TALLINNA TEHNIKAÜLIKOOL
TALLINN UNIVERSITY OF TECHNOLOGY

iktp

European Union
Regional Development Fund

Investing in your future

Workshop on Advanced Computer Architectures and Dependable Embedded Systems

Embedded systems are micro-scaled computers "hidden" in everyday electronic devices: from mobile phones and hi-fi equipment to cars and planes. These devices, appliances, vehicles and equipment include "embedded" computing, communication and control elements that make them work more effectively. They are often designed for a particular kind of activity that is required to work under constraints concerning (low) power, real-time operation, memory, processing capacity and security.

Embedded systems technology can be used in many applications. Broadly speaking, the application domains can be categorised as follows:

- "Industrial systems" - large, complex and safety critical systems, that embraces automotive, aerospace, manufacturing, and specific growth areas such as biomedical;
- "Nomadic Environments" – enabling devices such as smartphones, tablets and on-body systems to communicate in changing and mobile environments, that offer users access to information and services while on the move
- "Private Spaces", - such as homes, cars and offices, that offer systems and solutions for improved enjoyment, comfort, well-being and safety.
- "Public Infrastructure" – major infrastructure such as airports, cities and highways that embrace large scale deployment of systems and services that benefit the citizen at large (communications networks, improved mobility, energy distribution, intelligent buildings).[1]

Embedded systems impact many industrial sectors including automotive, aerospace, consumer electronics, communications, medical, defence and manufacturing. In fact, the aerospace sector is particularly interesting, because it intersects with all the above listed application domains. Likewise, the medical sector is highly relevant as it overlaps with Nomadic Environments, Private Spaces and Public Infrastructure.

Within the embedded systems domain, the specialised fields of "dependability" and "interoperability" are becoming increasingly important. In this instance, system dependability can be described as quality-of-service having attributes reliability, availability, maintainability, testability, integrity and safety[2] whilst inoperability is the "*ability to share information and services*"[3].

The global embedded technologies market is growing rapidly and doubled in size from €45 billion in 2004 to €88 billion in 2009 with a 14.0% average annual growth rate (AAGR).[4] Today, embedded technologies are undeniably the fastest growing sector in IT; nevertheless this is still an open field of research with many opportunities: a wide variety of technologies (RFID, ASICS, FPGA, DSP, CPU, MCU microcontrollers, processor IP)[5] used in different activity sectors (consumer's electronics, telecoms, transport, medical, manufacturing, etc.)

---

[1] Artemis Strategic Research Agenda, 2011. http://www.artemis-ia.eu/publications
[2] Mihkel Tagel, System-Level Design of Timing-Sensitive Network-on-Chip Based Dependable Systems, PhD Thesis, Tallinn Univeristy of Technology, 2012. http://digi.lib.ttu.ee/i/?718&&lang=en
[3] http://www.opengroup.org/architecture/togaf9-doc/arch/chap29.html
[4] Cordis, "Embedded Systems: Facts and Figures", http://cordis.europa.eu/ist/embedded/facts_figures.htm, 2009.
[5] VDC, "Embedded processors & Chipsets: Global market demand analysis a multi-client research study", 2008.

Already, 90% of the world's computing devices contain embedded systems, and with current growth rates, the number of embedded programmable components reached 16 billion by the end of 2010 (nearly 3 embedded devices per person on earth) and over 40 billion worldwide by 2020. But as the pervasiveness of embedded devices increases, it creates new challenges in the following topics: emerging technology, interoperability, standardization, methodology, safety, and security.

Medical and industrial/military applications do not represent the largest market segments for revenues. However, from the perspective of *dependable* embedded systems, they are vitally important. The medical sector requires embedded technologies to operate precisely and reliably during patient diagnostic, treatment and monitoring. Also, the many different communication standards used by proprietary medical technologies means that interoperability is an important issue.

With regard to military applications, a recent NATO report identified aeronautic and aerospace as the leading markets for dependable embedded system technologies.[6] Embedded systems - in the form of aviation electronics (avionics) - typically constitute over 50% of the total cost of an aircraft, and therefore a major share of the total value added of modern aircraft. In fact, there are few upcoming applications in aerospace/aeronautics that are not significantly dependent on innovation in embedded systems. The trend is to develop applications that have high precision, full predictability and advanced robustness for 100% operational availability and dependability: electronically controlled unmanned aerial vehicles (UAVs), advanced control systems, on-board/off-board communications systems in commercial aviation, and upcoming command-and control infrastructures for military applications.[7] It is also important to note that embedded technology developments for aeronautic applications can create major impacts in other mass-markets: other transportation (railway, automotive), communication and telecoms, consumer's electronics and manufacturing. For example, the space application GALILEO is helping to bring aerospace research to other applications such as navigation services for air and ground transportation.[8]

In this workshop the participants will get an overview of recent trends and developments in the area of dependable embedded systems and Multi-Processor Systems-on-Chip (MPSoC). It includes novel architectures for on-chip networks, system-level design issues for such complex SoC-s and also dependability challenges.

Professor Gert Jervan

Department of Computer Engineering

Tallinn University of Technology

E-mail: gert.jervan@ati.ttu.ee

WWW: http://www.ati.ttu.ee/~gerje

[6] NATO, "Validation, Verification & Certification of Embedded Systems", 2005.
[7] FAST GmbH, "Study of Worldwide Trends and R&D Programmes in Embedded Systems in View of Maximising the Impact of a Technology Platform in the Area", 2005.
[8] NATO, "Validation, Verification & Certification of Embedded Systems", 2005.