWRPC.

Figure 29

COMPARISON OF DOWNLOAD AND UPLOAD TRANSMISSION RATES BY HOUR OF DAY FOR CINGULAR WIRELESS GSM GPRS IN THE UNITED STATES



Source: Sigma Solutions Group, LLC, and SEWRPC.

Figures 27, 28, and 29 relate to the GSM/GPRS technology employed by Cingular Wireless. A 3G version of GSM wireless technologies has not been deployed in Southeastern Wisconsin, but these results indicate that the technology is potentially capable of achieving the 3G throughput objective of two megabits per second. This objective, however, is still below the 4G standard of 20 megabits per second of interest here, but also far above the regional CDMA 3G performance recorded in SEWRPC Planning Report No. 51 which averaged only 336 kilobits per second in download performance, and 79 kilobits per second in upload performance.

Clearwire Wireless is a national broadband wireless service provider that employs a proprietary wireless technology (Alvarion) and WiMAX to provide broadband communications services in certain areas of the United States, including Wisconsin. The Company has deployed networks in the states of Washington, Oregon, California, Texas, North Carolina and Florida as well as a network in the Eau Claire/Chippewa Falls, area of Wisconsin. The performance graphs presented in Figures 30, 31 and 32 indicate performance levels in the 1.0 to 1.5 megabits per second range, which are probably typical of most fixed wireless networks in the United States.

The performance of fixed wireless service providers can vary widely, however, as indicated by the performance graphs for Communicomm Wireless (Texas) and Keyon Wireless (Nevada) shown in Figures 33 and 34. As shown in Figure 33, a 1500/200 service offering Communicomm provides a throughput level below 500 kilobits per second in the download direction. Keyon Wireless for a 2048/512 service offering averages half of that level as shown in Figure 34.

Finally, wireless satellite performance data on a comparable graphical basis are recorded in Figures 35, 36 and 37 for SATNOW Satellite with a service offering of 1000/56. The upload service is essentially dial-up level throughput performance. Download performance, consistent with the service offering, is around 800-900 kilobits per second.

State of Wisconsin Broadband Communications Performances

A comparison of throughput performance of all ISPs for the United States as presented in Figure 9, and for Wisconsin, as presented in Figure 38, indicates general parity between these geographic areas. Wisconsin performance is more volatile, but that may be due to by the smaller sample sizes involved at the State level. For both the United States and for Wisconsin, overall broadband communications performance is currently in the one to two megabits per second range.

Available performance data for Time Warner Cable Road Runner broadband cable service within Wisconsin appeared to contain serious errors and therefore constituted an unusable data set. Accordingly, no comparison could be made between national and Wisconsin performance levels.

Charter Cable also appears to offer a lower throughput performance in Wisconsin than nationally as indicated by a comparison of Figure 39 with Figures 17, 18, and 19. The national level performance is significantly above two megabits per second, while the performance within Wisconsin generally ranges under two megabits per second and at times below one megabit per second.

The DSL performance provided within Wisconsin by the three ILEC carriers—AT&T, TDS and Verizon—shows quite similar performance in Figures 40, 41, and 42.

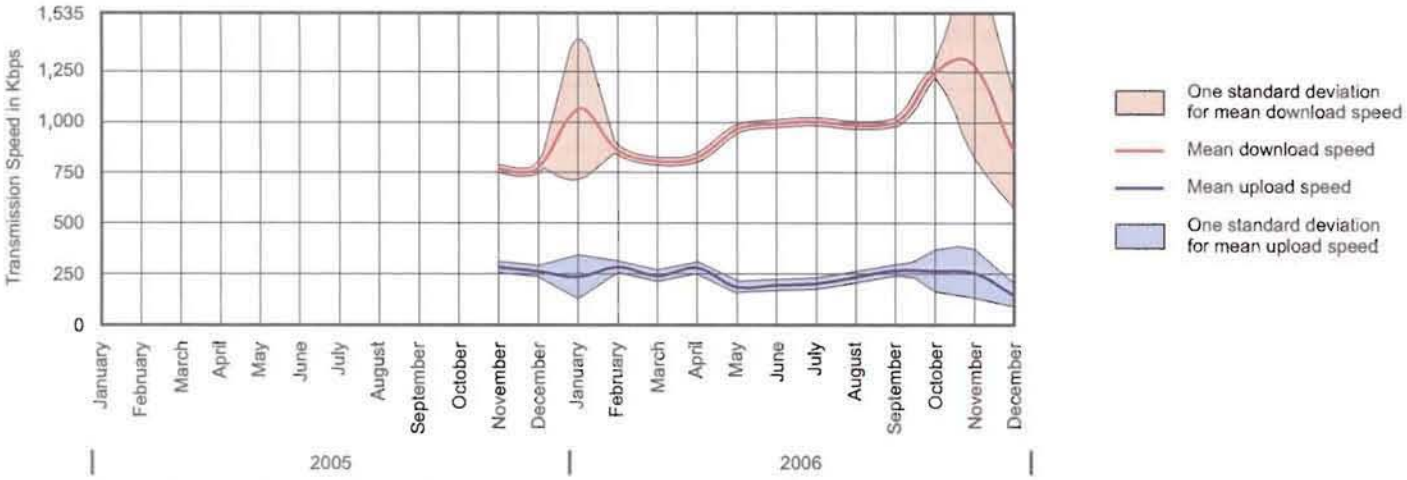
A composite tabulation of wireline broadband communication performance within Wisconsin is presented in Table 16.

