MINUTES OF THE FOURTEENTH MEETING

REGIONAL TELECOMMUNICATIONS PLANNING ADVISORY COMMITTEE (Reconstituted)

DATE: July 10, 2006

TIME: 2:00 P.M.

PLACE: Commissioners' Conference Room
Regional Planning Commission Offices
W239 N1812 Rockwood Drive
Waukesha, Wisconsin

Members Present

Kurt W. Bauer Chairman	Executive Director Emeritus, SEWRPC
Roger Caron	President, Racine Area Manufacturers and Commerce
Michael Falaschi	President, Wisconsin Internet
Barry Gatz	Network Supervisor, CenturyTel
Michael E. Klasen	Director, Regulatory Affairs, SBC Wisconsin
J. Michael Long	Attorney-at-Law, Murn and Martin, SC
Jeff M. Lowney	Vice President/General Manager, Time Warner Telecom
George E. Melcher	Director, Office of Planning and Development, Kenosha County
Paul E. Mueller	Administrator, Washington County Planning and Parks Department
Rob N. Richardson	Director, Racine County Information Systems
Steven L. Ritt	Attorney at Law, Michael Best & Friedrich
James W. Romlein	Managing Director, MVLabs, LLC
Michael Ulicki	Vice President and Chief Technology Officer, Norlight Telecommunications
Darryl Winston	Director of Data Services, City of Milwaukee Police Department
Gustav W. Wirth, Jr.	SEWRPC Commissioner

Members Absent

William R. Drew Vice Chairman	Vice-Chairman, SEWRPC; Executive Director, Milwaukee County Research Park
Bob Chernow	Chairman, Regional Telecommunications Commission
David L. DeAngelis	Village Manager, Village of Elm Grove
Jeff Mantes	Commissioner of Public Works, City of Milwaukee
Bennett Schliesman	Director, Kenosha County Emergency Management /Homeland Security
Dale R. Shaver	Director, Waukesha County Department of Parks and Land Use

Staff

Philip C. Evenson	Executive Director, SEWRPC
Kenneth J. Schlager, PhD	Chief Telecommunications Engineer, SEWRPC
Lynn G. Heis	Staff Secretary, SEWRPC

CALL TO ORDER AND ROLL CALL

Chairman Bauer called the meeting to order at 2:00P.M. Roll call was taken by circulating an attendance signature sheet, and a quorum was declared present.

CONSIDERATION OF THE MINUTES OF THE MEETING OF MAY 23, 2006

Chairman Bauer noted that copies of the minutes of the thirteenth meeting of the Reconstituted Regional Telecommunications Planning Advisory Committee held on May 23, 2006, had been distributed to all members of the Committee for review prior to the meeting. He asked the Committee to consider approval.

Chairman Bauer noted that under the Committee established procedure, approval of the minutes would also constitute final approval of Chapters VI, "Wireless Telecommunications Performance Inventory Findings," Chapter VIII, "Regional Wireless Network Plan Implementation," and Chapter IX, "Summary," of SEWRPC Planning Report No. 51, *A Wireless Antenna Siting and Related Infrastructure Plan for Southeastern Wisconsin.* He noted that these chapters incorporated changes, which the Committee had at its meeting held on May 23, 2006, directed to be made based upon the Committee review of preliminary drafts of these three chapters.

There being no corrections or additions, on a motion by Mr. Wirth, seconded by Mr. Melcher, and carried unanimously, the minutes of the meeting of May 23, 2006, were approved as submitted.

FURTHER CONSIDERATION OF REVISED PRELIMINARY DRAFT OF CHAPTER VII, "A REGIONAL WIRELESS TELECOMMUNICATIONS PLAN FOR SOUTHEASTERN WISCONSIN," OF SEWRPC PLANNING REPORT NO. 51, *A WIRELESS ANTENNA SITING AND RELATED INFRASTRUCTURE PLAN FOR SOUTHEASTERN WISCONSIN.*

Chairman Bauer recalled that the Committee at its meeting held on February 28, 2006, had considered a pre-preliminary draft of Chapter VII, "A Regional Wireless Telecommunications Plan For Southeastern Wisconsin," of SEWRPC Planning Report No. 51, *A Wireless Antenna Siting and Related Infrastructure Plan for Southeastern Wisconsin.* The Committee did not, at that meeting, approve the pre-preliminary draft, but did make a number of suggestions for consideration by the staff in preparing the actual preliminary draft.

Chairman Bauer noted that the Committee had at its meeting held on May 23, 2006, reviewed the preliminary draft of this chapter and directed that a number of changes be made in that draft. The Committee did not act to approve the chapter, but asked that it be resubmitted for further consideration in a revised draft that incorporated the directed changes. Chairman Bauer noted that a copy of the revised draft had been provided to all members of the Committee for review prior to the meeting. He then asked Dr. Schlager to undertake a review of the revised preliminary draft, focusing on the changes made in response to the Committee's direction; those changes being noted by strikeouts and italicized inserts in the revised draft. Chairman Bauer prefaced Dr. Schlager's review, noting that the revised text did, on page 31, indicate that the Commission staff would prepare an environmental assessment of the wireless telecommunications plan presented in Chapter VII and that assessment would be set forth in an appendix to the chapter. He indicated that the appendix would be presented to the Committee for review and comment at a future date.

In answer to a question by Mr. Ritt, Dr. Schlager indicated that the backhaul network cost estimates given on pages 21 and 22 were indeed complete in so far as capital costs were concerned. The only cost items not included were permit and other fees, and legal costs, these omissions being noted in the text. Dr.

Schlager indicated further that operating and maintenance costs had also been estimated and were set forth in the chapter.

Mr. Ritt questioned the adequacy of the estimated cost of constructing a backhaul base station antenna tower of 100 feet in height given as $14,500. A lengthy discussion ensued, in which Dr. Schlager indicated the cost estimate was based upon experience in the construction of such towers in British Columbia, Washington, and Oregon. Dr. Schlager indicated that the envisioned antenna towers were single pole towers that could indeed support the required antennas and ancillary equipment. Mr. Wirth agreed.

Mr. Ritt observed that municipal and county permitting agencies were unlikely to approve the construction of single user towers, these permitting agencies usually requiring that the towers accommodate co-locations and this could involve the need to mount additional antennas and equipment on the towers; and he questioned the structural adequacy of the envisioned type of low cost tower to accommodate co-locations. Mr. Ritt observed further that any approval of the construction of single user towers by a permitting agency may be expected to establish a precedent, and thus prevent the permitting agencies from requiring other providers to construct towers adequate for co-locations.

At the conclusion of the discussion attendant to Mr. Ritt's observations, it was agreed that the staff would draft a paragraph for insertion as a second full paragraph on page 22 describing the type of antenna towers proposed and the potential problems, if any, associated with co-location on such towers.

Secretary's Note: The following paragraph was prepared for insertion as the second full paragraph on page 22 of the text of Chapter VII:

"The backhaul network costs given for new tower sites are based on use of a 100 feet high steel tower with a concrete foundation. Such antenna towers have been built recently and are operational in the Canadian provinces of British Columbia and Saskatchewan serving wireless systems of Waveteq Communications, Inc., of British Columbia, Canada. The materials for these antenna tower structures are manufactured by AN Wireless Tower Company of Johnstown, Pennsylvania. They are available in heights from 20 feet to 120 feet, constructed from 50 KSI galvanized steel, and are specified for wind loadings of up to 120 miles per hour. AN Wireless Towers are currently deployed throughout North America. These towers need not be restricted to a single user, but can accommodate multiple users. In fact, the Waveteq towers in Canada are serving multiple users, so that the single user categorization is not applicable to these towers. It is, however, important to understand that these types of towers are not intended for support of large, eight feet diameter parabolic reflector antennas which would be attended by severe wind loadings. Point-to-point microwave links may require antenna structures costing $30,000 or more. The proposed antenna tower structures are intended to support point-to-multipoint communication, WiFi, WiMAX, and related technologies."

In answer to a question by Mr. Melcher, Dr. Schlager indicated that the cost item entitled "Shelters and Buildings" on pages 2 and 3 of Appendix I, represented the estimated cost of a simple box enclosure as required for some of the electronic equipment required. Upon a brief discussion, it was agreed that the cost item concerned would be labeled "Enclosures" rather than "Shelters and Buildings."

Mr. Klasen noted that the text on page 23 made reference to transport rate and Internet access rate tables, and the text indicated that these tables were listed in Appendix III. He noted that this Appendix was missing from the materials as distributed to the Committee. Chairman Bauer indicated that the Appendix III would be prepared and attached to the chapter.

Secretary's Note: Appendix III containing the transport and direct Internet access rate tables as provided to the Commission by the firm of Light Point Networks in a letter dated June 19, 2006, has been incorporated as Appendix III to the revised Chapter; a copy of the revised Chapter is attached to these minutes.

Mr. Ritt indicated that it would be helpful to include in the Chapter graphic representations of both the backhaul base station antenna structures and the access point antennas as mounted on street lampposts. Mr. Melcher agreed. Upon brief discussion, it was agreed that photographs of the two types of antenna structures would be included in the text.

Secretary's Note: Staff is obtaining photographs of a typical backhaul base station antenna structure, an access point antenna structure, and a fixed user antenna mounting for inclusion in the published report. Copies of these photographs will be provided to the Committee members when they become available.

In answer to a question by Mr. Long, Dr. Schlager indicated that there should be no significant environmental impacts associated with access point equipment as mounted on existing lampposts or other similar structures; that the environmental assessments of the backhaul base station towers -- other than the impacts associated with a radiation hazard which would be assessed in an appendix to the report -- were very site specific and, therefore, could not be addressed at the system planning stage.

Mr. Ritt observed that in Committee discussions references had been made to the wireless Internet access systems installed by various communities within the United States, such as the system for Chaska, Minnesota. He then distributed a copy of a San Jose Mercury news article describing problems that have been incurred with these types of systems, and in particular, with the Chaska, Minnesota system (copy attached to these minutes).

There being no further questions or comments, on a motion by Mr. Caron, seconded by Captain Winston, and carried, with Messrs. Klasen and Ritt voting no, the revised preliminary draft of Chapter VII, "A Regional Wireless Telecommunications Plan For Southeastern Wisconsin," of SEWRPC Planning Report No. 51, *A Wireless Antenna Siting and Related Infrastructure Plan for Southeastern Wisconsin* was approved as amended. A copy of the revised chapter is attached to these minutes.

Mr. Klasen explained his "no" vote, indicating that it was the position of AT&T, formerly SBC, to concur in the efforts of the Commission to inventory the current telecommunications facilities and service provided within the Region, but to object to Commission preparation of plans for the provisions of such facilities and services. Mr. Ritt concurred with Mr. Klasen's explanation.

CONSIDERATION OF PRELIMINARY DRAFT OF OUTLINE OF SEWRPC PLANNING REPORT NO. 53, *A REGIONAL COMPREHENSIVE BROADBAND TELECOMMUNICATIONS PLAN FOR SOUTHEASTERN WISCONSIN.*

Chairman Bauer noted that a copy of the preliminary draft of outline of SEWRPC Planning Report No. 53, *A Regional Comprehensive Broadband Telecommunications Plan for Southeastern Wisconsin,* had been provided to all members of the Committee for review prior to the meeting.

Chairman Bauer noted that all Committee members had received a copy of a staff memorandum dated July 5, 2006, together with a revised outline. The revised outline, he said, was dated June 30, 2006, and was intended to replace in its entirety the outline transmitted with the agenda for the meeting, that original outline being dated June 30, 2006.

Chairman Bauer then asked Dr. Schlager to undertake a page by page review of the preliminary draft with the Committee.

The Committee review of the proposed outline consisted of a number of questions, explanations, and attendant brief discussions of a few of the elements of the outline, but did not result in any recommended changes to the outline as presented.

There being no substantial questions or comments, on a motion by Mr. Melcher, seconded by Mr. Mueller, and carried, with Messes Klasen and Ritt voting no, the preliminary draft of outline of SEWRPC Planning Report No. 53, *A Regional Comprehensive Broadband Telecommunications Plan for Southeastern Wisconsin*, dated June 30, 2006, was approved as presented.

Mr. Klasen again explained his "no" vote, indicating that it was the position of AT&T, formerly SBC, to concur in the efforts of the Commission to inventory the current telecommunications facilities and service provided within the Region, but to object to Commission preparation of plans for the provisions of such facilities and services. Mr. Ritt again concurred with Mr. Klasen's explanation.

Mr. Caron observed that Racine County was currently considering the installation of a wireless Internet access system. He indicated that the Committee's and Commission's work were proving to be helpful to the County in this consideration, and that the County's experience to date with respect to the issues concerned appears to be consistent with, and supportive of, the Committee's and Commission's work to date.

CORRESPONDENCE

Chairman Bauer noted that the Committee's Secretary received an electronic communication from Committee member Mr. Jeff Mantes, dated July 6, 2006, commenting on the minutes of the meeting of May 23, 2006, and providing information concerning charges which the City of Milwaukee is proposing to levy on the firm of Midwest Fiber Networks for the attachment of antennas to City owned streetlamp and other posts; and noting that the cost of bringing electric power from municipal facilities to the antennas would have to be borne by the firm (copy attached to the minutes).

