Hybrid

Wireless Broadband Modems

Definition

Wireless broadband Internet access uses many frequency bands. Wireless broadband modems offer similar performance to cable modems operating over wired cable television systems (CATV), but the business is easier to enter as the transmitters cover an entire city or region.

Overview

A broadband wireless system can deliver up to 30-Mbps data capacity in a 6-MHz channel. The wireless system's strength is that it can quickly provide high burst speed Internet access to a 10-mile, 20-mile, or 35-mile radius depending on the frequency band used. This allows the service provider to work with or compete with CATV to serve small-sized and medium-sized business and high-end users. The CATV coaxial-cable plant typically services residential neighborhoods and may not serve these premium customers. Wireless impose special requirements on the technology and business relationships.

Topics

1. Internet Transmission Basics

Though it is not necessary to understand how the Internet works, the basic differences between the Internet and continuous data transmission should be understood. There are two key differences:

- Continuous data transfer concepts such as the bandwidth assigned to each user become meaningless, at least for Internet traffic. The Internet provides bandwidth on demand except it really transfers packets in bursts. There will be delays in receiving a file or burst of data if there are many users. These delays, which increase with traffic load, are a measure of the quality of service (QoS).

- Most forms of Internet file transfer require Internet protocol (IP) acknowledgments (ACKs). Delays or latency in returning ACKs back to the information source slow the downstream file transfer.

The downstream communication uses the transmission control protocol (TCP)/IP. The customer's computer acknowledges the receipt of packets by sending an ACK signal upstream. TCP uses a form of data flow control called a sliding-window protocol. This allows very fast downstream bursts suited to the high bit rate of the downstream channel (but lower average rates scaled to shared channels and the computer's ability to receive data at 1–Mbps to 2–Mbps). It optimizes burst communication where the latency or the delay time in receiving the ACK impacts the downstream speed.

The following are effects of TCP/IP on cable modem systems:

- TCP/IP is much more tolerant of occasional brief losses of downstream communication caused by interference than a television signal because it can request retransmissions.

- A return path is needed to acknowledge the transmitted packets as well as the request files.

- Traffic is asymmetric—that is, a 10–Mbps wireless downstream path still yields fast downstream file transfers even with a low bandwidth return path such as a 14.4–Kbps phone connection.

- A wireless downstream path with a telephone return path is a viable way to provide service. (Wireless return options are in their infancy due to the cost of the equipment and limited available bandwidth. They offer lower latency and in most cases a higher upstream speed for file transfers in business applications.)

- Both telephone and wireless return paths can introduce additional factors that cause high latency resulting in slower downstream speeds. For example, V.34 28.8-Kbit telephone modems have greater latency than V.32 14.4-Kbit telephone modems. Similarly, some cellular wireless and satellite data services have extreme latency and, as a result, give slow file transfers.

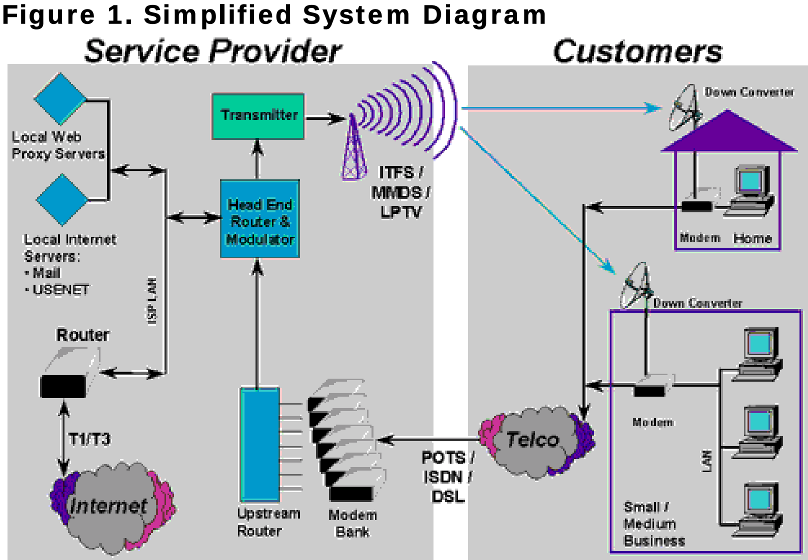
The broadband modem system can contribute round-trip latencies that vary from 25 msec for wireless return and upwards of 125 msec for telephone return. ACK is about 40 bytes long for telephone return systems and about 80 bytes long for wireless return due to their different protocols.

2. Basics of Cable-Modem System and Cable Modem

Cable Modem System

Figure 1 is used to bring out points applicable to wireless. The client-server modem architecture provides the operator control of the modems (customers) from the head end.

