# INVITED TALK: THE CHANGE PROJECT!
# ENABLING TECHNOLOGIES FOR SELF-AWARE ADAPTIVE COMPUTING SYSTEMS

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## Talk summary

The computing industry is at a major crossroad. Semiconductor technology offers billions of transistors on a chip, the level of integration and the speed of components have increased dramatically over the years, and advancements show no sign of abating. Post silicon technologies such as graphene electronics could offer even more industrially viable computing power within years. In recent times, unfortunately, these advancements have not resulted in a proportional increase in performance or other measures of interest to users. Even though technologies have improved, we continue to apply outdated approaches to our use of these resources, and key computer science abstractions have not changed since the 1960's. Furthermore, reconfigurable architectures and multicore processors are becoming prevalent. Therefore, the complexity of computing systems is increasing up to the point that it is no longer practical for an average programmer to balance all of the system constraints and produce applications that perform well on a variety of machines, in a variety of situations. Within this context, this is the right time for a fresh approach to the way systems are designed and used.

Imagine a revolutionary computing system that can observe its own execution and optimize its behavior with respect to the external environment, the user desiderata and the applications demands. Imagine providing users with the possibility to specify their desired goals rather than how to perform a task, along with constraints in terms of energy budget, time, and results accuracy. Imagine, further, a computing chip that performs better, according to a set of goals expressed by the user, the longer it runs an application. Self- Aware computing is a research area aimed at leveraging the new balance of resources to improve performance, utilization, reliability and programmability, overcoming the burden imposed by the increasing complexity and the associated workload of modern computing systems. Self-aware computing systems will be able to configure, heal, optimize, protect themselves and improve interaction with the user and the environment without the need for human intervention, through learning abilities that will allow them to automatically find the best way to accomplish a given goal with the resources at hand. Within this context, the need for a systematic approach to the design of architectures and systems enabling self-awareness has been motivated by some trends that have gained momentum in the past few years. On one hand there is the increasing importance of non-functional constraints in the perceived value of a digital system; features that cannot be completely translated to functionalities are getting more important. On the other hand there is the increasing structural complexity of devices, which in turn increases the number and the complexity of interacting peer elements at various levels, e.g., cores on a multicore processor, concurrent programs in a multitask operating system, number of threads within an application.

Within this context, this talk present the work that we are doing in proposing a new way of thinking and approaching computer systems that reflects 21st century demands and opportunities. During this talk, after a general presentation of the overall CHANGE project two examples, morphone and AcOS and will be presented and the relation between CHANGE and DRESD (the reconfigurable computing research project) will be discussed.

## About the speaker

Marco D. Santambrogio received his laurea (M.Sc. equivalent) degree in Computer Engineering from the Politecnico di Milano in 2004, his second M. Sc. degree in Computer Science from the University of Illinois at Chicago (UIC) in 2005 and his PhD degree in Computer Engineering from the Politecnico di Milano in 2008. Dr Santambrogio was at the Computer Science and Artificial Intelligence Laboratory (CSAIL) at MIT as postdoc fellow and he is now assistant professor at Politecnico di Milano, research affiliate at MIT and adjunct professor at UIC. Marco D. Santambrogio is a member of the IEEE, the IEEE Computer Society (CS) and the IEEE Circuits and Systems Society (CAS). He has been with the Micro Architectures Laboratory at the Politecnico di Milano, where he founded the Dynamic Reconfigurability in Embedded System Design (DRESD) project in 2004 and the CHANGE project (Self-Aware and Adaptive Computing Systems) in 2010. He conducts research and teaches in the areas of reconfigurable computing, computer architecture, operating system, hardware/software codesign, embedded systems, and high performance processors and systems.