Courtesy Airbus

The challenge of embedded systems

Kostas Glinos

What do a mobile phone, an industrial robot, a cable modem, an MP3 player, and a car have in common? They are all examples of products that use embedded systems. In fact, embedded technologies are one of the fastest growing sectors in IT today. However, increasing pressure to bring innovative products to the market ever faster and at ever diminishing prices means that guaranteeing product quality, while reducing the cost, development time and system complexity, has become a tough challenge.

Europe is considered a world leader in embedded technologies for the aerospace, automotive, industrial, communication and consumer electronics industries. However, this leading position is threatened by global competition, fragmentation and lack of coordination across these industry sectors. Maintaining a leading position in embedded systems technology will require significant – and appropriately targeted – investment in research and development.

To address these issues, the European Commission has facilitated the development of an initiative called ARTEMIS. ARTEMIS is a broad alliance of industrial and research players in the field of embedded system technologies. The ARTEMIS partnership draws upon many industrial sectors, including automotive, aerospace, consumer electronics, communications, medical and manufacturing, where European industry remains strong.

In a space of less than four decades, digital information technology has totally revolutionized the world in which we live. It has evolved from mainframe computers – mainly operated as hosts in computing centers – to the networked desktops and laptops we know today. Our everyday business and home life is deeply affected by this extensive digital infrastructure: from keeping in contact with friends and relatives around the world, to staying in business in a globalized and highly competitive market. Computers have become everyday tools, deeply integrated into all kinds of social and business activities.

More remarkable, however, is the less visible revolution in embedded digital technology. Embedded digital technology is found in all kinds of equipment and systems, and is used to increase functionality, as well as to improve operation at low cost. Indeed, embedded computers are now found in almost all technical devices, from simple everyday home appliances, to facilities and facility management such as heating, air conditioning, elevators and escalators, and in production units from robotics to production automation and control systems. They are also used extensively in medicine, in particular in diagnostic medical equipment, and in the increasing variety of intelligent devices that are implanted into the human body. Transportation is another area that has seen a rapid proliferation of embedded systems, be it cars, trucks, trains or airplanes.

The numbers are staggering: it is estimated that more than 90 percent of all computing devices are to be found in embedded rather than in desktop systems. In terms of market value, for example, the automotive sector alone accounts for about 5 percent of the

ARTEMIS – European joint technology initiative for embedded systems

world semiconductor market (approximately € 200 billion in 2005).

What is even more striking is how embedded systems are increasing the value of many products. For example, embedded systems now account for 20 percent of the total value of an average car and this is expected to increase to 36 percent in 2009. In the same year, embedded electronics and software will constitute 22 percent of the value of industrial automation systems, 41 percent of consumer electronics and 33 percent of medical equipment.

The growth rate is currently exceeding 10 percent per annum in all application sectors, and by 2020, it is predicted that there will be over 40 billion embedded chips worldwide.

Thanks to significant advances in semiconductor technology – which is itself driven by customer demands for innovative products and services, with increasing functionality at ever diminishing prices – embedded systems have evolved from the simple stand-alone, single-processor type computers of the 1980s and early 1990s, to the sophisticated multi-processor systems in use today. The downside, however, is that systems are becoming ever more complex and harder to design, test and verify. As these systems are themselves becoming more interconnected, they are also becoming more vulnerable. True interoperability is hampered by the lack of common open standards and appropriate middleware. While many of the developments are still sector-specific, there are significant synergies between sectors that should be exploited. And engineers with the appropriate skills in, for example, system architecture, are in short supply. These problems must be overcome. For its part, European industry is expected to invest more than € 22 billion per annum in embedded systems research and development by 2009[1]. This is almost double what it invested in 2003.

Because of the above research and industrial challenges, and the importance of embedded systems technology for key industrial sectors (from industrial automation and medical equipment to automotive and avionics), the European Commission has devoted a specific part of its Information Society Technologies (IST) program to embedded systems research. In the last three years alone, it has invested € 140 million in collaborative projects between industry, academia and research centers. These projects focus largely on systems design, safety-critical systems, embedded computing, middleware platforms, wireless sensor networks, and distributed and hybrid control systems. Embedded systems are also one of the six "pillars" of ICT research in the European Commission's proposals for the 7th Framework Programme, due to start in 2007.