Figure 1. Simplified System Diagram



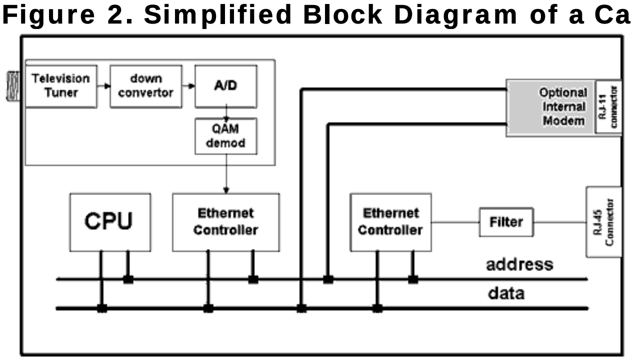
Starting with the service provider, a connection to the Internet is required in addition to a number of local servers, such as e-mail and a caching server, to save frequently accessed pages instead of requesting them repeatedly over the network. Connected to this local-area network (LAN) is some form of downstream router. The digital output is converted by a 64–quadrature amplitude modulation (QAM) modulator which provides a 44-MHz intermediate frequency (IF) signal to the transmitter. This signal occupies a 6-MHz bandwidth. (The modulation type and channel size varies according to the vendor.) The customer receives the line-of-sight (LOS) signal, and the cable modem is connected by way of Ethernet to the computer or multiple computers on an Ethernet LAN. The cable modem return path in this diagram is over the dial-up telephone network to a modem bank and an upstream router. This return path carries both upstream requests and acknowledgments of the downstream packets. Connecting the return path directly to the provider's LAN in this way gives the fastest file transfer from the local servers. The modem banks could also be at a remote location connected by traditional digital facilities. (The modem banks could also be connected to another Internet access point. This makes no difference to the traffic from the Internet but would slow the transfer from the local servers due to Internet delay of ACKs.)

Each 6-MHz channel can support about 9000 subscribers. The number varies according to the type of traffic and the user. It can be increased by using directional instead of omnidirectional transmitter antennas so that different sectors are served by different transmitters.

Cable Modem

Wireless broadband modem service builds upon the simpler system architecture of wired cable service so it is helpful to first understand operation in a cable system with fewer variables. A modern CATV system has downstream channels from 50 MHz to 806 MHz. The cable modem tunes to all or some of these channels depending on its design. The signal level is nominally 0dBmV (1 millivolt in 75 ohms) at the interface to the customer and is stable, varying slowly with temperature and time. USA CATV channels are 6-MHz wide and with 6-MHz spacing. A 64–QAM modulator can fit 30–Mbps of data in a 6-MHz channel.

Figure 2. Simplified Block Diagram of a Cable Modem



A cable modem consists of a standard digitally controlled cable-ready television tuner, a 64–QAM demodulator and an Ethernet connection to the customer's computer. The return path from the computer carries ACK messages or upstream file transfers such as e-mail. The upstream connection may use an RS232 connection to a telephone modem or a modulated upstream signal such as quaternary phase shift keying (QPSK) for return over the cable system. An internal processor with memory controls the tuner and the return path as well as more complex functions such as downstream packet filtering.

There are some points to note as regards modem tuning:

- The ideal modem operates both for wired CATV and wireless, although wireless has some different requirements due to propagation and the manner in which the signal is received.
- A standard digitally controlled TV tuner has fixed tuning steps of 62.5 kHz.
- The cable-modem vendor makes a modem that tunes only to fixed frequencies. Cable modems use discrete digital, not analog tuning. Many modems tune in 6-MHz steps, which is not sufficient for all wireless bands.
- The 64–QAM demodulator also drives the tuner. The demodulator has to be able to correct frequency errors that occur in the television tuner/downconverter and the received signal. The input frequency stability is normally in the range of ±50 kHz.

3. Architecture of a Wireless Downstream System

Engineering of a wireless system is complicated by several factors:

- The physical wireless-transmitter location may be different from the Internet head-end location.
- LOS transmission is required.
- The signal power falls with distance.
- Different fixed transmission frequencies are used according to license availability.
- multipath distortion

