More detail of some topics from:

1: Introduction to Broadband communication systems
(Matthew N. O. Sadiku)
2: Telecommunication Switching and Networks
(P.Gnanasivam) 2nd edtion
3: Introduction to Data Communications and Networking
(Wayne Tomasi)
4: Telecommunications Switching, Traffic and networking
(J.E Flood)
5: Internet & Other materials

Note: Calculations & Related Numerical details are attached on separate sheets

Broadband Networks Objectives:

Broadband communication is a type of telecommunication that supplies multiple channels of data in a single communications platform using some form of wave or frequency division multiplexing. In other words, broadband refers to the telecommunication in which a wide band of frequencies is available to transmit data. Broadband offers a new brand of services where data, voice, and video, commonly known as multimedia, can be delivered together as one packet. Some of the networks that are available for providing these types of services are asynchronous transfer mode (ATM), frame relay, and leased lines. These networks are instrumental in supplying customers with broadband services that have the potential of eventually overtaking the traditional dial-up Internet. Broadband communication systems distribute broadband services on the transmit end and also allow access to the services transmitted by the broadband provider on the receive end.

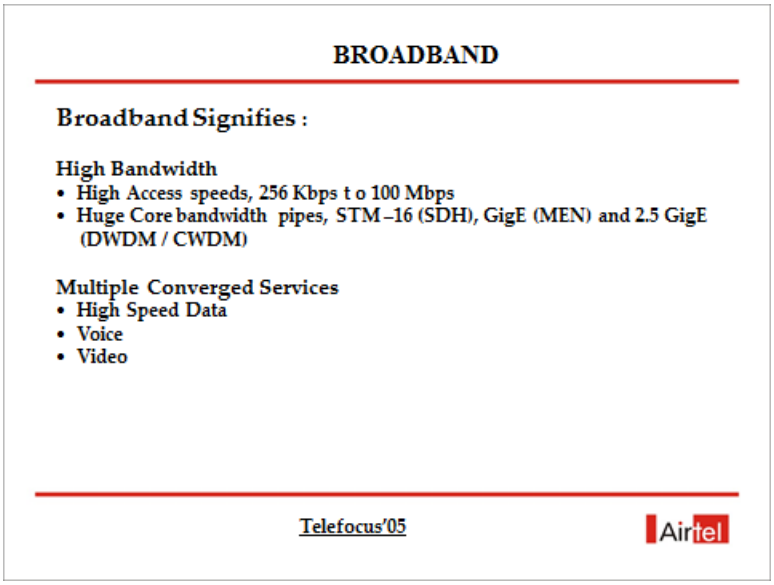
Broadband communications is usually considered to be any technology with transmission rates above the fastest speed available over a telephone line. Broadband transmission systems typically provide channels for data transmissions in different directions and by many different users. For example, the coaxial CATV system is a broadband system that delivers multiple television channels over the same cable. In addition, it can handle data transmissions (primarily Internet access for home users) in an entirely different frequency spectrum.

Refer to "Network Core Technologies" My lectures slides for information about transmission systems such as SONET and DWDM that are used at the core of carrier and service provider networks for Broadband networks.

Typical broadband communication systems include the following:

- **ISDN (Integrated Services Digital Network)** ISDN is implemented over existing copper telephone cables. The basic rate variety provides two channels of 64-Kbit/sec throughput that can be bonded to form a 128-Kbit/sec data channel. Primary rate ISDN provides additional bandwidth in increments of 64 Kbits/sec.
- **ATM (Asynchronous Transfer Mode)** Another high-bandwidth service available from the carriers. The carriers use of ATM benefits everyone, but medium to large companies can install ATM equipment on-site to connect directly into carrier ATM networks and gain all the benefits of those systems.
- **Frame Relay** A data networking and voice service offered by the carriers that is widely available. Like ATM, frame relay is primarily used for corporate rather than home connections.
- **Leased lines** and **T Carriers** Leased T1 lines provide dedicated throughput of 1.544 Mbits/sec over two-pair twisted wire. Existing telephone cable is usually adequate/acceptable.. T3 provides approximately 45-Mbit/sec throughput. Fractional T1 can be leased in increments of 64 Kbits/sec.
- **DSL (Digital Subscriber Line)** DSL is a whole family of high-bandwidth digital services that the telephone companies offer over copper telephone cable. Depending on the service, rates can reach into the multimegabit/sec rates.
- **Cable (CATV) Data Networks** The cable TV system is a well-established broadband network that now makes its system available for data links and Internet access..
- **Wireless Communications** A variety of wireless broadband services are now available or under development, including satellite-based systems and terrestrial-based systems that are essentially fixed cellular systems. Broadband wireless uses microwave and millimeter wave technology to transmit signals from base stations to customers. See "Wireless Broadband Access Technologies." For further detail.

