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Special Reports

System LSIs Creating a Digitally Converging World

System LSI Technologies Sustaining Our Digitized Information Society
FUJITA Yasuhiko

Trends in System LSI Technologies and Future Outlook
ITO Kenji / FUJITA Yasuhiko
System large-scale integrations (LSIs) have been playing an important role in the advancement of digital devices that make people□s lives more comfortable and convenient such as large flat-panel TVs and cellular phones with various functions. However, the system LSIs supporting this progress are facing a number of problems, including longer development periods and increased power dissipation due to the larger size of LSIs, and demands for cost reduction due to competition in the global market.
Toshiba has been developing system LSIs focusing on three application fields: home, mobile, and automotive. We have been dealing with the above-mentioned problems utilizing our comprehensive technical capabilities and taking advantage of our strengths as an integrated device manufacturer (IDM).

Third-Generation SoC for Digital Television
TASAKA Naoyasu / NAKATANI Takashi / OTODA Toshihiro
In recent years, digital television (DTV) has shifted to flat-panel display TV, and technical innovations of DTV have been progressing toward both higher performance and advanced features on the one hand, and basic features at a lower price on the other.
In response to these circumstances, Toshiba has developed a third-generation system on a chip (SoC) for DTV and in production for TV set manufacturers around the world. In order to shorten the development period and reduce the development cost of the third-generation SoC, we developed a simulator that can debug and test firmware (FW) efficiently before getting sample devices. In addition, we have developed a DTV reference system and started to provide it to TV set manufacturers as a software development tool that can easily evaluate DTV system and shorten the development period of TV sets.

Multimedia SoC for Mobile Applications
TAKAHASHI Masafumi / NOMURA Shuo
In order to realize handheld devices such as cellular phones with high performance and functionality, Toshiba has been developing the T-series mobile multimedia system on chips (SoCs).
The TC35295AXBG (development code: T5GP) SoC, based on our proprietary reduced instruction set computer (RISC) processor technology,can handle the functions of 3D graphics processing, audiovisual recording/playback, and still picture processing. Moreover, we have developed a next-generation multimedia core with a scalable microprocessor to satisfy various processing demands and respond to a wide variety of performance and functionality requirements in future mobile applications. This multimedia core realizes a low power consumption of 9.7 mW in audio decoding, and offers video recording/playback functions of high-definition (HD) quality.

SpursEngineSE1000 High-Performance Stream Processor
HIWADA Kazuhiro / KONDOH Nobuhiro
Toshiba has developed SpursEngineSE1000, a third processor operating in cooperation with a central processor unit (CPU) and a graphics processing unit (GPU), which utilizes multiple synergistic processor element (SPE) cores derived from the Cell Broadband Engine™. SpursEngineSE1000 has been designed to achieve a good power-performance ratio, especially in the area of streaming-media processing. Utilizing the advanced image-processing performance of SpursEngineSE1000, we have also developed□FACEMATION□, an image manipulation program that realizes high-performance real-time 3D face tracking on a consumer PC in conjunction with SpursEngineSE1000.

Dynastron™ CMOS Image Sensor and Camera Module Technologies
EGAWA Yoshitaka / IIZUKA Tomoaki
The annual global market for cellular phones exceeded 1.1 billion sets in 2007, and the picture-taking function is now becoming the norm with the cellular phone camera mounting rate having now surpassed 60%. This has given rise to an increasing need for diversification and enhanced performanceof camera technologies together with demand for small and low-cost camera phones.
To meet these requirements, Toshiba has been developing and commercializing various complementary metal-oxide semiconductor (CMOS) image sensors Dynastron™ utilizing a system on chip equipped with signal processing circuits.
Differentiation of camera modules has been achieved by our development of original image-sensor technologies, such as wide dynamic range (WDR) technology, white red-green-blue (RGB) color filter technology,and chip-scale camera module (CSCM) technology in which reflow mounting is possible.

Bluetooth™ Transceiver LSI Employing RF CMOS Technology
AGAWA Kenichi / KOIZUMI Masayuki / MAJIMA Hideaki
As wireless communication devices incorporate an increasing range of functions, the design of wireless communication LSIs using scaled complementary metal-oxide semiconductor (CMOS) technologies is now attracting considerable attention.
Utilizing a radio frequency (RF) CMOS technology, Toshiba has developed a 2.4 GHz transceiver LSI supporting Bluetooth™ V2.1 + enhanced data rate (EDR), which has achieved the world□s highest level of sensitivity. Furthermore, by applying the temperature compensation technique, which was reported at the Custom Integrated Circuits Conference (CICC) 2007, the high sensitivity of the LSI can be maintained over a wide temperature range between -40 and +90°C. Fabrication in a scaled 0.13 μm CMOS technology and operation at a low supply voltage of 1.5 V result in low cost and low power consumption. We are now planning to integrate the LSI into a single chip with larger scale digital intellectual property (IP) in the near future.

SDconnect Digital Rights Management System Technology Using SD Memory Card
NAKANO Kazunori / MATSUKAWA Shinichi / KASAHARA Akihiro
To prevent illegal copying of digital contents such as music, videos, maps, and books, content protection technologies to bind content to a specific medium have been used. In such systems, however, content distribution or handling of content in a personal environment has been restricted.
Toshiba has developed SDconnect, a technology that utilizes SD Memory Cards. It enables contents to be stored in any medium, with only the content keys being stored in a specific medium. This accommodates flexibility of content backup and move functions, and allows separate distribution of contents and content keys, improving convenience for both content distributors and users.

H.264 Decoder LSI Development Utilizing C-based High Level Design Flow
MIZUNO Atsushi / SUZUKI Kojiro / HORIKAWA Kazunari
The circuit scale and complexity of system on chips (SoCs) are increasing every year, giving rise to the problems of longer development periodsand more frequent redesign due to insufficient verification. Moreover, development periods for software are also becoming significantly longer. It is therefore necessary to improve both hardware and software design methodologies.
In response to this situation, Toshiba is engaged in the R-CUBE project aimed at improving the efficiency of development of large-scale SoCs. The key technology of R-CUBE is a system-level design methodology utilizing HW models written in C-based language with high-abstraction-level algorithms. The design flow of R-CUBE has been applied to the development of the TC90490XBG, an H.264 decoder large-scale integration (LSI), which is the first case in which the entire design flow of R-CUBE has been applied. This approach makes it possible to reuse the design data in each design stage, and significantly improves the efficiency of development of SoCs.

Advanced CMOS Device Technologies beyond Conventional Scaling Limit
MIYASHITA Katsura / NAKAYAMA Takeo / MATSUOKA Fumitomo
Conventional complementary metal-oxide semiconductor (CMOS) logic large-scale integrations (LSIs) have simultaneously achieved higher performance, lower power dissipation, and lower cost by sustaining the scaling of the CMOS. However, the achievement of these enhancements by CMOS scaling rules is becoming difficult in devices of the latest generation. To improve performance in the latest 45 nm technology node, the development of new technologies other than conventional scaling has begun.
For 32 nm technology node and beyond, Toshiba has developed dopant-segregated Schottky (DSS) source/drain (S/D) n-type field-effect transistors (nFETs) and embedded silicon germanium S/D p-type FETs (pFET) on Si (110) surfaces ((100) eSiGe pFETs), and confirmed the effectiveness of these technologies. The newly developed technologies are applicable to both low-power system LSIs and high-performance system LSIs.

Feature Articles

Dynamically Reconfigurable LSI for Media Application
YOSHIKAWA Takashi / YAMADA Yutaka / ASANO Shigehiro
The cost of developing large-scale integrations (LSIs) has been rising year by year with their increasing miniaturization and complexity of functions. At the same time, the frequency of LSI development has been increasing for media applications such as audio and video processing due to the diversification of digital devices and rapid progress of media processing. The realization of programmable LSIs is expected to reduce the cost by reducing the frequency of development or shortening the development period. However, the conventional products have had critical issues such as large area and high power dissipation.
With this as a background, Toshiba has developed a high-performance programmable LSI specifically for media processing that achieves a small area and low power dissipation by utilizing dynamic reconfiguration technology for the programmability of media applications. The use of this dynamically reconfigurable LSI makes it possible to implement software development for media processing instead of new LSI development, thereby reducing LSI development costs.

5 GHz Solid-State Weather Radar Contributing to Efficient Use of Radio Wave Resources
WADA Masakazu / MUTO Ryuichi / HORIKOMI Junichi
To prevent disasters caused by local heavy rainfall, speedy observation of rainfall over a wide area is becoming essential for weather forecasts. However, due to the limited availability of bandwidth with the rapidly increasing use of radio wave frequency resources, weather radar must make more effective use of the narrow bandwidth of radio frequencies available for radar systems.
Toshiba has developed a 5 GHz solid-state weather radar in which efficient use of radio frequencies has been achieved by adopting our state-of-the-art microwave transistor and advanced signal processing technology without degrading the conventional level of observation capability. The new radar allows the frequency separation required for interference suppression to be reduced to one-quarter, contributing to the efficient use of limited radio wave resources and meeting our goal of maximizing the eco-efficiency of products and systems.

Solid-State Drive Using Multilevel-Cell NAND Flash Memory for Smaller,Lighter Weight, and Highly Durable Mobile Notebook PC
TSUKAZAWA Hisao
Closing in on the concept of □true mobility□ for mobile notebook PCs,Toshiba has developed a Solid-State Drive (SSD)using multilevel-cell (MLC) NAND flash memory. This data storage technology offers high-speed data retrieval,excellent shock and vibration resistance,high durability,lighter weight and lower power consumption than standard Hard Disk Drives (HDDs). Various simulations were carried out in the early stage of development of the SSD in order to shorten the development period and enhance the quality of the design.

Frontiers of Research & Development

Bit-Patterned Media Fabrication by Lithography Using Self-Assembly