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Rad Hard Technology Tutorial*Dr. Leon Alkalai, Allan Johnston*

Length: Half-day

This tutorial provides both a top-down and a bottom-up view of radiation-hard and radiation-tolerant avionics and microelectronics technologies for space applications. It begins with an introduction and overview on "Perspectives on Dependable Computing for Solar System Exploration." The topic is addressed at the avionics architectural level, from the building block modules and up, with X2000 architecture as one example. It includes a summary of the current state of the practice within industry in the area of advanced avionics for space applications, as well as areas of advanced avionics concepts for future long-term solar system exploration missions. The tutorial also covers radiation effects on microelectronics, concentrating on soft and hard errors that are induced in advanced microelectronics by high-energy galactic particles. The impact of technology scaling on radiation sensitivity is discussed, along with comparisons between state-of-the-art commercial devices and special radiation-hardened products for space applications. Test results on advanced memories and microprocessors are used to demonstrate the complexity of effects in advanced devices when they are exposed to the space environment. Results for older systems during extended missions are also discussed, showing how first- and second-order errors affect error correction in space missions.

About the speaker(s):

Dr. Leon Alkalai is the Center Lead for the Center for Advanced Avionics at JPL, where he also manages the Space Avionics and Microsystems Program. Alkalai joined JPL in 1989 after receiving his PhD from the UCLA Computer Science Department. Since then, he has worked on advanced research topics in the area of avionics and micro-systems, including high-performance on-board computing, dependable computing, and highly miniaturized avionics components. Currently, Alkalai is also an Adjunct Professor at the UCLA Computer Science Department, as well as the University of Illinois, Champaign Urbana.

Allan Johnston is the Technical Group Supervisor of the Radiation Effects Group within the Electronic Parts Engineering Office (514) at the Jet Propulsion Laboratory (JPL), where he has worked for the past 10 years. He directs research and testing activities on radiation effects in electronic and opto-electronic devices for space applications. His previous experience includes more than twenty years at the Boeing Aerospace Company, dealing with radiation effects in integrated circuits and systems. His technical interests include ionization and single-event upset effects in semiconductor devices, with particular emphasis on low dose-rate effects, latchup, and applications of commercial technologies in space. Related interests include determining how new device technologies and device scaling will influence their radiation performance in space, as well as radiation effects on opto-electronic devices. Johnston has been the author or co-author of more than 80 papers in refereed journals. He received the Outstanding Paper award at the IEEE Nuclear and Space Radiation Effects Conference (NSREC) in 1999 and the Distinguished Poster Paper award at NSREC in 1987. Key publications include work on super-recovery (rebound) in MOS devices, latchup from single particles, dose rate effects in linear integrated circuits, the effects of device scaling on radiation susceptibility, and radiation effects in opto-electronics. He published invited papers on latchup in the IEEE Transactions on Nuclear Science (TNS) in 1996, on device scaling at the RADECS-1997 and RADECS-2002 Conferences, and on optoelectronics in the TNS in 2003. He has been

active in the IEEE Nuclear and Radiation Effects Conference, serving as Short Course Instructor, Local Arrangements Chairman, Short Course Chairman, and Awards Chairman. He was Technical Program Chairman for the 1997 NSREC, and is General Chairman for NSREC in 2003. He is a Fellow of the IEEE, and holds B.S. and M.S. degrees in physics from the University of Washington, Seattle, Washington.

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