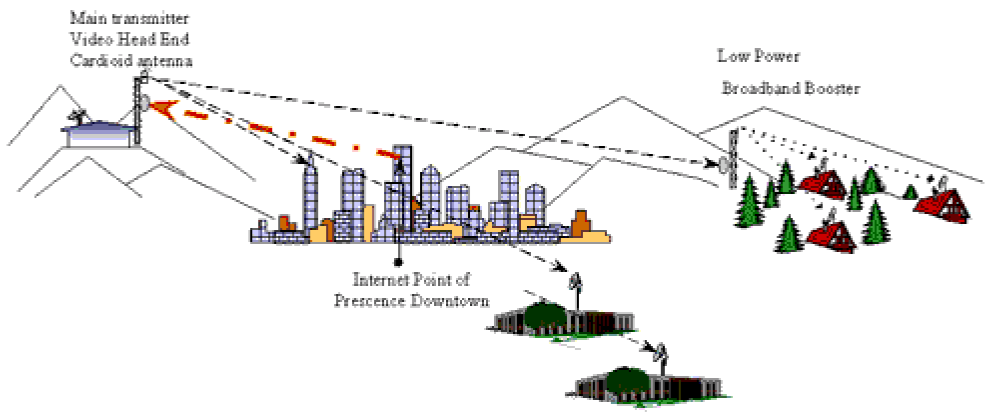
- A receiving antenna is required on the roof, the side of the building, or sometimes in a window.
- Two-way operation is limited by available licenses, bandwidth, and Federal Communications Commission (FCC) regulation.

Some of these requirements interact as described below:

- If one had complete freedom, the transmitter would be at a convenient site for an Internet service connection yet have LOS transmission to customers. These two requirements conflict about half the time, so the transmitter and the Internet head end cannot be colocated.
- The site for the wireless antenna and the transmitter is usually chosen to provide LOS television to a metropolitan area or several rural communities. The frequency bands were licensed for this wide-area coverage—they are not personal communications service (PCS) cells. As a result, the transmitter site may be physically inaccessible on a mountain.
- The nearest point of connection to the Internet is often downtown. This is often the best place for the Internet head-end maintenance.

As can be seen from *Figure 3*, the multipoint multichannel distribution service (MMDS) transmitter may not cover the whole area. A low-power booster may be needed to fill in areas where LOS does not exist.

Figure 3. MMDS Transmission Configuration: Distant Transmitter with Internet Head End Downtown Co-Located with Point of Presence (POP)



4. Frequency Bands and Limitations

The frequency band determines the type of receiving antenna and the coverage, or range, of the transmitter. MMDS, instructional television fixed service (ITFS) and multipoint distribution service (MDS) analog television transmitters were the first used for Internet access. The bands were underutilized for television and one, two, or even three digital 2-MHz subchannels could be made to work with adjustments to the analog-transmitter diplexers and filters. Digital transmitters have recently been made available from several vendors.

Wireless communications service (WCS) is a newly available band with wireless transmitters and downconverters under development. Ultra-high frequency (UHF) and very-high frequency (VHF) low-power transmitters are in service for Internet downstream access using experimental licenses. Most bandwidths are 6-MHz downstream, whereas WCS is 5 MHz.

Table 1. Frequency Band Designations

Name	Basic usage
MMDS	Most of these T.V. transmitters are analog and require upgrade to digital unless sub-channelization is used. (Note 1).
MDS	analog T.V. or not used
WCS	new
ITFS	educational service, includes Internet access
LMDS	local multipoint distribution service; new
ISM	instructional, scientific and medical; unlicensed bands used for LANs and for the return path of two-way modem systems
Note 1: Sub-channelization is a way to increase the power of the adaptive equalizer in the cable modem by applying it to a narrower bandwidth. A standard equalizer can equalize three times the amplitude tilt or triple the delay if it operates over a 2-MHz channel instead of a 6-MHz channel. The narrower bandwidth may allow operation without upgrading the diplexer or removing sound subcarrier stop filters of an existing analog transmitter. In the latter case, only one or two subchannels may operate instead of three.	

Table 2. Frequency Bands

Name	Frequency	Notes
MMDS	2500–2686 MHz	thirty-one individual 6-MHz television channels (transmitters) including ITFS; some operators have only four channels; range to 35 miles, requires LOS and is affected by multipath (note 2).
MDS1	2150–2156	single channel 6 MHz; see MMDS.
MDS2	2156–2162	single channel 6 MHz; see MMDS.

MDS2A	2156–2160	MDS2 truncated on one side to 4 MHz
WCS	2305–2320	5- or 10-MHz blocks; new in May 1997
WCS	2345–2360	5- or 10-MHz blocks; new in May 1997
ITFS	2500–2690	6-MHz channels shared with MMDS
low-power television service (LPTV)	54–72 78–88 174–216 470–806	low-power broadcast; 6-MHz channels, experimental licenses Low power can be 50-Kwatts effective radiated power (ERP) (This includes the antenna gain). LOS operation is advised.
LMDS	27500–28350 31000–31300	short range, 3 miles, 20-MHz channels, new Propagation is affected by rain.
ISM	902–928 2,400–2,483.5	short range 0.5 miles spread spectrum omnidirectional Short range, similar to 900 MHz, but can also be engineered beyond 15 miles point to point as the return path for a cable-modem system
Note 2: Multipath is the reception of two or more signals over different paths. The direct signal may combine with a reflection off a roof, wall, or other surface, refraction off trees or an atmospheric inversion layer. The received signal is the vector sum of the two signals creating both an amplitude and phase change. The distortion may move rapidly across the frequency band.		