Secretary's Note: With respect to the noted payment of an annual fee of $25 for the attachment of telecommunications antenna to City of Milwaukee and WE Energies poles, the cost estimates included in Chapter VII provide a comparable annual fee of $120.

In response to the comment concerning the provision of power to antennas, a paragraph has been added to page 25 of Chapter VII indicating that where operation of street lamps is controlled by a photovoltaic cell mounted on the lampposts, the provision and metering of electric power to an antenna mounted on that post could be readily provided at a relatively small cost. Where operation of the street lamps is controlled centrally, the provision and metering of electric power to antennas mounted on lampposts could require the laying of sub-surface power cables at substantial additional cost. The revised text will also indicate that the provision and metering of power to telecommunications antennas mounted on electric power poles could be readily provided at a relatively small cost.

Chairman Bauer reported that the Committee Secretary was also in receipt of a letter from Committee member Mr. Bob Chernow, commenting on the minutes of the meeting and on the text of Chapter VII. Mr. Chernow's comments he said, were supportive with the exception of three questions (copy of letter attached to minutes).

Secretary's Note: With respect to the first comment in Mr. Chernow's letter, concerning the of the performance by T-Mobile, an attempt will be made to obtain performance measurements through available data sources as a part of the preparation of the third report to be prepared under the planning effort: SEWPRC Planning Report No. 53, *A Regional Comprehensive Broadband Telecommunications Plan for Southeastern Wisconsin.*

The next three comments in Mr. Chernow's letter are supportive of the text of Chapter VII as submitted to the Committee and require no further comment.

With respect to the fifth comment in Mr. Chernow's letter, the basis for the referenced data transmission rate – 54 megabits per second – is established by IEEE Standard 802.4. The need to provide an amplifier to achieve the desired signal to noise ratio is dictated by Shannon's Law.

With respect to the sixth comment in Mr. Chernows' letter, the word "realty" is in fact "reality."

With respect to the final comment in Mr. Chernow's letter, the number of base stations required to serve an area is roughly proportional to the size of the service area.

DATE AND TIME OF NEXT MEETING

Chairman Bauer then asked the Committee to consider the date and time for the next Committee meeting.

After brief discussion, it was agreed that the next meeting of the Committee would be held on Tuesday, August 29, 2006 at the Commission offices beginning at 2:00PM.

ADJOURNMENT

There being no further business to come before the Committee, on a motion by Mr. Romlein, seconded by Mr. Mueller, and carried unanimously, the meeting was adjourned at 4:00 PM.

Respectfully Submitted,

Lynn G. Heis
Committee Secretary

KWB/lgh
7/21/06
#119050 V1 - T/C Minutes 14th Meeting

SEWRPC Planning Report No. 51
A WIRELESS ANTENNA SITING AND RELATED INFRASTRUCTURE PLAN
FOR SOUTHEASTERN WISCONSIN

Chapter VII

A REGIONAL WIRELESS TELECOMMUNICATIONS PLAN FOR SOUTHEASTERN WISCONSIN

INTRODUCTION

Previous chapters of this report have presented background for the contents of this chapter that sets forth a recommended fourth generation (4G) regional broadband wireless network plan for Southeastern Wisconsin. The objectives and standards of Chapter III provide the criteria for judging the merits of the recommended plan and alternatives thereto. The findings of the antenna site inventory documented in Chapter V provide the geographic and structural bases for plan design and implementation. The findings of the performance inventory of Chapter VI reveal both the capabilities and shortcomings of the present second (2G) and third (3G) generation networks serving the planning area. Table 1 defines the characteristics of 2G, 3G and 4G wireless telecommunications network technologies.

It is important to understand that the fourth generation (4G) regional broadband wireless plan for Southeastern Wisconsin as set forth in this chapter represents one of a number of possible plans by which the objectives and standards set forth in Chapter III of this report might be achieved. The plan herein set forth is not intended to impede the implementation of alternative plans prepared and put forth by private providers, or by counties or municipalities within the Region, that would move the existing level of service within the Region toward the agreed upon objectives and standards or to achieve those objectives and standards. It is, however, hoped that the plan herein presented would serve as a point of departure for further telecommunication planning by private providers and public agencies.

Table 1

COMPARISON OF 2G, 3G, AND 4G NETWORK TECHNOLOGIES

Key Features	2G Networks	3G Networks	4G Networks
Data rate	60 kbps	384 kbps to 2Mbps	20-100Mbps
Frequency band	0.8-1.9 GHz	1.8–2.4 GHz	2-8 GHz
Bandwidth	Variable	5MHz	About 100 MHz
Switching Technique	Circuit- and packet-switched	Circuit- and packet-switched	Completely digital with packet voice
Radio Access Technology	GSM, GPRS, Edge, CDMA, iDEN	UMTS, HSDPA, WCDMA, CDMA-2000.	OFDMA, MC-CDMA, HSUPA, WiFi, WiMAX
IP	IPv4.0	IPv4.0, IPv5.0, IPv6.0	IPv6.0

Source: SEWRPC.

The telecommunications plan presented in this chapter represents an "all-wireless" plan in that both the access networks and the backhaul networks are wireless in nature. This all-wireless designation, however, must be qualified in that all wireless networks must eventually connect to a national -- or international -- wireline network such as the Internet in order to reach message or call destinations outside of the Region. Even intra-regional calls outside of the wireless network itself must be routed through the Internet or telephone (POTS) networks. As an all-wireless network, the proposed plan design encounters basic technological problems that must be addressed if the planned network is to achieve the specified objectives and standards. The performance standards relating to transmission rate and accuracy are particularly difficult to achieve and are well beyond those achievable with current 3G systems. These performance standards, specified in Chapter III, call for data transmission rates in the 20 to 200 megabit per second range and maximum packet loss of ten percent or less. Fundamental changes in both hardware and protocol software technologies will be required to achieve these standards.

It is important to note that the recommended wireless telecommunication plan herein presented is also intended to provide one of the alternative plans to be considered in the development of the comprehensive regional telecommunications plan also proposed to be prepared under the regional telecommunications planning program. Other alternative plans to be considered in the development of the comprehensive plan may place more emphasis on the use of fiber transport, particularly in lieu of the wireless backhaul portions of the recommended wireless plan herein presented. Communication needs, however, now and in the future will in any case require wireless components to serve the needs of mobile communications since fiber telecommunications and other technologies do not provide for such mobility. The recommended comprehensive regional telecommunications plan may therefore contain as an integral component a modification of the wireless plan herein presented.

It is also very possible that hybrid plans involving the wireless part of this plan in some areas of the Region will be integrated with wireless plans in other parts of the Region to provide a mixed wireless/wireline plan that may be most cost effective for the Region.

Preparation of a wireless network plan involves a sequence of design activities that include:

1. Selecting a basic communications technology or set of technologies: GSM and its derivatives; CDMA and its derivatives; or WiFi/WiMAX and their derivatives;
2. Selecting accessory technologies in supporting system elements such as antennas and network management;
3. Identifying and defining the equipment requirements for various classes of network users: fixed enterprise, fixed residential, nomadic laptop computer, mobile phone and other hand-held devices as well as motorized vehicles; and

4. Selecting base station or access point locations with their associated antenna types, heights, patterns and powers and their respective geographic coverage areas.

The end result of this sequence of design activities is a proposed regional network infrastructure that supports a wide variety of broadband users with a fourth generation (4G) systems deployment.

Accordingly, this chapter describes a range of technologies, presenting their advantages and disadvantages, and selecting a set deemed best suited to future application in the Region. The chapter also defines network architecture at both the access level and the core level, with the final output being an antenna site and related infrastructure plan that defines the recommended all wireless regional telecommunications system.

TECHNOLOGICAL ALTERNATIVES

There are three current sources for evolving wireless communications technologies:

1. Proprietary Cellular/PCS, Mobile Wireless Technologies
2. Proprietary Fixed Wireless Technologies
3. Standards-Based Fixed/Mobile Wireless Technologies

Proprietary Cellular/PCS Mobile Technologies

Each of these sources of technologies can be further classified by the specific type of wireless technology. Beginning with cellular/PCS technologies, there are five primary technologies currently in use:

1. Advanced Mobile Phone Service (AMPS) based on analog signals. This technology is largely obsolete and out-of-service except in some rural areas of the United States.
2. Time Division Multiple Access (TDMA), a digital technology still in use but lacking a development path to 3G and beyond service. This technology may be expected to be replaced in the foreseeable future by other technologies.
3. Global System for Mobile Communications (GSM). This is one of the two primary current 2G/3G digital wireless technologies, and has a path to 3G and beyond as Universal Mobile Telecommunications System (UMTS) and High Speed Downlink Packet Access (HSDPA). Cingular and T-Mobile employ GSM technology in the Region.
4. Code Division Multiple Access (CDMA). This is the second primary current digital wireless technology. It has a path to 3G and beyond: Evolutionary Data Optimized (EV-DO). Sprint, Verizon and U.S. Cellular employ this technology in the Region.

5. Integrated Dispatch Enhanced Network (iDEN). This is a proprietary digital Motorola technology used by Nextel -- now part of Sprint -- but still a separate network. This technology is a variant of TDMA and is known for its push-to-talk feature. It does not have a known 3G and beyond path. The "push to talk" feature may be expected to be incorporated into other technologies.

Proprietary Fixed Wireless Technologies

While fixed wireless represents a different kind of wireless communications service, the technologies tend to be similar to those employed either in cellular/PCS or standards-based technologies. An example of a cellular technology is the Motorola Canopy System which is based on TDMA. An example of a standards technology is the Alvarion Frequency Hopping Spread Spectrum (FHSS) System which employs a methodology close to an earlier version of IEEE Standard 802.11 (WiFi). The relatively small size of the fixed wireless market has limited the amount of innovation possible in this area. Future trends also indicate the merging of fixed and mobile wireless into a single network, so that fixed wireless networks will probably cease to be independent entities.

Standards-Based Fixed-Mobile Technologies

Standards technologies for wireless communications emerged from wireless local area networks (WLANS) applications. These standards were developed under the aegis of the Institute of Electrical and Electronic Engineers (IEEE). IEEE in its standards setting activities establishes committees with knowledgeable representatives from the communications industry to develop communication technologies in the form of design specifications that manufacturers are intended to adhere to in their finished equipment designs. Standards-based technologies have the advantages of better performance as a result of multiple design creation resources and lower costs because of the higher production volumes typically associated with standards base equipment.

WiFi

The first broadband wireless standard was IEEE 802.11 or WiFi. The 802.11 standard was introduced in 1997, using the frequency hopping spread spectrum (FHSS) technology operating in the 2.4 gigahertz band. The frequency hopping spread spectrum technology originally used in WiFi service was abandoned and WiFi standards technologies were specified as either direct sequence spread spectrums (DSSS-IEEE standards 802.11b), or orthogonal frequency division multiplanning (OFDM-IEEE standard 802.11g) for physical layer operation. Initially, the speed of the network was considered too slow at only 1 to 2 megabits per second. A new standard, 802.11b, was then introduced with an average connection speed of 5.5 megabits per second with a maximum speed of 11 megabits per second. The 802.11b standard became popular as the "hot spot" WiFi which was deployed in coffee shops, airports, schools, homes, and other locations throughout the United States and other countries. It represented a significant connection speed upgrade compared not only to dialup access, but also to some wireline broadband services such as digital subscriber line (DSL). Over the last few years, the number of WiFi hot spots has grown rapidly both in the Region and elsewhere in the United States and throughout the world. The 802.11b standard has now been superseded by 802.11g which has connection speeds up to 54 megabits per second. A third 802.11 standard, 802.11a, operates at a higher frequency, 5.2-5.8 gigahertz (GHz), also with a maximum rate of 54 megabits per second. The “a” standard has been used primarily for backhaul networks to Internet access points. Aside from public hot spots, a second major application for WiFi has been the wireless home. Many home users now employ a WiFi router to establish a home-based wireless local area network to interconnect multiple desktop/laptop computers and other devices.

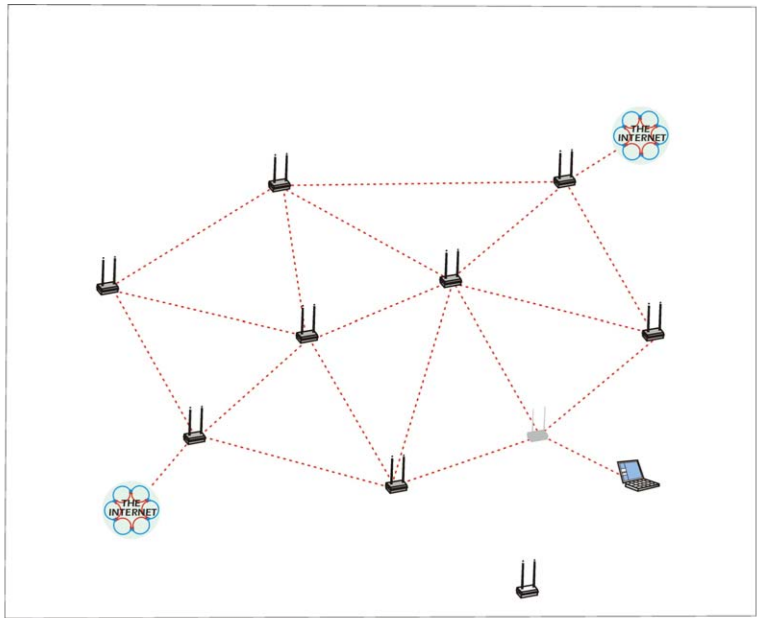
A second stage of WiFi communications development has been the mesh network in which an entire metropolitan area is blanketed with WiFi coverage. A mesh network involves the interconnection of the WiFi access points -- hot spots -- into a mesh topology. In such a network, shown in Figure 1, each access point serves as both a direct wireless connection and as a router passing messages from the other access points on to their destination. A message transmission may require multiple “hops” across access points prior to reaching its destination within the mesh network or to Internet connection points, known as gateways, which are scattered throughout the network. A mesh network differs from a collection of WiFi hot spots in that the access points are interconnected in a mesh structure and with Internet access only at selected gateway locations. A mesh network topology has some significant advantages as well as some disadvantages which are described in a later section on network topology.

