

NANOTECHNOLOGIES FOR FUTURE MOBILE DEVICES

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Nanotechnologies for Future Mobile Devices

Learn how nanotechnologies, mobile communication, and the Internet are related to each other, and explore the potential for nanotechnologies to transform future mobile and Internet communications and the value networks of future electronics manufacturing. Based on a research collaboration between Nokia, Helsinki University of Technology, and the University of Cambridge, here leading researchers and business analysts review the current state-of-the-art and future prospects for:

- Structural materials in mobile devices, including novel multifunctional materials, dirt-repellent, self-healing surface materials, and lightweight structural materials capable of adapting their shape.
- Portable energy storage using supercapacitor-battery hybrids based on new materials including carbon nanohorns and porous electrodes, fuel cell technologies, energy harvesting, and more efficient solar cells.
- Electronics and computing advances reaching beyond IC scaling limits, new computing approaches and architectures, embedded intelligence, and future memory technologies.
- Nanoscale transducers for mechanical, optical, and chemical sensing, nature's way of sensing and actuation, biomimetics in sensor signal processing, and nanoscale actuation.
- Nanoelectronics, for example based on graphene, to create ultrafast and adaptive electronics for future radio technologies, such as cognitive radio.
- Flat panel displays – how nanotechnologies can be used to achieve greater robustness, improved resolution, brightness and contrast, as well as mechanical flexibility.
- Open innovation in nanotechnology development, future manufacturing, and value networks.
- Commercialization of nanotechnologies.

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3 Energy and power

M. Rouvala, G. A. J. Amaratunga, D. Wei, and A. Colli

3.1 Energy needs of future mobile devices

3.1.1 Renewable energy – portable energy sources

The increasing need for portable energy storage density due to the growing number of miniaturized and thin devices is driving the current development of energy storage in phones and other portable devices [1]. Figure 3.1 shows the development from the mobile phones of the 1990s to the multimedia centers of two decades later, and the evident development of the devices to thinner and more flexible forms.

The total power consumption will become even more important when more electronic devices are embedded in the environment. Also with standalone devices designed to operate without mains power supply for long periods, like years, there are new requirements. Energy storage and power management are among the top three issues for customers and developers in current and future mobile multimedia portable devices.

Improvements in conventional battery at the current yearly level are not expected to provide enough energy density to meet all the requirements of future multimedia portables. Even though the use of cellular radio frequency (RF) engine power is expected to reduce with integrated circuit (IC) process and intelligent circuit development, the increasing number of radios and integration of new digital radio, video, and multimedia broadcasting (DAB, DVB-H, DMB) and channel decoders represents a significant challenge both in terms of energy consumption and component costs. Adding wireless local area network (WLAN) and local radio capabilities increases the overall power consumption of smartphones that are already suffering from high energy drain due to the high power consumption of 2.5G/3G wireless modules. Lower power dissipation will be needed in all technologies, through wafer fabrication, software, displays, embedded processors, and interconnects. In the longer term lower energy usage patterns will have some effect.

Energy density and power density mark two different perspectives in mobile energy. Energy is needed for long phone calls, ever increasing internet uploads with mobile radio technologies, and generally for the long stand-by times required by users. High-power sources on the other hand are needed to source fast bursts of current used by multimedia

5 Sensing, actuation, and interaction

P. Andrew, M. J. A. Bailey, T. Ryhänen, and D. Wei

5.1 Introduction

5.1.1 Ubiquitous sensing, actuation, and interaction

The London of 2020, as described in Chapter 1, will have conserved most of its old character but it will also have become a mixed reality built upon the connections between the ubiquitous Internet and the physical world. These connections will be made by a variety of different intelligent embedded devices. Networks of distributed sensors and actuators together with their computing and communication capabilities will have spread throughout the infrastructures of cities and to various smaller objects in the everyday environment. Mobile devices will connect their users to this local sensory information and these smart environments. In this context, the mobile device will be a gateway connecting the local physical environment of its user to the specific digital services of interest, creating an experience of mixed virtual and physical realities. (See also Figure 1.1.)

Human interaction with this mixed reality will be based on various devices that make the immediate environment sensitive and responsive to the person in contact with it. Intelligence will become distributed across this heterogeneous network of devices that vary from passive radio frequency identification (RFID) tags to powerful computers and mobile devices. In addition, this device network will be capable of sharing information that is both measured by and stored in it, and of processing and evaluating the information on various levels. The networks of the future will be cognitive systems that consist of processes capable of: (1) perception of the physical world, through various sensory processes, (2) cognitive processing of information, which can be subdivided into attention, categorization, memory, and learning, and finally (3) action, i.e., the ability to influence the physical world. These systems will have different levels of complexity, varying from simple control loops to extremely complex and nonlinear systems. To achieve this vision we cannot limit ourselves solely to classical control systems, i.e., sensors, microcontrollers, and actuators. Data collection and feedback will have to become much more complex dynamical processes as has been discussed elsewhere, e.g., in the context of sensor networks [1, 2].