IEEE PACKET SPEECH MILESTONE CELEBRATED AT MIT LINCOLN LABORATORY

by David Walden, Corresponding Member, IEEE History Committee

In 1971 Jim Forgie of MIT Lincoln Laboratory did experiments with the two-year old ARPANET that showed the feasibility of sending speech over that first packet-switching network. At the time, in the context of traditional dial-up full-duplex telephone communications, many people doubted that packetized speech, in which packets flow over varying network paths with varying time delays, could work. In 1974 the Advanced Research Projects Agency (ARPA) began a multi-institution packet speech program, lasting through 1982, that firmly demonstrated the utility of packet speech. This was the initiating technology of what we know today as Voice over IP and capabilities such as Vonage and Skype.

On 8 December 2011, a Milestone was dedicated at MIT Lincoln Laboratory, which had been the central player in the ARPA packet speech program. The plaque citation reads:

> **First Real-Time Speech Communication on Packet Networks, 1974-1982** In August 1974, the first real-time speech communication over a packet-switched network was demonstrated via the ARPANET between MIT Lincoln Laboratory and USC Information Sciences Institute. By 1982, these technologies enabled Internet packet speech and conferencing linking terrestrial, packet radio, and satellite networks. This work in real-time network protocols and speech coding laid the foundation for voice-over Internet Protocol (VoIP) communications and related applications including Internet video conferencing.

L to R: Cliff Weinstein, Lincoln Lab Human Language Technology, Peter Staecker, IEEE President-Elect, Karen Panetta IEEE Boston Section Chair, Gilmore Cooke, IEEE Boston Section Historian, and Eric Evans, Director of MIT Lincoln Laboratory with the Milestone Plaque

This IEEE Milestone in packetized speech was sponsored by IEEE Signal Processing Society and the Boston section of IEEE. The public dedication was attended by more than one hundred people including many of the 1974-1982 participants, several of whom came from across the country. Welcomes were given by Karen Panetta, IEEE Boston Section Chair; Mostafa Kaveh, IEEE Signal Processing Society President; and Eric Evans, director of MIT Lincoln Laboratory.

Cliff Weinstein, leader of Lincoln Laboratory's Human Language Technology group and himself a key member of the 1974-1982 research, sketched the history of the effort, from Jim Forgie's early feasibility study; through the milestone years; and to Bob Gray's July 2005 paper in the *IEEE Signal Processing Magazine* which brought the 1974-1982 work to the attention of a 21st century audience. Weinstein emphasized the multi-institutional composition of the research effort: you need people at other locations to demonstrate long distance, packetized two-person telephone conversations and teleconferencing. In addition, the different institutions had different computers and end-user equipment and helped develop the necessary network protocols enabling communication among varied devices. Cliff also played an audio tape from May 1978 of an early demonstration of a voice conference among the Lincoln Laboratory in Massachusetts and USC Information Sciences Institute and Culler-Harrison Inc., both in southern California. Bob Kahn, ARPA program manager when the packet speech project was initiated, was the keynote speaker. He too emphasized how many people from how many places participated in the program. He also noted that part of his purpose in creating the speech program was to show the importance of packet technology. The ARPANET had been created to demonstrate packet switching, and it could transmit data of many types. Bob described changes that had to be made to the internal ARPANET algorithms and its external interface to allow high bandwidth, low-delay speech. Also, TCP (which originally contained both the TCP and IP functions) was split into TCP and IP which enabled applications such as packet speech (and its protocols) to communicate directly with IP. A goal was 1Kbps speech at a time when 4.8Kbps or 2.4Kbps speech were regarding as minimums. This goal was reached, partly because packet speech did not require a full duplex connection (saving 50 percent immediately) and packets did not have to be sent during silences, etc., saving an additional significant percentage. Finally, Bob noted that there are still possibilities for improving the way speech is transmitted over the Internet, and he envisions a time when speech may be the primary user interface to computers.

The formal session ended with Peter Staecker, 2013 IEEE president, and Eric Evans, director of Lincoln Laboratory unveiling the plaque and handing out miniature versions of the plaque to participants in the 1972-1984 research.

IEEE President-Elect Peter Staecker speaking at Packet Speech Milestone Ceremony