A number of American cities have entered into agreements with private service providers to install WiFi mesh networks, including among others, the Cities of Milwaukee, Philadelphia, and San Francisco. The first known major city to install a citywide wireless mesh network is Taipei, Taiwan, a city of about 2.6 million people. Nortel Networks has been installing the Taipei network over the last few years, and it now covers about half of that city’s approximately 106 square mile area and with 3,300 wireless access points, or 63 access points per square mile. Tropos Networks has installed a WiFi mesh network in Chaska, Minnesota, a city of about 18,000 residents with an area of about 16 square miles. Tropos installed 250 access points to cover the City of Chaska for a density of 16 access points per square mile, considerably less than the Nortel experience in Taipei, Taiwan. High density cities generally require higher access point densities for two reasons: (1) to overcome the effects of “clutter” attendant to the presence of numerous high-rise structures; and (2) to provide the needed capacity to serve higher user density and demand.

Mesh networking has brought new applications and continuing growth to 802.11 WiFi technologies. The scope and capabilities of 802.11 also continue to grow and expand with new versions of the technology in process for later release. An example is standard 802.11n which will extend the range and increase the throughput of WiFi using phased array multiple input multiple output (MIMO) antennas. A second example is 802.11s which concern WiFi networks using mesh network topologies. A third that is very pertinent to the regional plan and its impact on

Figure 1

CONCEPTUAL MESH NETWORK



Source: Tropos and SEWRPC.

transportation is 802.11p which is developing a roadside version of WiFi called wireless access in vehicular environments (WAVE) which will provide mobile communications on a special licensed 5.9 GHz frequency band.

WiMAX

A new major IEEE standard 802.16 (WiMAX) is due for release in 2006 in the form of standard 802.16d. WiMAX is an acronym for Worldwide Interoperability for Microwave Access. Orignally conceived as a technology for metropolitan area networks, WiMAX was promoted as a long range version of 802.11 WiFi. Some experts even forecast the decline and eventual demise of WiFi. WiMAX capabilities included extending the range of WiFi from 300 feet to up to 30 miles. After a number of years of some confusion, the relative roles -- at least in the short-term -- of WiFi and WiMAX, have now been clarified. WiFi is well established as a low cost, high speed access network for direct interconnection with end users. Since WiFi continues to grow in performance and capabilities, it may be expected to be difficult to dislodge from its primary role in wireless Internet access and potentially Internet-based voice communications (VoIP). WiMAX with its orientation to wide area networks is well positioned to serve as a backhaul network for localized WiFi access networks. Using WiMAX as an upper level backhaul network will minimize the need for fiber wireline Internet gateways. It is important to understand, however, that there is nothing inherent in the WiMAX technology that extends the range of operation of an antenna base station. Operating in the same frequency band -- such as 5.8 GHz -- with the same power output through the same antenna, a WiMAX base station would have the same range as an 802.11a WiFi base station. This is true in spite of the contradiction with the original objectives to increase the range of WiFi. To function as a backhaul network, WiMAX will require higher gain transmitters and antennas as well as more sensitive and noise-free receivers.

WiMAX does, however, have technical features and capabilities that potentially enhance its role in a backhaul network. Such features and capabilities include:

1. WiMAX can provide an improved quality of service through a better media access control (MAC) protocol that can share a radio channel among hundreds of users. It should be noted, however, that a WiFi group 802.11e is working to include a simalar feature in WiFi.
2. WiMAX can provide higher data transmission rates from the same bandwidth as measured by bits per second transmitted versus Hertz of bandwidth used.
3. WiMAX has mandatory encryption for security. It should again be noted, however, that a WiFi 802.11i group is working to incorporate better security in WiFi.
4. The 802.16e version of WiMAX will have mobile capabilities. A WiMAX 802.11p work group is moving rapidly to provide this capability on a special 5.9 GHz band for application along roadway networks.

The introduction of WiMAX is behind schedule. Originally scheduled for release in its 802.16d version in late 2005, certification is expected in 2006 with equipment availability following. The mobile version of WiMAX (802.16e) is scheduled for release in the 2007 to 2008 timeframe.

There are at least two scenarios under which WiMAX would provide user access as well as backhaul network services. The first is in rural areas where a community based WiFi network may not be cost effective. The other is in mobile public safety networks where law enforcement, fire, and emergency medical rescue services will have their own operating band in the 4.9 GHz region. This report does not address planning for the mobile public safety networks, which networks are intended to be addressed in a separate Commission planning effort and the results documented in a separate Commission planning report. In the rural application, however, there are cost issues, since WiMAX equipment will probably be more costly than WiFi equipment for some years. Such high costs may limit broadband wireless development in rural areas.

Mobile-Fi (IEEE 802.20)

A third standards-based wireless technology deserves consideration here since it may influence later versions of the regional broadband wireless communications plan. The 802.20 Mobile Broadband Wireless Access Working Group was established in December 2002, with a mission of developing a mobile broadband wireless technology. Unlike WiMAX which began with an emphasis on fixed users, Mobile-Fi was focused on mobile communications from the start. To date, little is known about Mobile-Fi except that it is focused at bands below 3.5 GHz. It also seems to be focused on licensed carriers rather than the unlicensed bands. Early versions of WiMAX also seem to have a licensed band bias. Given the existence of 802.11p WiFi for vehicular communications, the outcome of competition with a standards-based mobile broadband wireless communications is at this time uncertain.

COMMUNICATIONS TECHNOLOGY SELECTION

For use in plan preparation, a selection must be made from an array of known technological alternatives available for use in a fourth generation regional wireless telecommunications system. The primary criteria for such selection should be standards compliance. If multiple technologies comply with the standards, then the most cost effective technology should be selected. From the previous presentations on alternative technologies, the four alternative technology candidates are:

1. GSM/UMTS and its beyond 3G HSDPA extensions;
2. CDMA and its beyond 3G EV-DO extensions;
3. WiFi and all of its 802.11 variants and extensions; and,
4. WiMAX and its planned variants

Although all of the alternative plans considered will be rated using all of the objectives and supporting standards set forth in Chapter III, many of the standards are not relevant to technology selection, but only to the evaluation of a geographically deployed plan. A review of the standards was, therefore, conducted to identify a subset of criteria for use in technology selection including:

1. Performance Standards
   Throughput – 20 to 200 megabits per second
   Availability – 99.9 percent
   Voice quality – Mean Opinion Score (MOS) greater than 4.0
   Packet loss – less than 10 percent
2. Universal Service Standard
   - Independent of technology selection
3. Redundancy Standard
   - Independent of technology selection
4. Antenna Site Number Optimization
   - Independent of technology selection
5. Most Demanding Application
6. - The most demanding applications relate to video communications with transmission data rate requirements up to 200 megabits per second.Network Infrastructure Cost Minimization Standard
   - The sum total of capital investment and discounted operating costs should be minimized. Full use should be made of existing site facilities.
7. Antenna Site Aesthetics and Safety
   - Independent of technology selection
8. Public Safety Emergence Preference Standard
   - Independent of technology selection

Based upon the foregoing review, technology selection was based upon the performance, most demanding application, and cost minimization standards. All of the above technologies are being improved to meet higher performance standards particularly for the throughput standard beyond the current 3G standard peak transmission rate of 2 megabits per second. It is not clear, however, that either of the proprietary wireless technologies -- GSM and CDMA -- in their advanced versions are even specifying throughput rates as high as 100 megabits per second. In fact, both technologies envision eventually switching to Orthogonal Frequency Division Multiplexing (OFDM) technology, the same radio technology currently employed in both WiFi and WiMAX.

Even if the specifications for GSM/HSDPA and CDMA/ED-DO were revised upward to comply with the throughput standards, they would fail to qualify under standard number six for cost minimization. A major justification for the development of standards technologies has been cost minimization. The past history of Ethernet and WiFi both testify to the ability of standards based technologies to drastically reduce user costs. Such a cost minimization history inevitably moves the technology selection toward standards-based technologies-WiFi and WiMAX. Aside from standards compliance, the proprietary technologies also suffer from the disadvantage of favoring the mobile user. The 4G regional wireless plan must provide for both fixed and mobile users. Selecting a mobile-alone wireless technology inevitably compromises performance for the fixed user. The technology choice is thus reduced to a selection between WiFi (IEEE 802.11) and WiMAX (IEEE 802.16).

WiFi technology has the advantage of proven performance particularly relating to access networks. Its disadvantage is typically stated in terms of its limited range -- about 300 feet -- but this limitation is a function of the network topology and the equipment employed not of the technology itself. WiFi, has also been lacking in important aspects related to security and quality of service, but almost every current limitation of the technology is being addressed by an IEEE subcommittee with the goal of upgrading future versions of the standard.

WiMAX technology was originally introduced as a longer range higher quality version of WiFi (IEEE 802.11). As previously stated, there is nothing inherent in WiMAX technology that extends the range of operation. Given the same antenna with the same power output transmitting to the same class of receiver, WiFi and WiMAX will have identical range performance. A number of desirable features have been introduced into the WiMAX technology that will make WiMAX networks more secure with a better quality of service. The design viewpoint inherent in WiMAX is one of a wide area network, and the technology has many design features that make it well suited for use in regional wireless backhaul networks.

An important consideration with WiMAX, however, is its higher costs. As a new technology being introduced in 2006, the costs of WiMAX network elements may be expected to exceed the cost of equivalent WiFi elements for some time to come. For that reason alone, WiFi technology must be favored for access networks restricting WiMAX for those applications where its features most apply.

Weighing the advantages and disadvantages of the two potential technologies, WiFi is the preferred choice for access networks, with WiMAX providing the regional wireless backhaul network. WiMAX would also be a possible choice for the provision of direct access in rural areas of the Region. Thus, WiFi networks would be the preferred choice for access except in rural areas where the deployment of a community WiFi network would not be cost effective. A WiFi-WiMAX combination would build upon the strengths of both technologies and should provide for minimal capital costs as called for in Standard Number Six.

This hybrid set of technologies would also allow for early buildup of WiFi-based community networks which will inevitably be part of any regional telecommunications plan, and allow for later cost benefit comparisons between wireless and fiber wireline backhaul networks. Since WiMAX wireless technology is in its initial application stage, the preferred choice for regional backhaul can be evaluated prior to the ready availability of WiMAX equipment.

Having identified the combination of technologies deemed to be best suited to achieving the performance objectives and standards set forth in Chapter III, it is important to identify some shortcomings of these technologies that must be overcome if the plan design standards are to be achieved. Certain technical argumentations in both equipment performance and network protocols will be necessary to fully meet the standards previously specified.

Accessory Technologies for Standards Compliance

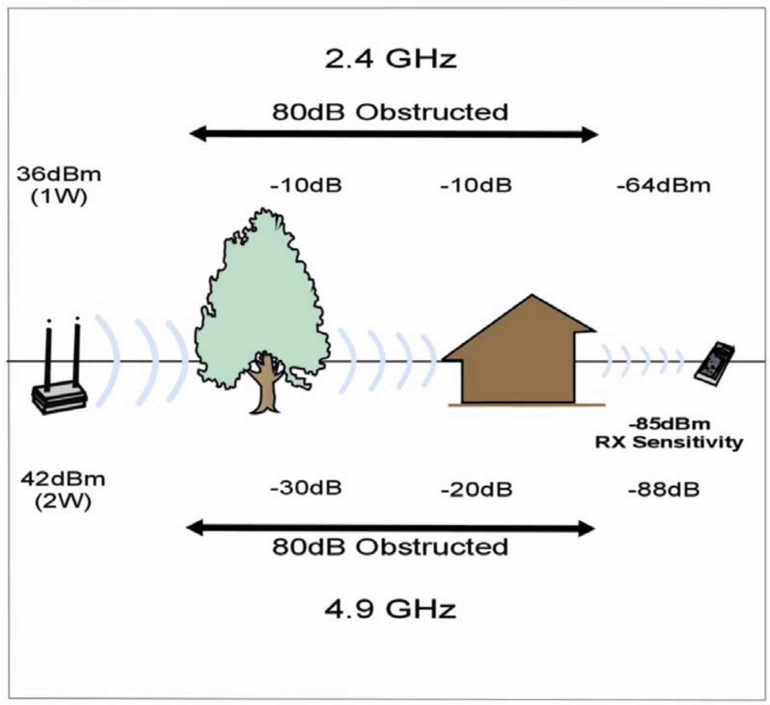
Recent experience with mesh networks in smaller cities such as Chaska, Minnesota (Tropos Networks) and Buffalo, Minnesota (Motorola) have demonstrated that WiFi technology in its current state (802.11g, 802.11a) will not achieve the performance standards for both throughput -- 20 megabits per second -- and associated packet loss rate -- 10 percent -- specified in Chapter III. Two shortcomings of these technologies combine to limit system performance. The first relates to signal levels achievable given the FCC specified power output levels and the signal attenuations caused by natural foliage and man-made structures. This "clutter" problem is illustrated in Figure 2 where the extra attenuations caused by foliage and structures is illustrated for two frequencies. While the attenuation caused at the 4.9 GHz band -- a public safety band -- is worse than the attenuation at the 2.4 GHz band -- a WiFi band -- both bands suffer from natural and man-made transmission losses. These lower signal levels even when detected by the network user result in slower data rates than those called for in the performance standards. These lower signal levels also result in higher packet loss rates that further reduce data rate levels because of the need to retransmit loss packets. Signal level problems may be resolved in one of two ways – increasing the power output of the transmitter, or increasing the sensitivity of the receiver. Since the FCC limits the power output of WiFi/WiMAX transmitters, the only recourse is improving receiver sensitivity.