Local-Level Broadband Performance Within Southeastern Wisconsin

While national and State level broadband performance data provide a comparative evaluation of the wireline broadband communications technologies in use within the Southeastern Wisconsin Region, it is instructive to investigate equivalent network performance at local levels to verify the consistency of broadband performance on a Regional basis. If local level broadband performance data are consistent with national and State evaluation data, then regional performance is likely to match the throughput performance of the same technologies in other states and regions of the United States. In the future, when performance data at the postal zip code level become more readily available, it will become possible to map regional broadband performance in some detail.

Figure 30

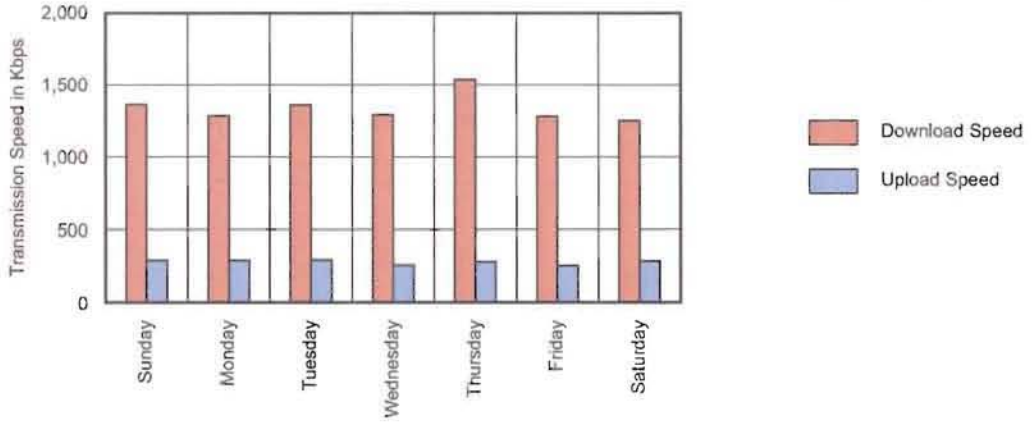
COMPARISON OF DOWNLOAD (1500 Kbps) AND UPLOAD (256 Kbps) TRANSMISSION RATES BY MONTH FOR CLEARWIRE WIRELESS - PROPRIETARY IN THE UNITED STATES: NOVEMBER 2005 THROUGH DECEMBER 2006



Source: Sigma Solutions Group, LLC, and SEWRPC.

Figure 31

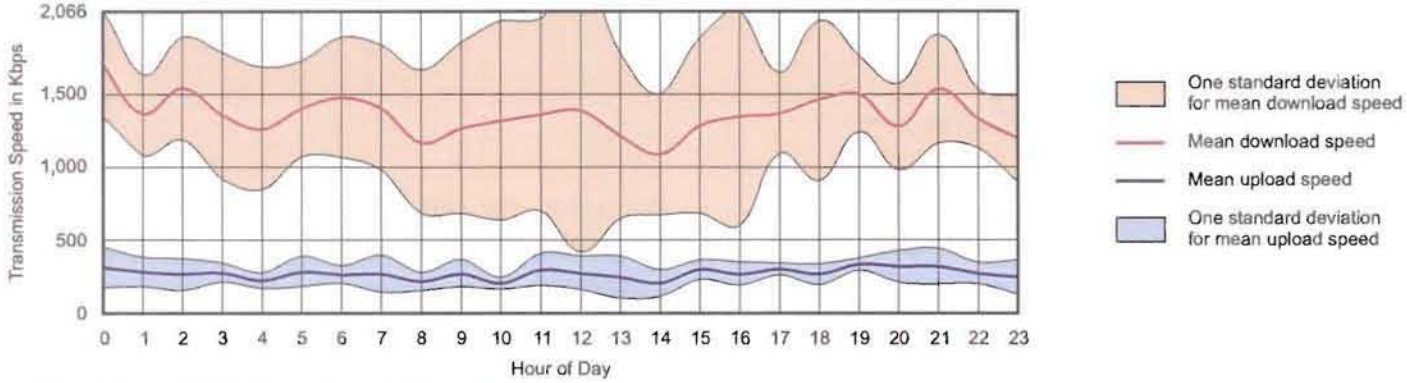
COMPARISON OF DOWNLOAD (1500 Kbps) AND UPLOAD (256 Kbps) TRANSMISSION RATES BY DAY OF WEEK FOR CLEARWIRE WIRELESS - PROPRIETARY IN THE UNITED STATES



Source: Sigma Solutions Group, LLC, and SEWRPC.

