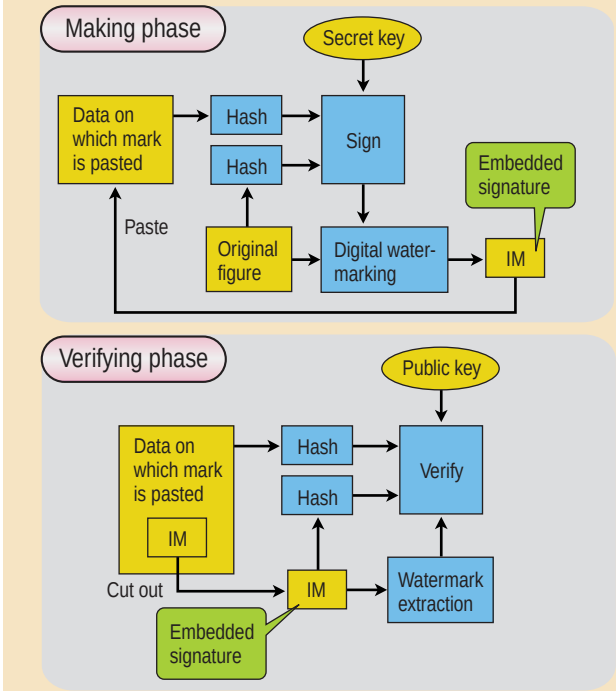
# Research and Development

The future prosperity of the global society depends on our challenges of new technology frontiers. It highlights the crucial role of research and development in such areas as information systems, systems on a chip, environmental protection, energy, and life science. Interdisciplinary approaches are emphasized to maximize the synergy of advanced information technology, low-power electronics, new materials, biotechnology, and measurement systems. Through its vigorous R&D activities, Hitachi will continue to develop new technologies and contribute to the prosperity of its customers and the society worldwide.

# Internet-marks: Clear and Secure Visual Marks for the Cyber World




*Making and verifying Internet-marks*

Visual marks, such as logos of organizations or trust marks to ensure authenticity, are of key importance in the physical world. In the cyber world, there is also a need for a secure mark system. But the use of marks in the cyber world is limited because they are easy to forge, tamper with, and copy onto unauthorized contents.

For visual marks to be used in the cyber world, we must be able to:

- make sure that the mark has not been forged or tampered with.
- make sure that the mark is used for the contents it has been approved for.
- see the mark clearly enough to identify it.

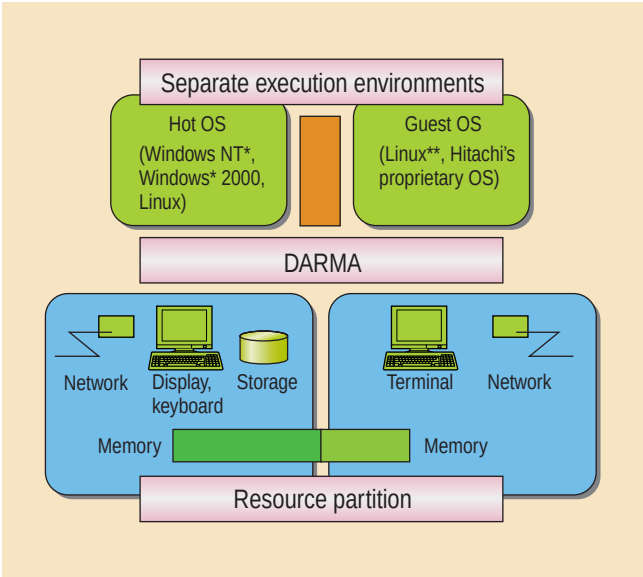
To enable visual marks to meet these requirements, Hitachi has developed a technique that combines a digital signature and digital watermarking.