These technology shortcomings concerned are best understood by reference to Shannon's Law which defines the channel capacity -- maximum transmission rate -- for any communications link. According to this law channel capacity -- Throughput -- depends *only* upon:

- Bandwidth of the medium
- Signal power at the receiver; and
- Noise power at the receiver.

Figure 2

RADIO PROPAGATION CLUTTER LOSSES



Source: Tropos 2004.

Stated mathematically:

$$C = B \times \log_2(1 + S/N)$$

C – channel capacity – bits/second

B – bandwidth – Hertz

S – signal power – milliwatts

N – noise power – milliwatts

Most considerations of broadband communications focus on the bandwidth of the medium which in the case of wireless communications is the radio bandwidth of the frequency channel allocated by the Federal Communications Commission (FCC). In the case of WiFi, a typical bandwidth is 20 megahertz which should at a minimum (100 percent spectral efficiency) produce a 20 megabits per second data transfer rate. In IEEE standard 802.11g, spectral efficiency will exceed 100 percent. Bandwidth from the above equation, however, is only one determinant. If the signal to noise ratio of the receiver does not allow for the bandwidth potential data rate, than degraded performance results. For example, in a Tropos mesh network, a signal level of -77 decibel-milliwatts (dBm) is required at the access point receiver to achieve the maximum data rate of 54 megabits per second. To qualify under the IEEE standard 802.11g, a laptop network interface card and its associated antenna must be able to process 54 megabits per second with a signal level of - 65 dBm. Since the signal levels in most WiFi mesh networks are much weaker than -65 dBm, the achievable data rates are generally under 3 megabits per second.

Such improvements in receiver sensitivity must be accomplished without changing the IEEE 802.11g standard related to WiFi and/or IEEE standard 802.16 related to WiMAX. The only such components in the two technologies that are independent of the standards are the antennas and the radio frequency receivers at both the access point and user ends.

To increase the signal levels at both the access points and the remote users, the gain of an antenna-preamplifier combination must be improved on the order of 20 decibels or more to achieve the maximum data rates of 54 megabits per second. Since laptop users are typically limited by the antenna and amplifier built into the laptop itself, antenna-preamplifier upgrading must be limited to the infrastructure access points and to residential and other fixed location users who have antenna-preamplifier options in their receiver system configurations. It will be shown in the 4G wireless plan presented that with antenna-preamplifier augmentations in the infrastructures and fixed end user equipment that the throughput and packet loss performance specifications can be achieved.

The throughput rates actually achieved in operational mesh WiFi networks -- such as those installed by Tropos Networks and Motorola -- are considerably less than those predicted based on signal levels. This discrepancy arises from the high packet loss rates experienced in these networks which range from under 10 percent to as high as 40 percent. Every lost packet must be retransmitted to maintain data integrity. These high packet loss rates are exacerbated by the manner in the Internet routing and transport protocol (TCP/IP) handles their detection and retransmission. The TCP/IP protocol was developed for wireline networks with packet loss rates well under one percent. In such a wireline environment, the TCP part of the TCP/IP protocol functions quite well. In a wireless communications environment, however, with its high packet loss rates, the TCP protocol aggravates the situation by slowing the transmission rate further reducing link throughput. Since almost all wireless data traffic is controlled by the TCP/IP Internet protocol, this protocol's wireless network shortcomings place a limit on WiFi-WiMAX technology performance even if received signal levels are improved through receiver enhancements as previously described. The solution is a revised backward compatible TCP/IP protocol that is more attuned to the packet loss situation characteristic of wireless network environments. Such a protocol is currently being developed by Architecture Technology Corporation of Minneapolis, Minnesota under the Defense Advanced Research Project Agency of the United States Department of Defense. This protocol will be available for Beta testing in the Region by September 2006. Such testing will be incorporated as part of the regional broadband wireless plan to allow for achieving the agreed upon performance objectives and standards.

It is important to emphasize, however, that even without the new TCP/IP protocol, the receiver equipment enhancements for improved signal levels will dramatically improve throughput regional coverage and packet loss rates for much higher wireless system performance.

User Requirements and System Performance

Differences in potential user equipment capabilities require a precise definition of the various potential users and their transceiver specifications in order to develop a meaningful region-wide wireless communications plan. The network user classes to be served by the 4G regional wireless plan include:

1. The nomadic laptop user
2. The mobile WiFi phone user
3. The fixed location residential, small business or enterprise user

Providing high quality service to the nomadic laptop computer users presents the greatest challenge to network system design because of the poor receiver sensitivity and low transmit power characteristic of this equipment. Mobile WiFi phone users may have even worse sensitivity and lower transmit power, but this class of users does not have high data rate requirements – at most 64 kilobits per second – for voice communications. This reduced need is true even though some data and video communications are accomplished. The fixed location users will have the advantages of high receiver sensitivity and higher transmit power for the best level of telecommunications throughput performance.

The system plan will be designed to serve the nomadic laptop computer user as the weakest and most demanding of network users. The approach will involve the synthesis of a network design that provides broadband performance to the nomadic laptop user as the primary objective of the wireless plan. Other users such as the fixed location residential or business users will then experience better throughput performance because of their higher signal levels. While the reality experienced in low density rural areas may sometimes require compromises to this objective, wireless broadband communications will still be available to all three classes of users throughout the Region.

These three classes of users must then be specified in terms of the equipment characteristics required to achieve the agreed upon objectives and standards, namely:

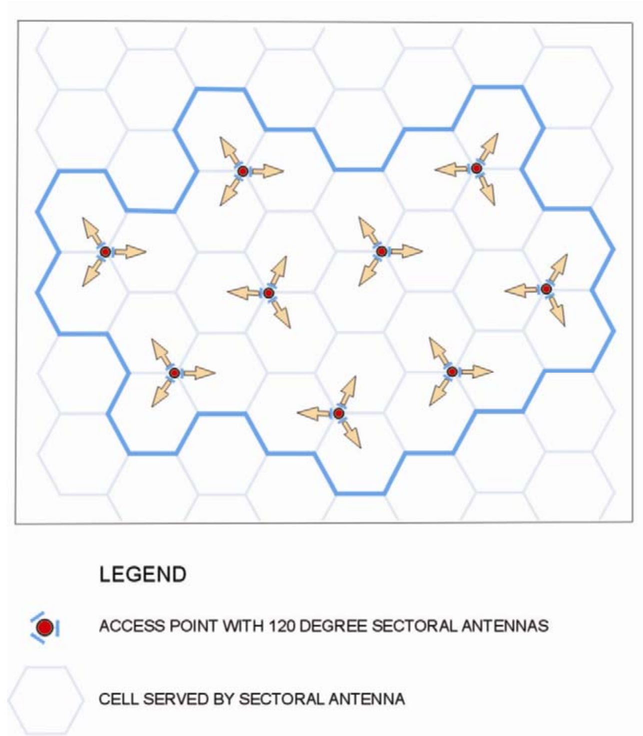
1. The nomadic laptop user
   - Transmit power – 200 milliwatts = 23 decibel-milliwatts
   - Receiver sensitivity – (-82 decibel-milliwatts) @ 6 megabits per second
   - Antenna gain – 5 dBi (decibels isotropic)
2. The mobile WiFi phone user
   - Transmit power – 100 milliwatts = 20 decibel-milliwatts
   - Receiver sensitivity – (-82 decibel-milliwatts) @ 11 megabits per second
   - Antenna gain – 0 dBi (decibels isotropic)
3. The fixed location residential, small business or enterprise user
   - Transmit power – 200 milliwatts = 23 decibel-milliwatts
   - Receiver sensitivity – (-74 decibel-milliwatts) @ 24 megabits per second
   - Antenna gain – 13 dbi (decibels-isotropic)
   - Preamplifier gain – 22 decibels

Network Topology

A basic consideration in any wireless network system design is the network topology -- or interconnection structure -- of the network layout. Two major classes of network topologies are currently employed in wireless communications: network cellular topologies and mesh topologies. In cellular networks, as shown in Figure 3, the service areas is subdivided into cells with each cell serviced by a sector of an individual base station. Each base station is then connected through a backhaul link directly or indirectly either to a core telephone or Internet network. A mesh network topology, as shown in Figure 1, employs a series of access points that like cellular base stations service a defined area. Unlike cellular networks, however, these access points are interconnected with many other access points in a mesh. Such a mesh network allows data traffic to find its way through a series of access points to its destination either within the local network or to outside destinations through an Internet connection. Most cell phone service providers employ the cellular topology in their networks using GSM, CDMA or other wireless

Figure 3

CONCEPTUAL SECTORAL CELLULAR NETWORK



Source: SEWRPC.

technologies. WiFi networks, however, evolving from a network of isolated "hot spots" have generally employed the mesh network topology. Mesh networks are sometimes seen to provide an advantage over cellular network with respect to redundancy and reliability. The mesh network are seen as largely "self-healing" in that the failure of a single access point does not disable the entire network. In this respect, however, it should be noted that the failure of a single access point in a cellular network – while leading to a loss of service in a relatively small sub-area of the total service area of the network -- does not lead to failure of the entire network. Mesh networks also suffer from major disadvantages that are critical to their adoption, such as higher infrastructure costs.

These disadvantages are best confirmed by comparing the infrastructure cost and performance of networks designed with both topologies for the same geographic areas. Such a comparison will be provided below for two community network designs for the Cedarburg-Grafton area.

Assumptions Concerning Use Of Licensed And Unlicensed Bands In The Broadcast Spectrum

The existing private wireless telecommunication providers within the Region have as a part of the development of their service network acquired -- at substantial cost -- Federal licenses to the exclusive use of a specific bandwidth of the radio frequency. In the preparation of the wireless telecommunication service plan set forth in this Chapter, it was assumed that plan implementation could occur through either private or public action, with the implementing agency deciding whether to utilize the licensed or unlicensed part of the radio frequency spectrum. It is important to note, however, that no costs were provided in the plan for acquisition of exclusive use licenses.

4G Plan Description

The proposed 4G plan, as previously discussed, will combine a Regional Wi-MAX-based wireless backhaul network with a multitude of community WiFi-based access networks. The rationale for a regional backhaul network is primarily economic. Significant infrastructure installation cost savings and continuing operating cost savings are possible with the higher volume of data traffic linked to the Internet through a backhaul network. The alternative is a more costly piecemeal approach, with each community seeking its own Internet gateway connection with the attendant higher installation and operating costs.

The 4G Regional Wireless Communications System Plan will be presented in two parts:

1. Regional Wireless Backhaul Network Plan
2. Sample Community Broadband Wireless Network Plan
   - based on the City of Cedarburg and the Village of Grafton as an integrated combined network

Regional Wireless Backhaul Network

Map 1 illustrates the regional backhaul network in its entirety. In total there are 54 base stations in the Regional Backhaul Network with a county breakdown as follows:

Kenosha	5
Milwaukee	7
Ozaukee	4
Racine	4
Walworth	10
Washington	10
Waukesha	14

The plan was prepared using a combination of radio propagation modeling and a SEWPRC mathematical programming model that minimizes the number of base stations required to provide backhaul coverage throughout the Region. Radio propagation modeling operates in conjunction with a "clutter" data base that records the topographic terrain along with natural (wooded areas) and artificial (buildings) features that obstruct and attenuate radio signals. Based on antenna height, transmit power, and receiver sensitivity, the radio propagation model estimates the geographic coverage of each potential antenna base station. This coverage data provide inputs to a mathematical programming model that determines the minimal number of antenna sites required to provide total coverage. A regional antenna site database of 755 existing cellular antenna sites was used as the starting point for backhaul network design optimization. The mathematical programming model evaluates in a systematic fashion various combinations of antenna sites until it iteratively determines the minimal number for total regional coverage. The input to the model is a set of "w" vectors that define the quarter sections covered by each potential base station and the output is a designated set of optimal sites.

There are two types of antenna base stations in the wireless backhaul network: a backhaul station and a backhaul gateway (POP) station. A backhaul station collects backhaul data from surrounding community WiFi network access points over 802.11a WiFi links operating in the 5.8 GHz frequency band. This same station forwards all incoming data directly to a backhaul gateway station for entry into the Internet.

