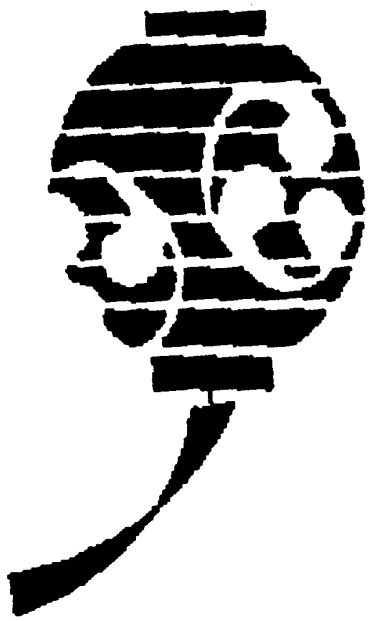
Recent Trends



Ken Sakamura
University of Tokyo

TRON is the major project now under way in the Japanese microcomputer world. Although its name is an acronym for The Real-time Operating System Nucleus, TRON's goal is not to create simply a real-time operating system. Rather, it is to create an integrated, open design for all aspects of microcomputer architecture and use—from microprocessor to bus, LAN, operating system, user interface, and application languages.

Readers familiar with the April 1987 issue of *IEEE Micro,* the special issue entitled "Japan's TRON Project" of which I had the honor to be guest editor, will already have an overview of TRON. In the year since that issue, TRON has made great strides. Association members successfully achieved first silicon of the 32-bit VLSI microprocessor, the TRON VLSI CPU. Other members developed a working prototype of BTRON, the multimedia workstation-oriented operating system. ITRON, the TRON family member of embedded and industrial applications, enjoyed widening use. And a first-stage implementation of CTRON, the communications operating system was completed.

These threads came together at the Third TRON Symposium held in Tokyo on November 13, 1987. James Farrell, Editor-in-Chief of *IEEE Micro*, and Alan Jay Smith from the University of California at Berkeley were kind enough to present papers. Altogether well over 700 attendees, including several score from overseas, were present. It was natural, given the TRON project's emphasis on open architecture, that Springer-Verlag decided to publish the proceedings for sale in bookstores throughout the world.[1]

TRON's fundamental goal is to create the architecture for a computer environment that both technologically and legally achieves wide acceptance in and out of Japan. To do this, we had to anticipate and incorporate a vision of the technological and cultural environment in the 1990's.

Concretely, the architecture begins with a 32- to 64-bit microprocessor and goes on to define

- the real-time operating system for industrial applications, ITRON;
- BTRON, a real-time operating system for personal computers and workstations;
- an operating system for central systems called CTRON; and, last but not least,
- the MTRON network operating system to tie these pieces together.

We designed these elements keeping firmly in mind the extremely high

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level of distributed processing that we believe will characterize the future. Our image is of hundreds, thousands, and tens of thousands of CPUs residing ubiquitously in all sorts of objects (the so-called "intelligent objects") and buildings. We call such a highly distributed system HFDS, or Highly Functional Distributed System. We see all these CPUs connected to create this highly distributed network. This vision is at the heart of TRON. It accounts for our ambitious attempt to standardize the user interface and to create protocols for interchange and translation of mixed numeric, textual, graphics, motion, and voice data across such networks. It is our belief that such a system, once realized, will dramatically change the way humans live and work and the productivity with which they do so.

To summarize, TRON integrates electronics and computer science to create a new computer architecture.

Currently, nearly all the major semiconductor and computer manufacturers in Japan are participating in TRON in one form or another. It is worth noting that, unlike most other projects involving many manufacturers, the government is not involved in TRON. Perhaps this accounts for the fact that manufacturers from North America and Europe have joined the total of over 100 firms that have chosen to move forward with TRON-related activities. More details on the current status of TRON appear in *TRON Project 1987.*[1]

Leaving TRON aside for a moment, we note that 1987 was a year of great change for the Japanese semiconductor industry. For the first time, MOS logic circuits such as ASICs and microprocessors exceeded, on a yen basis, the production of Japan's historical semiconductor strength, memory chips. Technology based on the 1.2- and 1.3-micrometer rule achieved practical use in the production of logic circuits such as custom LSIs and gate arrays. Chips with up to several hundred thousand transistors became possible.

Based on this technology, Japanese manufacturers developed 32-bit microprocessors, DSPs (digital signal processors), graphics, and other specialized chips. Sample shipments of 4M-bit DRAMs are a near reality, and under-100-ns, 1M-bit DRAM shipments increased. Application-specific memory chips, including on-board frame buffers and cache circuitry, became more popular.

Given this background, we dedicate this special issue on Japan to recent trends in microelectronics, in particular to key 32-bit microprocessors. The TRON VLSI CPUs, Hitachi's Gmicro/200, and Toshiba's TX1, are being developed with proprietary enhancement. The V60/V70, NEC's proprietary CPU, is the first commercial-base, general-purpose, 32-bit microprocessor in Japan. This issue gives a rather complete overview of the current state of the major logic LSI activities in Japan.

In addition to the manufacturers represented here, Matsushita, Fujitsu, Mitsubishi Electric, and Oki Electric have TRON VLSI CPU developments under way. More information on the activities of these manufacturers is available in *TRON Project 1987.*[1]

We also present two articles on high-speed buses. The first, Tobus, is a high-speed system bus. The μBTRON bus, on the other hand, connects BTRON personal computers with what we call "electronic stationery goods" or "electronic office supplies"—various sorts of intelligent tools.

In conclusion, I would like to express my deep appreciation to Jim Farrell for giving me the opportunity to guest edit this special issue and the assistance he provided.

Reference

1. K. Sakamura, ed., *TRON Project 1987: Open Architecture Computer Systems, Proc. Third TRON Project Symp.*, Springer-Verlag, Tokyo, 1987.

Ken Sakamura is an associate professor in the Department of Information Science at the University of Tokyo. He initiated the TRON project in 1984. Under his leadership, several universities and over 100 manufacturers now participate in the project to help build computers for the 1990's.

In addition to his involvement with TRON, Sakamura chairs several committees of the Japan Electronics Industry Development Association and the Information Processing Society of Japan. He has written numerous technical papers and books and received the BS, ME, and PhD degrees in electrical engineering from Keio University in Yokohama.

Questions about this article or the project in general can be directed to Sakamura at the Department of Information Science, Faculty of Science, University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113, Japan.