



THE CHINESE UNIVERSITY OF HONG KONG

Department of Information Engineering

Seminar

History of OFDM

by

Dr. Stephen B. Weinstein

Date : 5 November, 2009 (Thur.)
Time : 10:00-11:00am
Venue : Room 833, Ho Sin Hang Engineering Bldg.
The Chinese University of Hong Kong

Abstract

Orthogonal Frequency Division Multiplexing (OFDM) is a relatively recent development in a long history, beginning in the nineteenth century, of frequency division multiplexing technologies. This talk offers an overview of the nineteenth century ancestors of modern OFDM, including the earliest description of the fast Fourier transform, and then describes the series of advances of the last five decades. These include overlapping but non-interfering subband signals, application of the fast Fourier transform, and use of the cyclic prefix to avoid intersymbol interference.

The talk will illustrate, through a cyclic matrix channel representation, why OFDM realizes non-interfering "private lines" for its subbands. Finally, this talk provides an overview of the range of consumer-oriented applications of OFDM beginning with ADSL and including wireless and optical systems. This talk will be at a relatively high level accessible to a broad audience.

Biography

Dr Stephen B. Weinstein, an IEEE Life Fellow, received his SB, MS, and PhD degrees in Electrical Engineering from M.I.T., the University of Michigan, and the University of California at Berkeley respectively. After a career with Bell Laboratories, American Express, Bellcore (Telcordia), and NEC Research Labs America, he is now a part-time consultant (Communication Theory & Technology Consulting LLC) to industry and law firms.

At Bell Labs in the early 1970s, Dr. Weinstein invented the data-driven echo cancellation technique used in voiceband modems for full-duplex data transmission within the same bandwidth on a dialed line, a normal component of almost all voiceband modems that is incorporated into V.32 and later industry standards. He pioneered, in those same years, the application of the Fast Fourier Transform to bandwidth-efficient parallel transmission of data in small frequency subchannels. This was the beginning of economically practical OFDM/DMT modulation, a technique increasingly used in communication systems including ADSL, WiFi, WiMAX and Digital Video Broadcasting.

At the American Express Company, Dr. Weinstein advised senior management on technical aspects of transactional networks, including interactive TV and "smart card" applications. Shortly after leaving American Express he wrote the book *Getting the Picture: A Guide to CATV and the New Electronic Media* (IEEE Press, 1986), an early overview of the emergence of broadband multimedia communications. Although not able to persuade American Express to implement smart card products at that time, he invented an authentication mechanism for these cards and participated actively in ANSI standardization activities.

As a department head at Bellcore from 1984 through 1993, he led early development of networked multimedia applications including end-to-end systems for on-demand video and for informal multimedia group collaboration. His organization's "video window" application, a large-screen informal teleconferencing system, was demonstrated at the Smithsonian Institution in Washington, DC. He took a strong interest in the human-computer interface, including a behavioral psychology group in his department and advancing the then-futuristic concept of service available anywhere, anytime, in any media. With the help of a few Bellcore colleagues, Dr. Weinstein and his wife, Judith, a library manager, linked the Morris County, NJ library network to the Internet in the summer of 1993, an accomplishment reported on CNN. It was only the second library system in the U.S., after Seattle, to offer broadband Internet access to the public.

In addition to the CATV book cited above, he is co-author of the textbook *Data Communication Principles* (Plenum, 1992), and is the author of *The Multimedia Internet* (Springer, 2005), an overview of the technologies supporting audio/video media on the Internet. His 1971 paper on parallel data transmission, co-authored with Paul Ebert, is included in the IEEE Communication Society's commemorative book of the 100 most significant papers of the Society's first fifty years.

Presently chair of the IEEE Communications Society Awards Committee and of the IEEE Recognitions Council, he served as President (1996-97) of the IEEE Communications Society and Division III Director (2002-2003) on the IEEE Board. He is also chair of the IEEE Ad-Hoc (2009) Committee on Travel Cost Displacement, studying the opportunities to replace a portion of IEEE business travel with electronic teleconferencing. He has served in many capacities in publications and conference activities. He is known in particular for developing IEEE Communications Magazine from a newsletter into a widely cited technical magazine, and as a co-founder of the IEEE/ACM Transactions on Networking. He was 2004 Program Chair of the IEEE Wireless Networking and Communications Conference (WCNC) and of several smaller conferences sponsored jointly by the IEEE Communications Society and the IEEE Circuits and Systems Society, the last held in Shanghai in May, 2008. He was elected to IEEE Fellow grade in 1984 for contributions to data communications and to IEEE publications. He received the IEEE Centennial Medal in 1984 and the IEEE Second Millennium Medal in 2000. He was the recipient of the 2006 Eduard Rhein Foundation (Germany) Basic Research Award for his early OFDM work.

**** ALL ARE WELCOME ****

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