Figure 32

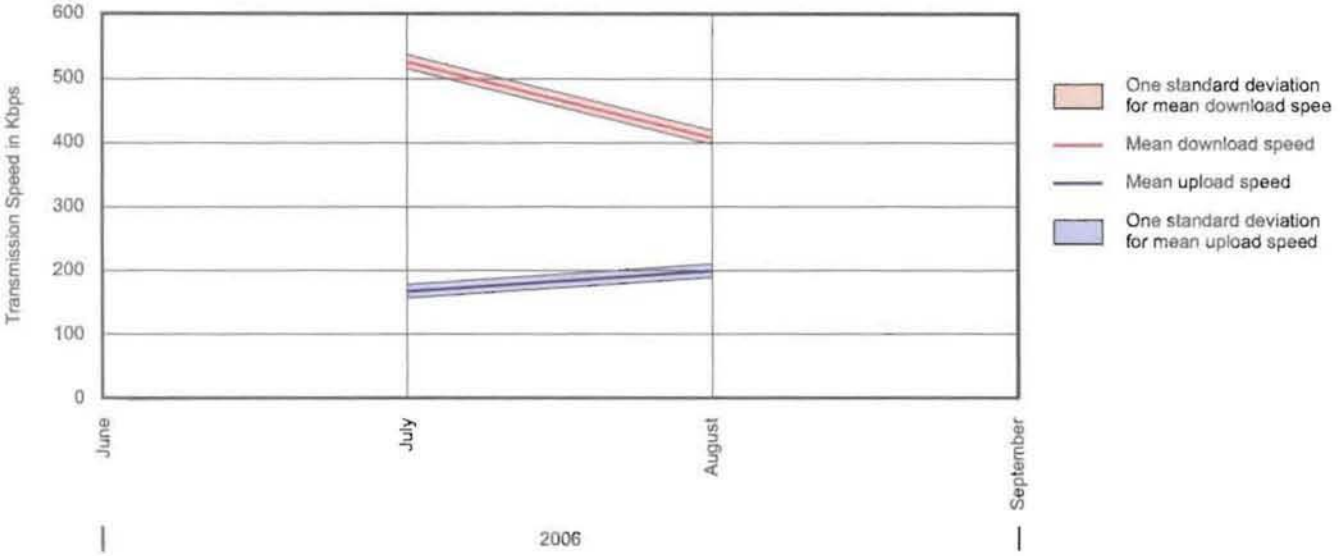
COMPARISON OF DOWNLOAD (1500 Kbps) AND UPLOAD (256 kbps) TRANSMISSION RATES BY HOUR OF DAY FOR CLEARWIRE WIRELESS - PROPRIETARY IN THE UNITED STATES



Source: Sigma Solutions Group, LLC, and SEWRPC.

Figure 33

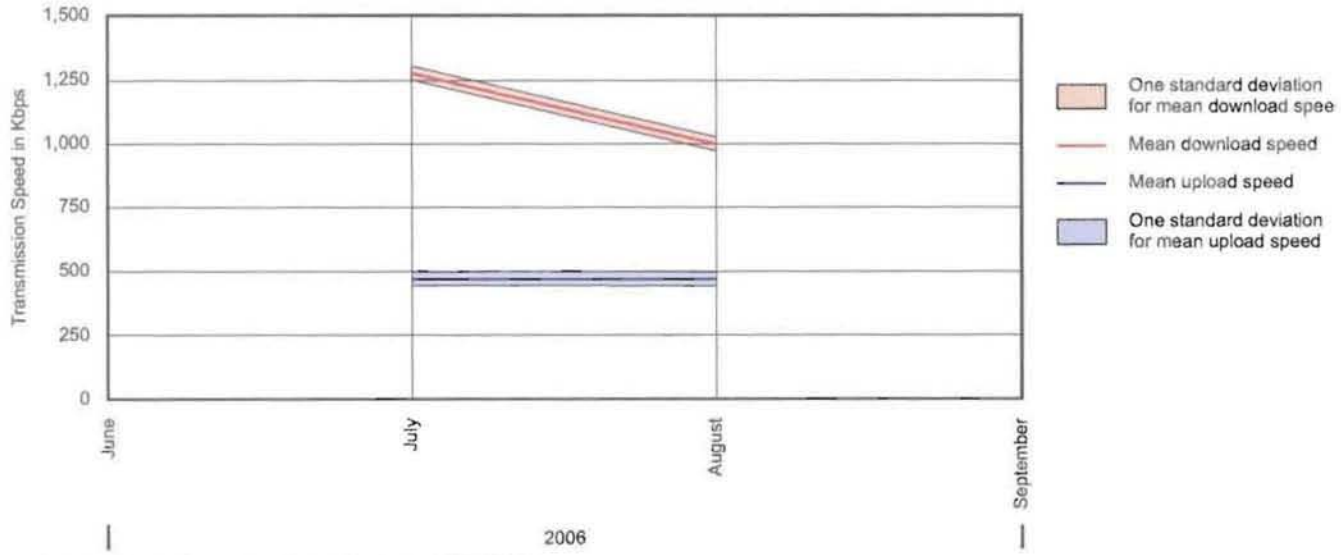
COMPARISON OF DOWNLOAD (1500Kbps) AND UPLOAD (200Kbps) TRANSMISSION RATES BY MONTH FOR COMMUNICOMM WIRELESS – PROPRIETARY IN THE UNITED STATES: JULY 2006



Source: Sigma Solutions Group, LLC, and SEWRPC.