5. Receiving the Signal at the Subscriber

The frequency band determines the type of receiving antenna and downconverter (if needed). LPTV signals are received by the cable modem using a normal outside TV antenna, possibly with an amplifier but paying more attention to the signal level than one would with an analog television set. The level must be close to the high end of the range acceptable to the modem, as the signal is more likely to fade than increase in level.

MMDS, MDS, and WCS require a small antenna integrated with a downconverter mounted on the roof or on the side of the building. These low-cost units are one-third the price of the cable modem. The antennas may be flat arrays, one foot square with 17-dB gain, or dome-shaped designs with similar characteristics. Other products use partial parabolas, two feet in diameter, or cast Yagi antennas, two feet long. Most downconverters allow a choice of internal gain as well as antenna gain so that output signal level can be as close as possible to 0 dBmV for the modem.

The following are points to note in a wireless environment:

- Locate the antenna to minimize multipath.
- Make sure the antenna is located to receive the direct signal rather than a stronger reflected signal off a building which may vary in level.
- Set the signal level close to 0 dBmV.
- Work with the downconverter vendor to achieve the simplest selection of amplifier gain and antenna gain for the coverage area to minimize the number of different models needed.
- Use the appropriate path-loss calculations for microwave links. The calculation for multiple modulators through a common transmitter (sub-channelization) is a little different from a single signal on a transmitter.
- A downconverter installation engineered for a cable modem can also support video service. The reverse may not be true as the cable modem has specific level requirements.
- The nominal signal in a wired cable environment is 0 dBmV in 75 ohms. The cable modem tuner/demodulator will accept a limited variation in input level. Depending on manufacturer, model, frequency of operation and MMDS environment, the path loss is stable except for multipath distortion (ideally removed by the cable modem adaptive equalizer), and the antenna or downconverter gain can be selected to provide the right level to the cable modem. In the case of LPTV, path fading is more common but an outdoor antenna with LOS operation will minimize the level variations from multipath.

6. Getting the Signal to the Broadcast Wireless Transmitter

Most wireless transmitters require high towers to get the coverage area. These are often out of town so the problem is to get the downstream signal from the Internet POP to the transmitter. This path is as important as the rest of the system and must be properly designed. There are two basic transmission media, wireless and fiber optics, and two transmission technologies, amplitude modulation and frequency modulation. Amplitude modulation offers more channels. The choice depends, however, on whether there are existing links for television signals and how far it is possible to plan ahead as the business grows.

Table 3. A Choice of Uplink Types

	Amplitude Modulation	**Frequency Modulation**
wireless	amplitude-modulated link (AML) to 31 channels	studio transmitter link (STL) 1 data channel
precautions	Noise filter may be needed.	downconvert from 44 MHz to baseband, noise filter used
fiber optics	standard CATV fiber optics link 36 to > 69 channels	frequency modulation (FM) fiber link 1 to 16 channels, obsolescent
precautions	standard	downconvert from 44 MHz to baseband, noise filter used

It is important to note that in a wireless environment, frequency drift in the uplink degrades the stability of the final transmitted downstream signal. In the STL case, the downconverters and upconverters convert the 44-MHz IF signal to near the baseband stability. In the case of amplitude-modulated links, the conversion to the CATV band and back to IF degrades stability unless the devices can be locked to a stable reference.

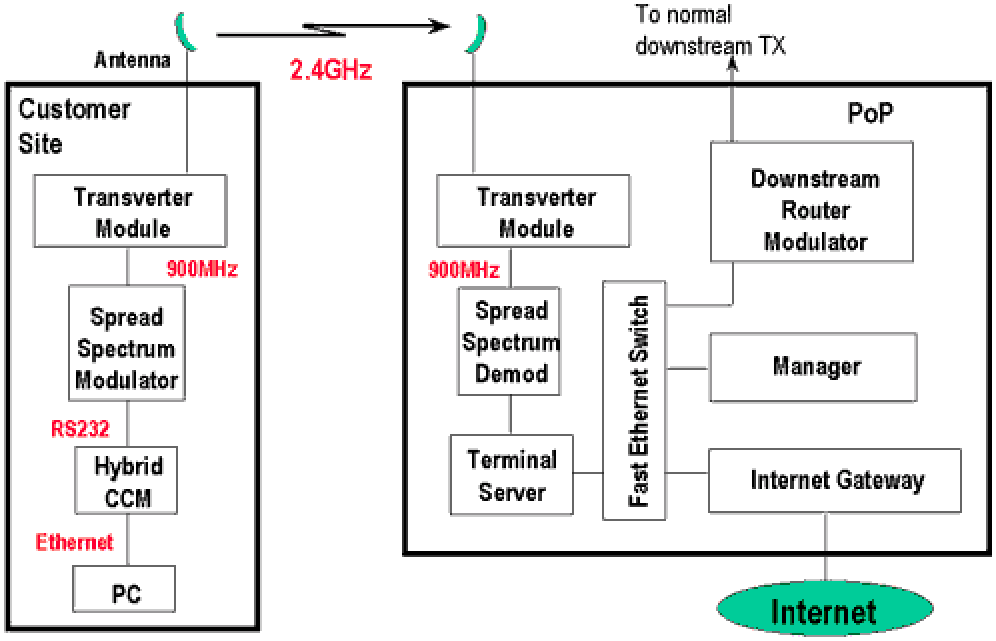
7. Wireless Return (Two-Way Wireless) Options

