LMDS: Opening Up the Spectrum

by

Ronald G. Wolak
wolakron@scis.nova.edu

A paper submitted in fulfillment of the requirements
for DISS 740 - Assignment Three, Task One

School of Computer and Information Sciences
Nova Southeastern University

November 1998

An Abstract of a Paper Submitted to Nova Southeastern University
in Fulfillment of the Requirements for DISS 740 - Assignment Three, Task One

LMDS: Opening Up the Spectrum

by
Ronald G. Wolak

November 1998

LMDS is a wireless, two-way, multichannel, data, video, and telephony technology that may have the potential to satisfy our seemingly insatiable appetites for bandwidth. Recent advancements in the technology, coupled with FCC auctions, have opened up a significant chunk of the RF spectrum for use in high-speed wireless networking. LMDS encompasses one of the largest spans of this spectrum devoted to any one type of service. Its frequency is significantly higher than most wireless applications. In the following pages, this paper looked further into LMDS technology and its origin. The results of recent FCC license auctions were discussed, and a brief look was taken at the successful bidders. Next, the advantages of LMDS over competing technologies were explored, followed by a discussion of the deployment issues unique to the technology. Also, the close ties between LMDS and ATM were explained.

LMDS: Opening Up the Spectrum

Local Multipoint Distribution Service (LMDS) was chosen one of this year's ten hottest technologies in telecommunications by *Telecommunications Magazine* (Flanagan, 1998). LMDS is a wireless, two-way, multichannel, data, video, and telephony technology that may have the potential to satisfy our seemingly insatiable appetites for bandwidth. Recent advancements in the technology (allowing the increased use of millimeter wavelengths), coupled with FCC auctions, have opened up a significant chunk of the RF spectrum for use in high-speed wireless networking.

LMDS encompasses one of the largest spans of this spectrum devoted to any one type of service (bandwidth of 1.3 GHz surrounding the 28-GHz Ka-band). Its frequency is significantly higher than most wireless applications. In the following pages, this paper will look further into LMDS technology and its origin. The results of recent FCC license auctions are discussed, and a brief look is taken at the successful bidders. Next, the advantages of LMDS over competing technologies are explored, followed by a discussion of the deployment issues unique to the technology. Also, the close ties between LMDS and ATM are explained.

LMDS Technology and Its Origin

Bernard B. Bossard is recognized as the developer of CellularVision (LMDS) technology. In the past, everyone agreed that using high frequency microwaves to transmit video was impractical. Engineers focused their attention at lower frequencies in the RF spectrum. Lower frequencies (with enough power) could be sent long distances and penetrate obstacles.

Bossard, who had worked with microwaves in the military, took a different approach. Instead of using high power and low frequencies, he focused on sending low power, high frequency signals over short distances. His model was similar to that currently used with cellular mobile phones. Also, by using frequency modulation (FM) instead of the standard amplitude modulation (AM) used in cable systems, CellularVision was able to generate signals with 10 times the signal quality of cable. This created a surplus of signal that allowed the signals to penetrate even hard, driving, rain.

Bossard thinks of his creation (LMDS) as a "16 lane super highway," when compared to the "three foot garden path" that integrated services digital network (ISDN) covers. It uses line of sight and requires a transmitter every couple of miles. Also, LMDS provides greater upstream bandwidth than Multichannel Multi-point Distribution Service MMDS and other wireless services. Baud rates are in excess of 1 Gbps downstream and 200 Mbps upstream.

In 1986, Bossard received funding from Shant Hovnanian and his father, Vahak to explore his ideas. Together they created CellularVision in Long Island, N.Y. CellularVision USA (CVUS) was the first LMDS provider licensed by the FCC. CVUS

now serves the 1,100 square mile New York Primary Metropolitan Statistical Area, which encompasses approximately 8.6 million people.

Providers of LMDS services, like CellularVision, are likely to earn $6.5 billion by 2007 according to a report by Pioneer Consulting (Cambridge, Mass.). The LMDS market has the potential to become a significant segment of the global access market. This market includes technologies such as xDSL, cable modems, broadband satellites, and fiber optic systems. In the U.S., LMDS is projected to be to make its impact in small office/home office (SOHO) and small- and medium-sized business (Mason, 1998).

