Public data network

- PSTN - Used for data transmission to carry data through the use of MODEM's
- MODEM – Convert data from host computers into digital signals – transmitted across PSTN.
- Increased data rates.
- physical limitations of modem data rates drive into new technology like PDN.
- The fig.1.5 shows one possible view of PDN.
- PDN often depicted as fuzzy "cloud".

Public data network

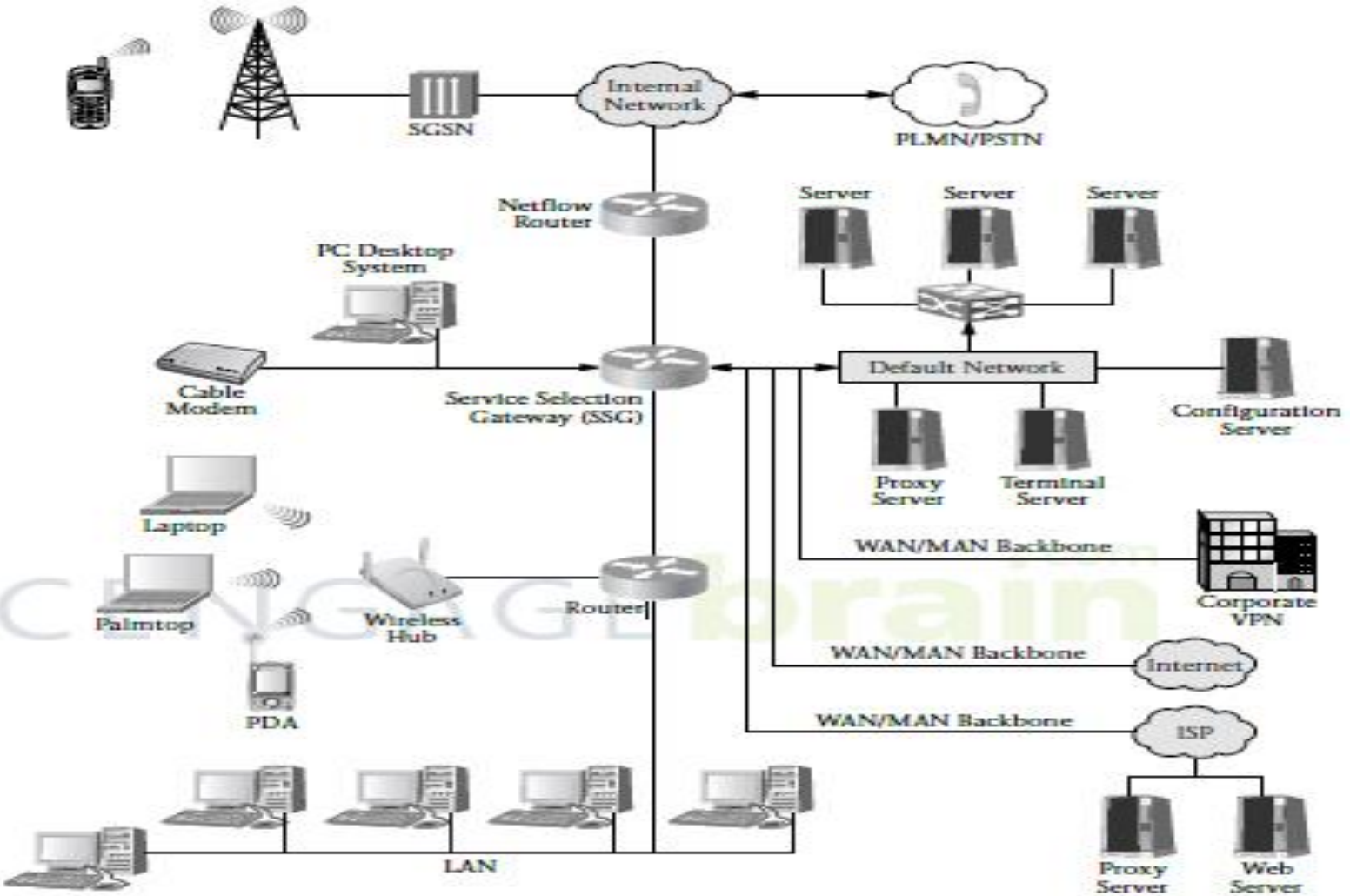


FIGURE 1–5 A depiction of the public data network.

