Beating the Shannon Limit in Voiceband Modems
The Case of the 56K Modem

Virtual Distinguished Lecture by Dr. Ender Ayanoglu
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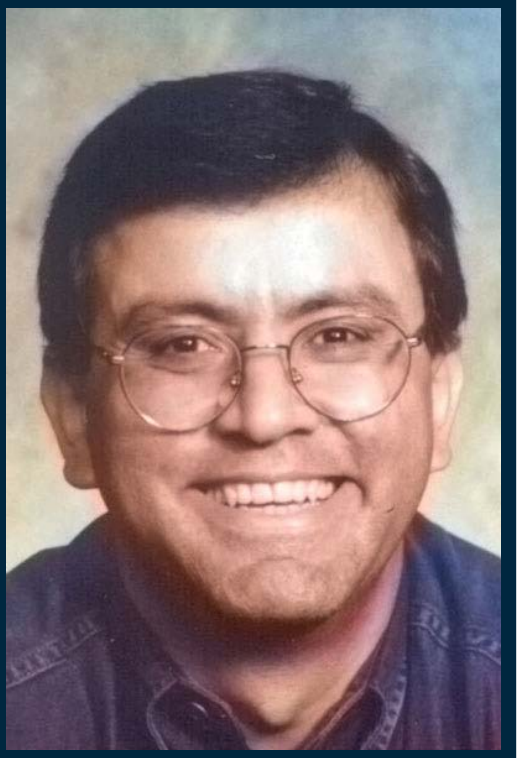

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Voiceband modems convert a stream of digital symbols into audible signals and transmit them over the Public Switched Telephone Network (PSTN). The first voiceband modem was developed in 1958 and operated at 110 bits/s. Being subject to international standards developed by the International Union of Telecommunications, Telecommunication Standardization Sector (ITU-T), a body of the United Nations, these modems consistently increased their transmission speeds within the next several decades. Every step in the standards process involved a major development in signal processing and communications, such as various forms of adaptive equalization, echo cancellation, and trellis coded modulation. These contributions approximately doubled the transmission speed every step of the standardization process, starting with 300 b/s in 1962 until about 28.8-33.6 kb/s in 1996. Modem designers invoked Shannon's capacity formula and considering quantization noise occurring at the Analog-to-Digital conversion process in the PSTN Central Office as additive white Gaussian noise, decided that the channel capacity for such modems is about 36 kb/s. Yet, towards the end of 1990s, modems that operated at transmission speeds close to 56 kb/s, known generally as 56K modems appeared. This talk will first give a brief history of voiceband modems, and it will describe how it was possible to beat the Shannon capacity formula with the 56K modems. The underlying modeling process and the related mathematics will be described. A history of the development of the 56K modems will be presented and, looking back several decades, the technological, as well as the economic and social impact of these modems, will be discussed.

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