

Chapter I --Part I

Brief History of Digital Communications

Chapter 1-References

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1.1 Brief History of Digital Communications

1864-1945

- 1864** **James Clerk Maxwell** formulated the Maxwell equations and predicted the existence of radio waves.
- 1876** **Alexander Graham Bell** develops and patents the telephone.
- 1887** **Heinrich Hertz** demonstrated the physical existence of radio wave.
- 1894** **Oliver Lodge** demonstrates wireless communication over a distance of 150 yards.
- 1895** **Guglielmo Marconi** developed an apparatus for transmitting radio waves over long distances.

- 1901** **G.Marconi** demonstrates wireless telegraph across the Atlantic Ocean, a distance of 2100 miles and proves that wireless waves are not affected by curvature of the Earth on December 12,1901.
- 1905** **Reginald Fessenden** conducted the first radio broadcast , transmitting music and voice using a technique known as **amplitude modulation** (AM) radio.
- 1920** **KDKA** , Pittsburgh , PA, begins the 1st radio broadcast.
- 1921** The 1st 2M Hz land mobile radiotelephone system is installed by the Detroit Police Department.

- 1927 The Detroit Police Department made the first significant use of wireless communications in a vehicle, operating a radio system at a carrier frequency close to 2 MHz .**
- 1927 Bell Labs demonstrated television broadcasts in New York area, John Baird made similar demonstrations in the United Kingdom.**
- 1934 Edwin H. Armstrong invents *FM*.**

1946- 1980s

- 1946 The first electronic computer ENIAC** is completed by by the team led by John W. Mauchly 與 J.Presper Eckert at the University of Pennsylvania, USA.
- 1946** The first public mobile telephone systems were introduced in five American cities (St. Louis and others).
- 1947** The first microwave relay system consisting 7 towers connecting New York and Boston became operational.
- 1947** John Bardeen , Walter H. Brattain and William Shockley invent the point-contact transistor.
- 1948** William Shockley invents *bipolar junction transistor*.
- 1948** **Claud E. Shannon** published his work on information theory “ **A Mathematical Theory of Communication**”.

Information Theory: The Copernican System of Communications

James L. Massey

Shannon's Theory of Information
as the proper scientific basis for
technical communications

December 1984—Vol. 22, No. 12
IEEE Communications Magazine

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2. *In 1924, Nyquist published "Certain Factors Affecting Telegraph Speed," an analysis of the relationship between the speed of a telegraph system and the number of signal values used by the system. His 1928 paper "Certain Topics in Telegraph Transmission Theory" refined his earlier results and established the principles of sampling continuous signals to convert them to digital signals. The Nyquist sampling theorem showed that the sampling rate must be at least twice the highest frequency present in the sample in order to reconstruct the original signal.*

These two papers by Nyquist, along with one by R.V.L. Hartley, are cited in the first paragraph of Claude Shannon's classic essay "A Mathematical Theory of Communication" (1948), where their seminal role in the development of information theory is acknowledged.

- 1950** Time-division multiplexing is applied to telephony.
- 1950** **R.W. Hamming** introduces the *first* error-correcting code, Hamming code.
- 1953** The 1st transatlantic telephone cable (36 voice channels) is laid.
- 1955** **J.R. Pierce** proposes satellite communication systems.
- 1957** First earth satellite, *Sputnik* , is launched by USSR on the 4th of October.
- 1961** **Len Kleinrock** publishes the first paper on *packet switching*.
- 1962** The 1st active satellite , *Telstar I*, relays TV signals between USA and Europe.
- 1964** The 1st communication satellite, *Early Bird* , is placed into service.

- 1966** K.C. Kao and G.A. Hockham publish the principles of fiber optic communication.
- 1969** ARPANET is established.
- 1971** Intel introduces **4004 4-bit microprocessor**.
- 1975** Bill Gates and Paul Allen found the *Microsoft* corporation.
- 1976** Stephen G. Wozniak and Steven P. Jobs found *Apple Computers*.

- 1978 Intel produces 16-bit microprocessor 8086.**
- 1979 64kb random access memory (RAM) ushers in the era of VLSI circuits.**
- 1980 Stand alone complete DSP available (NEC μ PD7720).**
- 1983 Texas Instrument TMS 32010 is available. Microsoft Windows available .**
- 1982 Trellis coded modulation technique is introduced by G.Ungerboeck .**
- 1993 G.Bererou ,A. Glavieux, and P. Thitimajshima present the paper on turbo codes .**
- 1997 D.J.C.MacKay and R.M. Neal rediscover the LDPC codes , invented originally by R.G.Gallager in 1962**
- 1998 S.M. Alamouti publishes the paper on Alamouti code for transmit diversity of multiantenna systems**

1979--- 2000s

Mobile Communications

- 1979** **Nippon Telephone and Telegraph** established a commercial cellular telephone system in Tokyo.
- 1981** In Europe, an analog cellular phone system known as **Nordic Mobile Telephone (NMT)** was introduced in Scandinavia.
- 1983** The **Advanced Mobile Phone Service (AMPS)** was deployed in North America.
- 1988** **TDMA (Time Division Multiple Access)** was voted as a digital cellular standard (**IS-54**, and later **IS-136**) in USA.
- 1992** The first digital cellular system **GSM (Global System for Mobile Communications)** was deployed in Europe. This was also the first second generation cellular system
- 1993** **CDMA(Code Division Multiple Access)** was voted as another digital cellular standard (**IS-95**) in USA.