In 2004, the Technology Platform ARTEMIS (Advanced Research and Technology for EMbedded Intelligence and Systems) was set up. ARTEMIS is an industry-led initiative to reinforce the EU's position as a leading global player in the design, integration and supply of embedded systems[2]. Its manifesto, entitled "Building ARTEMIS", was signed by 20 executives from various EU companies, and is aimed at establishing and implementing a coherent and integrated European strategy for embedded systems that covers aspects from research and development priorities, and the research infrastructures needed, to the standardization policy as well as the educational curricula. This strategy has been recently published as the ARTEMIS "Strategic Research Agenda".

The driving force behind ARTEMIS is the vision of a society where all systems, machines, and objects have become digital, communicating, self-managed resources. These transformations are possible through advances in embedded systems technologies and their large-scale deployment, not only in industry and services, but in all areas of human activity. Such developments have a range of important consequences for society and the economy:

- Life in our society – and its safety and security – will depend increasingly on embedded systems.
- The competitiveness of European industries, in almost all sectors, will

Music center – courtesy Nokia

A380 cockpit – courtesy Airbus

Footnotes

[1] FAST Study on "Worldwide Trends and R&D Programmes in Embedded Systems in view of maximising the impact of a Technology Platform in the area"

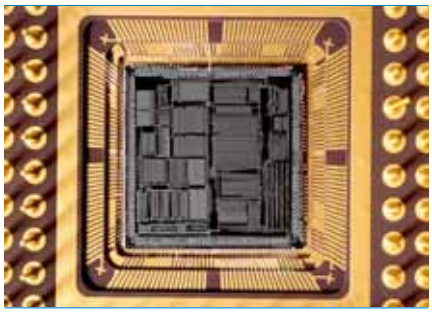
[2] http://www.cordis.lu/ist/artemis/index.html

Embedded system technologies

Concept car – courtesy DaimlerChrysler

Ambient room – courtesy Philips

Embedded components



rely on innovation capabilities in the area of embedded systems.

- Given the dramatically increasing importance of embedded systems to productivity growth, these technologies will be critically important in redressing the present imbalance in productivity growth between Europe, the US and Asia.

Maintaining a leading position in embedded systems technology will require significant investment in research and development that is focused on specific joint priorities. While tackling the R&D challenges is necessary it is not, on its own sufficient. ARTEMIS will facilitate and stimulate European success in embedded systems by establishing an environment supportive of innovation, in which both co-operation and competition in technological development are enhanced. It will also proactively stimulate the emergence of a new supply industry for components, tools and design methodologies, supporting embedded systems, and focus research and development to make more effective use of resources to avoid fragmentation and facilitate deployment.

Industrial robot – courtesy ABB

Embedded digital technology is found in all kinds of equipment and systems, and is used to increase functionality, as well as to improve operation at low cost.

While custom-designed embedded systems add high value for customers, and individual projects and products may be highly profitable, the markets themselves are highly fragmented. Traditionally, this has led to the fragmentation of both the supply industry and R&D investment. The ARTEMIS strategy was conceived to overcome this fragmentation so as to increase the efficiency of technological development and, at the same time, facilitate the establishment of a competitive market in the supply of technologies.

Kostas Glinos

Kostas Glinos has been with the European Commission since 1992. He now leads the Embedded Systems unit of the IST Program. Before joining the Commission he worked with multinational companies and research institutes in the US, Greece and Belgium. He holds a Ph.D. in chemical engineering and a Masters' in financial management.

The conception, design and deployment of customized systems will add even greater value to most products and services in the future Information Society. Over the last few decades, Europe has been strong in this area, most notably with successes in mobile phones, bespoke systems for transport and aerospace, and industrial engineering. ARTEMIS aims to derive maximum benefit from Europe's strengths, while being cognizant of the strengths of global competitors. The ARTEMIS approach will remove barriers between application sectors, thus stimulating creativity and yielding multi-domain reusable results.

I strongly believe that by creating an environment that favors and supports innovation in embedded systems and by focusing our research and development resources to achieve common and ambitious objectives, we will not only maximize our impact in terms of industrial competitiveness, but we will also improve the quality of life, safety and security of people. Success in this endeavor can be achieved only if all parties – public or private, industrial or academic – work closely together and remain committed to their common objectives. Rapid progress in this direction over the past year makes me confident that this will indeed be the case and that this collective effort will be successful.

Kostas Glinos
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The views expressed are those of the author and do not necessarily represent the official view of the European Commission on the subject.