LMDS technology will have broader application oversees. Wherever current telecommunications infrastructure is poor, LMDS provides a fast method of deploying high-bandwidth digital communications over a flexible network architecture. In Russia for example, only 17 out of every 100 Russians have phone service (Sykes, 1997). In response, the Russia Telecom Investors Fund (RTIF) is providing $1 billion in capital over the next five years to fund the implementation of LMDS technology.

LMDS technology will offer Russian customers phone, fax, Internet, and data service. The first cell towers will go up in Moscow and St. Petersburg and will provide 50,000 subscriber lines in each city. Another example of a LMDS application oversees is Japan's decision to use LMDS following the Kobe earthquake. During that earthquake, major portions of Japan's telecom infrastructure were destroyed.

FCC LMDS Auctions

Two major factors are responsible for making LMDS wireless a reality. The first is the new technology made possible by Bernard Bossard and others. Today's faster microprocessors and ASICs allow the complex modulation schemes needed by LMDS applications. Also, advances in technology have brought down the price points for broadband wireless to a commercially viable level (Arora & Nagpaul, 1998). The second factor is the recent availability of spectrum in the millimeter wavebands for use in commercial applications. Spectrum in the 24-26 GHz is available in Europe for broadband services. In the US, the FCC recently auctioned spectrum in the 28 and 31 GHz bands for LMDS use.

FCC LMDS auctions were completed on March 25, 1998. Two licenses were auctioned off for each market area in the country. A-block licenses covered 1,150 MHz of the high-frequency spectrum, and B-block licenses covered 150 MHz of spectrum. The wider bandwidth A-block licenses allow licensees to provide inexpensive megabit-speed service wherever line-of-sight exists. The narrower B-block licenses will primarily be used for telemetry (e.g. monitoring industrial processes and security systems). They will also provide an alternate (non-RBOC) means of local backhaul.

After 128 rounds of bidding, the FCC sold 864 of 986 offered licenses for a net total of $578.6 million (Breimhurst, 1998). WNP Communications of Earlysville, Va. was the largest bidder in the FCC auction. WNP won 80 licenses at a cost of $186.9 million.

Those licenses cover areas such as Los Angeles, New York, Chicago, and Detroit. WNP is a collection of seven East Coast venture capital funds.

NextBand Communications of Washington, DC was the second highest bidder in the LMDS auction (1998, Pioneer Consulting). It acquired 42 licenses for $134.7 million. The company plans to use the spectrum to support its two operating backers, Nextel and NextLink. NextBand is exploring LMDS for a couple of reasons. First LMDS may offer an inexpensive way of supplementing its fiber network build-out in some locations. Second, a wireless local loop alternative, such a LMDS, may create competitive pressure on high loop costs in some areas. NextBand plans to use its 13 A-block licenses to support NextLink's operations for point-to-multipoint connectivity. The 29 B-block licenses will provide backhaul links for Nextel and also support point-to-point NextLink connections.

Advantages

The marketplace for access services will become increasingly competitive in the next few years due to the wider availability of cable modems, DSL, satellite systems, and wireless local loop. LMDS has an edge because it is profitable at low subscriber rates. LMDS is able to make money with a lower percentage of potential subscribers than other access services (Flanagan, 1998). In addition, LMDS technology has the following benefits over fiber and other traditional wireline services:

- Lower deployment costs
- Lower network maintenance, management, and operating expenses
- Minimal disruption of the community and the environment
- Rapid service deployment
- Faster realization of revenue as a result of faster deployment

Also, LMDS costs are shifted from fixed to variable components. In traditional wireline systems, the majority of the capital investment is in infrastructure. However, for LMDS the investment is shifted to customer-premises equipment. As a result, an LMDS operator spends only when a revenue-paying customer signs on. There is no "stranded capital" since the service is easily redeployable when a customer relocates or terminates service.

Deployment Issues

Spectrum has become a scarce commodity. Competitors for available spectrum with LMDS include wireless third generation mobile systems such as UMTS and IMT-2000. Also, competing are low earth orbit (LEO) satellite systems. As a result, it is important for LMDS technology to maximize efficiency. Modulation techniques such as 16 and 64-QAM (Quadrature Amplitude Modulation) provide spectral efficiencies of up to 5 bps/Hz. Other techniques such as dynamic bandwidth allocation using time division multiple access (TDMA) ensure that spectrum is only allocated when there is demand for data transfer from an end-user (Steckley, 1998).