- 1994** America TDMA cellular system was operable in Seattle.
- 1995** CDMA was operable in Hong Kong.
- 1997** Wideband CDMA was considered as one of the third-generation mobile communication technologies.
- 1999** **ITU**(International Telecommunication Union) decided the next generation mobile communication system(e.g. W-CDMA, cdma2000, TD-SCDMA).
- 2001** W-CDMA commercial service began from October in Japan.
- 2002** **FCC** approved additional frequency band for Ultra-Wideband (UWB)

- 1987** The IEEE 802.11 Wireless LAN working group was founded to begin standardization of spread spectrum WLANs for use in the ISM bands(Industrial Scientific and Medical bands)
- 1999** The IEEE 802 committee set up the **802.16** working group to develop broadband wireless standards. It aims to prepare formal specifications for the global deployment of broadband **Wireless Metropolitan Area Networks** (WirelessMAN).
An industrial group , the **WiMAX**(worldwide Interoperability for Microwave Access) Forum has been formed since June 2001 to promote the 802.16 standards and to develop interoperability specifications.

- 1999** The IEEE 802.11 committee on wireless LANs releases the 802.11a standard for OFDM operation in 5GHz UNI band.
- 2002** The IEEE 802.16 committee releases an OFDM- based standard for wireless broadband access for metropolitan area networks under revision 802.16a. 802.16a also specifies additional MAC -layer option, including support for OFDMA.
- 2003** The IEEE 802.11 committee releases the 802.11g standard for operation in the 2.4 GHz band.
- 2004** IEEE Std 802.16-2004 replaces IEEE Standards 802.16- 2001, 802.16c-2002, and 802.16a-2003. It addresses only fixed systems
- 2005** The IEEE 802.16 committee publishes formally 802.16e-2005. It specifies scalable OFDM for the physical layer and makes further modifications to the MAC layer to accommodate high-speed mobility.

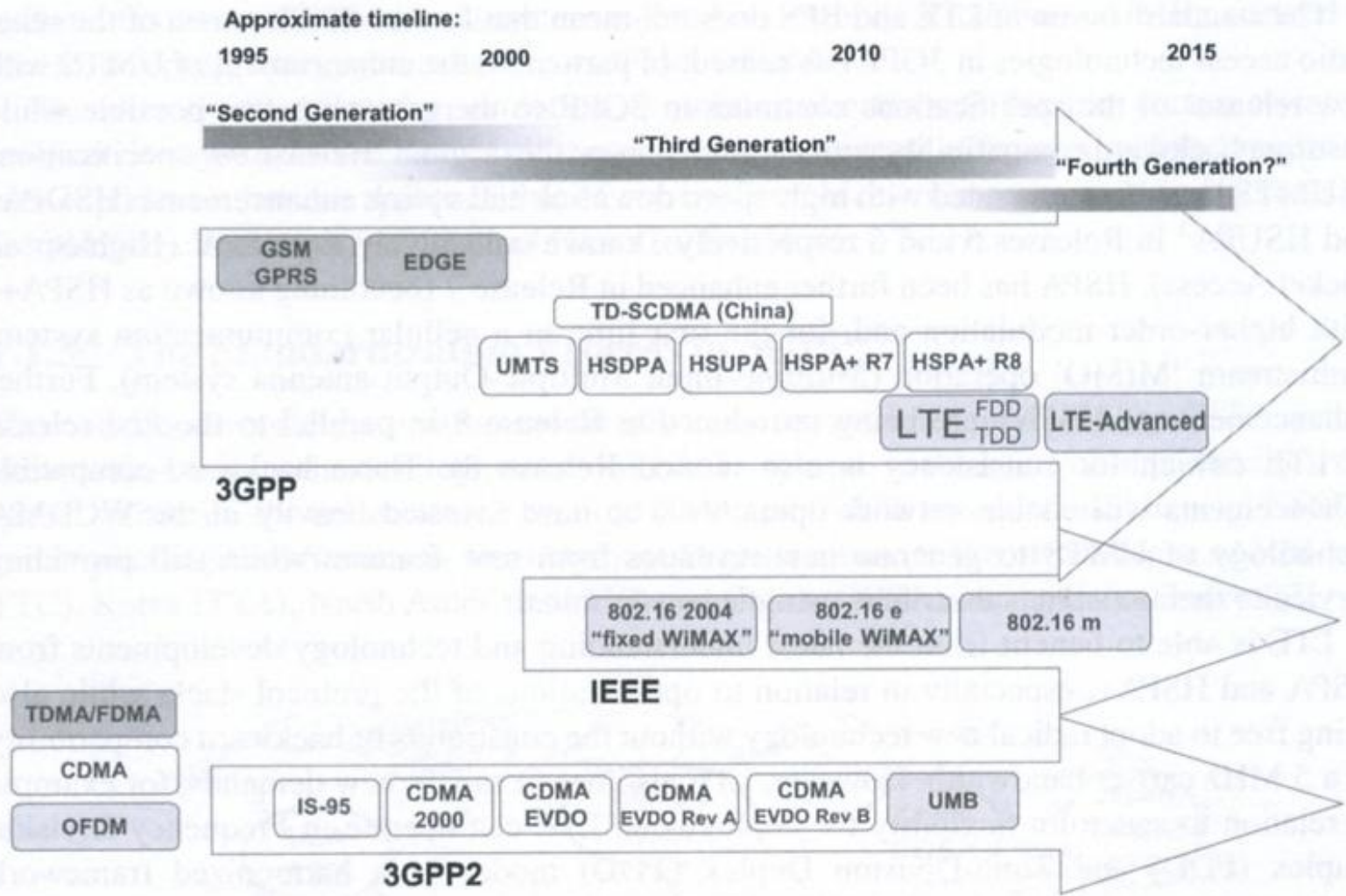


Figure 1.1 Approximate timeline of the mobile communications standards landscape.