Two-way wireless operation is in its infancy due to the availability of spectrum, equipment, and the changing FCC regulations. The technology, regulations, and business issues are changing very quickly. A service provider will use a mix of telephone, integrated services digital network (ISDN), and wireless return as necessary to meet customer needs.

Use of ISM Bands

It is possible to use commercially available spread-spectrum modulators in any of the ISM bands. These can be driven from the RS232 output of a cable modem the same way as an external phone modem for telephone return. The advantage is that the spectrum is free and available now. It allows an operator to understand the deployment issues. It can be a viable long-term solution given the cost of spectrum in the traditional frequency bands, and the highly directional 2.4-GHz antennas minimize the probability of interference with other users.

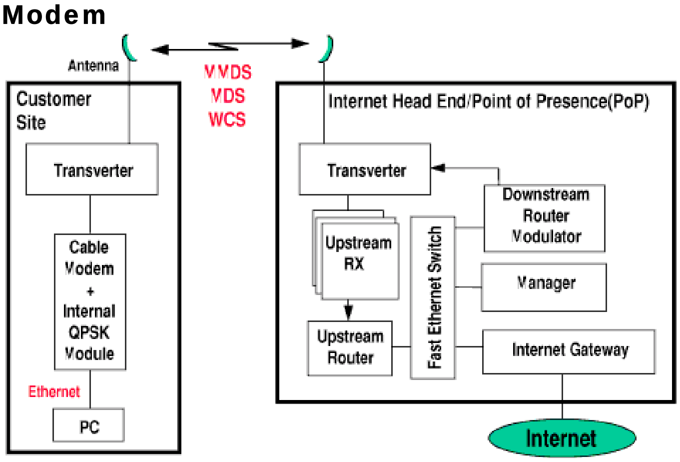
Figure 4. One Way to Use the ISM Band for Wireless Return 900 MHz / 2.4 GHz



Use of the QPSK Signal from a Cable Modem

Transverters and upconverters are under development from various vendors to take the 5- to 42-MHz QPSK signal output of a cable-return modem and translate it to the WCS, MDS1, MDS2, and MDS2A bands. A transverter is simply a combined downconverter and upconverter. These units are similar in appearance to downconverters and generate 50 mW or 100 mW of transmitted power. This is enough to reach back to the downstream transmitter site or to the Internet head end if it is closer and a LOS exists. The QPSK signal bit rate can be set to different values, from 256 Kbps to 5.12 Mbps. Lower values allow more users.

Figure 5. Wireless Return Using the QPSK Signal from a Cable Modem



The following are issues facing two-way operators:

- If the transmitter is separated from the Internet head end, a return path must be licensed and purchased similar to the downstream.
- the system cost, including the opportunity cost of spectrum which could be used for downstream signals rather than upstream
- the bandwidth/bit rate used for the upstream; as an example, the 12 MHz of bandwidth in the combined MDS1 and MDS2 bands could be sliced into 200-kHz channels with 256- or 320-Kbps rates. This gives 60 channels supporting around 3000 subscribers with omnidirectional non-sectored antennas. This means that the return-path receive antennas must be sectored as the business grows to achieve the same upstream subscriber capacity as the downstream.
- The QPSK modulator and the transverter upconverter portion determine the frequency stability and spurious signal output of the return-path transmission.
- Transmitting back to the downstream transmitter site allows integrated transmit-and-receive antennas at the customer site. These cost less than separate units and, since they are pointing in the same direction, the transmit antenna is automatically aligned when the receive antenna is installed and aligned.
- Transmitting back to the Internet head-end PoP where possible requires separate antennas with individual alignment. It sidesteps the requirement to get the return signal from the downstream transmitter back to the PoP.

8. Business Background for Wireless Internet Access

Typically the wireless operator does not offer Internet service directly but partners with an Internet service provider (ISP) with an existing customer base and the necessary data-networking skills. Some larger ISPs even provide service using telephone access, ISDN, cable modems over wired CATV plant, and service over wireless. One result of this is that ISPs need cable-modem systems that work for both cable and wireless; another is that telephone return systems usually use the ISPs' existing phone-modem banks.