Figure 34

COMPARISON OF DOWNLOAD (2048Kbps) AND UPLOAD (512Kbps) TRANSMISSION RATES BY MONTH FOR KEYON WIRELESS – PROPRIETARY IN THE UNITED STATES: JULY 2006



Source: Sigma Solutions Group, LLC, and SEWRPC.

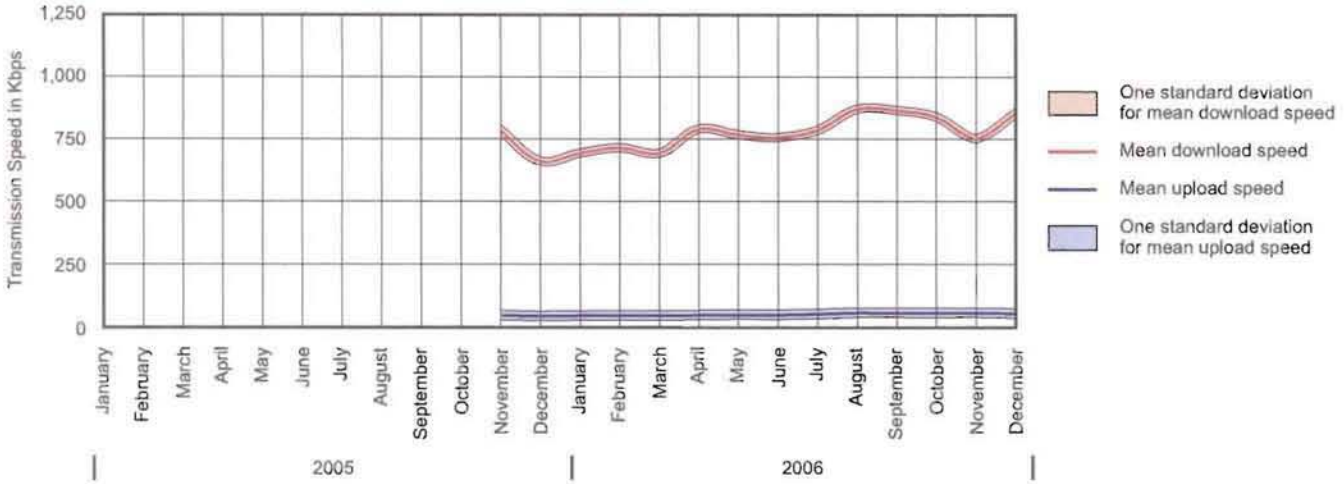
Currently, it is possible only to verify performance equivalency with national and State performance levels.

The next level of source data below the state category for the TCP/IQ website is the postal zip code. Source data at the zip code level is sparse with many zip code areas having no data reported. For this reason, the performance data herein presented for smaller geographic areas, was severely constrained.

Broadband cable performance in the City of Lake Geneva, Walworth County—zip code 53147 shown on Map 28—in Figure 43, evaluates the same downward trend as exhibited at the State level

Figure 35

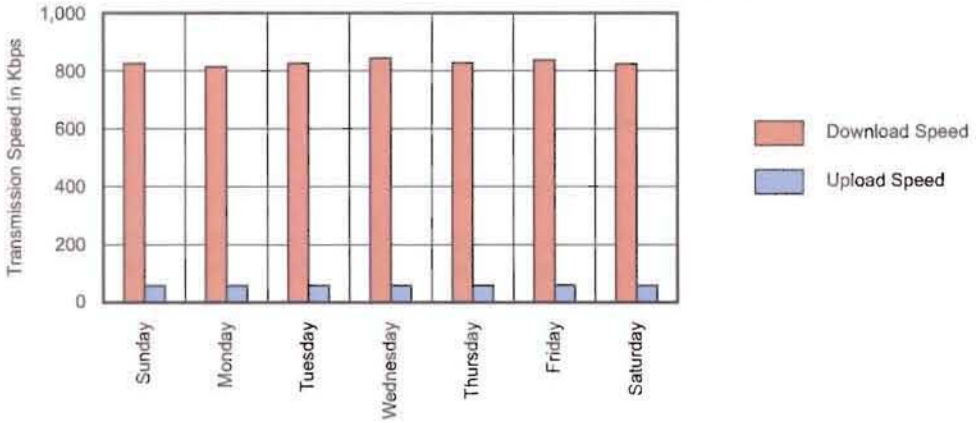
COMPARISON OF DOWNLOAD (1000 Kbps) AND UPLOAD (56 Kbps) TRANSMISSION RATES BY MONTH FOR SATNOW SATELLITE INTERNET SATELLITE + PHONE IN THE UNITED STATES: NOVEMBER 2005 THROUGH DECEMBER 2006



Source: Sigma Solutions Group, LLC, and SEWRPC.

