Principles of Atomic Clocks

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Atomic frequency standards provide the ultimate source of accuracy and stability for all modern communications, navigation, and time-keeping systems. Commercially-available "Industrial" atomic clocks, including cesium beam frequency standards, rubidium oscillators, and hydrogen masers, are based on technology originally developed in the 1950's. Since that time, technology evolution and field experience have led to a level of performance and reliability that atomic clocks are now deployed throughout critical infrastructure applications.

Recently, for the first time in 50 years, a new type of atomic clock has transitioned from the laboratory into practical application. Chip-Scale Atomic Clocks (CSAC) employ novel techniques for atomic confinement and interrogation, combined with micro-electromechanical systems (MEMS) and modern electronics, to enable atomic timing accuracy in portable battery-powered devices. While CSAC technology is yet relatively immature, already a new family of applications has emerged in handheld communication systems, enhanced personal navigation systems, and remote sensing.

The tutorial will provide an introduction to industrial atomic clocks, focusing on mature technologies: rubidium oscillators, cesium beam frequency standards, and hydrogen masers, as well as the emerging technology of CSAC.

About the presenter

Robert Lutwak is a senior scientist at Symmetricom's Technology Realization Center. He provides support for the development of products based on mature atomic clock technologies, as well as engineering the transition of emerging technologies from the laboratory to robust implementation. Recently, Dr. Lutwak has led projects to develop next generation atomic clock technology for deployment onboard the GPS-NAVSTAR satellite constellation as well as the development of chip-scale atomic clocks, 100X smaller and lower power than existing technologies. Dr. Lutwak is a Senior Member of the IEEE and has served on the Frequency Control Symposium Technical Program Committee since 2001.