Technologies such as asymmetric digital subscriber line (ADSL), T1, or wired cable may require a larger capital investment and time for construction. As a result, some CATV or telephone-based ISPs exercise a deliberate strategy of test marketing service using wireless. Once the customer response is known, it is possible to make a business case for longer-term investment to build out the coaxial cable for higher-service penetration.

The larger wireless-cable operators are finding high-speed Internet service an aid to competition with the local CATV companies as well as businesses in their own right. Internet service on one or two wireless channels is compatible with offering both analog and digital video on adjacent channels. There is no loss of capacity or interference.

The following are several reasons why businesses, libraries, hotels, and schools are the first marketing targets:

- They usually pay a premium price, reflecting a greater need for speed.
- It is easier to locate an antenna on the roof than on most homes.
- They require less support, as they have their own management information system (MIS) people.
- The service organization has time to be trained before handling large numbers of customers.

In addition, larger businesses may prefer wireless for Internet access. They may not wish to pay for an actual T1 connection to the Internet even though they may have T1 (1.544 Mbps) local digital facilities installed for telephone service. This initial business focus drives the following two requirements:

- the need for a modem that serves multiple users
- The ISP must use some form of technology to preserve performance for businesses at the same time as adding residential service. One technique is to assign two subchannels to a few businesses and one subchannel to a larger number of residential users.

9. Business Applications of the Internet

- The Internet is a worldwide technical library at a time when most companies cannot afford an in-house library. Search engines beat microfilm readers for most applications. (IBM has its patent library and the FCC its wireless orders and rulings on-line for everyone to use; National Technical Information Service (NTIS), the federal bookstore, provides on-line access to Department of Commerce regulations for a fee.)

- Most technical suppliers provide a Web site with sufficient information to produce at least the starting point of a product catalog or data search.

- Some cities have the building permit process online and provide access to regulations.

- Realtors have their listings. It is possible for salespeople to qualify the prospect by showing pictures. This allows comparison of what the customer says he wants with what he wants and can cut down the time to search. It avoids excessive time driving around and exposure to other Realtors.

- So you want to buy a car? The salesman knows that he has one and knows where it is to close the sale right there. (This is especially important in the new era of mega dealers such as Republic Industries.)

- online banking, accounting, outsourcing accounting services

- Farms are small businesses, requiring data ranging from weather updates to price trends. The physical isolation of farm families can make the school, educational, catalog shopping, and communications applications more important. Many wireless operators cover rural areas.

- Electronic data transfer supporting the purchasing, billing, and accounting functions is especially important for the large number of smaller businesses providing just-in-time service for larger businesses. The concept started with manufacturing but extends to the medical and professional fields.

10. MMDS/WCS Transmitter Systems for Internet Access*

MMDS is presently used in the United States of America to deliver video program content for entertainment and, in cooperation with ITFS operators, to deliver video for distance-learning activities. Most systems now use analog transmission under the National Television Systems Committee (NTSC) standard to deliver one video program per 6-MHz radio frequency (RF) channel. The available downstream spectrum includes the following:

- 2 MDS channels 2150–2162 MHz

- 16 ITFS channels A through D Group 2500–2596 MHz

- 8 MMDS channels E and F Group 2596–2644 MHz
- 4 ITFS G Group interleaved with 3 MMDS H1/2/3 channels 2644–2686 MHz

In many other countries, a similar amount of downstream spectrum has been assigned for MMDS use within the range of 2 GHz to 3 GHz.

A major change is occurring in the MMDS industry with the transition to digital-video compression and transmission. The digital technology enables compression of at least five video streams of similar resolution to NTSC analog video into one 6-MHz RF channel. In the digital environment, an operator who has access to most of the downstream channels listed above can offer a selection of program streams that can aggressively compete with either direct broadcast satellite (DBS) or CATV entertainment video-delivery systems with a few channels to spare.

With the spectral efficiencies of digital-video compression, a few RF channels per MMDS system can be dedicated to provide broadband (>10–Mbps) high-speed data service to Internet users and provide an additional revenue stream for MMDS operators. This is already authorized by the FCC for the case of RF downstream with telco line upstream. To meet the FCC guidelines, the downstream transmission must be substantially similar to one of the presently authorized digital-video modulation formats for cochannel and adjacent-channel interference reasons. A single 6-MHz RF channel using 64–QAM can deliver a raw data rate of 30–Mbps or 27–Mbps after forward error correction (FEC).

Several operators have applied for developmental licenses for various cities to test data access schemes with RF return path from subscriber to hub. A consortium of several MMDS industry participants has been formed and is funding theoretical studies and conducting lab and field tests. These activities are intended to support a formal request to the FCC for rulemaking to authorize standard rules to permit RF two-way data access via MMDS.

Assuming that most of the MMDS RF channels are dedicated to an entertainment video-delivery service, only a limited number of channels are available for downstream data. A conversion to digital video may be an attractive way to increase the capacity of systems and the channels available for data. It is an alternative to antenna sectorization.

MMDS/WCS transmitter systems for Internet access include channelized transmitters, channel combiners, automatic backup, and network management equipment. Digital transmitters accept a 44-MHz centered QAM IF then upconvert and amplify the signal. Transmitters are available with 5 W to 100 W of average output power. Crystal oscillators are used to provide excellent phase noise. Feedforward amplifiers and equalization techniques provide good gain and phase linearity while minimizing power consumption. To improve system availability, an automatic backup system with primary and backup transmitters can be used. Spectral shaping filters are required for WCS systems to meet stringent FCC specifications for out-of-band power. Channel combiners utilize waveguide directional filters to combine either non-adjacent or adjacent microwave channels for transmission. Transmitter systems are supplied with signaling network-management protocol (SNMP) capability for remote configuration and fault management.

Figure 6. A Typical MMDS/WCS Transmitter Block Diagram

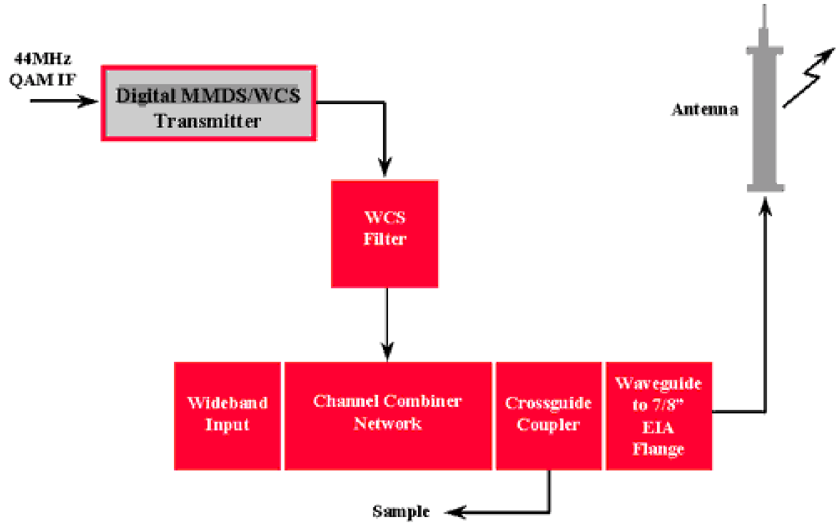
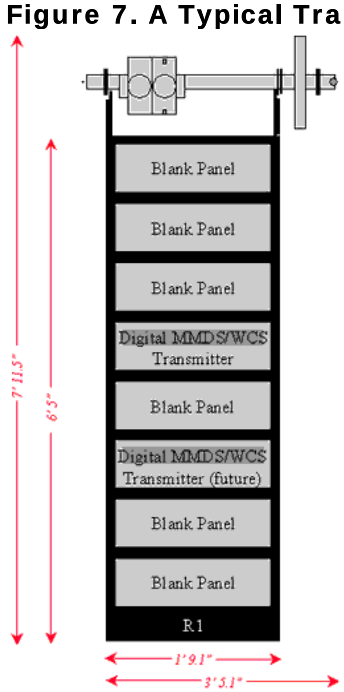


Figure 7. A Typical Transmitter Rack with Two Transmitters



*This module provided courtesy of the ITS division of ADC.

11. MMDS Path Engineering: An Example*

As this is only an example, actual figures will vary according to the specific downconverter vendor's product. Sample coverage assumes the following design criteria:

- 2.5 dB typical channel combiner loss
- 2 dB typical waveguide/jumper loss
- 13 dBi transmit antenna gain
- 32 dB block downconverter gain
- 2.5 dB block downconverter noise figure
- 6 dB typical receive line loss
- 15 dB typical fade margin

Table 4. Sample Coverage

Tx Output Power	Rx Antenna Gain	Maximum Coverage
5 watts avg.	18 dBi 24 dBi	12.5 mi. 25.5 mi.
10 watts avg.	18 dBi 24 dBi	12.5 mi. 25.5 mi.
15 watts avg.	18 dBi 24 dBi	15.5 mi 31.0 mi

*This module provided courtesy of the ITS division of ADC.

