Introduction

Leon Alkalai*

Jet Propulsion Laboratory,
California Institute of Technology,
MS 301-327, 4800 Oak Grove Dr.,
Pasadena, CA 91109, USA
E-mail: leon.alkalai@jpl.nasa.gov
*Corresponding author

Timothy Tsai

Nvidia Corporation,
2701 San Tomas Expressway,
Santa Clara, CA 95050, USA
E-mail: timothytsai@gmail.com

Tomohiro Yoneda

Information Systems Architecture Science Research Division,
National Institute of Informatics,
2-1-2 Hitotsubashi, Chiyoda-ku, Tokyo 101-8430, Japan
E-mail: yoneda@nii.ac.jp

Biographical notes: Leon Alkalai is the Assistant Division Manager for the Systems Engineering and Formulation Division at the Jet Propulsion Laboratory (JPL) California Institute of Technology, where he has worked since 1989. He received his MSc and PhD degrees from the UCLA Computer Science Department in 1986 and 1989 respectively. He is a full member of the International Academy of Astronautics (IAA). In 2012, he received the NASA Individual Distinguished Achievement Medal for the successful formulation of the Gravity Recovery And Interior Laboratory (GRAIL) mission to recover the detailed gravity map of the moon. GRAIL launched successfully in 2011 and completed its mission in 2012. He was also the formulation lead for the next NASA Mars lander called *InSight*, which is scheduled to launch in March 2016.

Timothy Tsai is a Senior Research Scientist at Nvidia Corporation, where he investigates topics related to resilience, high performance computing, and parallel processing. He received his MS and PhD degrees from the University of Illinois at Urbana-Champaign and BS degree from Brigham Young University. His research interests include dependable computing, exascale computing, fault tolerance, and storage systems.

Tomohiro Yoneda received his BE, ME, and Dr Eng degrees in Computer Science from the Tokyo Institute of Technology, Tokyo, Japan in 1980, 1982, and 1985, respectively. In 1985, he joined the staff of Tokyo Institute of Technology, and he moved to National Institute of Informatics in 2002, where he is currently a Professor. He was a Visiting Researcher of Carnegie Mellon

University from 1990 to 1991. His research activities currently focus on formal verification of hardware and synthesis of asynchronous circuits. He is a member of IEEE, Institute of Electronics, Information, and Communication Engineers of Japan, and Information Processing Society of Japan.

As Guest Editor of this special issue of the *International Journal of Critical Computer-Based Systems* (*IJCCBS*), it is my pleasure to highlight five papers that were selected for their outstanding quality from the 2011 Pacific Rim Conference on Dependable Computing (PRDC 2011), that was held in Pasadena, California, on 12–14 December 2011. These authors were invited to submit significant expanded versions of their PRDC papers which were then subjected to an additional round of peer reviews before being accepted for this special issue.

As the General Chair of the conference, the proximity of the event location to NASA's Jet Propulsion Laboratory (JPL), California Institute of Technology (Caltech), where I have been working for almost 25 years, has a special meaning and a special connection to the topic of both the conference and this special issue. Not only has JPL been in the forefront of developing and fielding highly dependable and critical computer-based systems for robotic space exploration for over 60 years, but, the past year alone has witnessed some truly remarkable achievements in this field worth a mention. In August 2012, the Curiosity rover performed a magnificent 'out of this world' autonomous landing on Mars using the 'Sky Crane' Entry Descent and Landing (EDL) system, with a series of critical events and manoeuvres appropriately branded as '7-minutes of terror'. Had any one of these many critical events gone wrong, the system would have crashed. With a one-way time delay of 8 minutes, there is no time or possible option of operator in the loop control. Every step has to be fully automated, tested extensively, and executed flawlessly, for the system to succeed. Overall, the Curiosity autonomous EDL system is a perfect example of critical computer-based systems at work.

The second space event relates even more closely to the topic of this special issue and the journal as a whole. Only a few weeks ago, Voyager-1 Project Scientist, and former JPL Director Edward C. Stone announced that the Voyager-1 spaceship has 'officially' entered inter-stellar space and is thus the first Earth-based robotic system to do so in space exploration history. He compared the significance of this historic event to the first landing of Apollo astronauts on the moon. To the community that studies critical computer-based systems, the Voyager-1 survivability and continued operation for over 36 years in a very harsh space-based environment, has tremendous meaning.

It is thus not surprising that many of the challenge problems in the design and implementation of critical computer-based systems, relate directly to problems in civilian aeronautics and space and thus to NASA's human and robotic space exploration missions. Such is also the case with the selected five papers highlighted in this special issue.

First, the paper by Camille Fayollas et al. of the University of Toulouse and CNRS, LAAS in Toulouse looks at 'Interactive cockpits as critical applications: a model-based and a fault-tolerant approach', as part of the Airbus avionics digital cockpit system. The design of such highly interactive and critical systems is a challenge in both software systems engineering and fault-tolerant systems design. The continued design of such

highly resilient and interactive systems is a necessity for any future human computer interface to highly critical systems.

The following three papers: 'Efficient online memory error assessment and circumvention for Linux with RAMpage' by Horst Schirmeier et al.; 'Towards spatial isolation design in a multi-core real-time kernel targeting safety-critical applications' by Gang Li and Søren Top; and 'Low-power test sets under test-related primary input constraints' by Irith Pomeranz, all describe specific important building block elements in the architecture of a fault-tolerant highly critical computer-based system.

Finally, the fifth paper by Wilfried Steiner and Bruno Dutertre describes 'The TTEthernet synchronisation protocols and their formal verification' as part of a communication platform for critical and distributed computer-based systems. One of the TTEthernet high-end configurations has been selected by NASA for the Orion multi-purpose crew vehicle (MPCV) programme.

In summary, even though the five papers selected here for publication in the special issue of the *International Journal of Critical Computer-Based Systems* represent a small sampling of the outstanding work in the field, and those presented at the PRDC 2011, they reflect a common theme of challenges facing the community in the near future, as critical computer-based systems become more complex in their use of multi-core computing elements, more diverse in their support of both critical and non-critical applications on the same platform, and more interactive as human-computer interfaces expand in new directions and new media.

Finally, I would like to thank the *International Journal of Critical Computer-Based Systems* for providing the opportunity to highlight these selected papers from the PRDC-2011 and for giving myself and my co-Editors of this special issue an opportunity to serve the community.