- PDN evolved in response to connectivity needs of business, industry & govt. – for transport of data over WAN's.
- PDN – Often depicted as fuzzy "cloud" on diagrams –show how end users are connected to it.
- Reason for the use of cloud – N/W uses different transport technologies-(like T-carrier,, XDSL, Ethernet, ISDN,ATM,SONET ect.) and physical media to transmit Data within it & from end pt. to end pt.
- Connections - through copper pairs, fiber facilities or wireless radio links.

- Data n/w- transports packets of data depending on type of transport protocol.
- PDN- supports service structures including

  (i) permanent (ii)virtual (iii) switched virtual circuits & (iv)semi permanent virtual circuits.
- PDN – consists of “connectionless systems – use connectionless protocols – to forward data packets through n/w – reduce overhead requirements & faster.
- New technology – uses both connection oriented and connectionless protocols- to obtain the benefits of both technologies.
- In addition to this there are 2 more n/w’s

  - Private data n/w

  - virtual private data n/w(VPDN)
- Private data n/w use same tech.as PDN- can be constructed, owned & maintained by user/leased from some service provider.

- VPDN – use PDN maintaining privacy through use of tunnelling protocol.
- Security is provided through use of Encryption and Decryption procedure.

Additional PDN’s

- Broadband cable system
- Internet
- Cellular telephone system

Broad band cable system
(BBCN – one more connection to PDN)