A typical backhaul station will include the following elements:

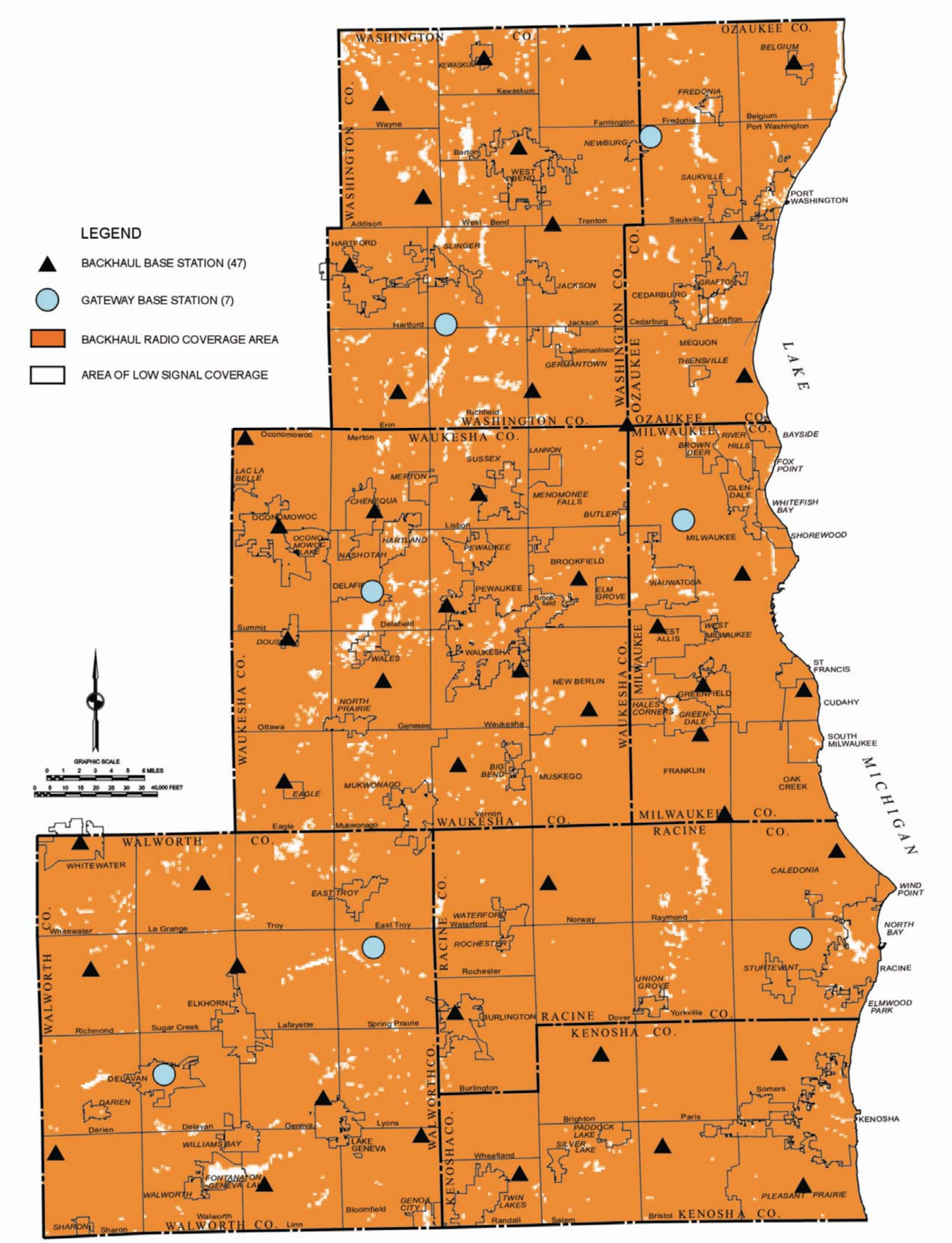
1. Antennas

   4 – 16 dBi 90 degree sectorals (802.11a)

   1 – 21 dBi directional (802.16d)

Map 1

POTENTIAL LOCATIONS OF BASE STATIONS AND ATTENDANT PERFORMANCE OF BACKHAUL IN THE REGION



Source: SEWRPC.

2. Transceivers

   2 – 802.11a WiFi

   1 – 802.16 WiMAX

3. Power Conditioning and Backup

   1 – UPS Battery Backup Unit

All antennas are proposed to be mounted on a co-location basis on existing cellular/PCS towers at a height of 100 feet or higher. All transceiver equipment will be mounted at antenna height with the power conditioning equipment housed in a small ground structure.

The gateway backhaul station provides all of the services of a backhaul station servicing community networks in its coverage area. In addition, the gateway links community networks to the Internet through a high-end multi-protocol label switching (MPLS) router. Supplementing the equipment listed above for a regular backhaul station, the following additional equipment is needed at a gateway backhaul station:

1. MPLS Router
2. Fiber interconnection equipment

Following the optimal selection of a backhaul station set, a second stage of mathematical optimization was used to select the minimal number of gateway stations needed to service the backhaul network. Minimizing the number of backhaul gateway stations is important not only to minimize the additional investment that each of these gateways requires, but also to minimize ongoing network operating costs. The cost of a megabit/second unit of bandwidth declines by about 32 percent for a 8:1 ratio of gateways to base stations.

Based on a regional backhaul network of 54 base stations, 7 of which provide gateways, the following initial infrastructure costs are estimated: A detailed support listing of the components of these estimated costs are included in Appendix I.

Backhaul Network with Co-located Sites

1. Forty-Seven Backhaul Base Stations: approximately $1.10 million

   =

2. Seven Gateway Stations: approximately 640,000

   =

3. Project Management and Engineering: approximately 350,000

   Total: approximately $ 2.09 million

Backhaul Network Costs with New Tower Sites

1.	Forty-Seven Backhaul Base Stations:	approximately	$1.80 million
2.	Seven Gateway Stations:	approximately	740,000
3.	Project Management and Engineering:	approximately	350,000
	Total:	approximately	$2.90 million

The backhaul network costs given for new tower sites are based on use of a 100 feet high steel tower with a concrete foundation. Such antenna towers have been recently built and are operational in the Canadian provinces of British Columbia and Saskatchewan serving wireless systems of Waveteq Communications, Inc., of British Columbia, Canada. The materials for these antenna tower structures are manufactured by AN Wireless Tower Company of Johnstown, Pennsylvania. They are available in heights from 20 feet to 120 feet, constructed from 50 KSI galvanized steel, and are specified for wind loadings of up to 120 miles per hour. AN Wireless Towers are currently deployed throughout North America. These towers need not be restricted to a single user, but can accommodate multiple users. In fact, the Waveteq towers in Canada are serving multiple users, so that the single user categorization is not applicable to these towers. It is, however, important to understand that these types of towers are not intended for support of large, eight feet diameter parabolic reflector antennas which would be attended by severe wind loadings. Point-to-point microwave links may require antenna structures costing $30,000 or more. The proposed antenna tower structures are intended to support point-to-multipoint communication, WiFi, WiMAX, and related technologies.

The foregoing estimate of costs includes only the costs of equipment and associated installation. Importantly, these costs do not include operation or maintenance costs; nor such costs as exclusive use license fees, if the provider deems such exclusive use desirable or essential; municipal permit fees, if any; municipal rental charges, if any, for use of municipal structures to mount antennas; nor legal fees. The capital costs of the antenna base stations and gateway stations set forth on pages 21 and 22, should, therefore, be considered as minimal. These costs will need to be refined as implementation proceeds based upon field tests and inspections, and on site specific analyses. If such further investigations indicate the impracticality of co-location of antenna on any given existing structure identified in the plan, an alternative structure will have to be found for co-location, or a new base station with attendant tower constructed. The capital costs could range up to about $2.9 million if new base station installations had to be constructed for each of the backhaul and gateway base stations shown on the plan. In any case, it must be recognized that the costs provided are based upon a system level of planning; and refinement of those costs should be expected as plan implementation proceeds through the preliminary engineering and final design stages.

The operational cost savings from such a network would depend on the traffic volume on the network, but if each of the 47 base stations and 7 gateway stations were operating at a capacity of 100 megabits per second, the increased transport volume at each gateway would be approximately 8 times the volume of each base station connecting to the Internet individually. Such an increase in volume would result in a 32.6 percent cost savings based on the Light Point transport rate tables listed in Appendix III. Each base station, therefore, would save 32.6 percent of its monthly transport cost of $7,400 per month or $2,412 per month. The total cost savings for a 54 station network would then be $130,240 per month or $1,562,926 per year . The annual savings would approximate 54 percent of the cost of the original network of $2,855,754. Following the return of the initial investment, an annual savings of $1.56 million would be realized.

These same antenna base station sites could be used to implement a 4.9 GHz broadband public safety communications system throughout the Region. Such a network would provide full regional interoperability first for high speed data transfer and later for voice traffic. A preliminary analysis of radio coverage for public safety vehicles indicates that such a co-located system network is feasible although preparation of a plan for such a network is not within the scope of this planning report.

The estimated cost of the Regional Wireless Backhaul Network was based upon equipment cost quotations from a WiFi/WiMAX equipment manufacturer. The costs of WiMAX equipment are less certain than WiFi equipment since the first WiMAX equipment will enter the market only this year. WiFi equipment costs are well established in a competitive marketplace.

Part of the project engineering costs quoted would support field testing to verify the performance of the backhaul network. These field tests would result in signal level coverage maps of the Region. Such coverage maps verify the placement of the base stations and help to insure successful operation of the network. The pre-startup engineering effort would also establish a network monitoring system that provide the tools for ongoing network monitoring and management.

Two alternative business models are proposed as alternatives for plan implementation. The first and preferred alternative would involve a private investor-operator who would finance, install, and operate the regional backhaul network. The second option would involve multi-county ownership and operation of the system, if an acceptable and qualified investor-operator firm does not receive approval of a multi-county regional consortium. Both models provide this critical component of the regional telecommunication plan. Both models also call for an experienced network operator with from either the private or public sector: Since there is no existing regional telecommunications authority, a public ownership initiative would require some multi-county consortium to effect the installation and operation of the system.

Although the deployment and operation of the proposed regional wireless backhaul network system could serve as the key infrastructure component of the regional economic development initiatives, the development of such a regional backhaul network system in a timely manner within the Region is unlikely, since no institutional structure presently exists for the development of such a network. Moreover, it is likely that community level networks will be developed first, with such network being connected on a case by case basis to the closest available fiber cable interconnection. This probable sequence of development will tend to negate the need for an integrated regional backhaul network.

Sectoral Cellular Cedarburg-Grafton Wireless Network Plan

The sectoral cellular wireless plan for the Cedarburg-Grafton area is shown in Maps 2 and 3. There are 41 proposed access points shown by numbered dot symbol designations on these maps. The State Plane Coordinate locations of the numbered access points are given in Table 2. The two color coverage pattern in Map 2 designates two ranges of performance for the nomadic laptop computer user. The orange area designates throughput performance in the 24 to 54 megabits per second range. The yellow area indicates throughput performance in the 6 to 24 megabits per second range. The laptop computer equipment is assumed to have the technical characteristics previously defined for this class of user.

In Map 3 the same access points are shown, but the single color coverage map indicates that all fixed users would experience throughput performance in the 24 to 54 megabits per second range. The fixed user differs from the nomadic user in both transmit power and receiver sensitivity. The fixed user equipment would be as previously described, except that no preamplifiers are assumed to be employed.

The equipment configuration at a typical access point would include:

1. 3 – 802.11g transceivers
2. 1 – 801.11a backhaul transceiver
3. 1 – 120 degree sectorized antenna
4. Electrical and lightning surge protective equipment
5. Power over ethernet (POE) power injector
6. Ethernet and coaxial cabling
7. Weatherproof enclosures for auxiliary equipment
8. Mounting hardware

Plans call for the use of heavy duty wall brackets to mount the communications equipment at each access point. Four equipment modules will be pole-mounted: transceiver modules (2), sectorized antenna (1), and auxiliary equipment enclosure (1).

It is also assumed that the access point equipment generally will not employ preamplifiers. Such preamplifiers will be required, however, in low density rural areas of the Region. Without such preamplifiers, rural broadband communications to the agreed upon throughput standards would not be possible. All access point equipment is assumed to be mounted on street lampposts or equivalent structures at an assumed height of about 20 feet. Small variations in heights should not significantly alter the structure of the network. Variations in geographic position within a range of 100 feet also should not significantly alter the network structure. User to access point communication would employ IEEE standard 802.11g equipment. All access points would backhaul to a single WiMAX base station as shown on Maps 2 and 3. Equipment based on IEEE standard 802.11a would be used for backhaul communication to the nearest WiMAX base station.

The WiMAX backhaul network previously shown in Map 1 would also serve to provide alternate backhaul base stations as may be required.

The estimated cost of cellular infrastructure deployment for Cedarburg-Grafton was based upon equipment cost quotations from a WiFi/WiMAX equipment manufacturer. Total cost of the infrastructure was determined based upon the cost of each access point plus the cost of Internet access -- whether the access is provided through the WiMAX backhaul network or through a direct point-of-presence (POP) connection to a optical fiber network. In either case, additional equipment would be required at the POP point for the Internet interconnection.

