

# Green Intelligent & Connected Systems at the Trillion Scale, Sustainably

## SPEAKER:

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**ABSTRACT** Recent semiconductor scaling trends continue to support the evolution of silicon systems beyond the inevitable end of technology scaling, growing the deployment of intelligent and connected chips towards the trillion range by the end of the decade. Such evolution vastly outranges any application ever deployed by human beings, and its sustained growth is now fundamentally impeded by batteries as conventional source of energy. From a silicon chip viewpoint, batteries at the trillion scale severely limit advances in cost, form factor, system lifespan and chip availability over time. From a societal perspective, batteries in the trillions threaten economic and environmental sustainability of the underlying scaling trend, and hence its feasibility.

This talk introduces the key ideas and their silicon demonstrations to enable a new breed of always-on silicon systems from sensing, to computing and wireless communications with no battery inside (or any other energy storage). Highly power-scalable systems with adaptation to the highly-fluctuating power profile of energy harvesters is shown to enable next-generation pervasive integrated systems with cost well below 1\$, size of few millimeters, long lifetime well beyond the traditional shelf life of batteries, yet at near-100% up-time.

Sensor interfaces, processors and wireless transceivers fitting existing infrastructure (e.g., WiFi, Bluetooth) with power reductions by orders of magnitude are discussed and exemplified by numerous silicon demonstrations from our research group, and their system integration. Ultimately, the technological pathway discussed in this talk supports sustainable growth of applications leveraging large-scale deployments of silicon systems, making our planet smarter. And greener too.

**BIO** Massimo Alioto is Provost's Chair Professor at the ECE Department of the National University of Singapore, where he leads the Green IC group and the Integrated Circuits and Embedded Systems area. Previously, he held positions at the University of Siena, Intel Labs – CRL (2013), University of Michigan - Ann Arbor (2011-2012), University of California – Berkeley (2009-2011), EPFL - Lausanne.

He is (co)author of 400 publications on journals and conference proceedings, and four books with Springer (with two more coming). His primary research interests include ultra-low power and self-powered systems, green computing, circuits for machine intelligence, hardware security, and emerging technologies.

He was the Editor in Chief of the IEEE Transactions on VLSI Systems and Deputy Editor in Chief of the IEEE Journal on Emerging and Selected Topics in Circuits and Systems. He was the Chair of the Distinguished Lecturer Program for the IEEE CAS Society, and was a Distinguished Lecturer for the SSC and CAS Society. Previously, Prof. Alioto was the Chair of the "VLSI Systems and Applications" Technical Committee of the IEEE Circuits and Systems Society (2010-2012). He served as Guest Editor of numerous journal special issues (JSSC, TCAS-I, JETCAS...), Technical Program Chair of several IEEE conferences (ISCAS, SOCC, PRIME, ICECS), and TPC member (ISSCC, ASSCC). His research group contribution has been recognized through various best

paper awards (e.g., ISSCC), and in the ten technological highlights of the TSMC annual report, among the others. Prof. Alioto is an IEEE Fellow.