- To ensure that the mark has not been tampered with, the characteristic values, such as the hash values of the mark, are calculated.
- To ensure that the mark is used for approved contents, the characteristic values of the contents, such as the hash values of the contents or identifiers of the contents, are fixed.
- These values are guarded by a digital signature on a public key infrastructure and embedded into the mark by a digital watermarking technique.
- A specially developed watermarking technique is used to enable seeing the mark after the values have been embedded into it.

In the verification phase, the mark is cut out from the contents and the values embedded into it by watermarking are checked by using a digital signature.

The technique described above is Hitachi's Internet-marks solution. It enables operation of different trust-mark or logo-mark systems. The Internet-marks technique is a result of research and development entrusted to Hitachi by the Telecommunications Advancement Organization of Japan.

# DARMA Technology for PC-based Solution




*DARMA technology enables two operating systems to coexist by partitioning the resources and building separate execution environments. It improves the functions and performance of PC-based systems.*

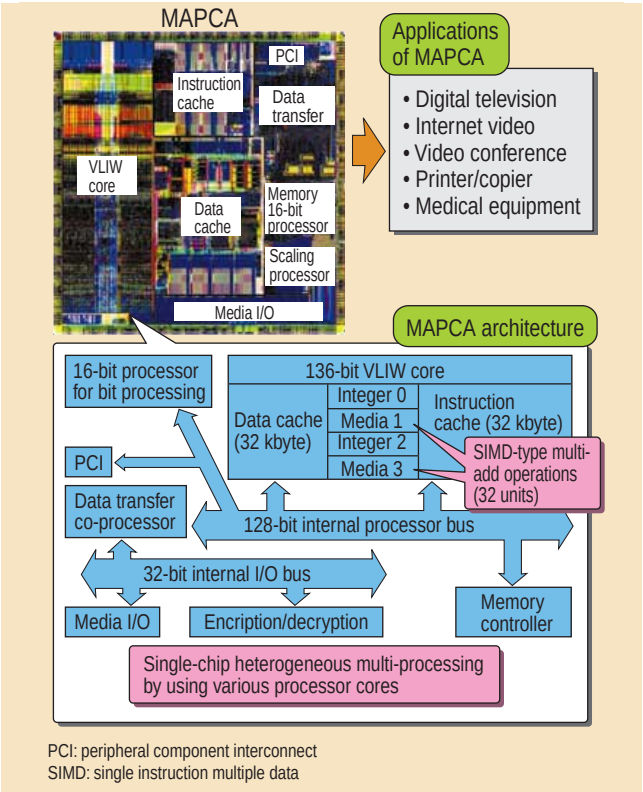
Intel-based PCs have become so powerful and cost-effective that IT professionals consider PCs as an attractive alternative to more expensive RISC-based UNIX®*** servers. However, they are also aware of the fact that PCs still lack a number of important characteristics such as reliability and security, which are indispensable for mission-critical applications.

To add these essential features to PC-based systems, we have developed a novel software technology called DARMA (dependable autonomous real-time management). DARMA enables two operating systems (host and guest) to coexist in a single PC. Typically, an application on the host system does the main job such as that of a web server. An application on the guest system complements the application on the host system to improve the system as a whole. For example, software running on the guest system monitors if the host system can ensure better availability and manageability of the whole system. The monitoring software can also detect and filter out illegal attempts to access the file system, which improves the security of the whole system. Currently, Microsoft®* Windows®* NT, Windows®* 2000, and Linux®** are a host OS. Linux® and Hitachi's proprietary real-time operating system are a guest OS.

DARMA divides the resources in a single PC, such as memory and devices, into two groups and builds two completely separate environments for the host and guest operating systems. Even when the host system crashes, the guest system keeps running due to the separate environments provided by DARMA. Also, DARMA can control the execution priority between the host and guest systems. A real-time operating system can thus be operated as a guest system without any performance degradation.

* Microsoft, Windows NT, and Windows are trademarks or registered trademarks of Microsoft Corporation in the US.
**Linux is a registered trademark of Linus Torvalds in the US and other countries.
***UNIX is a registered trademark in the US and other countries, licensed exclusively through X/Open Company, Limited.

# Media Processor "MAPCA" for New Digital-media Era



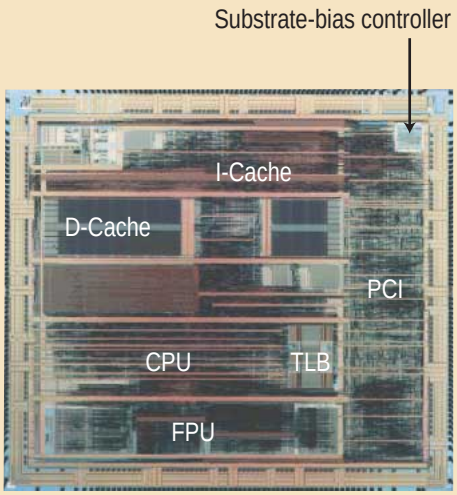

PCI: peripheral component interconnect
SIMD: single instruction multiple data

*Architecture and applications of MAPCA*

A media processor called "MAPCA" (media accelerated processor for consumer appliances), which is based on VLIW (very long instruction word) architecture was developed in conjunction with Equator Technologies, Inc., of the United States, with the intention to make it a de-facto standard for improved digital-media equipment. MAPCA processes media data at a speed of 30 GOPS (giga operations per second)— the highest speed demonstrated up to this day. With MAPCA, digital-media equipment developers can develop high-performance applications using only software. This media processor enables quicker functional expansion and adaptation to new standards than does the conventional ASIC (application specific IC) approach. Because core functions are delivered through the application software rather than the dedicated hardware, products can be multi-functional. For example, a MAPCA-based set-top box can support MPEG (Motion Picture Expert Group)-4, H.263 teleconferencing, analog time shifting, modems, and a host of other services without an incremental increase in costs or complexity. Similarly, the imaging engine in a color printer/copier can be fully soft, and can effectively support a wide range of image formats and algorithms at low cost. AFD™* (All Format Decoder) can be used as software applications to accelerate consumer product development. The AFD™ technology is currently used to decode all eighteen Advanced Television Systems Committee (ATSC) formats in the United States, which include high-definition formats, and convert them into a standard-definition format. Thus, a standard-definition TV set so equipped enables receiving high-definition broadcasting to accelerate the demand for consumer products. To maximize the overall system performance and minimize the system cost, MAPCA integrates a VLIW processor core, a flexible media-data input/output controller, and a data-transfer co-processor on a single chip with a 352-pin BGA (ball grid array) package.

* AFD™ is a registered trademark of Hitachi America, Ltd.

# High-speed Operation of System LSIs at Sub-1-V Supply Voltages



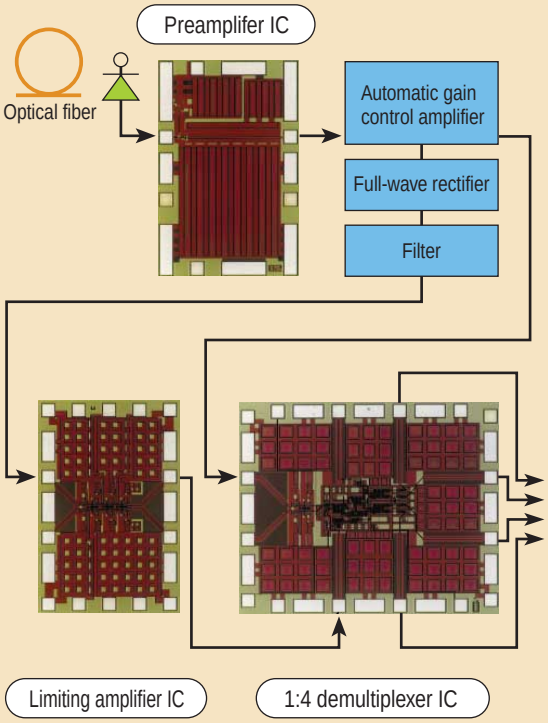

*Experimental 32-bit RISC-microprocessor chip*

Low-power operation of the system LSI is the key in developing high-performance hand-held devices, such as 3-G cellular phones and personal digital assistants (PDA). We developed dynamic substrate-bias-controlling scheme to enable system operation at voltages as low as sub-1 V.