Power connections at network access points will be site-specific based on the situation in each community. If street lights are controlled by a local photo sensor, then power interconnection through the sensor enclosure should be a simple and low-cost procedure. Where the operation of the street lights are centrally controlled, the provision of electric power to access point transceivers could require the laying of sub-surface power cables at substantial additional cost. The extent of such costs are indicated by recent experience in the City of Waukesha where WE Energies quoted a charge of $800 per pole power installation. Provision for power and associated metering for access points located on electric power poles should also be relatively low in cost. For the WE Energy quote noted above, the power company did not require metering, but quoted a fixed unmetered rate of $6.00 per month per access point.

Based on the 41 access points deployed - 18 for Cedarburg and 23 for Grafton – the infrastructure deployment cost was estimated at $ $353,336, expressed in year 2006 real dollars. This total cost included the cost of the equipment and equipment installation for each access point estimated at $6,196 each or $254,036; Internet access equipment – in the form of a WiMAX or fiber connection - $34,600; a network monitoring system - $10,000; and project management and engineering costs of $55,000. The foregoing estimate of costs include only the costs of equipment and equipment installation.

Operating and maintenance costs including network management and utility pole rental costs are detailed in Appendix II. Total continuing costs are estimated at $112 per month for each access point.

Part of the project engineering cost would support field testing to verify the performance of the access point locations in providing specified signal levels throughout their individual coverage areas. The cost estimate encompasses only the network infrastructure and does not include the cost of user equipment which would be purchased by individual users.

Mesh Network Evaluation of a Cedarburg/Grafton Deployment

Sufficient experience with WiFi-based mesh networks has been reported to allow for comparative cost and performance estimates of a potential wireless mesh network deployment in the Cedarburg-Grafton area. The Tropos Networks report on a mesh network deployment in Chaska, Minnesota is particularly helpful in this respect. Tropos is the reported leader in the number of wireless mesh networks deployed in American communities. Tropos is also purported to be the supplier for the forthcoming Milwaukee wireless network. In Chaska, Tropos required an access point density of 16 per square mile at a cost of approximately $3,100 per access point. Applying these cost rates and point densities to the Cedarburg-Grafton area, a total access point deployment cost of $381,300 is indicated. Adding the costs of a network monitoring system and project management and engineering would place the total cost at about $456,300. Other mesh network manufacturers such as Nortel Networks and Motorola specify higher access point densities for their networks. Nortel specified 30 access points per square mile for suburban areas which would increase the mesh network deployment cost for the Cedarburg-Grafton area to over $800,000.

Even with these increased costs, mesh network throughput performance does not rise to the standards specified for a 4G network. Based on the Tropos Chaska experience, data throughput in the 0.5 to 3.0 megabits per second range was achieved. This performance is below the low threshold of 6.0 megabits per second in the cellular network alternative and well below the 24 to 54 megabits per second provided the fixed location user in the recommended cellular plan.

On a cost-performance basis, the cellular wireless plan is decidedly superior. Two primary characteristics are believed to account for the difference in mesh network performance:

1. Omnidirectional Antennas

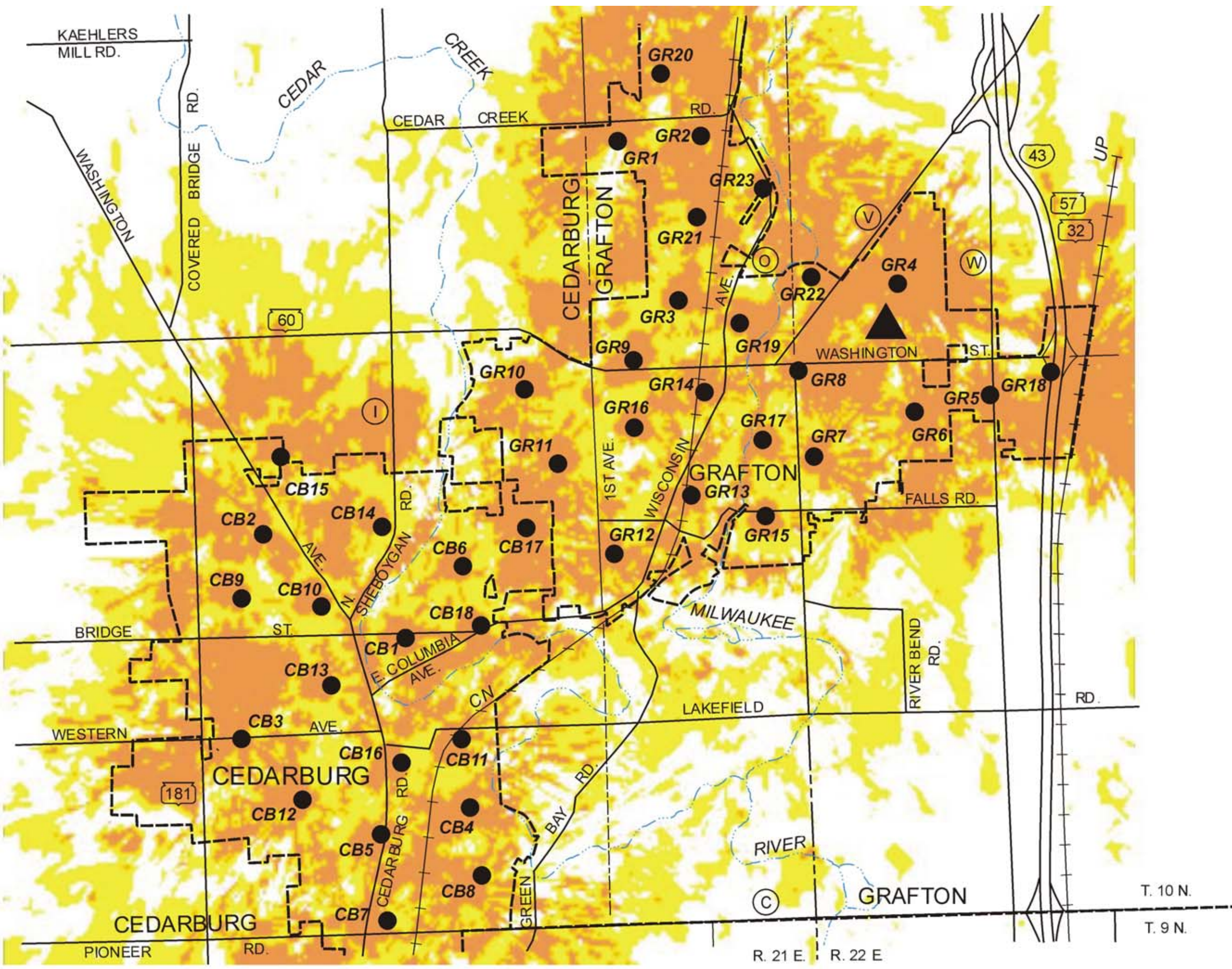
   The nature of a mesh network requires the use of omnidirectional antennas which have significantly lower gain than the directional antennas used in the cellular system. These lower gain antennas result in reduced signal levels and correspondingly lower data transmission rates.

2. High packet loss rates

   The lower signal levels in turn cause high packet loss rates which further reduce throughput performance. Such reduction is compounded by the procedures followed by the Internet TCP/IP protocol in handling packet losses.

Map 2

POTENTIAL LOCATIONS OF WiFi ACCESS POINTS AND ATTENDANT PERFORMANCE OF ACCESS NETWORK FOR NOMADIC USERS IN THE CEDARBURG-GRAFTON AREA: BASE STATION TO USER



LEGEND

▲ EXISTING BASE STATION TO BE USED FOR WiMAX APPLICATION

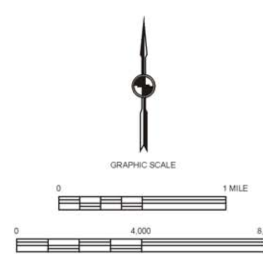
● RECOMMENDED LOCATION OF WiFi ACCESS POINT

GR3 IDENTIFICATION NUMBER

RECEIVED POWER AT REMOTE: -70dBmW TO -79dBmW, THROUGHPUT: 24 Mpbs to 54Mbps

RECEIVED POWER AT REMOTE: -79dBmW to -87dBmW, THROUGHPUT: 6Mps to 24 Mbps

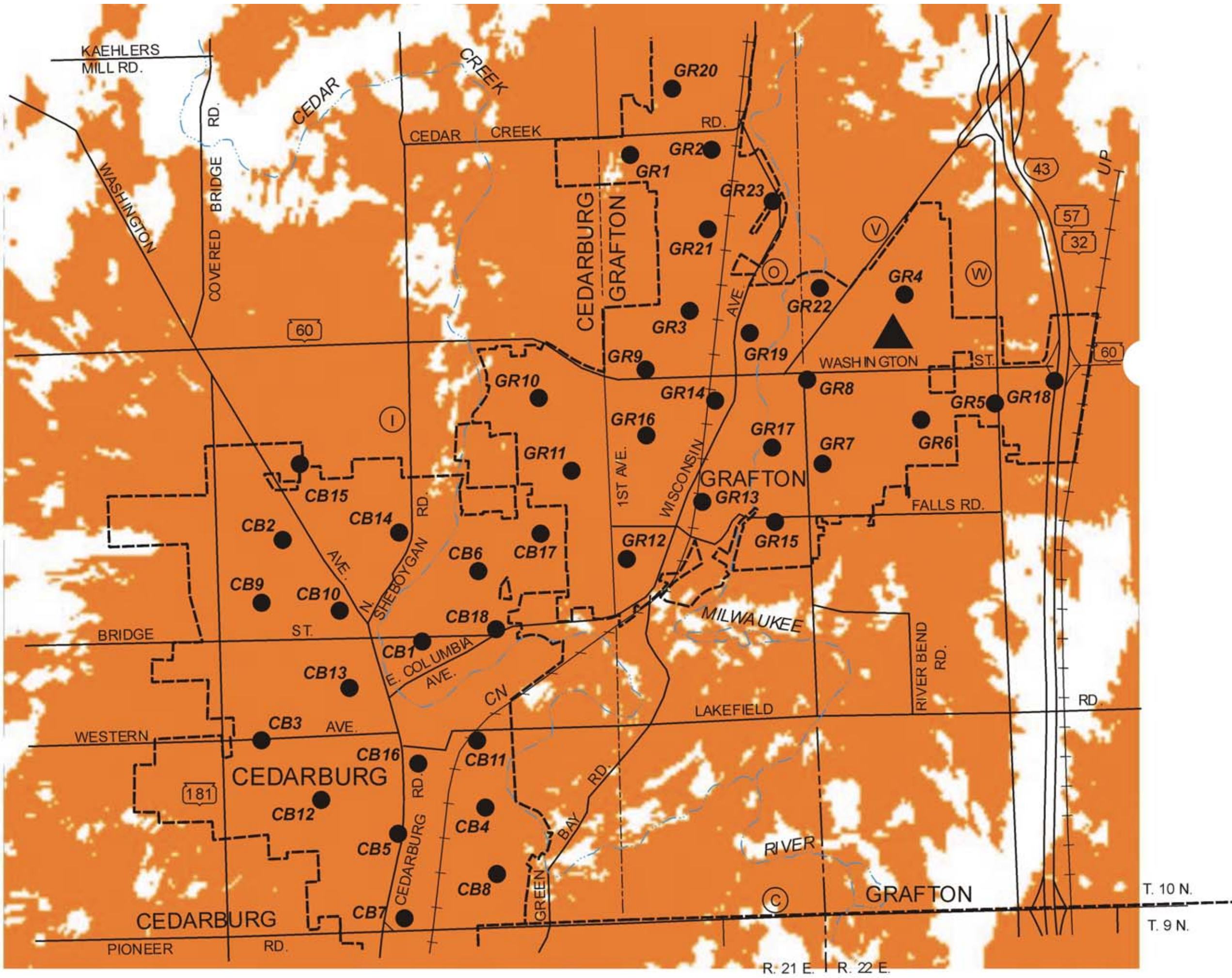
AREA NOT WITHIN ACCEPTABLE COVERAGE



Source: SEWRPC.

Map 3

POTENTIAL LOCATIONS OF WiFi ACCESS POINTS AND ATTENDANT PERFORMANCE OF ACCESS NETWORK FOR FIXED USERS IN THE CEDARBURG-GRAFTON AREA: BASE STATION TO REMOTE



LEGEND

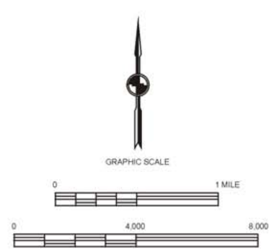
EXISTING BASE STATION TO BE USED FOR WiMAX APPLICATION

RECOMMENDED LOCATION OF WiFi ACCESS POINT

GR3 IDENTIFICATION NUMBER

RECEIVED POWER AT REMOTE:
-70dBmW TO -87dBmW,
THROUGHPUT: 24 Mpbs to 54Mbps

AREA NOT WITHIN ACCEPTABLE COVERAGE



Source: SEWRPC.