DSL, cable TV, and broadband wireless LMDS MMDS,WLL,WIMAX will largely solve the problem of providing high bandwidth to home users. As bandwidth increases, customers will gain access to higher qualities of service for voice, video, and data using packet-based Internet technologies. Global Internet-based telephone calls and videoconferences will become more commonplace, as will distance learning and high-resolution imaging as applied in areas like telemedicine.



BROADBAND SERVICES

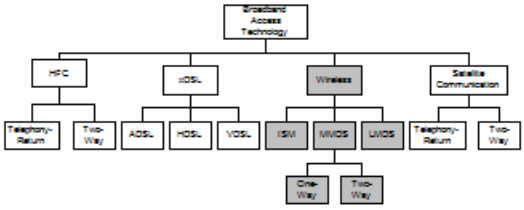
Services Offered On Broadband:

- Data Services
  - High Speed Internet Services
  - Point to Point and Point to Multi Point VPN Services
  - Web Hosting Applications
  - Walled garden (Internet on TV)
- Voices Services
  - Audio Conference
  - Voice over IP (VoIP)
- Video Services
  - Video Broadcast
  - Video on Demand
  - Video telephony
  - Online Gaming

Telefocus'05

Airtel

Access Technologies



Notes

- Wireless: Terrestrial fixed wireless systems
  - Instructional scientific and medical (ISM): 902 - 928 MHz (0.5 mile) and 2400 - 2483 MHz (15 miles)
  - Multichannel multipoint distribution service (MMDS) 2500 - 2686 MHz (35 miles)
  - Local multipoint distribution service 27,500 - 28,350 MHz and 31,000 - 31,300 MHz (3 miles)

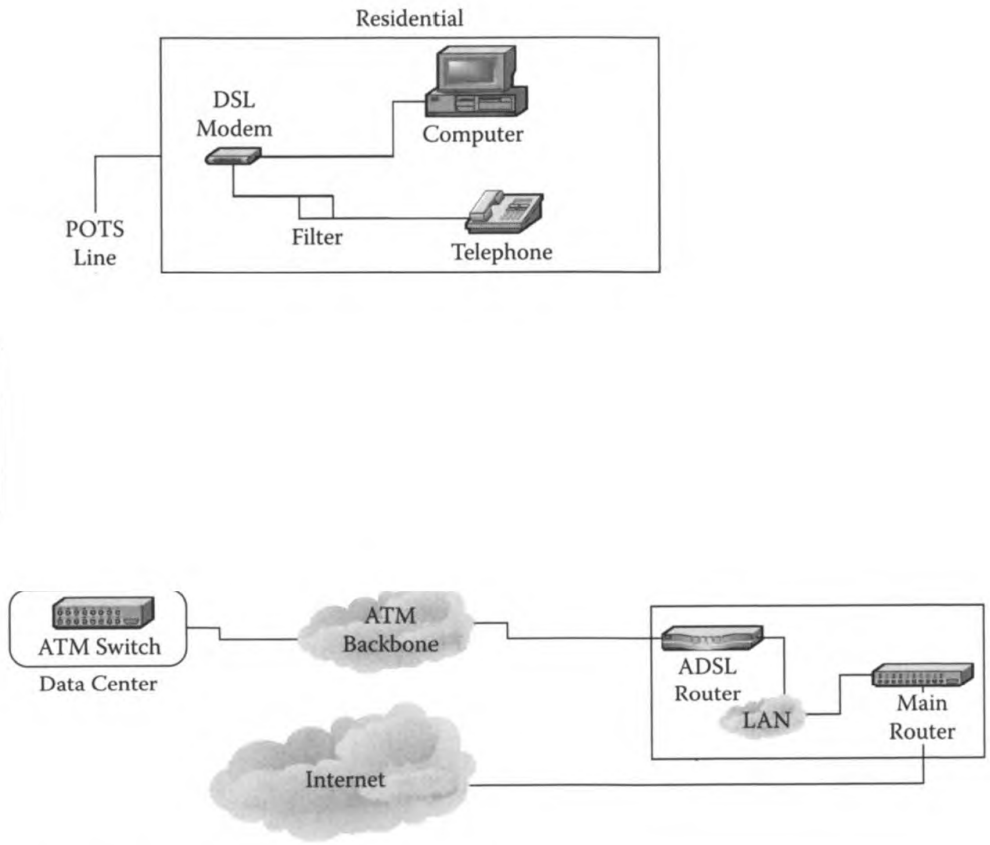


FIGURE 1.1 Typical broadband network architecture.