12. MMDS Path Engineering: The Math*

Txp = transmitter output power in dBm

CL = channel combiner losses in dB

TLL = total transmission line loss in dB

TAG = transmit antenna gain in dBi

PL = free space path loss in dB = 96.6 +20 Log (frequency in GHz) + 20 Log (distance in miles)

RAG = receive antenna gain in dBi

BDCG = block downconverter gain in dB

RLL = total receive line loss in dB

NF = thermal noise floor (-108 dB)

nf = noise figure of receive system (2.6 dB typical)

FM = fade margin (15 dB typical)

The critical design factor for a digital system is the required signal-to-noise ratio (SNR) of the receiver. For this case, 25 dB S/N. Fade margin is an estimated value that will vary at each site. Factors that can contribute to fade include heavy rain, multipath, terrain, and foliage blockage.

Signal Strength Link Budget

Txp - CL - TLL + TAG - PL - FM + RAG + BDCG - RLL = signal strength @ rx site in dBm

S/N Link Budget

Txp - CL - TLL + TAG - PL - FM + RAG - nf - NF = S/N @ rx site in dB

Note that this calculation applies for a modem with 2-MHz channels and 4.5 dB transmitter additional headroom to allow for the transmission of the peak signal arising from three modulators on one channel. The numbers vary for a single modulator and for more subchannels.

*This module courtesy of the ITS division of ADC

13. Additional Sources of Information

For additional information on wireless broadband modems, please consult the following sources:

TCP/IP Illustrated, Volume 1: The Protocols, written by W. Richard Stevens and published by Addison-Wesley

Cable Datacom News http://cabledatacomnews.com

FCC Web Page http://www.fcc.gov

National Science Foundation Wireless Field tests (2.4 GHz)
http://wireless.oldcolo.com

Self-Test

1. Which of the following is not one of the parameters with significant impact on downstream speed for IP traffic?

   a. downstream bandwidth

   b. latency or round-trip delay to the server

   c. upstream bandwidth

2. Approximately how long does it take to transmit an ACK through a 14.4 Kbit telephone return channel? (Ignore any latency in the modem.)

   a. 33.3 msecs

   b. 45.0 msecs

   c. 15.2 msecs

3. What is the typical frequency stability requirement on a customer's downconverter?

   a. 5 ppm (12.5 kHz)

   b. 30 ppm (75 kHz)

   c. 50 ppm (125 kHz)

4. Why is this frequency stability important?

   a. The modem demodulator has to track this offset.

   b. impacts the upstream frequency stability

   c. requires retuning the modem

5. Which of the following wireless bands is not used for analog television today?

   a. MDS1

   b. MMDS

   c. WCS

6. Why is LOS operation recommended (though not essential) for VHF, UHF, and LPTV as well as for the 2GHz bands?

    a. Multipath can add or detract from the signal strength.

    b. Multipath changes the phase of the received signal.

    c. It is easier to stay within the signal level required by the modem.

7. Which factor influences the location of the Internet head end or POP?

    a. accessibility for maintenance

    b. location of the wireless transmitter

    c. both of the above

Correct Answers

1. Which of the following is not one of the parameters with significant impact on downstream speed for IP traffic?

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    c. upstream bandwidth

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    b. impacts the upstream frequency stability

    c. requires retuning the modem

5. Which of the following wireless bands is not used for analog television today?

    a. MDS1

    b. MMDS

    c. WCS

6. Why is LOS operation recommended (though not essential) for VHF, UHF, and LPTV as well as for the 2GHz bands?

    a. Multipath can add or detract from the signal strength.

    b. Multipath changes the phase of the received signal.

    c. It is easier to stay within the signal level required by the modem.

7. Which factor influences the location of the Internet head end or POP?

    a. accessibility for maintenance

    b. location of the wireless transmitter

    c. both of the above

Glossary

ACK
Internet protocol acknowledgment

ADSL
asymmetric digital subscriber line

AML
amplitude-modulated link

CATV
cable television

DBS
direct broadcast satellite

ERP
effective radiated power

FCC
Federal Communications Commission

FEC
forward error correction

FM
frequency modulation

IF
intermediate frequency

IP
Internet protocol

ISDN
integrated services digital network

ISM
instructional, scientific, and medical

ISP
Internet service provider

ITFS
instructional television fixed service

LAN
local-area network

LMDS
local multipoint distribution service

LOS
line of sight

LPTV
low-power television service

MDS
multipoint distribution service

MIS
management information system

MMDS
multipoint multichannel distribution service

NTSC
National Television Systems Committee

NTIS
National Technical Information Service

PoP
point of presence

QAM
quadrature amplitude modulation

QoS
quality of service

QPSK
quadrature phase shift keying

PCS
personal communications service

RF
radio frequency

SNMP
signaling network-management protocol

SNR
signal-to-noise ratio

STL
studio transmitter link

TCP
transmission control protocol

UHF
ultra-high frequency

VHF
very-high frequency

WCS
wireless communications service