Table 2

LOCATIONS OF RECOMMENDED WIRELESS ACCESS POINTS TO BE USED FOR WiFi PURPOSES IN THE CITY OF CEDARBURG AND VILLAGE OF GRAFTON, OZAUKEE COUNTY, WISCONSIN

Site Number (See Maps 2 and 3)	0Location			
	State Plane Coordinates[a]		U.S. Public Land Survey	
	North	East	Township-Range-Section	Civil Division
GR1	493,567	2,542,022	T. 10 N., R. 21 E. Sec. 13	Village of Grafton
GB2	488,807	2,545,318	T. 10 N., R. 21 E. Sec.13	Village of Grafton
GR3	489,372	2,543,603	T. 10 N., R. 21 E. Sec. 13	Village of Grafton
GR4	489,971	2,549,446	T. 10 N., R. 22 E. Sec. 18	Village of Grafton
GR5	486,743	2,551,950	T. 10 N., R. 22 E. Sec. 19	Village of Grafton
GR6	486,450	2,549,905	T.10 N., R. 22 E. Sec. 19	Village of Grafton
GR7	485,296	2,547,322	T. 10 N., R. 22 E. Sec. 19	Village of Grafton
GR8	487,628	2,46,826	T. 10 N., R. 22 E. Sec. 19	Village of Grafton
GR9	487,928`	2,542,530	T. 10 N., R. 21 E. Sec. 24	Village of Grafton
GR10	487,149	2,539,665	T. 10 N., R. 21 E. Sec. 23	Village of Grafton
GR11	485,188	2,540,599	T. 10 N., R. 21 E. Sec. 23	Village of Grafton
GR12	482,694	2,541,918	T. 10 N., R. 21 E. Sec. 25	Village of Grafton
GR13	484,267	2,544,017	T. 10 N., R. 21 E. Sec. 24	Village of Grafton
GR14	487,002	2,544,322	T. 10 N., R. 21 E. Sec. 24	Village of Grafton
GR15	483,683	2,545,926	T. 10 N., R. 21 E. Sec. 25	Village of Grafton
GR16	485,980	2,542,482	T. 10 N., R. 21 E. Sec. 24	Village of Grafton
GR17	485,633	2,545,878	T. 10 N., R. 21 E. Sec. 26	Village of Grafton
GR18	487,463	2,553,785	T. 100 N., R. 21 E. Sec. 26	Village of Grafton
GR19	488,807	2,545,318	T. 10 N., R. 21 E. Sec. 24	Village of Grafton
GR20	495,301	2,543,229	T. 10 N., R. 21 E. Sec. 12	Village of Grafton
GR21	491,564	2,544,215	T. 10 N., R. 21 E. Sec. 13	Village of Grafton
GR22	490,090	2,547,290	T. 10 N., R. 22 E. Sec. 18	Village of Grafton

Table 2 continued

Site Number (See Maps 2 and 3)	Location			
	State Plane Coordinates[a]		U.S. Public Land Survey Township-Range-Section	Civil Division
	North	East		
GR23	492,355	2,546,028	T. 10 N., R. 21 E. Sec. 13	Village of Grafton
CB1	480,488	2,536,424	T. 10 N., R. 21 E. Sec.26	City of Cedarburg
CB2	483,338	2,532,805	T. 10 N., R. 21 E. Sec. 27	City of Cedarburg
CB3	477,856	2,532,271	T. 10 N., R. 21 E. Sec. 34	City of Cedarburg
CB4	475,954	2,538,218	T. 10 N., R. 21 E. Sec. 25	City of Cedarburg
CB5	475,207	2,535,812	T.10 N., R. 21 E. Sec. 24	City of Cedarburg
CB6	482,317	2,537,883	T. 10 N., R. 21 E. Sec. 26	City of Cedarburg
CB7	473,063	2,535,915	T. 10 N., R. 21 E. Sec. 34	City of Cedarburg
CB8	474,070	2,538,428	T. 10 N., R. 21 E. Sec. 35	City of Cedarburg
CB9	481,530	2,532,094	T. 10 N., R. 21 E. Sec. 27	City of Cedarburg
CB10	481,367	2,534,206	T. 10 N., R. 21 E. Sec. 27	City of Cedarburg
CB11	477,791	2,537,969	T. 10 N., R. 21 E. Sec. 35	City of Cedarburg
CB12	476.276	2,533,937	T. 10 N., R. 21 E. Sec. 34	City of Cedarburg
CB13	479,193	2,534,415	T. 10 N., R. 21 E. Sec. 27	City of Cedarburg
CB14	483,477	2,535,790	T. 10 N., R. 21 E. Sec. 27	City of Cedarburg
CB15	483,417	2,533,281	T. 10 N., R. 21 E. Sec. 22	City of Cedarburg
CB16	477,206	2,536,337	T. 10 N., R. 21 E. Sec. 24	City of Cedarburg
CB17	483,309	2,539,755	T. 10 N., R. 21 E. Sec. 26	City of Cedarburg
CB18	480,689	2,538,419	T. 10 N., R. 21 E. Sec. 26	City of Cedarburg

[a]*State Plane Coordinates are from the Wisconsin State Plane Coordinate System, South Zone, North American Datum of 1927. Coordinates are rounded to the nearest foot.*

Source: SEWRPC.

A final comment concerning WiFi-based mesh networks is relevant here. Because these networks employ proprietary routing protocols and other vendor specific features, they no longer qualify as IEEE standards technologies with the lower costs and other benefits of standards-based technologies. A future WiFi standard for mesh networks, IEEE 802.11s, attempts to standardize mesh networks, but it is still in preparation, and current mesh networks are non-standard with variations from one manufacturer to another.

Multimedia Extensions

The cellular broadband wireless system plan described here for the Cedarburg-Grafton area will initially provide data services for Internet access. The structure of the network with short latency times and low packet loss rates will make it readily expandable for voice communications based on VoIP technology. Latency times and packet loss rates are the primary determinants of voice quality in a telephony network. As previously stated, latency times and packet loss rates tend to limit the potential of mesh networks with their currently high packet loss rates and extended latency times. With transmission rates exceeding 20 megabits per second for fixed user installations and moving higher in the coming years, video services over the network become a strong possibility.

ENVIRONMENTAL ASSESSMENT

Commission policy as well as Federal and State regulations require the Commission to prepare an environmental assessment in connection with the development of any elements of the Commission's comprehensive plan for the physical development of the Region. Such an assessment, focusing on radiation hazards, would be presented to the Committee for review and comment at a future date.

SUMMARY

A five-step plan development sequence has been presented for a fourth generation (4G) wireless network plan for Southeastern Wisconsin. This sequence includes the following work activities:

1. Selecting a basic wireless communications technology
2. Supporting this basic technology with accessory technologies required to achieve performance standards
3. Identifying and defining equipment requirements for various classes of network users to be serviced by the new wireless network
4. Planning an optimized WiMAX-based regional wireless backhaul network to service multiple community WiFi networks
5. Formulating a community-level WiFi network plan for a sample community -- the Cedarburg-Grafton area in Ozaukee County

A standards-based WiFi-WiMAX wireless communications technology was selected as the foundation for the regional wireless network plan. WiFi would serve as the access network for individual local communities, and WiMAX would provide the backhaul connection to other WiFi networks and the Internet. Competing proprietary wireless technologies are more costly and less likely to achieve 4G performance standards.

Achieving throughput and other 4G performance standards required an improvement in receiver sensitivity performance. An approach to achieving this higher level receiver performance was described in some detail.

Two classes of current users were defined – the nomadic laptop computer user and the fixed location user. A plan objective was to support the laptop user as the defining measure for plan design with a strong broadband communications capability. The fixed location user could then benefit with higher data rate performance because of enhanced equipment capabilities.

Pilot system plans were prepared for both a WiMAX-based Regional Wireless Backhaul network and a community-based WiFi network. The regional wireless backhaul network would result in both infrastructure and operation savings that allow for an investment pay-back period of less than one year. A sectoral cellular network plan was generated based on radio propagation modeling for the Cedarburg-Grafton area that provided high speed data transmission rates of 24 to 54 megabits/second to all fixed location users at a system infrastructure cost of approximately $295,000 compared with approximately $456,000 for an equivalent Tropos mesh network that does not achieve the performance standards.

KJS/KWB/lgh
07/21/06
#115251 V6 - T/C - PR No. 51-Chapter VII

Appendix I

INFRASTRUCTURE,
COST ESTIMATE TABULATIONS

COMMUNITY WiFi NETWORK (802.11)

ACCESS POINT EQUIPMENT

WiFi (802.11 a,g) Access Point

1.	Transceiver Modules	
	2 at $1,500 =	$3,000
2.	Sectorized Antenna	995
3.	Auxiliary Equipment	841
4.	Installation and Testing	
	17 hours at $80	1,360
	Total	$6,196

For rural wireless network, add:

Three sets of preamplifiers, connectors and power injectors - $645

WiFi Network Cost Summary - Cedarburg-Grafton

1.	Access Points	
	41 at $6,196 =	$254,036
2.	Gateway Stations	
	2 at $17,300 =	34,600
3.	Network Monitoring System	10,000
4.	Project Management and Engineering	55,000
	Total	$353,336

BACKHAUL WiMAX/WiFi NETWORK (802.11, 802.16)

BASE STATION EQUIPMENT

Co-located Site

1.	Site Preparation and Cleanup	$ 1,000
2.	~~Shelters and Buildings~~ *Enclosures*	200
3.	Utility Connection	2,000
4.	Power Conditioning and Backup	7,020
5.	21 dBi Antenna	150
6.	16 dBi Sectorized Antenna	1,404
7.	Transceiver Modules	
	WiFi (802.11) (2)	2,800
	WiMAX (802.16) (1)	3,000
8.	Installation and Testing	
	40 hours at $80	3,200
9.	Miscellaneous	
	(Freight, cabling and travel)	2,250
	Total	$23,024

New Site

1.	Items 1-9 of co-located site above		$23,024
2.	Town Erection		
	100 foot tower	$7,200	
	Foundation	4,100	
	Labor	2,200	
	Climb Shield	1,000	14,500
	Total		$37,524

Gateway Station

1.	Site Preparation and Cleanup	$ 1,000
2.	~~Shelters and Building~~ *Enclosures*	10,850
3.	Utility Connection	2,000
4.	Power Conditioning and Backup	7,020
5.	31.2 dBi Antenna	3,874
6.	16 dBi Sectorized Antenna	1,404
7.	Transceiver Modules	
	WiFi (802.11) (2)	2,800
	WiMAX (802.16) (1)	3,000
8.	Internet Interconnection	
	MPLS Router	30,420
	Fiber Interconnect Equipment	20,000
9.	Installation and Testing	
	80 hours at $80	6,400
10.	Miscellaneous	
	(Freight, cabling and travel)	2,750
	Total	$91,518
	If new tower required	14,500
		$106,018

Backhaul Network Cost Summary – Co-Location

1.	Antenna Base Stations	
	47 at $23,024 =	$1,082,128
2.	Gateway Stations	
	7 at $91,518 =	640,626
3.	Project Management and Engineering	350,000
	Total	$2,072,754

Backhaul Network Cost Summary – New Tower Sites

1.	Antenna Base Stations	
	47 at $37,524 =	$1,763,628
2.	Gateway Stations	
	7 at $106,018 =	742,126
3.	Project Management and Engineering	350,000
	Total	$2,855,754

Appendix II

OPERATING COST

ESTIMATE TABULATIONS

Access Point

Community WiFi Network

1.	Electric Power	
	50 watts at $0.05/kwh	$1.80/month
2.	Maintenance and Network	
	Management	25.00/month
3.	Pole Rental	10.00/month
	Total	$ 36.80/month

Backhaul Base Station

WiFi/WiMAX Network – Co-location

1.	Electric Power	
	20 watts at $0.05/kwh	$7.20/month
2.	Maintenance and Network	
	Management	100.00/month
3.	Base Station Rental	
	$4/foot/month	
	100 foot tower	400.00/month
4.	Transport Costs (100 Mbps)	
	74 x 100 =	7,400.00/month
	Total	$7,907.20/month

Backhaul Base Station

WiFi/WiMAX Network – New Towers

1.	Electric Power	
	200 watts at $0.05/kwh	$7.20/month
2.	Maintenance and Network	
	Management	100.00/month
3.	Land usage fee	1,060.00/month
4.	Transport Costs (100 Mbps)	
	74 x 100 =	$7,400.00/month
		$8,507.20/month

Note:

Base station operators are often required to have liability insurance in the range of $1-3 million for each base station site. Less often they are required to post performance bands for the contingency of tower abandonment. Neither of these costs are included here.

Appendix III

INTERNET ACCESS AND TRANSPORT BUDGETARY RATES

APPENDIX III

INTERNET ACCESS AND TRANSPORT BUDGETARY RATES[1]

TRANSPORT	
Speed	24 Month
2Mb	$400
5Mb	$765
10Mb	$1,035
20Mb	$1,410
30Mb	$1,565
40Mb	$1,720
50Mb	$1,875
60Mb	$2,035
70Mb	$2,195
80Mb	$2,355
90Mb	$2,515
100Mb	$2,625
ICB	-

DIRECT INTERNET ACCESS					
COMMITTED	12 MONTH	24 MONTH	36 MONTH	48 MONTH	60 MONTH
10Mbps	$108	$107	$106	$105	$104
20Mbps	$100	$99	$98	$97	$96
30Mbps	$92	$91	$90	$89	$88
40Mbps	$89	$88	$87	$86	$85
50Mbps	$86	$85	$84	$83	$82
60Mbps	$84	$83	$82	$81	$80
70Mbps	$81	$80	$79	$78	$77
80Mbps	$80	$79	$78	$77	$76
90Mbps	$76	$75	$74	$73	$72
100Mbps	$74	$73	$72	$71	$70
110Mbps	$72	$71	$70	$69	$68
120Mbps	$70	$69	$68	$67	$66
130Mbps	$68	$67	$66	$65	$64
140Mbps	$66	$65	$64	$63	$62
150Mbps	$64	$63	$62	$61	$60
250Mbps	$62	$61	$60	$59	$58

1 Rates provided by LightPoint Networks, 1807 N. Center Street, Beaver Dame, WI 53916, via letter from Mr. Daniel W. Matson, Sales Agent, dated June 19, 2006.