The system LSI's performance at sub-1-V voltages is usually strongly affected by variations in environment conditions, such as supply voltages, temperatures, and process variations. Hitachi used a new scheme to generate a substrate bias to control the device performance so that the system LSI's performance was in line with the internal clock, which enabled the system LSI to be operated independently of any variations in environment conditions. This scheme helps the system LSI achieve high performance even at supply voltages below 1 V.

The feasibility of the scheme was evaluated by using a 32-bit RISC microprocessor. The processor exhibited low power and high-performance operation of 1,200 MIPS/W.

# Receiver ICs Using SiGe HBTs for 40-Gbit/s Optical-fiber Links



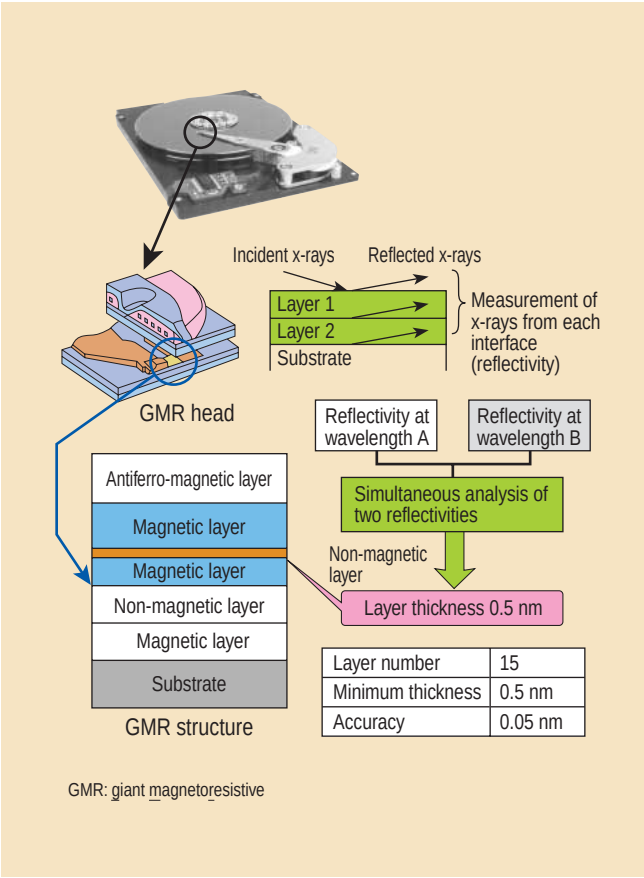

*Structure of receiver ICs for optical-fiber links and developed three receiver ICs*

Transmission capacity of backbone network has been expanding to enable meeting great demand for new technology posed by recent advances in information infrastructure, and the proliferation of the Internet. To lower the price of communication using high-capacity optical transmission systems, manufacturing costs of high-speed ICs must be reduced.

Ultra-high-speed SiGe HBTs (heterojunction bipolar transistors) with self-aligned structure that enable 5.5-ps ECL (emitter-coupled logic) gate delay and that were developed based on selective-epitaxial-growth technology can be fabricated using existing Si production lines. Using these SiGe HBTs, Hitachi developed three receiver ICs for 40-Gbit/s optical-fiber links. They are: a wide-bandwidth preamplifier IC that uses a circuit to reduce parasitic capacitance; a high-gain limiting amplifier IC with a peaking circuit; and a high-sensitivity 1:4 demultiplexer IC with a built-in decision circuit. The ICs are functional and their performance satisfies the specifications for their practical use in 40-Gbit/s optical-fiber-link systems. Hitachi also developed a frequency divider with an 82-GHz operating frequency to be used in millimeter-wave radio communication.

These devices will make it possible to further accelerate the development of future optical transmission and radio communication systems.

# GMR-head Analysis Method Based on Two-wavelength X-ray Reflectometry




*Hard disk drive and new layered-structure analysis*

Hitachi has been successfully commercializing giant magnetoresistive (GMR) spin-valve heads for their use in high-recording-density rigid disk drives and for high-sensitivity reading of magnetic records. The heads have a layered structure consisting of two ferromagnetic layers separated by a noble-metal spacer, a few nm thick. Their magnetic properties strongly depend on the thickness and interface roughness of each layer. Therefore, to produce good heads and improve their magnetic properties, a precise structural characterization of GMR multilayers was developed.

An x-ray reflectivity method is a powerful tool for analyzing layer thickness, electron density, and interface roughness. However, it is difficult to use a conventional x-ray-reflectivity method in analyzing GMR transition-metal multilayered structures because of low specular x-ray intensities of their interfaces. Therefore, specific wavelengths were chosen to enhance reflected x-rays, and two wavelengths were used simultaneously to ensure accuracy of our analysis. The layer as thin as 0.5 nm which corresponds to 4-atomic scale can be analyzed using this two-wavelength technique.

Our analytical method based on two-wavelength x-ray reflectometry can also be used in analyzing multilayered structures consisting of semiconductors and organic materials.

# Surgery Support System That Alleviates Patients' Suffering and Improves Medical Care


*Prototype system supporting minimally invasive neurosurgery*
*In a thin insertion probe, [A] three micro manipulators are bundled together; a surgeon is operating from an operating console [B]*

Minimally invasive surgery,* which can alleviate patients' suffering and promote early recovery and the shortening of hospitalization periods has been attracting a lot of attention lately. We developed an operation support system consisting of three sets of micro manipulators to support minimally invasive neurosurgery.

This system consists of three sets of micro manipulators, an operating console, an endoscope device, holding apparatus, and a power supply system. The micro manipulators have a thin cylindrical insertion part with an external diameter of 10 mm. The insertion probe is inserted through a small opening forward toward the organ with the disease. Three sets of micro manipulators and an endoscope lens are bundled together in the insertion part. The micro manipulators have a tip with three degrees of freedom (neck swing movement, up/down movements, and rotational movement) with an external diameter of 3 mm. A micro surgical tool (e.g., a forceps) is attached to one of the micro manipulators through an internal hole. The surgeon uses these micro manipulators to perform an operation based on the input from the operation input devices on the console.

Hitachi used a master-slave manipulator control technology to achieve a high degree of operability. By using a sub-millimeter mechanism control technology, a micro forceps with an external diameter of 1 mm can enable highly accurate operations.

The system was evaluated by surgeons who used non-human tissue and was found functional. We are now pushing forward toward the practical use of the system.

Hitachi is also pushing forward toward the development of an operation support system that will integrate treatment and diagnosis to enable minimally invasive surgery by using micro manipulators to be conducted in a CT monitor environment with the help of nucleus-magnetic-resonance-image diagnosis device (MRI).

The trial micro manipulator system was fabricated under the auspices of the New Energy and Industrial Technology Development Organization (NEDO) as part of the National Research and Development Program for Medical and Welfare Apparatus.

*Minimally invasive surgery: An operation method that enables performing an operation through small incisions to alleviate patients' suffering.

GO TO THE RELEVANT SITE

# 1-MV Holography Electron Microscope


*1-MV holography electron microscope*

Hitachi has been leading the way in electron microscope technology, developing microscopes which have come to be indispensable in fields ranging from semiconductors to molecular biology. Electron holography, implemented by Hitachi, Ltd., in 1963, has evolved to enable observing electric and magnetic fields of sub-micron size directly.

In March 2000, a new-generation ultra-high-voltage (1 MV) holography electron microscope was developed that is based on a cold-field-emission-electron gun. It enables achieving the most coherent electron beam (the brightest and most monochromatic electron beam). The basic performance of the microscope was tested and the tests yielded lattice resolution of 49.8 pm — an all-time world record. This new 1-MV holography electron microscope uses the properties of electrons not only as particles but also as waves to enable observing electric and magnetic fields with atomic resolution. This new instrument can clearly help in investigating the origins of quantum phenomena, and exploring the structure and functions of materials in the 21th century.

The microscope was developed in collaboration with the University of Tokyo with the support of the Core Research for Evolutional Science and Technology (CREST) program of the Japan Science and Technology Corporation (JST).

GO TO THE RELEVANT SITE

# Outline of Hitachi

Hitachi, Ltd. was established in 1910 by a young engineer named Namihei Odaira as an electrical repair shop for a copper mining company in Japan. Concerned about Japan's heavy dependence on imported machinery and technology, Odaira founded Hitachi in order to help Japan build up its industrial foundation with its own technology.
Hitachi is now one of the world's leading global electronics companies, manufacturing and marketing a wide range of products including information systems, electronics, consumer products, and power and industrial equipment. To make the world of the 21st century a safer and a more comfortable place, Hitachi is determined to further contribute to the prosperity of our society and to improve the quality of life all over the world.

*Namihei Odaira*

## Net Sales

Billions of yen

| Year | 1999 | 2000 | 2001 |
|---|---|---|---|
| Net Sales | 7,977 | 8,001 | 8,417 |

Years ended March

## Net Income (loss)

Billions of yen

| Year | 1999 | 2000 | 2001 |
|---|---|---|---|
| Net Income | (328) | 17 | 104 |

Years ended March

## Capital Investment

Billions of yen

| Year | 1999 | 2000 | 2001 |
|---|---|---|---|
| Capital Investment | 586 | 575 | 971 |

Years ended March

## Overseas Sales

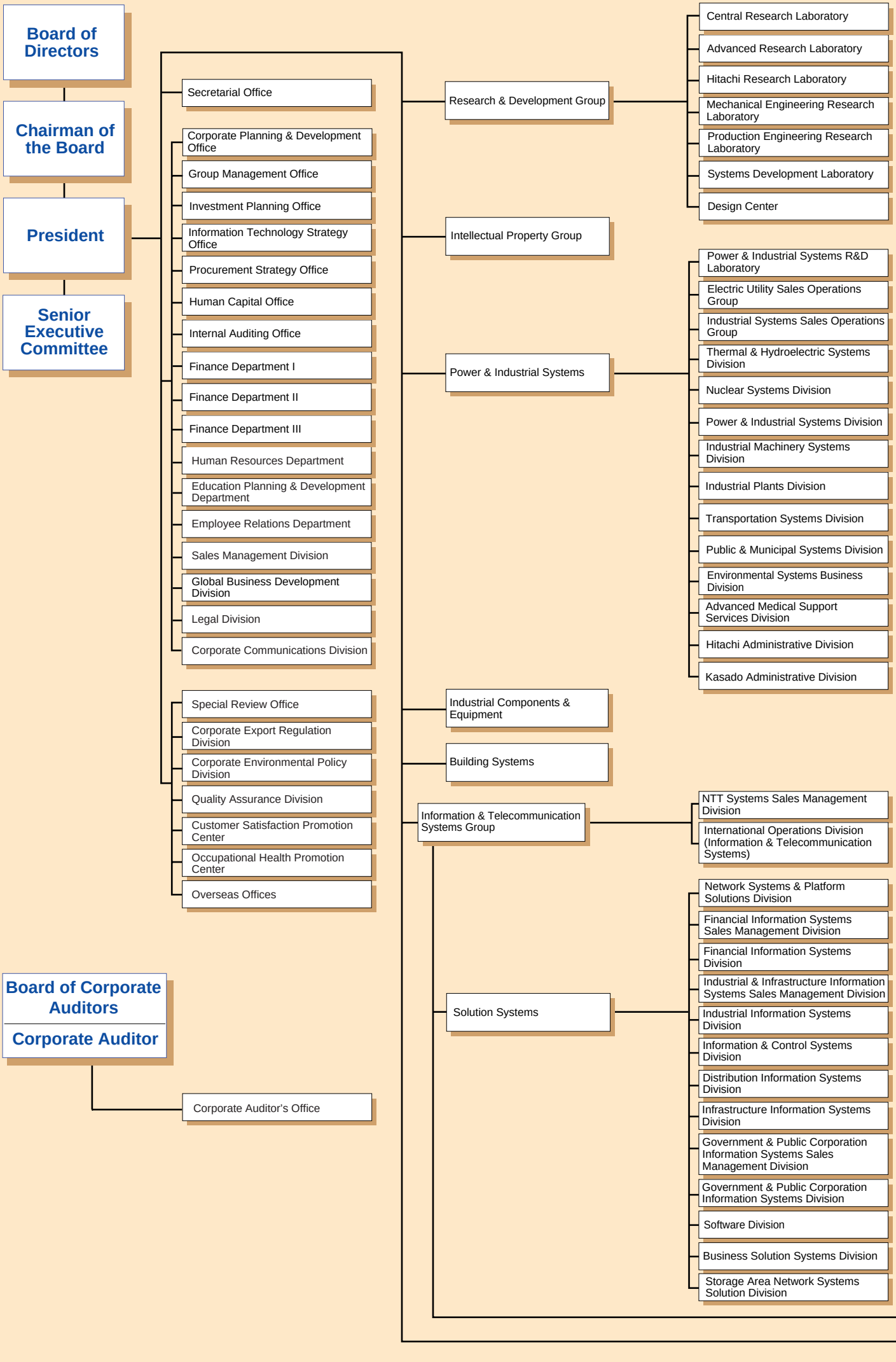
Billions of yen

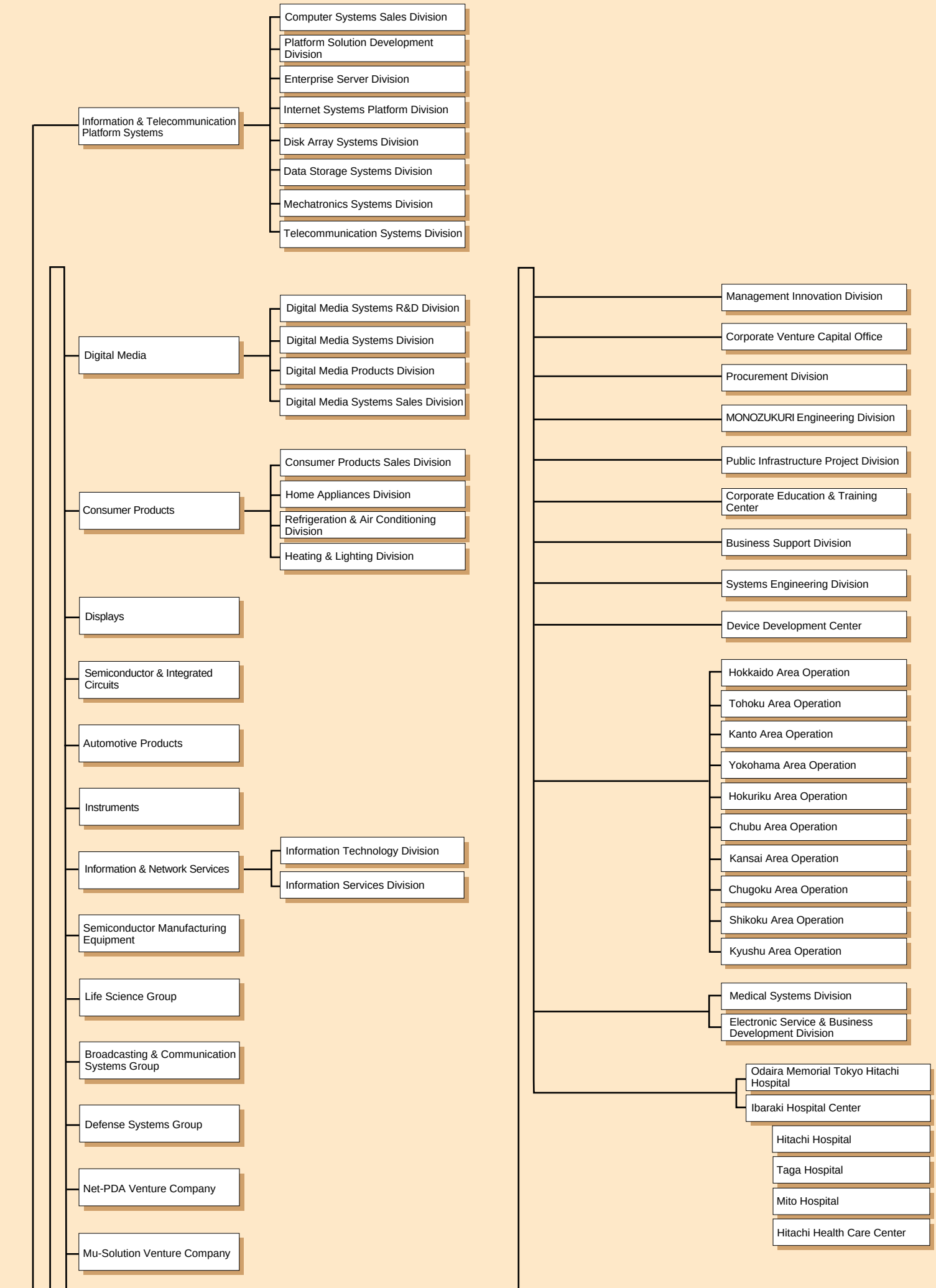
| Year | 1999 | 2000 | 2001 |
|---|---|---|---|
| Overseas Sales | 2,444 | 2,344 | 2,626 |

Years ended March

# Organizational Chart

As of July 1, 2001




Information & Telecommunication Platform Systems
Computer Systems Sales Division
Platform Solution Development Division
Enterprise Server Division
Internet Systems Platform Division
Disk Array Systems Division
Data Storage Systems Division
Mechatronics Systems Division
Telecommunication Systems Division
Digital Media
Digital Media Systems R&D Division
Digital Media Systems Division
Digital Media Products Division
Digital Media Systems Sales Division
Consumer Products
Consumer Products Sales Division
Home Appliances Division
Refrigeration & Air Conditioning Division
Heating & Lighting Division
Displays
Semiconductor & Integrated Circuits
Automotive Products
Instruments
Information & Network Services
Information Technology Division
Information Services Division
Semiconductor Manufacturing Equipment
Life Science Group
Broadcasting & Communication Systems Group
Defense Systems Group
Net-PDA Venture Company
Mu-Solution Venture Company
Management Innovation Division
Corporate Venture Capital Office
Procurement Division
MONOZUKURI Engineering Division
Public Infrastructure Project Division
Corporate Education & Training Center
Business Support Division
Systems Engineering Division
Device Development Center
Hokkaido Area Operation
Tohoku Area Operation
Kanto Area Operation
Yokohama Area Operation
Hokuriku Area Operation
Chubu Area Operation
Kansai Area Operation
Chugoku Area Operation
Shikoku Area Operation
Kyushu Area Operation
Medical Systems Division
Electronic Service & Business Development Division
Odaira Memorial Tokyo Hitachi Hospital
Ibaraki Hospital Center
Hitachi Hospital
Taga Hospital
Mito Hospital
Hitachi Health Care Center

HITACHI

Inspire the Next