Figure 36

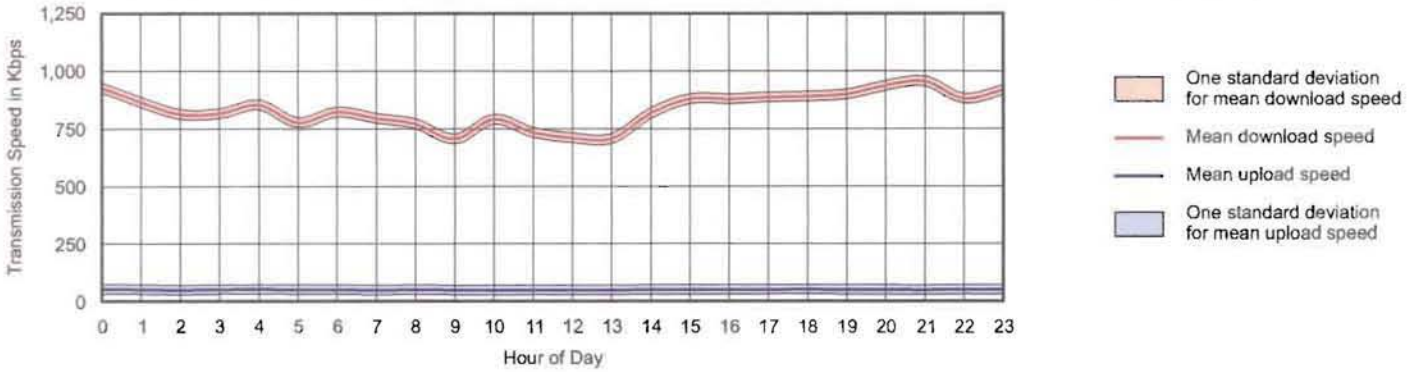
COMPARISON OF DOWNLOAD (1000 Kbps) AND UPLOAD (56 Kbps) TRANSMISSION RATES BY DAY OF WEEK FOR SATNOW SATELLITE INTERNET SATELLITE + PHONE IN THE UNITED STATES



Source: Sigma Solutions Group, LLC, and SEWRPC.

Figure 37

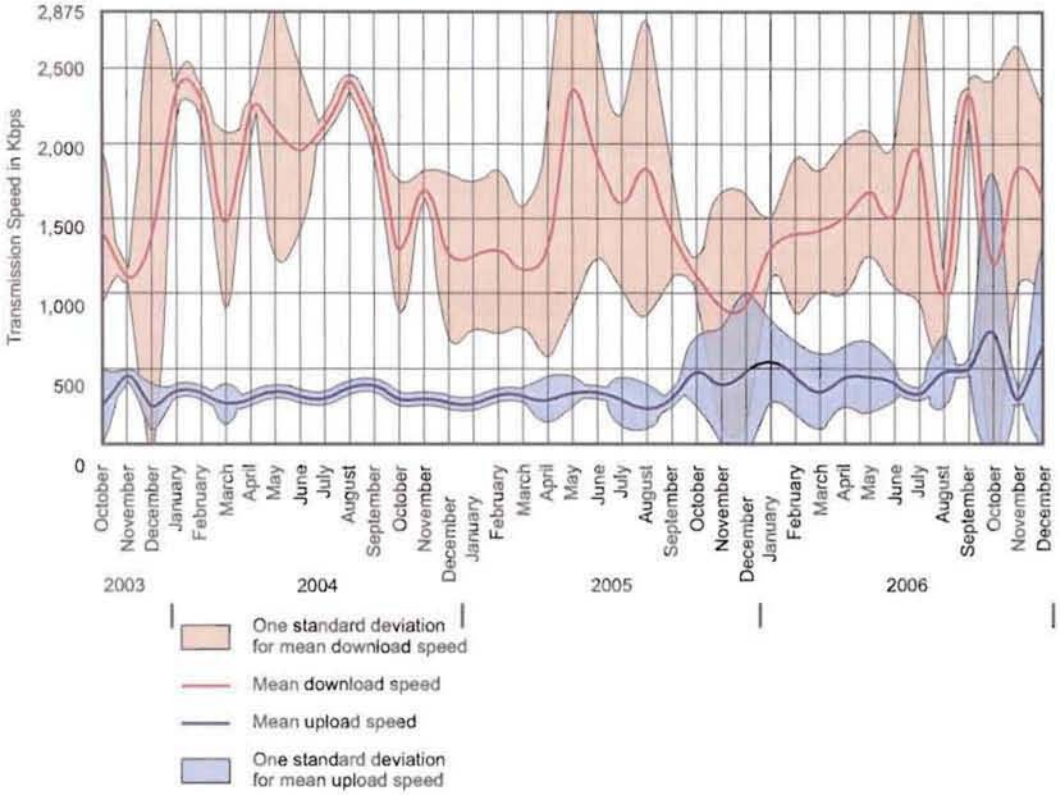
COMPARISON OF DOWNLOAD (1000 Kbps) AND UPLOAD (56 Kbps) TRANSMISSION RATES BY HOUR OF DAY FOR SATNOW SATELLITE INTERNET SATELLITE + PHONE IN THE UNITED STATES



Source: Sigma Solutions Group, LLC, and SEWRPC.