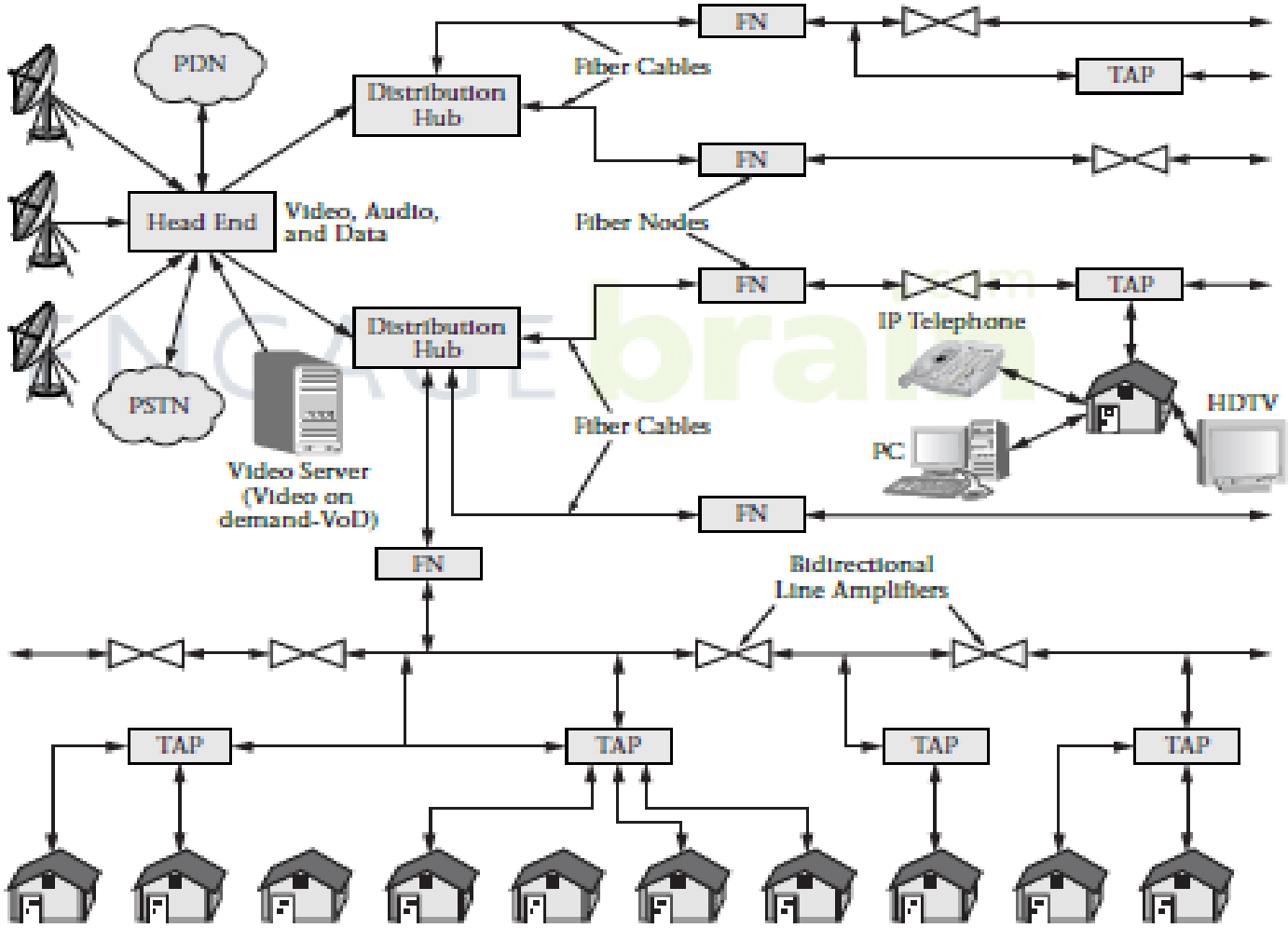


FIGURE 1–6 Modern two-way hybrid fiber-coaxial cable-TV system with fiber nodes.

Broad band cable system

- Broadband cable - sophisticated and complex wideband networks designed to deliver analog and digital video signals (including HDTV), data, and plain-old telephone service to the subscriber.
- The video content can come from local off-air television stations, satellite feeds of network or distant-station program content, and local access facilities
- The data service typically connects to an Internet service provider (ISP) and telephone service connects to the PSTN.
- The most important change in the legacy cable-TV plant is the migration to the two-way hybrid fibre coaxial cable system shown in Figure 1–6.
- The bandwidth of cable systems has been expanded to 870 MHz, and the use of the frequency spectrum between 5 and 42 MHz now allows for upstream data transmission over the network
- Another important aspect to the evolution of the cable system is the development and standardization of the cable modem (CM)

- The data-over-cable-service interface specification (DOCSIS) project has led to

  - multiple-vendor interoperability of cable modems located at the subscriber premise and-

  - cable modem termination systems (CMTS) located at the cable service providers' network centres.