Other LMDS deployment issues involve microwave planning techniques that enable high bandwidth within each LMDS cell. Included are horizontal/vertical polarization, sectorization, and frequency reuse. For example, a 360-degree transmission pattern, sectored into four quadrants of alternating polarity, allows for the effective reuse of all spectrum frequencies and provides an overlapping node pattern that significantly improves coverage (McCabe, 1998).

Factors affecting system performance include rain fading, line-of-sight requirements, and free-space path loss. Fading as a result of rain and snow in the millimeter-wave frequencies used by LMDS dictates that a typical cell is a maximum of three to five kilometers. Cell planing is important to ensure that these fading problems are overcome. Power control and dynamic modulation algorithms are effective in addressing signal fading.

ATM and LMDS

Currently, there are several architectures to deliver LMDS broadband wireless service. However, wireless ATM is emerging as the frontrunner for the following reasons:

- Bundled services -- ATM offers two-way integrated voice, data, and video over one network architecture.
- Fiber-like QoS -- ATM extends the existing wireline ATM cell-based transport to the wireless environment.
- High efficiency -- ATM architectures optimize bandwidth utilization.

Wireless ATM will also allow LMDS providers to offer services such as:

- Switched virtual circuit (SVC) services
- Various QoS levels supported by ATM
- Support for IP services over ATM with QoS

Broadband wireless providers such as WinStar and Advanced Radio support wireless ATM since their wireline infrastructures already use ATM protocols (Sweeney, 1998). "ATM over point-to-point microwave connection is trivial," said Motorola's Lou Dellaverson. "The protocol doesn't really know whether the connection is fiber or airwaves. Multipoint is a little harder, but the problems have essentially been solved. Mobile is what is difficult." LMDS equipment manufacturers such a Nortel have selected ATM because it supports voice, text, and video all on one network. Embedded ATM is fast becoming the standard due to its ability to manage the delays inherent in a wireless broadband network (Sweeney, 1998).

Conclusion

The FCC auctions are over, and LMDS providers are preparing to go head-to-head with the competition. Advances in technology, coupled with increasing demand for broadband services will continue to drive the evolution of LMDS wireless networks. Technology

refinements such as active antenna designs and higher sectored antennas will increase the capacity, reliability, and penetration of LMDS systems. High volume manufacturing of RF and digital components will drive down the cost of subscriber equipment. These factors all add up to some pretty stiff competition for the incumbents and less expensive and more available bandwidth for the customer.

Reference List

Arora, S., & Nagpaul, A. (1998, September). Broadband wireless solutions for global business. *Telecommunications*. http://www.telecoms-mag.com/issues/199809/tci/arora.html

Breimhurst, H. (1998, April 6). WNP and NextBand win licenses for new wireless technology. *CityBusiness*. http://www.amcity.com/twincities/stories/040698/story5.html

FCC Web Site. http://www.fcc.gov/wtb/auctions

Flanagan, P. (1998, May). This year's 10 hottest technologies in telecom. *Telecommunications*. http://www.telecoms-mag.com/issues/199805/tcs/flanagan.html

Mason, C. (1998, September 1). LMDS: Huge niche technology. *America's Network*, 102(17), 73.

McCabe, T. (1998, June 15). What lies ahead for LMDS. *America's Network*, 102(12), S8.

Pioneer Consulting. (1998). NextBand Communications, L.L.C. *LMDS Buildout Strategies Sample Profile*. http://www.pioneerconsulting.com/lmds/samppro.html Accessed November 14, 1998.

Steckley, E. (1998, February). Broadband wireless -- The dawn of a new era. *Telecommunications*. http://www.telecoms-mag.com/issues/199802/tci/steckley.html

Sweeney, D. (1998, October 1). The wireless ATM debate. *Wireless Review*, 15(19), 18.

Sykes, R. (1997, March 24). Russia to get phone upgrade. *InfoWorld*, 19(12), 44F.