Figure 38

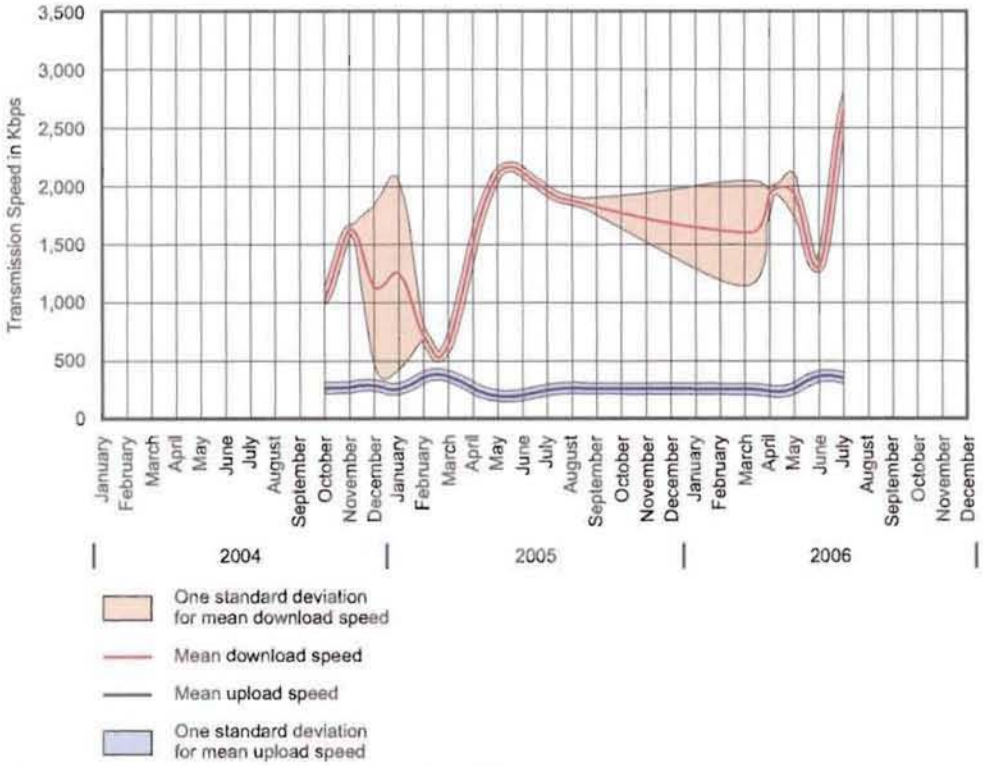
COMPARISON OF DOWNLOAD AND UPLOAD TRANSMISSION RATES FOR ALL INTERNET SERVICE PROVIDERS IN WISCONSIN: OCTOBER 2003 - DECEMBER 2006



Source: Sigma Solutions Group, LLC, and SEWRPC.

Figure 39

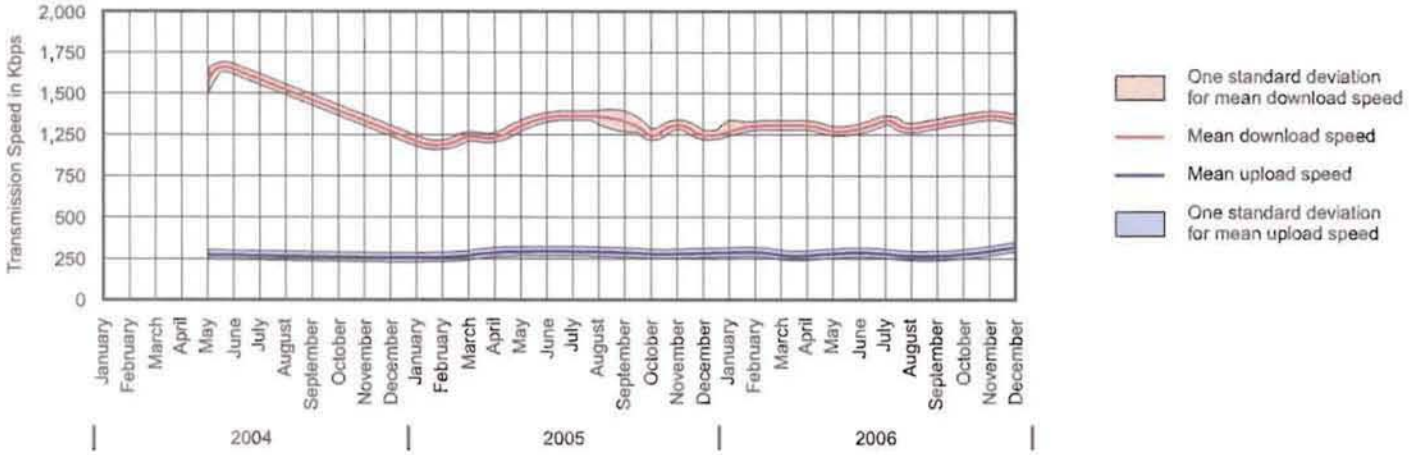
COMPARISON OF DOWNLOAD (3000 Kbps) AND UPLOAD (256 Kbps) TRANSMISSION RATES BY MONTH FOR CHARTER CABLE IN WISCONSIN: OCTOBER 2004 THROUGH JULY 2006



Source: Sigma Solutions Group, LLC, and SEWRPC.

