

## DEDICATION OF THREE NEW IEEE MILESTONES: LORAN, WHIRLWIND, SAGE

by David Walden, History Committee Corresponding Member

On June 27 at the Westin Copley Place hotel in Boston, the IEEE Boston Section hosted the dedication ceremony for the LORAN, Whirlwind, and SAGE IEEE Milestones.

Boston Section Chair Soon Wan welcomed attendees, described the Milestone program, and highlighted the founding of the Boston Section in 1913 (as a branch of the AIEE, a predecessor organization of IEEE). Arthur Winston, honorary chair of the section Milestones committee, introduced rest of the participants in the ceremony. Gilmore Cooke, Boston Section History and Milestones Committee Chair, outlined the rest of the proceedings, and he thanked MIT Lincoln Laboratory and the MITRE Corporation for their corporate support of the event.

Erik Johannesen, the president of Megapulse, Inc. (which manufactures LORAN systems), gave a brief history of LORAN. There was a "loran-like hyperbolic radio navigation system" in the UK in 1937, and Alfred Lee Loomis (of Tuxedo Park fame) conceived LORAN. MIT's Radiation Laboratory was chosen as a subdivision of the National Defense Research Committee, and in 1941 John Pierce joined the laboratory and, for his guiding efforts, he became known as the father of LORAN. LORAN was deployed at an astonishing rate around the North Atlantic and then in the Pacific in the middle years of WWII. The early system required operator involvement, later supported with pre-computed lines overprinted on navigation charts. The more modern LORAN-C became operational in 1957 with involvement of many countries, manufacturing by 30 or so companies, and eventual full continental US coverage. With the development and deployment of GPS, LORAN was phased out of operational use in the United States although development of a more modern system as a backup for GPS continued until 2010. Johannesen says, "Although loran signals were terminated in the US, they still exist in many parts of the world and the future of LORAN, both internationally and Domestically, is still a history to be written."

Capt. Alan Arsenault, who spent twelve of his years with the Coast Guard working with LORAN, noted the breadth of use of LORAN: marine and terrestrial navigation and for timing without navigation (e.g., in banking or power generation). As an electrical engineer himself, he called LORAN "an engineers dream—nanosecond timing and control and 700,000 to 1,200,000 watt transmitters."

Eric Evans, Director of MIT Lincoln Laboratory, noted that Lincoln Laboratory was created to develop SAGE and— in turn— Lincoln Laboratory had come out of the Radiation Laboratory's radar work. In time, MITRE Corporation spun out of Lincoln Laboratory to carry on the SAGE work. Evans then introduced Jay Forrester, who with Bob Everett, led the development of Whirlwind and the early phases of SAGE.

Forrester credited Parry Crawford, George Valley, and Carl Compton with providing vision for connecting a digital com-

puter to a radar, for seeing the defense need, and for requesting the multi-year plan that led to construction of the SAGE system. Forester emphasized that the project was set up in a way that his and Everett's MIT team had central influence with the military and the vendors; this made possible construction of a operational and reliable system. Along the way they had to understand how to make vacuum tubes be very reliable, and they included margin-checking hardware in the system and pairs of computer running in parallel at each site (one monitoring the other and available for switching to operational). Thus they achieved 99.8 percent system uptime.

Bob Everett who was with the Whirlwind and SAGE projects from their beginnings was a founding member of the MITRE Corporation in 1958 (at the time the first SAGE site was deployed) and president from 1969-1986. He credited Jay Forrester with being responsible for the creation of Whirlwind, SAGE, Lincoln Laboratory, and MITRE. Everett went on to describe the 250 engineers at Lincoln Laboratory who developed the SAGE system (fifty of whom were computer programmers) and the involvement of other organizations (such as IBM and SDC) with thousands of additional engineers. Development of SAGE was done in close collaboration with the Air Force customer, which supported Lincoln Laboratory acting as director of the project, while arranging for SAC bombers to do fly-bys for systems tests, and eventually taking over maintenance of the system.

IEEE 2012 President Gordon Day noted that each of the three projects was like nothing that came before—they all were ground-breaking, building on the then-latest research, and each had broad impact, moving technology ahead beyond the specific application. All three were related to MIT and funding came from the Department of Defense in each case. Then Day unveiled the plaques with help for LORAN from Professor William Freeman of MIT and Capt. Allan Arsenault; help for Whirlwind from Freeman; and help for SAGE from Eric Evans, Jay Forrester, and Bob Everett.

The development of LORAN under wartime conditions transformed navigation, providing the world's first near real-time positioning information. Whirlwind was the first real-time high-speed digital computer using random-access magnetic-core memory.

SAGE was an engineering marvel for its time in terms of the computing, networking, and successful management of an enormous project.

Gilmore Cooke and Soon Wan passed out miniatures of the plaques to the participants in the ceremony. Soon Wan concluded the event with an invitation for attendees to come back next year for the 110 anniversary of the Boston Section and a request for all participants and attendees to stay for a group photo with the plaques. People then went to the next door meeting room for a reception and to continue meeting new people and old colleagues and friends and to celebrate the LORAN, Whirlwind, and SAGE Milestones.