Preface

This double issue of the *IBM Journal of Research and Development* focuses on the communication technologies in IBM that are contributing to the increasingly rapid and efficient movement of data. The issue contains fourteen papers on relevant work on semiconductor processes, models, and innovative architectures, as well as circuit design and testing efforts. Its cover is a composition of various aspects of that work. A broad array of important applications are covered in the fields of wired and wireless communications, including switches, network processors, wireless LANs (local area networks), cellular radios, and optical data transceivers.

The papers are organized into four groups. The first pertains to the core technology and associated design enablement: The SiGe bipolar chip technology is increasingly becoming the technology of choice for high-frequency or radio frequency analog front ends, rapidly displacing GaAs- and InP-based chips. Many of the industry's advances in SiGe were made by IBM, and it is fitting that the two papers in this group describe the technology and how it is used. Dunn et al. describe the SiGe transistor and its properties, as well as the key passive structures, including resistors, inductors, and varactors, which make it a "technology" for communications. In addition, they review the issues related to creating a full BiCMOS SiGe technology, as well as the opportunities offered by using CMOS transistors together with the passive devices, thereby creating what is known in the industry as an "rf CMOS" technology. The paper by Harame et al. describes how the technologies were made useful to circuit designers through extensive modeling and design automation methods.

An important comment should be made here for the reader. The CMOS technology is and continues to be the true workhorse technology for communications. This is especially true in many of the digitally intensive communications functions such as switches, network processors, digital signal processors, and baseband circuits. Indeed, the technology has even captured many of the analog and rf functions that were previously the domain of III–V compound semiconductors as well as SiGe. Advances in CMOS technology have been well covered and documented both in this journal and in the scientific literature and are not repeated here.

The second group of papers covers networking infrastructure. The network processor provides the intelligence and processing power to process data packets. The run-to-completion-based IBM PowerNP™ network processor is described in the paper by Allen et al. The authors articulate how the PowerNP offers advantages over former-generation network products based on general-purpose processors or ASICs (application-specific integrated circuits). In the next paper, Engbersen describes a decade of evolution of the Prizma switch fabric architecture from an output-buffered switch with backpressure to a robust switch for Internet traffic using a balanced combination of input queueing and output buffering. In the last paper in this group, Clauberg discusses the framing architectures, which support the aggregation of SDH/SONET (synchronous digital hierarchy/synchronous optical network) data packets from several line ports.

The third group pertains to physical layer design. Once data is appropriately framed, it is placed on some type of physical medium—either wired (cable or optical) or wireless (a carrier of specific frequency band). The paper by Pepeljugoski and Kuchta addresses the design of multimode optical data links through the use of an extensive simulation tool for modeling the salient parameters of devices and fibers in Fibre Channel-, Ethernet-, and ATM-based links. In the next paper, Bona et al. describe a means to fabricate planar optical waveguide circuits containing waveguides based on the use of a SiON core and SiO_2 cladding layers. By exploiting the thermo-optical effect, the authors show how practical optical functions can be realized, including a gain-flattening filter and adaptive dispersion compensator. In their paper, Trewhella et al. describe the design and testing of the plastic optical subassemblies used in modern-day Gigabit Ethernet and Fibre Channel links.

The final group of papers covers both wired and wireless physical link implementations. Friedman et al. discuss how the SiGe technology can be used to address the performance requirements of numerous data communication standards, including Ethernet and SONET. The paper by Kosonocky et al. complements the previous paper by addressing the challenge faced by designers of battery-operated devices—i.e., the need for low-V_t transistors which allow voltage scaling for active power but consume ever-increasing amounts of power in the off state through leakage currents. Moreno et al. describe a low-power, high-performance programmable signal processor which takes advantage of these circuit techniques, along with a design methodology, architecture, and compiler to create a low-power-domain-specific microprocessor.

The wireless data communication landscape is rapidly evolving. Already, system engineers are defining not only third-generation networks but also fourth-generation networks. In their paper, Chevillat and Schott examine the underlying technologies driving this wireless revolution. Reynolds et al. then describe a direct-conversion receiver integrated circuit for WCDMA (wideband code-division multiple access) mobile systems, designed, simulated, and fabricated in the IBM SiGe technology, which meets aggressive handset power requirements and meets the specifications of the ITU (International Telecommunication Union) third-generation WCDMA standard. Finally,

Liu et al. describe the methodology and rigor required to design an integrated antenna for the ThinkPad® laptop computer. The antenna not only supports the IEEE 802.11b wireless LAN standard but also conforms to requirements imposed by industrial design constraints.

In summary, this issue of the *IBM Journal of Research and Development* covers many of the rapid advances in communication technologies that we have experienced over the past several years. Looking forward, we expect the rapid pace of innovation to continue. For example, soon after the papers for this issue were submitted, Si-based divider circuits were fabricated that could function at 100 GHz, fiber optic transceivers broke the 100-Gb/s barrier (12 channels × 10.3 Gb/s per channel), and IBM announced the ThinkPad® R40, capable of supporting both the IEEE 802.11a and b wireless LAN standards.

Modest M. Oprysko
Department Group Manager
Communication Technologies
IBM Thomas J. Watson Research Center
Yorktown Heights, New York

Guest Editor