Figure 40

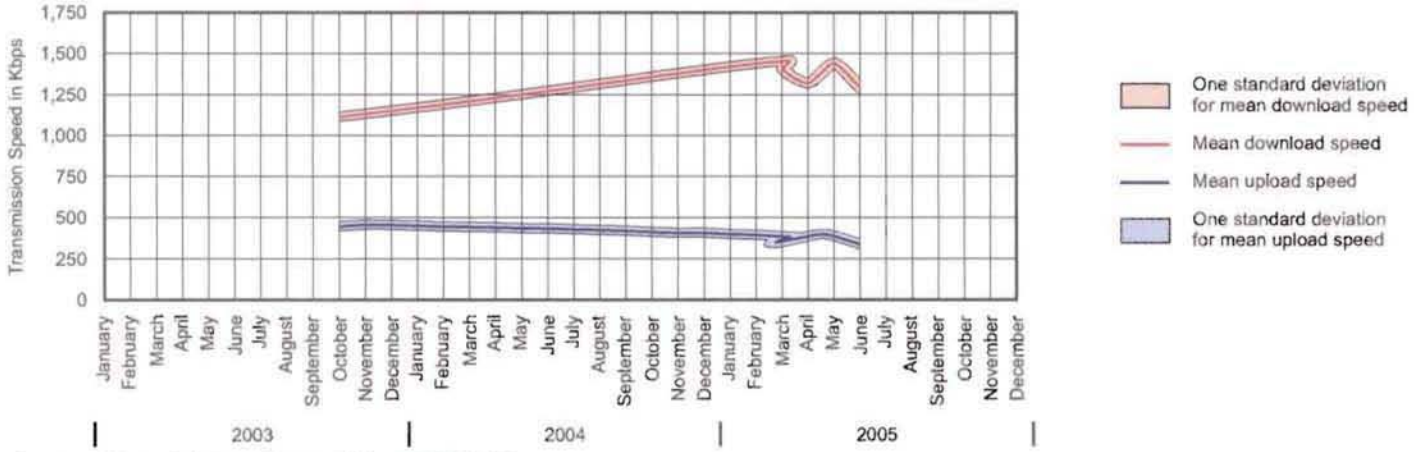
COMPARISON OF DOWNLOAD (1500 Kbps) AND UPLOAD (384 Kbps) TRANSMISSION RATES BY MONTH FOR SBC - AT&T xDSL IN WISCONSIN: MAY 2004 THROUGH DECEMBER 2006



Source: Sigma Solutions Group, LLC, and SEWRPC.

Figure 41

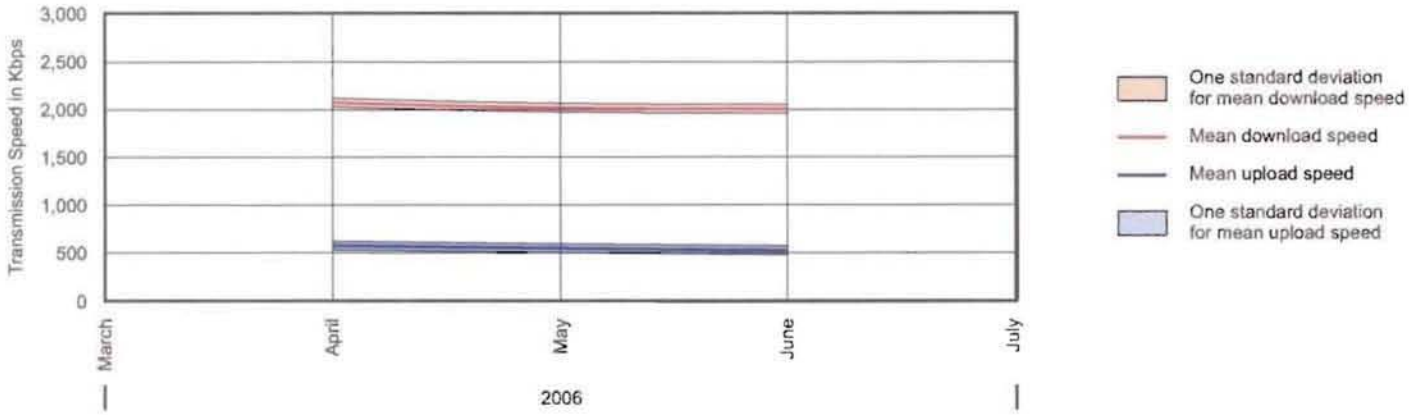
COMPARISON OF DOWNLOAD (1500 Kbps) AND UPLOAD (512 Kbps) TRANSMISSION RATES BY MONTH FOR TDS.net xDSL IN WISCONSIN: OCTOBER 2003 THROUGH JUNE 2005



Source: Sigma Solutions Group, LLC, and SEWRPC.

Figure 42

COMPARISON OF DOWNLOAD (3000 Kbps) AND UPLOAD (768 Kbps) TRANSMISSION RATES BY MONTH VERIZON xDSL IN WISCONSIN: APRIL 2006 THROUGH JUNE 2006



Source: Sigma Solutions Group, LLC, and SEWRPC.

Table 16

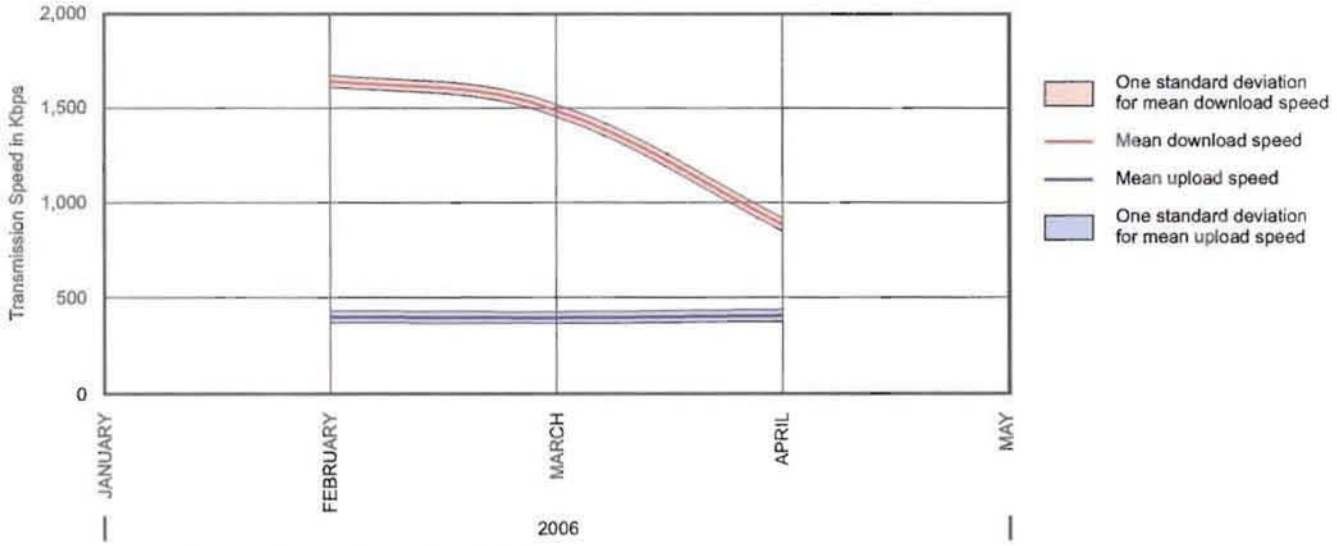
COMPARATIVE WIRELINE BROADBAND COMMUNICATIONS PERFORMANCE WITHIN WISCONSIN: 2006

Provider	Technology	Samples	Average Download Throughput (Mbps)
Time Warner Cable	Cable	30,111	2.59
Charter Communications	Cable	48,773	1.91
AT&T	ADSL	12,100	1.01
CenturyTel	ADSL	2,491	0.72
TDS	ADSL	2,725	0.47
Netwurx	Fixed / Wireless	130	1.19

Source: SEWRPC.

Figure 43

COMPARISON OF DOWNLOAD (5000Kbps) AND UPLOAD (768Kbps) TRANSMISSION RATES BY MONTH FOR TIME WARNER CABLE ROAD RUNNER SERVICE IN THE U.S. POSTAL ZIP CODE 53147 AREA OF THE CITY OF LAKE GENEVA, WALWORTH COUNTY AND ENVIRONS: FEBRUARY 2006 THROUGH APRIL 2006



Source: Sigma Solutions Group, LLC, and SEWRPC.

shown in Figure 40.Initial average download transmission rates in 2006 exceeded 1.5 megabits per second but declined over the first half year to average rates under 0.8 megabit per second. This decline in performance as a function of subscriber load is inherent in the hybrid fiber coaxial architecture cable. Upload throughput, though much lower in value, is remarkably stable. It is of interest to note that the offered service level of 5000/768 is significantly above actual performance.

A remarkably different performance trend for broadband DSL is indicated for AT&T DSL as shown in Figure 44 for West Bend, Washington County—zip code area 53095 as shown on Map 28. Transmission rates are stable near the offered service level of 1500/384 with no apparent downtrend in either download or upload throughput over time.

Data for zip code area 53207 as shown on Map 28 representing an area in the south side of the City of Milwaukee as given in Figure 45 indicates a lower level of performance than another AT&T site in West Bend. Comparing the performance provided in the south side of Milwaukee with that provided for West Bend as given in Figure 44, performance in the West Bend area is about 30 percent faster than in the selected area of Milwaukee using the same broadband DSL technology. This performance difference is probably best explained by the presence of multiple remote terminals in the West Bend area because of its size and newly developed subdivisions. Remote terminals enhance performance by bringing greater fiber optic bandwidth closer to the user. DSL performance degrades with distance from either the Central Office or fiber-linked terminals.