

PROJECT RESULTS

CA505

Towards the better management of power production, consumption and dissipation in smart mobile devices [BENEFIC]

Energy inefficiency and poor power management are obstacles in the way of smart mobile-devices: their potential growth and success in many sectors of society. Responding to this problem, the BENEFIC (or Best ENergy Efficiency solutions for heterogeneous multicore Communicating systems) project deploys a holistic approach in developing new ways to improve energy efficiency.

A new category of smart mobile-devices is invading our daily lives. They are always connected, and contain multicores which work at higher frequencies and under low, tightly controlled power-consumption constraints. Simple analysis shows that a maximum sustainable power-dissipation of 4W for a smartphone, and close to 15W for display devices which are larger than seven inches in size. A lot has already been done to improve power efficiency, but much more is needed to address these and other important energy-related challenges.

The total approach to power management

Important breakthroughs can only be achieved if the total energy chain in a system is addressed. Therefore, the main objective of the BENEFIC project is to provide a holistic approach to integrating new sources of energy-harvesting (the process by which energy is derived from external sources, like solar, thermal and kinetic) and innovative approaches of distributing energy closer to places where it is deployed. These new methods will allow for better prediction and management strategies for power consumption through the insight combination of elementary techniques from lower physical layers to middleware optimization targeting to improve the Performance/Power ratio by a factor 5 at application level.

The BENEFIC project is organised around five applications domains, for which ten physical hardware demonstrators were built to test and validate energy-related improvements that were developed. The following describes developments in each of the five domains:

1. Professional communication

- Improved low-power ARC processor: subsystem for low-power application for software-defined radio (SDR) in which measurements and power estimations are based on realistic applications, and not just synthetic benchmarks. This demonstrator succeeded to improve the Performance/Power ratio by a factor x6.25;
- Energy Neutral Operation (ENO) platform: main objective is to reach ENO for the wake up system supplied by harvesting. This demonstrator succeeded to improve the Performance/Power ratio by a factor x4 to a factor x7.5 depending on use case conditions.

2. Connected objects and cars

- Connect objects in cars: Variability-aware design techniques to improve reliability and yield of next-generation SDR platforms;
- Improved low-power hardware building block for entertainment: a system-on-a-chip (SoC) was developed and succeeded to improve the Performance/Power ratio by a factor x5;
- 13MPIX Sensor with digital CDS readout: to improve frame ratio in order to reduce power consumption and die area for advanced imaging technology. The demonstrator succeeded to highlight the improvement of the Performance/Power ratio by a factor x5.

3. Health care

Energy-efficient platform for health monitoring applications: integrated platform for efficient processing of biomedical signals, and addressing technological challenges, such as excessive process variability, energy transfer and power management. This demonstrator succeeded to improve the Performance/Power ratio by a factor x4.

4. Space

Reliable multi-core digital signal processor (DSP) architecture: showed the impact of reliability/fault-tolerance mechanisms in relation to power and scalability. This demonstrator succeeded to improve the Performance/Power ratio by a factor x8.

5. Advanced energy efficiency

- Ultra-wide voltage range DSP in fully depleted silicon on insulator (FDSOI) process technology: delivers benefits of reduced silicon geometries for high-energy efficiency. Those techniques succeeded to improve the Performance/Power ratio by a factor x2 to x40 depending on use case conditions;
- Low-power radio frequency front-end component: tunable wide-frequency range bandpass filter from GSM to LTE mobile network technologies. This demonstrator succeeded to improve the Performance/Power ratio by a factor x5.

PROJECT CONTRIBUTES TO

- ✓ Communication
- ✓ Automotive and transport
- ✓ Health and aging society
- ✓ Energy efficiency
- ✓ Digital lifestyle
- ✓ Design technology
- ✓ Process development

PARTNERS

STM-Gnb
 STM-Alps
 STM-Crolles
 Ericsson
 NXP
 Atrenta
 Thales - TCS
 Thales - TRT
 Synopsys
 RECORE
 Beyond Vision
 TUD
 TUE
 LEAT
 CEA LIST
 CEA LETI
 TIMA
 IPCB
 IT-PT
 IMEC

COUNTRIES INVOLVED

-  France
-  Netherlands
-  Portugal

PROJECT LEADER

Armand Castillejo
 STMicroelectronics

KEY PROJECT DATES

1 January 2013 - 30 June 2016

- Energy-efficient heterogeneous many-cores for smart camera: the demonstrator succeeded to improve the Performance/Power ratio by a factor x2 to x25 depending on use case conditions;

BENEFIC was a success, based on the technical achievements reached – and even exceeded – by the eight demonstrators. Importantly, there were clear links between the elementary technical bricks used in these demonstrators and the application domains where these technologies were demonstrated, illustrating the benefits of BENEFIC's holistic approach.

The project was also successful in terms of intellectual property (IP) and scientific output, adding value by generating seven patents; 45 scientific publications and posters; and being runner-up for the IET Innovation Awards.

Market share and well-developed, disseminated research

In concrete terms, the project generated significant added-value to the project partners by creating the first and only European DSP intellectual property (IP) in space; and providing various technologies that will give participants a competitive edge in the image sensor market, estimated at 6 billion units in 2018.

The industrial project partners are aiming to increase their footprint in their markets, as well as win market share with innovative and robust products. To achieve all of this, the contribution by BENEFIC's academic partners was essential in the research and development of new technologies, which, in turn, helps these participants fulfil their primary mission: to develop and disseminate knowledge needed to keep European R&D at the cutting-edge.

Benefits to sales and ecology

Thanks to BENEFIC, benefits from energy collection and distribution will be, in general, integrated and these innovations transferred to other energy-constrained domains, where growth of smart mobile-devices will be directly or indirectly affected. This means that BENEFIC's technological advancements in energy will also give other European suppliers a competitive advantage. The market for ground and satellite radios, for example, is estimated at US\$1,582m in 2018;

and the biggest growth is expected between 2012 and 2015 with the introduction of new SDR systems on the market. The professional radio market is estimated at US\$9 billion a year, and equipment volume estimated between 22m-40m units worldwide.

Then there is the Internet of Things (IoT), with increasing opportunities for new mobile devices. A significant increase in connections is envisaged, reaching 350m by 2016. Importantly, delivering digital content with the right user-experience across different devices (digital convergence) is already visible; and large-scale adoption will be possible, thanks to the longer battery life these devices need.

BENEFIC developments also address the many-core market, especially in the space domain, where many actors are developing new applications. Market-size estimates for space-oriented many-cores will exceed €100m in 2016 and could reach up to €800m in 2020. With satellite systems enabled for space use through BENEFIC techniques, this market could be worth €1 billion by 2020.

BENEFIC also impacts advanced R&D in energy efficiency, leading to innovation needed to create the next technological breakthrough, and ensure competitive advantage and market opportunities. BENEFIC's advances should help industry focus on high-level systems and tools; architectural innovations and design; and efficient technological devices at process level.

BENEFIC will play an important role in helping healthcare move from today's hospital-centric approach, to a more patient-centric one, enabling ubiquitous and pervasive health monitoring. Costs will also be significantly reduced and well-being improved once patients are treated in their own environment. The total size of the medical-devices market in 2011 was estimated to be US\$309 billion. And growth will continue to be driven by a global ageing population and the expected increase in the incidence of chronic diseases, particularly in developing countries.

Finally, there is also an environmental spin-off from this project. Energy harvesting creates green energy, thus reducing the use of carbon-based energy (with its environmental hazards). The distribution part of the system must be built to gather the harvested energy when available. This requires the integration of harvesting in the whole process of storing, managing and distributing power.