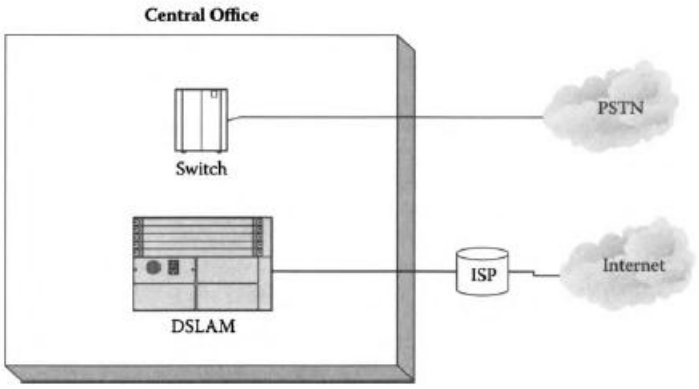
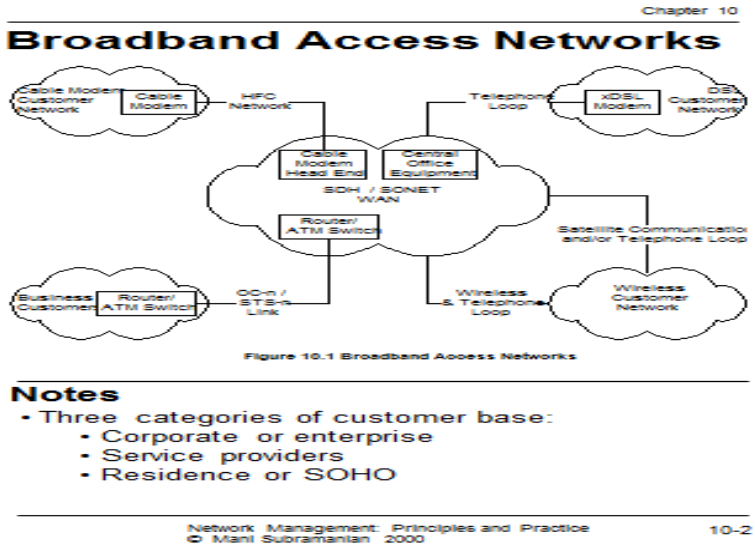


FIGURE 1.2 Diagram of the DSLAM and switch together in the CO for access to the PSTN and Internet.



COMPONENTS OF BROADBAND COMMUNICATION SYSTEMS

The components that affect the broadband telecommunication industry can be clas-sified as the switched and dedicated components. The switched components, also known as circuit switching, or telephone calls, are connected on the public switch telephone network (PSTN). It is composed of three phases, which are

• call setup
• call transmission
• call termination

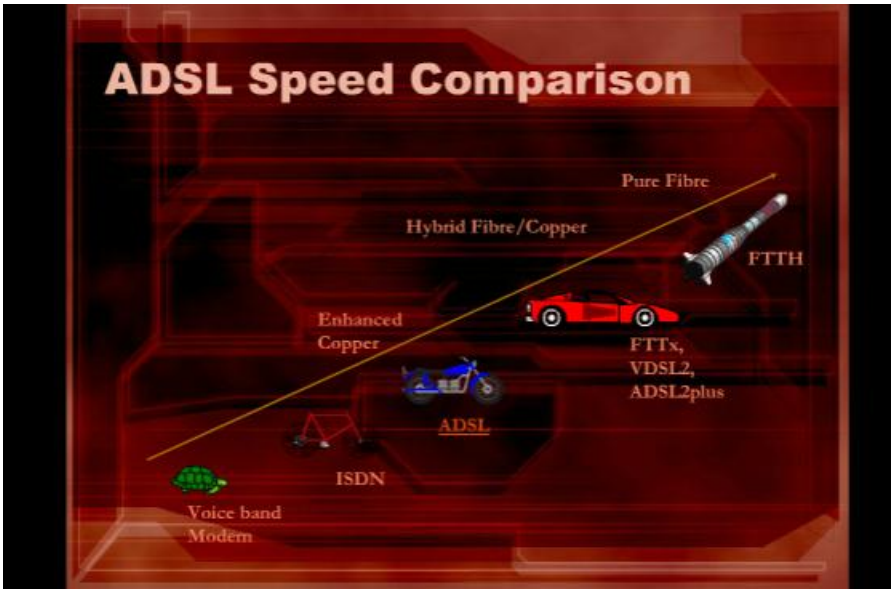
The dedicated components are the private lines for businesses that need 24-hour- a-day access. With the dedicated components, the user has permanent access with no dial-up The elements of data communication consist of the following components:

