Advances in Memory Technology

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ABSTRACT

The continuous growth of the memory market, whose early beginnings in the 70's and 80's were marked by PC and server DRAMs, has experienced a new boost since the beginning of the 21st century due to the emergence of digital consumer & mobile markets such as cellular phone, DSC, and MP3. The join of the nonvolatile and low-power Flash memory has led to a further explosive growth. Ever increasing density and decreasing costs have evoked a tremendous rise in consumer demand.

Innovations in memory technology are reflected in the continuous advance in high density, high speed and low power technologies, in the course of which the design rule has shown a transition from micrometer to nanometer scale. Additionally, the development of new materials has given birth to new high-performance nonvolatile memory types (PRAM, RRAM, MRAM, FRAM, etc.), which open even more opportunities for growth of the semiconductor market.

The steep increase in technology of today's memories shows itself in the capacity and speed of storing information of everybody's use: a $1cm^2$ memory chip can store 10Gbit information now, which corresponds to either 80K pages of newspaper, 20 hours of music or 2.5 movie hours. Today's DRAM shows a random access time of 25-50ns and I/O bandwidth of 3-4GHz. Technical innovations will continue to drive the increase of memory density and speed in the future. Higher storage density is expected to be achieved by breakthroughs such as 3D memory stacking technology (cell/chip/package), the use of 3-dimensional transistors or the shrinkage of memory storage nodes to the atomic scale. Memory system performance will possibly be enhanced by the fusion of conventional commodity memories and new memories: several memories like Flash, SRAM, DRAM, new memories will be merged together with logic and software. Thus we expect that semiconductor products will show a larger variety of high performance systems with much higher robustness and persistence.

In the 21st century, which has just begun, memory technology will combine with various other fields (IT, BT, NT) and thus open new markets such as massive data & information processing, bio & health care, and humanoid & aerospace. It will contribute to a world with more comfort and stability, where everywhere and anytime people can exchange and share their thoughts, sensations and emotions.

VLDB '06, September 12–15, 2006, Seoul, Korea.

Biography

Changhyun Kim is Samsung fellow and VP of advanced technology development team at Samsung Electronics semiconductor division in Hwasung, Gyeonggi-Do, Korea. He received the B.S. and M.S. degrees in electronics engineering from Seoul National University, Seoul, Korea, in 1982 and 1984, respectively, and the Ph.D. degree in electrical engineering from the University of Michigan, Ann Arbor in 1994.

In 1984, he joined Samsung Electronics Co., Ltd., where he has been involved in circuit design for high-speed dynamic RAM's, ranging from 64Kb to 16Mb in size. From 1989 to 1995, he was a research assistant and research faculty member of the Center for Integrated Sensors and Circuits, University of Michigan.

In 1995, he rejoined Samsung Electronics and worked for Gigabit DRAM and high speed devices, such as RDRAM & DDR2. His present research interests are in the area of circuit design for low-voltage and high-performance Giga-scale DRAM's and future high performance memory architectures (DDR3, XDR, NMT), ranging from 1 GHz to 8 GHz in speed.

He received the Grand Prize from the Samsung group for the successful development of 1Mb and 1Gb DRAM's in 1986 and 1996, respectively. He also received several technical achievement awards from R&D center of Samsung for his work on the development of high speed devices and the characterization of sub-micron devices and reliability issues in high-density DRAM's, including reducing soft-error rates and reducing sensitivity to electrostatic discharge problems. He received the first prize for design excellence in student VLSI design contests at the Center for Integrated Sensors and Circuits in 1991 and 1993, sponsored by several U.S. companies. He is a senior member of IEEE and serves as a committee member of the Symposium on VLSI Circuits.