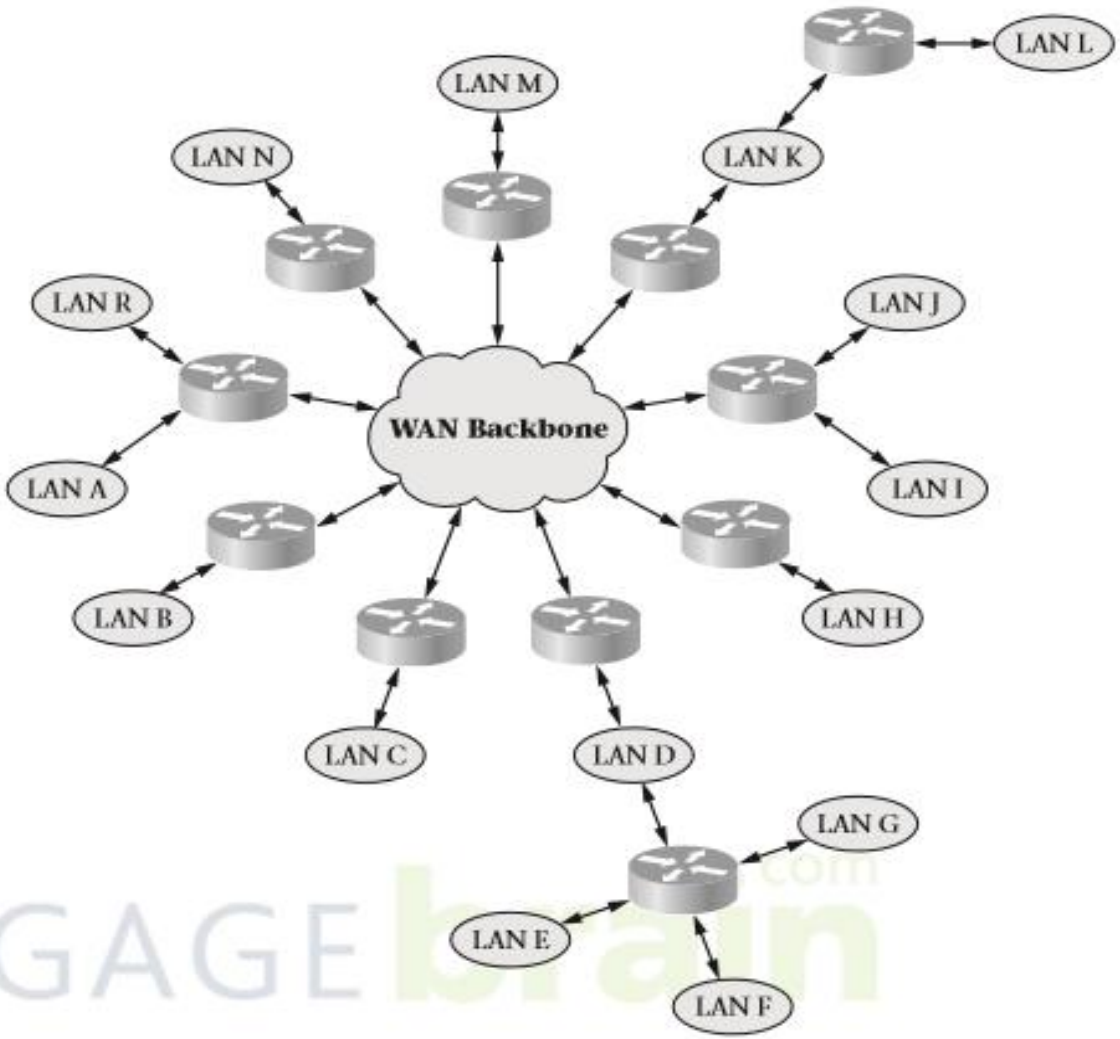
- These systems allow for a shared high-speed data connection over the cable network to the Internet that passes Ethernet packets to and from the subscriber's cable modem to the subscriber's PC.

The Internet

- The Internet is the world's largest computer network.
- Over the Internet any computer or computer network may access any other computer or computer network.
- The structure of the Internet is shown in Figure.
- It consists of thousands of computer networks interconnected by dedicated special-purpose switches called routers.
- The routers are interconnected by a wide area network (WAN) backbone.
- WAN backbone actually consists of several networks operated by national service providers (SprintLink, UUNet Technologies, internet MCI, etc.)
- These networks consist mainly of high-speed, fiber-optic, long-haul transport systems that are interconnected at a limited number of hubs that also allow for the connection of regional ISPs.

The Internet

FIGURE 1–7
Conceptual structure of the Internet.



- These national service provider (NSP) networks are interconnected to each other at switching centers known as network access points (NAPs).
- Regional ISPs may tap into the backbone at either the NSP hubs or the NAPs.
- If an individual wants to connect to the Internet, he or she must usually go through an ISP.
- The user might connect to the ISP through the PSTN over a low-speed dial-up connection using a modem that communicates with a “modem pool” at the ISP, or through high-speed cable modem or ADSL (adaptive digital subscriber line) service. These services are usually connected through the PDN to the ISP.

