Complexity Challenges towards 4th Generation Communication Solutions

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Abstract

The market for cellular phones is with more than 1 billion units one of the most exciting and at the same time technically challenging markets for embedded systems. As it develops from a strongly technology and network centric into a consumer centric environment some of the existing paradigms for the design of the respective embedded systems need to be revisited. Examples are the split between hardware and software, the partitioning between RF, mixed signal and digital architectures and devices. There are some already visible changes in the consumer behaviour that drive such changes like the so-called "Web 2.0", new types of content or new business models like flat rate tariffs.

The evolution of communication technologies towards 4th generation mobile devices result in a strong increase of data rates, convergence of services in fixed and mobile communication networks and the increased expectation of service quality and service continuity. While convergence, not only of data and voice, fixed and mobile but also of device types (multimedia, music, internet etc.) is a general trend that can be observed and that lends to ever higher levels of integration into the embedded system, there is also a need for device manufacturers and OEMs to differentiate and a trend for fragmentation in the market where ultra low cost mass market devices, fashion consumer devices with some dedicated feature themes and high end fully integrated devices co-exist.

The challenges that arise from this environment for the embedded system architect are on the one side rooted in the complexity of technologies and features employed in future products but also in the nature of embedded systems, namely strong cost, resource and power constraints. One of the consequences of the increasing complexity of subsystems to be integrated into the overall product is the verification complexity, because the combination of even pre-integrated subsystems generates dependencies on embedded architectures that require tremendous efforts at late stages of the development process. A further aspect that drives future system architecture decision is the span of possible and required innovation cycles in different areas of a mobile consumer device. This may lead to different, sometimes segment specific partitioning decisions.

Progress of basic technologies like semiconductor manufacturing processes, package technologies but also SW technologies, however, also allow for new opportunities to master these challenges. One example are new CMOS radio frequency architectures that allow to effectively integrate digital signal processing and RF circuit technology and so can result in a partitioning between RF and baseband with an interface in between that abstracts from hard RF processing and timing aspects and thus shields the RF engine and takes complexity away from the baseband development. More generally a unification of subsystem interfaces and definition of suitable abstractions across product families can lead to significantly reduced verification efforts. To decouple the development and innovation processes of the hardware, system and end-product design higher use of software instead of dedicated hardware are used, which in turn require suitable SW architecture and development concepts.

One of the major architectural approaches both in the user application and the modem systems can be multiprocessor architectures. For these effective programming and SW verification and maintenance solutions that hold up to a competitive industry environment will be required. Amongst other research challenges we see the effective modelling (and verification) of heterogeneous embedded systems a very important one. This should give early feedback about essential criteria like cost and power and allows for a predictable integration of legacy (or COTS) system components.

Categories and Subject Descriptors

B.7.1Hardware, INTEGRATED CIRCUITS, Types and Design Styles, Algorithms implemented in hardware; VLSI (very large scale integration)

General Term

Design.

Keywords

4G, RF CMOS.

CODES+ISSS'07, September 30–October 3, 2007, Salzburg, Austria.
ACM 978-1-59593-824-4/07/0009.