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Langberg: Tread carefully with municipal wireless

By Mike Langberg
Mercury News

Residents of St. Cloud, Fla., get more than just free street lights, parks and libraries -- they live in the first U.S. community to offer free city-owned wireless Internet access.

Cyber Spot, operated by Hewlett-Packard under a city contract, launched in St. Cloud on March 6. Less than four months later, 55 percent of the Orlando suburb's 10,000 households have signed up.

St. Cloud's apparent success with the much-hyped concept of municipal wireless networks was the talk of this week's Muni Wireless Silicon Valley '06 conference, which ended its three-day run Wednesday at the Santa Clara Mariott.

An audience of about 600, including officials from cities around the country, equipment vendors and venture capitalists, heard speaker after speaker talk about the Florida town.

One statistic should strike fear into Internet service providers, or ISPs, especially phone and cable companies: A staggering 84 percent of Cyber Spot users, according to a recent city survey, ``are either currently or plan to ultimately use (the service) as their only access to the Internet."

In other words, several thousand households in St. Cloud may be dropping their DSL lines or cable modems.

Muni wireless systems are cheap to build -- St. Cloud spent about $3 million -- and tap the same WiFi technology found in most notebook computers.

Cities around the country are racing to set up their own wireless networks, or allowing private companies to build and run them, by attaching two-way WiFi radios to light poles.

Google is in the process of launching a free WiFi network in Mountain View this month,

M
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and is working on a WiFi network for San Francisco in partnership with EarthLink. Wireless Silicon Valley, a coalition of government and non-profit agencies, is seeking to blanket 40 local cities with wireless Internet access. The first round of bids from contractors is due June 30.

But amid all the excitement, there was an undercurrent of anxiety running through the conference.

Several speakers worried that muni wireless is being oversold, and two projects prominently featured at previous Muni Wireless conferences were hardly mentioned this time around.

Chaska, Minn., was the muni wireless poster child before St. Cloud.

The Minneapolis suburb launched a municipally owned and operated system in September 2004 offering wireless access to all of its 7,000 households for $16 a month. Within a few months, a third of the community -- 2,300 households -- signed up.

But a story in the Chicago Tribune on June 11 revealed the Chaska network had previously undisclosed problems with poor connections, unresponsive customer service and high customer turnover. Earlier this year, the city had to replace all of its radio equipment with a new generation of hardware, and turned over management of the network to an outside contractor.

Another notable absence from this week's conference was MetroFi of Mountain View, which runs a free wireless network in much of Cupertino, Santa Clara and Sunnyvale.

MetroFi initially tried selling service at $19.95 a month, but found few takers. In January, the company began offering the service for free -- inserting a small strip of ads in the browser to pay the bills.

But, according to a Tuesday story in the Wall Street Journal, the MetroFi system today has only about 10,000 users in an area with a population of about 250,000.

I tested MetroFi's service for a column in February. While I liked the idea of getting Internet access for free, the quality was spotty. The service wasn't always fast, and the signal was often blocked by walls.

Before you dismiss me as a professional skeptic, or a stooge for AT&T and Comcast, listen to some of the comments from the Muni Wireless stage.

``Hype happens with every new technology, but boy, with wireless it really comes out,'' said Steve Goldberg of the venture capital firm Venrock Associates in Menlo Park.

``Performance isn't quite as good as everybody hoped it would be,'' Goldberg added.

Chris Sacca, head of Google's wireless projects in Mountain View and San Francisco, said, ``Whenever I talk to vendors in this space, I can never get a straight answer.''

Equipment makers trash each other instead of offering hard performance data, Sacca complained, then make ``outrageous and exaggerated claims'' about their own products.

I'm a believer in the potential of muni wireless. If the evangelists start making realistic estimates of cost and performance, muni wireless could evolve into a long-overdue ``third pipe" into the home that would force more competitive pricing from the two-headed monopoly of cable and DSL broadband.

Until that happens, though, the industry risks a stinging backlash from disappointed cities and citizens.

Contact Mike Langberg at mike@langberg.com or (408) 920-5084. Past columns may be read at www.langberg.com.

Lynn G. Heis

From: Jeffrey J. Mantes [jmante@mpw.net]
Sent: Thursday, July 06, 2006 11:51 AM
To: Lynn G. Heis
Subject: Re: Telecommunications Advisory Committee Meeting

I have been scheduled for a meeting with the Mayor at 1:00 PM on Monday the 10th so will be unable to make the 2:00 PM meeting. However I have reviewed the materials and have found it to be acceptable from our stand point. I'm sure the telecoms will have many comments as they seem to always have.

One correction to the minutes...p. 14 para. # 3 . use of our poles etc is not free. The agreement with Midwest Fiber Networks(MWFN) calls for a $25.00 charge per pole per year attachment fee for each anntennae. Additionally, MWFN, would pay the cost to bring a power feed out of any of our facilities such as traffic signal controller boxes, pumping stations, etc. We too only power our lights at night, so it does not seem likely that there will be attachments to light poles, except in alleys where we put our light on WE Energies poles and there is a constant power source from WE(our lights are aech controlled by photo cell in these cases)Our understanding is that MWFN, has the same arrangemnet with WE at $25.00/pole/year for being on their poles.

Jeff

Quoting "Lynn G. Heis" <LHEIS@SEWRPC.org>:

> Please be advised that the next meeting of the Telecommunications
> Advisory Committee is scheduleld to be held on Monday, July 10, 2005
> beginning at 2:00PM in the Commission offices. Please mark your
> calendars.
>
> Should you have any questions concerning this matter, please do not
> hesitate to call Lynn Heis at 262-547-6721 (extension 245).
>
> Kurt W. Bauer
> SEWRPC
> W239 N1812 Rockwood Drive
> P. O. Box 1607
> Waukesha, WI 53187-1607
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--
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e-mail: bob.chernow@rbcdain.com

June 27, 2006

To SEWRPC Committee

Please accept my apologies for not attending the July 1oth meeting. I will be northern Ontario fishing. As Emerson said "Some men fish all their lives without realizing that it's not fish they are after."

I am in agreement with the minutes, although I am still troubled by (page 7, 3rd paragraph) by our monitoring system that was unable to work with T-mobile, a major provider in our region.

As to Chapter VII, I am in agreement, again.

Page 3, 1st paragraph, 3rd sentence. I suspect that routing improvements over the next seven years will greatly improve the speed and performance (clarity) for intra-regional transmission.

Page 3, 2on paragraph, 3rd and 4th sentence. Technology ought to solve this problem of mobility by interconnecting with fiber; we are probably a decade away.

Page 8, WiMax. The extension of range from 300 feet to 30 miles is a significant breakthrough that overcomes the additional cost. My guess is this technology will be rapidly adopted.

Page 14, 3rd paragraph. What is the basis for the requirement that antenna-preamplifer combination be improved 20 decibels to achieve the maximum data rate of 54 megabits per second? And why is this (54 megabits) the standard?

Page 16, 1st paragraph, 2nd sentence. What does "realty" in this sentence mean?

Page 19

Am I missing something here? Why 10 base stations in Walworth, Washington & Waukesha but only 7 in Milwaukee and fewer elsewhere?

Bob

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
W239 N1812 ROCKWOOD DRIVE • PO BOX 1607 • WAUKESHA, WI 53187-1607•
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MEMORANDUM

TO: All Members of the Regional Telecommunications Planning Advisory Committee

FROM: K. W. Bauer, Chairman
Regional Telecommunications Planning Advisory Committee

DATE: July 5, 2006

SUBJECT: REVISED OUTLINE

Item No. 4 of the agenda for the Regional Telecommunications Planning Advisory Committee meeting scheduled to be held on Monday, July 10, 2006, consists of consideration of a preliminary draft outline of SEWRPC Planning Report No. 53, *A Regional Comprehensive Broadband Telecommunications Plan for Southeastern Wisconsin.* A copy of this draft outline dated June 20, 2006, was provided to all Committee members with the agenda for the meeting.

The outline, and more specifically, Items V D; Item VI; and Item VII B have been revised. Item V E has been added. A copy of the revised outline dated June 30, 2006 is enclosed for your review prior to the meeting. Please discard the draft initially provided dated June 20, 2006.

Should you have any questions concerning this matter, please do not hesitate to call.

* * *

PCE/KWB/lgh
#119284 T/C – Memo-Revised Outline

Enclosure

SEWRPC PLANNING REPORT NO. 53

A REGIONAL COMPREHENSIVE BROADBAND TELECOMMUNICATIONS SYSTEM PLAN FOR SOUTHEASTERN WISCONSIN

I Introduction

- A. Introduction
- B. Need for Regional Planning
- C. The Regional Planning Commission
- D. The Regional Planning Concept in Southeastern Wisconsin
- E. The Region
- F. Commission Work Programs to Date
- G. Telecommunications – Definition and Importance
- H. Advisory Committee
- I. Prospectus
- J. Need for Telecommunications Planning
- K. Plan Design Year
- L. Integration with Previous Regional Wireless Telecommunications Plan
- M. Scheme of Presentation

II Basic Principles and Concepts

- A. Introduction
- B. Basic Principles Underlying the Regional Planning Process
- C. Involved Technologies
    1. Mobile Wireless Access Networks
    2. Fixed Wireless Access Networks
    3. Wireless Backhaul Networks
    4. Wireline Access Networks
    5. Wireline Core Networks

III Objectives, Principles and Standards

- A. Introduction
- B. Definitions
- C. Objectives, Principles and Standards

1. Broadband Communication Performance
    a. Access Networks
    b. Core Networks
2. Universal Broadband Telecommunications Services
3. Redundancy
4. Network Infrastructure Community-Impact Minimization
5. Serve Most Demanding Applications
6. Network Infrastructure Cost Minimization
7. Preference for Use in Public Safety Emergencies

IV Inventory Findings – Background Conditions

A. Introduction
B. Demographic and Economic Base
    1. Population
    2. Households
    3. Employment
C. Land Use
D. Agricultural Resource Base
E. Transportation Facilities and Services
    1. Arterial Street and Highway System
    2. Public Transit
F. Summary

V Telecommunications Broadband Infrastructure Inventory Findings

A. Introduction
B. Infrastructure Inventory Data Sources
C. Broadband Wireline Service Areas
    1. By provider
    2. By county
    3. By technology
        a. DSL
        b. Cable
        c. Fiber to premises

D. Broadband Wireless Service Areas
   1. By provider
      a. Cellular/PCS
      b. Fixed
      c. Satelite
      d. WiFi
   2. By county
   3. By technology
      a. GSM
      b. CDMA
      c. iDEN
      d. TDMA
      e. FHSS
      f. Satellite
      g. WiFi

E. Core Network Inventory
   1. Existing Points of Presence (POP)
      a. By provider
      b. By county
      c. Bandwidth
   2. New Required Points of Presence

VI Broadband Telecommunications Performance Inventory
A. Web-based Performance Measurements
B. Network Monitoring Parameters
   1. Throughput Speed
      a. Download
      b. Upload
   2. Latency (Response) Time
C. Performance Monitoring
   1. Wireline
      a. By region
      b. By service provider

c. By county

d. By technology

2. Wireless

a. By region

b. By service provider

c. By county

d. By technology

VII A Regional Comprehensive Broadband Telecommunications Plan for Southeastern Wisconsin

A. Introduction

1. An integrated wireline - wireless communications network

2. Access and core networks

B. Technological Alternatives

1. Access Networks

a. Wireline – Copper

b. Wireline – Fiber

c. Wireless – Cellular/PCS

d. Wireless – WiFi/WiMAX

e. Wireless – Other

f. Fixed vs. Nomadic vs. Mobile Users

2. Core Networks

a. Wireline – Fiber

b. Wireless – Backhaul

C. Technology Evaluation and Selection

1. Access Networks

a. Wireless vs. Fiber

2. Core Networks

a. Wireless Backhaul

b. Wireline Fiber

D. Comprehensive Plan Description

1. Core and Backhaul Networks

2. Access Networks

a. By community

VIII Plan Implementation

A. Introduction

1. Role of public telecommunications planning
2. Public safety and enterprise communications networks
3. Commercial communications networks

B. Implementation Process – Public Enterprise Communications Networks

1. Plans Preparation
2. Field Test
3. Infrastructure Procurement
4. Education and Training
5. Operation

C. Implementation Process – Commercial Communications Networks

1. Plan Preparation
2. Field Test
3. Infrastructure/ISP Procurement Cycle
4. Education and Training
5. Operation

D. Summary

IX Summary

A. Chapter by Chapter series of brief summaries

1. Chapters I to VIII

KWB/KJS/lgh
06/30/06
#118969 V1 - T/C - OUTLINE REG COMP BROADBAND PLAN