VLSI in Mobile Communications

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Abstract

In recent years, the demand for mobile operation of all types of electronic systems has become significant. It seems that by merely providing the same functionality of a desktop system in a mobile unit, a significant market advantage can be obtained for virtually any electronic function. Consumer electronics companies have been highly successful by creating portable televisions, video tape recorders and compact disk players, as well as, cordless phones —with limited mobile access for voice communications — and cellular phones for virtually unlimited access. Simultaneously, laptops, notebooks and palmtops are becoming the fastest growing types of computer products. In the future, a number of portable products will emerge to satisfy consumer demands for mobile communications of voice, computer data and video with much higher capacity, quality and bandwidth than is currently available. This paper examines the system design, integrated circuits and node architectures that will be needed to enable such products. Common design principles for achieving low-power and high performance will be presented.

Communications and Networking System Requirements: Mobile communication devices will be required that can operate in a number of different scenarios ranging from information access (e.g. news, movies, stock quotes) to multimedia networking (e.g. mobile video conferencing). Access units such as the Berkeley Infopad, support low-power wireless communication of video, speech or computer data between a wired infrastructure and a hand-held subscriber unit. Adaptive wireless terminals such as the UCLA PC-laptop node support multimedia communications while providing local computing resources to allow peer-to-peer mobile networking in the absence of an infrastructure. The different requirements result in the need for different types of wireless network protocols as well as different types of communications, signal processing and network control circuits.

Multimedia Signal Processing Circuits: A key requirement for multimedia mobile communication is video compression, due to the limited bandwidth in a wireless environment. In information access systems, very low-power decoders can be achieved by using asymmetric techniques such as vector quantization (VQ). For peer-to-peer wireless video conferencing, discrete wavelet transforms (DWT) can provide a low power compression and decompression scheme that also allows quality-of-service versus bandwidth trade-offs. Circuits to support both VQ and DWT video coding will be presented.

Digital Modem Circuits: To support adaptive features in a multimedia mobile communications environment, digital modems are required where the data rate and noise immunity can be programmed dynamically to adapt to varying channel conditions, available bandwidth and traffic demands. Spread-spectrum based CDMA modems can naturally support this adaptivity by changing codes and processing gain. Architectures and circuits are described for direct-sequence spread-spectrum transceivers that can achieve low power using voltage scaling and direct conversion to simplify the receiver, and robustness through coherent demodulation and pulse shaping.

Node Architecture: Conventional techniques for integrating multimedia processing, wireless modems and laptops rely on shared-bus oriented architectures that cause data throughput losses due to time spent in moving the data between the host CPU, system memory, video processor and the modem. To achieve low power and high throughput, new architectures are being developed that use network control processors to route the multimedia data within the node using localized buses. Such processors also save CPU power by executing the lower level protocols for the mobile communications system.

Biographies:

Rajeev Jain received his B.Tech from IIT Delhi and Ph.D. from Katholieke Universiteit Leuven. He has been a Design Engineer at Siemens AG, a Research Manager at IMEC, and has been on the EE faculty at UCLA since 1988. His research interests are in the circuit and architecture design for multimedia wireless nodes.

Robert Brodersen received the B.S. in E.E.and Mathematics from the California State Polytechnic University and the M.S. and Ph.D. in E.E. from M.I.T. From 1972-1976 he was with the Central Research Laboratory at Texas Instruments. Since 1976, he has been on the EECS faculty of the University of California at Berkeley, where he is now a professor. His research interests are in applications of integrated circuits, and are currently focused on the areas of low-power design and wireless communications, as well as associated CAD tools.

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