- A local area network (LAN) at an Enterprise location will usually be connected to the ISP through some type of high-speed connection to the PDN (usually leased from a service provider) and then through the ISP's high-speed connection to the PDN.
- The ISP will in turn be connected to the Internet through another high-speed network connection.
- Today, one may be connected to the Internet by a wireless device while roaming or while connected to a LAN.
- telephones and personal digital assistants (PDAs) allow one to connect through the packet data network. The Web "browser" experience is not the same as with a desktop computer, but it is an Internet connection.

Cellular Telephone Systems

- The technology used to implement cellular systems has evolved from analog (first generation or 1G), to digital (second generation or 2G), to systems with medium-speed data access (called 2.5G).
- High-speed data-access third-generation or 3G systems are already being deployed worldwide.
- Cellular operators have expanded coverage and capacity by using new frequency allocations, new air interface technologies, and cell splitting, and they have increased the functionality of their systems by expanding their scope to include access to the PDN, as well as the PSTN.

Overview of Existing Network Infrastructure

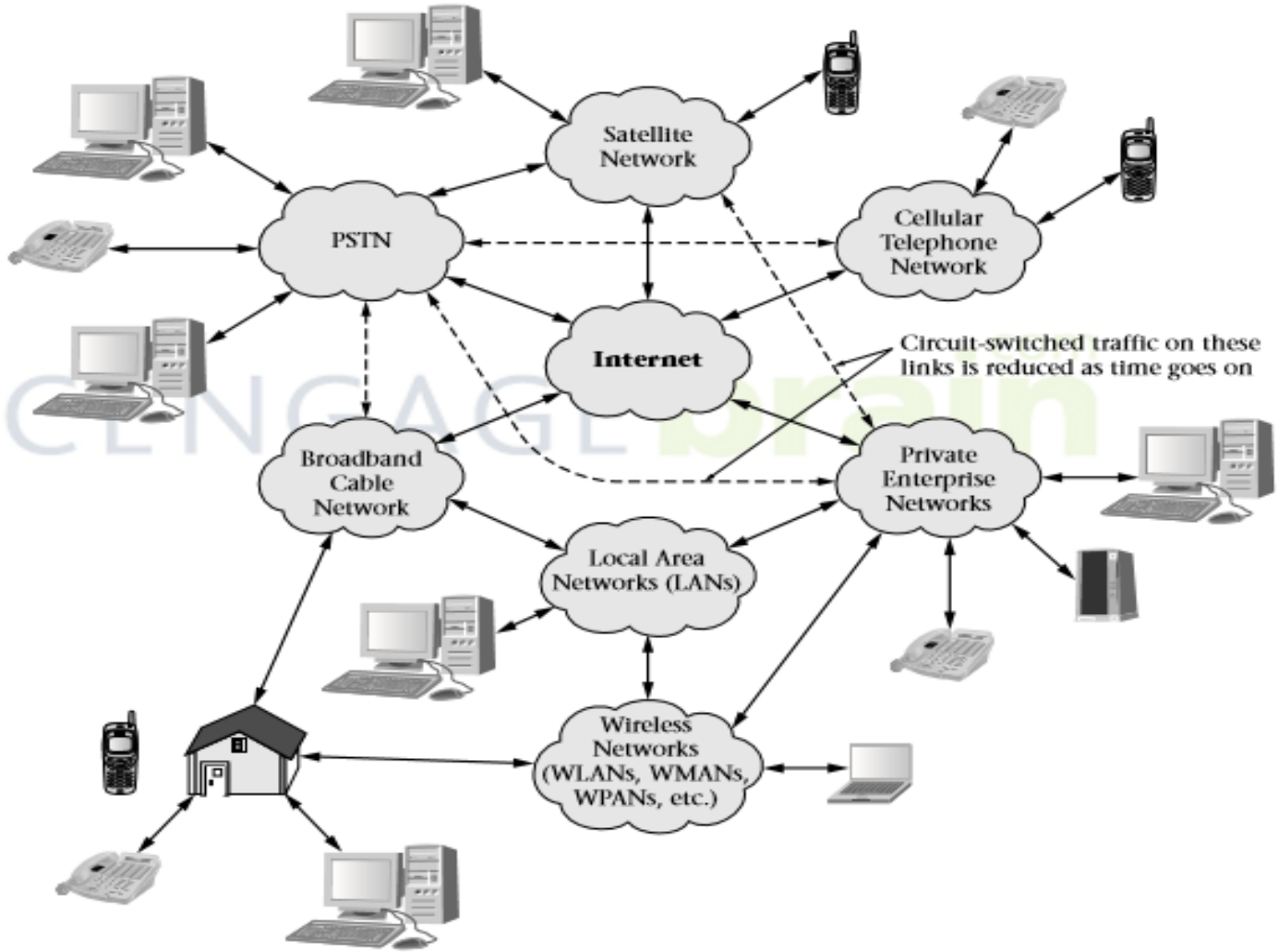


FIGURE 1–8 Today's existing network infrastructure.

- Wireless telecommunication systems and networks perform the function of connecting to the existing network infrastructure.
- The three major types of **traffic** carried by the telecommunications network infrastructure are **voice, video, and data** (often known collectively as multimedia).

Voice:-

- The **PSTN** was originally designed for voice transmission.
- The PSTN was structured in such a way as to provide a circuit-switched path for the conversation, which occurs in real time and therefore requires a certain Quality of Service (QoS).
- This physical path would be set up during the dialling of the call and torn down at the completion of the call.

- Supervisory, alerting, and progress tones and signals are generated by the system to - facilitate creation of the connection and perform call handshaking functions.
- The network would take care of authentication and billing functions.
- Today the PSTN is an almost entirely digital system except for the analog signals that propagate over the copper wire pairs that provide a subscriber, access to the network.
- The **cellular telephone system** gives a subscriber access to the PSTN.

Video:-

- The fixed network infrastructure developed to transport broadband analog video or television signals to the public is the hybrid fiber-coaxial cable (HFC) **broadband cable television network.**
- This system broadcasts the same video signals to all the subscribers connected to the network.

- A **cable modem or set-top box** allows the system to provide different levels of access to the entire suit of video signals transmitted over the system.
- If a subscriber has paid for premium services, these services are allowed to be passed to the subscriber's television tuner or are decrypted if they had previously been encrypted or "scrambled."
- Through system upgrades and rebuilds and use of the DOCSIS standard, the **modern cable television network** has become bidirectional, allowing both downstream and upstream data transmission.
- Most cable operators now offer shared high-speed Internet access over their systems.

Data :-

- The **data network** was originally developed to carry bursty data traffic for business and industry. As technology has evolved the Enterprise data network has also evolved.
- Today's Enterprise data networks tend to have a wide area network (WAN) or metropolitan area network (MAN) high speed backbone with a collection **of local area networks (LANs)** connected to it.
- This backbone network may be dedicated or switched and might use several different types of data transport technologies.
- Voice, data, and video can share these transport facilities.

Review of 7 – layer OSI model

Wireless Network Applications

- Wireless Markets
- Voice Network Evolution
- Data Network Evolution

Wireless Markets:

- The markets for wireless services have evolved into two basic categories:
  (i) voice-oriented market
  (ii)data-oriented market.
- The first market has enjoyed an amazing acceptance by the general public with an extremely fast take-up rate for the service offered—a connection to the PSTN via cellular telephone.
- The newer data-oriented market has evolved around the Internet and computer LAN technology.
- More recently the cellular telephone data-oriented market has been driven by short messaging service (SMS), instant messaging (IM), and multimedia messaging service (MMS) applications and other novel entertainment type applications.
- This shift has been noted by both service providers and content developers and is focusing applications development on entertainment- or “infotainment”-based uses of the cell phone.
- In addition, wireless MANs and PANs are starting to be seen in the market place.

Voice Network Evolution :

- The development of voice-oriented wireless networks began during the early 1970s at AT&T's Bell Labs.
- later in 1983 -The technology for frequency division multiple access (FDMA) analog cellular systems was developed as the Advanced Mobile Phone System (AMPS).
- The GSM group was formed in an attempt to deal with international roaming, which was a serious problem for the European Union countries.
- This led to a new digital time division multiple access (TDMA) second-generation technology (i.e., GSM) that was deployed in many parts of the world beginning in late 1992.
- At present approximately 72% of cellular telephone users are serviced by GSM systems.
- The most recent entry into the cellular mix has been a code division multiple access (CDMA) technology-based system.
- An additional standard, personal digital cellular (PDC), is a Japanese TDMA-based standard.
- It also has a subscriber base of approximately 60 million users; however, some Japanese operators have already announced plans to phase out their PDC systems and shift to CDMA systems.

- cordless telephones belong to the wireless voice network class of products also- First introduced in the late1970s.
- These devices, which provided a wireless connection from the telephone handset to a fixed “base station,” became an instant commercial success.
- Second-generation digital cordless telephones appeared in the early 1980s and the concept of the PCS device evolved in the early 1990s
- A PCS service was considered the next generation of residential cordless telephone.
- most operators are using the PCS bands for cellular service and to fill gaps in their coverage area.

Data Network Evolution :

- The concept of data-oriented wireless networks started in the 1970s, but development did not start in earnest until the early 1980s.
- Amateur radio operators had built and operated simple wireless packet radio networks earlier, but commercial development of radio-based LANs did not begin until 1985 when the FCC(Federal communications commission) opened up the industrial, scientific, and medical (ISM) bands located between 920 MHz and 5.85 GHz to the public.
- During the early 1990s the Institute of Electrical Engineers (IEEE) formed a “working group” to set standards for wireless LANs.
- The IEEE finalized the initial 802.11 standard in 1997 for operation at 2.4 GHz with data rates of 1 and 2 mbps.
- Advances in wireless LAN technology have been occurring at a rapid pace. The IEEE 802.11x family of standards has been expanded to include operation in the 5-GHz U-NII bands with data rates of up to 54 mbps through the use of complex digital modulation schemes.

- The IEEE has adopted two other families of standards

  - IEEE 802.15x for operation of wireless personal area networks (wireless PANs), also known as Bluetooth,

  -IEEE 802.16x for the operation of wireless metropolitan area networks (wireless MANs), also known as broadband wireless access.
- There are parallel development activities occurring in Europe under the European Telecommunications Standards Institute (ETSI) for high speed wireless LANs that appear to have characteristics similar to IEEE 802.11x-based products.
- The ETSI Hiper LAN/2 standard specifies opera*tion in the 5-GHz band and also has the same maximum data rate of 54 mbps*
- Data speeds over these networks range from less than 2.4 kbps for two-way paging applications to 19.2 kbps for the fastest systems.
- General packet radio service (GPRS) with its slightly higher user data rates of 20 to 50 kbps has been available over GSM systems since the early 2000s.
- GSM systems are implementing EDGE technology (2.5G to 3G) worldwide to achieve enhanced data rates. EDGE stands for Enhanced Data Rate for Global Evolution.

- The first operational CDMA systems offered data throughput rates to 14.4 kbps.
- The second phase of CDMA systems (IS-95-B) offer higher data rates (up to 56 kbps).
- The evolutionary pathway to third-generation (3G) CDMA systems includes a phasing in of greater packet data transfer rates.
- The first implementation phase (offered in 2002) of 3G is known as cdma2000 1xRTT and offers packet data rates of up to 144 kbps with real throughput rates of from 60 to 80 kbps.
- Future plans for all cellular technologies include upgrades to 3G technologies with even higher standard data rates and increased mobility.

Future Wireless Networks

- The future of wireless telecommunications technology appears to be unlimited!