• transmitter
• receiver
• transmission medium
• communication equipment

Many components are classified as customer premise equipment (CPE). They are workstations, printers, servers, and mainframes. In order for the broadband net- works to be able to communicate with each other, a common language called “pro- tocol” must be established. There are different types of protocols that can be used on a broadband network depending on the classification and infrastructure of the network. Internet Packet exchange/sequenced packet exchange (IPX/SPX), and the transmission control pro- tocol/Internet protocol (TCP/IP) are three of the broadband network protocols in use today, IPX/SPX and TCP/IP are routable.

DEFINITION: A set of rules and procedures that permit the orderly exchange of infor- mation within and across a network is called protocol.

Comparison of some broadband technologies:



ADSL Speed Factors

- The distance from the local exchange
- The type and thickness of wires used
- The number and type of joins in the wire
- The proximity of the wire to other wires carrying ADSL, ISDN and other non-voice signals
- The proximity of the wires to radio transmitters.

ADSL Range

- In general, the maximum range for DSL without a repeater is 5.5 km
- As distance decreases toward the telephone company office, the data rate increases

Data Rate	Wire gauge	Wire size	Distance
1.5 or 2 Mbps	24 AWG	0.5 mm	5.5 km
1.5 or 2 Mbps	26 AWG	0.4 mm	4.6 km
6.1 Mbps	24 AWG	0.5 mm	3.7 km
1.5 or 2 Mbps	26 AWG	0.4 mm	2.7

- For larger distances, you may be able to have DSL if your phone company has extended the local loop with optical fiber cable

ADSL network components

- The ADSL modem at the customer premises(ATU-R)
- The modem of the central office (ATU-C)
- DSL access multiplexer (DSLAM)
- Broadband Access Server (BAS)
- Splitter - an electronic low pass filter that separates the analogue voice or ISDN signal from ADSL data frequencies DSLAM.

Table 11–1: A summary of the X.25 and Frame Relay services

Service	X.25	Frame Relay
Statistical TDM	Yes	Yes
OSI layer used	Layer 3 (Network)	Layer 2 (Data link)
ACK and NAK	Yes, extensive	None
Retransmissions	Yes, extensive done at each node on the network	None done by the Frame Relay nodes; retransmissions are requested by higher–level protocols at the end
Packet/frame size	Up to 128 bytes average network; up to 512 bytes in some implementations	Up to 1,610 bytes in networks; up to some 4,096 bytes in some vendor products
Speed of transmission	Up to 64 Kbps	Starts at 56 Kbps; up to 50 Mbps, depending on the vendor products

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Table 11–3: Comparing Frame Relay and IP

Frame Relay	IP
Multiprotocol support	Any–to–any connectivity
Predictable and reliable performance	Limited *quality of service* (QoS)
Robust network management capabilities	Security concerns abound
Primarily intracompany connectivity	Linking intercompany business partners
WAN only	LAN or WAN
Focus is on logical connections versus intelligence	Dialup and international access available

Comparison between MMDS and LMDS

This section describes merits and demerits of MMDS and LMDS and also mentions similarities or difference between these technologies.
LMDS technical and design issues. A normal LMDS setup has a central facility with a fiber-linked PSTN and internet connections relay signal via point to point microwave links which in turn pass the signal along to hubs, located on rooftops or as stand-alone towers, for Point to Multipoint (PMP)transport to the end site. Basically, four parts in the LMDS architecture are Network operations center(NOC)0. Fiber based infrastructure1. Base station2. Customer Premise Equipment and NOC designs.3. The network management equipment for managing regions of customer network come under the NOC. Multiple NOC can be interconnected. The fiber based infrastructure basically consists of SONET OC-12 OC-3 and DS-3 links, the ATM and IP switching systems, Interconnections with the PSTN, the central office equipment. The conversion from fibered infrastructure to a wireless infrastructure happens at the base stations. Interface for fiber termination, modulation and demodulation functions, microwave transmission and reception equipment are a part of the base station equipment. Local switching can also be present in the base station. If local switching is present then customers communicating in the same base station can communicate with each other without entering the fiber infrastructure. The customer premise equipment varies widely from vendor to vendor. All configurations include in door digital equipment include modulation and out door mounted microwave equipment. The customer premise equipment may attach to network using TDMA, FDMA or

CDMA. Different customer premise equipment require different Local Multipoint Distribution Service (LMDS) http://www.cis.ohio-state.edu/~jain/cis788-99/lmds/index.html (6 of 13) [2/7/2000 1:35:37 PM] configurations. The customer premise will run the full range from DS0, POTS, 10BaseT,Unstructured DS1 structured DS1 Frame Relay, ATM25 serial ATM over T1, DS-3, OC-3 and OC-1. And the customer premise locations can range anywhere from malls to residential locations. 4.1 Architectural options There is one commonly discussed architecture with radio frequency planning. Typically the radio frequency

>> As mentioned both are used for TV and 2-way internet service using fixed wireless access.

>> Due to lower RF frequency range MMDS provide lesser BW compare to LMDS. Higher data rates are also going to be achievable owing to OFDM technology advancement with MMDS. But MMDS is ideal for small business enterprises and residential users and LMDS is used for larger businesses. LMDS offers higher data rates.

>> MMDS signal can cover long distance and hence used in large cell network scenario. LMDS signal can cover short distance from Base Station equipments.

>> Due to larger wavelength MMDS signals are less susceptible to rain and absorption losses compare to shorter wavelength LMDS signal.

Let us summarize tabular difference between LMDS and MMDS below.

Specifications	LMDS	MMDS
Full Form	Local Multipoint Distribution Service	Multichannel Multipoint Distribution Service
Architecture	The LMDS architecture consists of NOC (Network Operation Center), BS, CPE and Fiber backbone. It has cellular like architecture.	The MMDS architecture consists of tall antenna tower, backbone internet connectivity using router and network management system. It has microwave link like architecture.
Frequency of operation	28 GHz, 36 GHz	2.5 GHz, 3.5 GHz
Network Topology	P2MP (Point to Multi-point)	P2P (Point to Point)
Distance coverage	Good more smaller distances. (2 to 8 Km)	Covers larger distance. (50 to 100 Km)

Number of cells	more	very few
Data rate	1 to 10 Mbps	upto 2 Mbps
cost	CPE cost and deployment cost is medium to high.	CPE cost and deployment cost is low compare to LMDS.

LMDS technical and design issues.

A normal LMDS setup has a central facility with a fiber-linked PSTN and internet connections relay signal via point to point microwave links which in turn pass the signal along to hubs, located on rooftops or as stand-alone towers, for Point to Multipoint (PMP)transport to the end site. Basically, four parts in the LMDS architecture are Network operations center(NOC)0. Fiber based infrastructure1. Base station2. Customer Premise Equipment and NOC designs.3. The network management equipment for managing regions of customer network come under the NOC. Multiple NOC can be interconnected. The fiber based infrastructure basically consists of SONET OC-12 OC-3 and DS-3 links, the ATM and IP switching systems, Interconnections with the PSTN, the central office equipment. The conversion from fibered infrastructure to a wireless infrastructure happens at the base stations. Interface for fiber termination, modulation and demodulation functions, microwave transmission and reception equipment are a part of the base station equipment. Local switching can also be present in the base station. If local switching is present then customers communicating in the same base station can communicate with each other without entering the fiber infrastructure. The customer premise equipment varies widely from vendor to vendor. All configurations include in door digital equipment include modulation and out door mounted microwave equipment. The customer premise equipment may attach to network using TDMA, FDMA or CDMA. Different customer premise equipment require different Local Multipoint Distribution Service (LMDS) http://www.cis.ohio-state.edu/~jain/cis788-99/lmds/index.html (6 of 13) [2/7/2000 1:35:37 PM] configurations. The customer premise will run the full range from DS0, POTS, 10BaseT,Unstructured DS1 structured DS1 Frame Relay, ATM25 serial ATM over T1, DS-3, OC-3 and OC-1. And the customer premise locations can range anywhere from malls to residential locations. 4.1 Architectural options There is one commonly discussed architecture with radio frequency planning. Typically the radio frequency

WLL: