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Hitachi's Integrated SAN-based Storage Solution "Storeplaza"

From left to right: Yoji Tomono, Engineering Manager of the Business Planning Div. of the Information & Computer Systems; Hisashi Takamatsu, Deputy Manager of the Information & Telecommunication Systems, Data Storage & Retrieval Systems Division; Yosiyuki Nukui, GL Engineer, Information & Telecommunication Systems, Information Systems Division in planning and development of "Storeplaza."

Along with the full-scale shift to network computing that has resulted from the popularization of the Internet and intranets, the volume of data stored on networks has increased rapidly, and a growing burden is being placed on those networks. Furthermore, with the rapid increase in data volumes stored by corporations, there has been a proportionate increase in operating costs for storage devices that are connected to numerous distributed servers. At the same time, there is an increasing need to share among various divisions the huge amounts of data accumulated in mainframe systems. The operation and management of storage in the context of information systems has grown to become a major issue. For this reason, Hitachi, Ltd. has released "Storeplaza"(an Integrated Storage Solution using SAN (Storage Area Networks).

A new type of information system with storage at the core

— What led up to the inquiries into storage operation and management?

The popularization of applications that process huge amounts of data and the diversification of information formats resulting from the shift to multimedia have brought about a rapid increase in the volumes of data handled by corporations. There is thus a growing need to share this diverse and voluminous data among various divisions, and to make it as useful as possible. But the input/output capacity of disk drives and other memory formats used in systems is reaching a bottleneck, and, in addition, storage devices are connected individually to mainframes and various distributed servers. As a result, in order for data to be shared, the user must necessarily go through the LAN, but this sudden increase in data flow over the LAN brings about a decrease in system performance. Another issue is that the storage capacity for individual servers must be expanded to handle the increased data volumes, and operation costs are thus increasing as well. The final outcome of these combined factors is a demand for a new type of information system with strengthened storage operation and management capabilities. To respond to this need, Hitachi has released "Storeplaza," a storage solution system that applies SAN to achieve total storage operation and management even in an environment in which mainframes and servers are used in combination.

— What is a "SAN (Storage Area Network)"?

This is a specialized storage network, in which the storage, which in the past was connected individually to mainframes or servers, is isolated from the servers; these storage "groups" are then tied into mainframes or multiple distributed servers by "fibre channels," via a hub or a switch. With the use of these fibre channels, which have a high data transfer capacity, it becomes possible to transfer data at high speeds without going through the LAN. Among the various features offered by this system, the connection distance can be extended to a maximum of 10 km, so storage can be set up in locations that are separated from the mainframe or server.

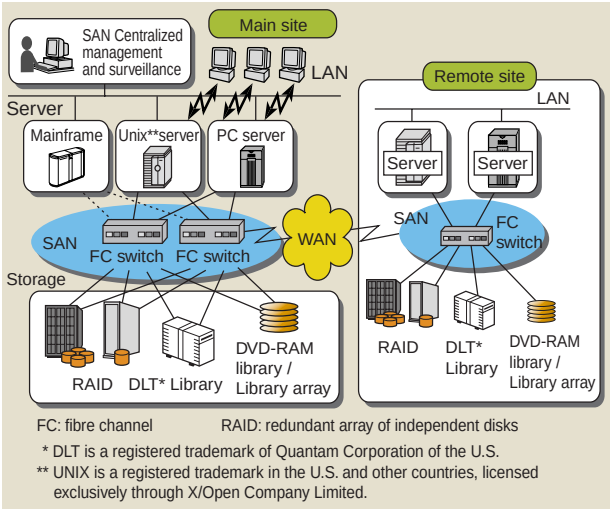
Achieving high-speed back-up and sharing of data

— What is the solution proposed by Storeplaza?

Through the use of "Data Protection Solutions," Storeplaza achieves high-speed backup of the data contained on high-volume disks via SANs, without interrupting the application. Data passes through the SAN and is placed in a sub-storage center in a remote location; in this way, it is possible to achieve high-speed, long-distance backup equipped with protection against earthquakes, fires, and other disasters. Furthermore, through the use of "Data Sharing Solutions," data with different file types or formatting types can be shared via the SAN. "Storage Management Solutions" allow storage that had been managed separately over several divisions to be centrally managed using uniform operations. The base that supports these three solutions is the "Foundation Solution," which is comprised of a new product group compatible with SANs, along with proposals for the configuration of these products in a system. Storage equipment, including disk array subsystems geared toward fibre channels, is provided together with hubs and switches used for fibre channel switching to create flexible storage that is amenable to both expansion and changes in configuration.

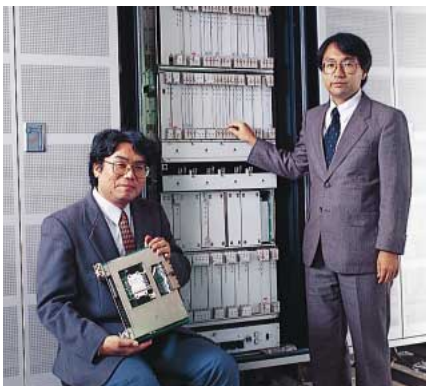
— What do you expect in terms of future developments?

Our goal is to respond to our customers' expectations by providing system planning, configuration, and operation that meet the requirements of those customers. By integrating not only Hitachi's original products, but also other manufacturers' products that conform to international and global standards, we will endeavor to provide even more outstanding storage solutions.



System configuration of "Storeplaza"

OXC Systems and OADM Systems that Achieve High-speed Recovery of Transmission Route Failures and Optical Add/Drop for Individual Wavelengths



The OXC and OADM systems were developed by: Engineer Yasushi Sawada (left) and Senior Engineer Hideaki Tsushima (right) of the Telecommunication Systems Division.

In the backdrop of an explosive increase in demand for the Internet, IP data traffic has grown rapidly, and as a result there is a growing demand for large-scale IP backbone networks that combine extra-large volume optical transmission technologies with ultra-high speed IP router technologies. For this reason, in 1998, Hitachi, Ltd. developed a wavelength multiplexing transmission system that multiplexes and transmits 10 Gbit/s optical signals of up to 32 wavelengths. Recently, in order to further increase network reliability and flexibility as well as cost performance, we have developed an optical cross-connect (OXC) system and an optical add/drop multiplexer system (OADM) as well.

Systems that achieve reliability, flexibility and cost reductions

— What led up to the requirements for OXC and OADM systems?

As a result of the popularization of the Internet, transmission volumes for data overtook those of telephones in the U.S. in 1999. On a global scale as well, there has been a rapid increase in the volume of data carried by IP (that is, over the Internet) and this volume is expected to further expand by 6 to 7 times current volumes by 2003. Hitachi has already developed a DWDM (dense wavelength division multiplexing) system with a total capacity of 320 Gbit/s, but in order to construct high-reliability, high-capacity optical networks in the future on a terabit scale, we must provide networks that combine reliability, flexibility, and cost performance. To accomplish this, we have created a 'double-ring' configuration for the IP over DWDM network, which has in the past been based on a connection between two locations, and developed two new systems: an OXC that can effect high-speed recovery of transmission route failures, and an OADM system that can freely add and drop data on each individual wavelength.

Optical fiber failures automatically recovered in 0.05 seconds

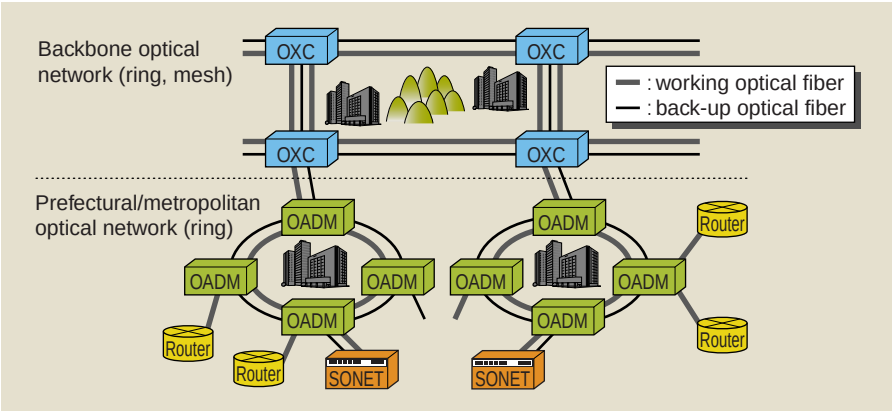
— What are the main features of the two systems?

The OXC system has a function such that when an optical fiber failure occurs in a backbone network, the signal is immediately and automatically re-routed to a back-up optical fiber, or an optical fiber on a separate route, to allow high-speed recovery. This is accomplished in a mere 0.05 seconds, so the end-user is not even aware that the signal has been interrupted. Furthermore, because an optical switch has been embedded, the system can be used regardless of the format of the optical signal. Because the optical switch is used, there is in principle no limit to the speed of the optical signal, and expansions in the near future to volumes on the terabit level are also possible.

The OADM system, meanwhile, is an optical switching system that can freely add and drop optical signals for each wavelength, without transforming them into electrical signals. This system is used by prefectures and large cities, which are positioned on a level below the backbone network. By using this system, if traffic in a given location increases, the bandwidth can be automatically expanded by dynamically adjusting the wavelength allocation, thus increasing the volume of data that can be transmitted. In this way, it becomes possible to automatically adjust the network configuration to correspond with the usage conditions. There is no need to make projections and preparations for surplus circuit volumes and transmission equipment, and electrically based transformation processing is entirely eliminated from the system. It is thus possible to construct flexible, high-speed optical IP networks at a low cost.

— What do you expect in terms of future developments?

With regard to OXC, Hitachi participated in technical field experiments conducted by MCI WorldCom Inc. in Dallas, Texas, in 1999, and has already achieved successful results. OADM, on the other hand, was developed by Hitachi with the technical instructions of NTT Network Innovation Laboratories; plans call for continued testing through MIRAInet experiments. In the future, we look forward to applying the results and experience gained through these experiments, and making a full-scale entry into the optical network market for IP over WDM in both Japan and North America.



Typical configuration of optical network for IP over WDM

High Image Quality Super-TFT LCD for Digital Multimedia

The high image quality Super-TFT LCD was developed by: Senior Engineer Shuusuke Endo (left), Flat Panel Display Design Dept. of the Displays; Senior Engineer Yuji Saeki (center), Digital Media Systems Operation; and Engineer Kazuhiro Ogawa (right), Flat Panel Display Design Dept. of the Displays.

Along with the increasing use of personal computers in companies and households, there has been an increasing demand for LCD monitors, which are easy on the eyes, and also offer low power consumption and compact design. At the same time, there users are demanding wide viewing angles and high image quality performance on the level of CRTs, in order to support DVD (digital versatile disc), digital cameras, and other digital media applications. To respond to these demands, we have developed a new Super-IPS (in-plane switching) technology that further improves upon the image quality offered by existing Super-TFT LCDs, and marketed a Super-TFT LCD monitor using this Super-IPS format. These monitors, which are available in 46-cm (18.1-in.) and 38-cm (15-in.) versions, offer high image quality rivaling that of CRTs, and demonstrate minimal color distortion over the full range of viewing angles.

Achieving a wide viewing angle with a zig-zag electrode construction

— How is Super-IPS different from existing IPS technologies?

In 1995, Hitachi developed the world's first Super-TFT LCD display adopting the IPS format, and received an excellent response on the global stage. Compared to TN (twisted nematic) format, which was the standard for TFT LCDs, the IPS format not only offers a substantially wider viewing angle, but also features minimal color distortion due to viewing angle. Nevertheless, there still remained, in segments of the display, some evidence of tone inversion as compared to CRTs; when viewed from a certain angle, the image appeared whitened as though in a photographic negative, or white areas of the display would appear to have a yellow or bluish tint. To remedy this, in the Super-IPS format, we adjusted the LCD element layout for the "blue shift" direction and the "yellow shift" direction, creating a new construction in which the electrodes were placed in a zig-zag pattern such that the blue and yellow shifts were cancelled out. In existing systems, the viewing angle without distortion is 130 degrees up/down and 160 degrees left/right. Using the Super-IPS format, we have increased this range to 160 degrees for both up/down and left/right, thus achieving a viewing angle and high image quality that can be said to rival that of CRTs.

Aiming for improved color purity and contrast as well

— What are the other technical features?

In order to achieve even higher image quality, we also endeavored to improve color purity and contrast. First of all, by improving on the color filter, we increased the color purity to 60% from the current 50% (according to NTSC comparisons), and also stepped up the color reproducibility. In traditional LCD technologies, 4 to 5-µm beads are distributed in between substrates to control the gap for the liquid crystal layer, but when black was displayed, a small amount of light could be seen leaking through the space around the beads. For the new product, we have developed a technology referred to as a "beadless process," which entirely eliminates such light leakage, and increased contrast to 300:1 from the previous 200:1. In other words, we have not only eliminated the dependency of color on viewing angle through a zig-zag electrode construction; by improving both color depth and contrast, we have achieved both high image quality and color reproducibility over a wide viewing angle that rivals even CRTs.

— What about problems concerning production cost and yield?

Because the Super-IPS format requires only a design change for the electrode photo mask, it is possible to manufacture these units using the same production line as the IPS format, with the same number of processes. There is no need for concern regarding reduced productivity or yield, and because we can now produce even higher quality products using the same facilities and processes, we can say that we have achieved an extremely high level of cost performance.

— What are the issues for the future?

We have already achieved high image quality and performance for still images on a level with CRTs. As the next step, we are currently developing a Super-TFT LCD for "Total moving images," with a response speed that rivals CRTs. Once we accomplish this, there is no doubt that the demand for these units as replacements for CRT monitors will increase at an even greater rate than we have seen in the past.

* IPS format: Standard TFT LCDs use the TN format for the LCD display. When an electrical field is applied between the top and bottom substrates, the crystals reorient so that they stand perpendicular to the surface of the substrate. As a result, color and contrast changes depending on the viewing angle. In the IPS format, with a horizontal electrical field, the crystals rotate to fall parallel with the substrate, so this format is characterized by minimal tone level inversion and reduced contrast in relation to the viewing angle.

High image quality Super-TFT LCD display

Measurement SEM "S-9300" for Large-diameter 300-mm Wafers

The semiconductor industry has been promoting a continuing shift toward the use of large-diameter wafers as a means of increasing production efficiency, and a full-scale move to the use of 300-mm diameter wafers is finally set to take place during 2000. A need is also arising for inspection equipment with high degrees of end-measurement accuracy, in order to increase the yield of high-integration, multi-layered semiconductor production processes. To respond to these needs, Hitachi, Ltd. has developed the "S-9300," an end-measurement SEM (scanning electron microscope) for 300mm diameter wafers, which is geared toward increasing wafer size and the continuing miniaturization of semiconductor-based devices. This product has inherited the superior aspects of its predecessor, the "S-8C40," which has already secured a substantial market share, while adding improvements in terms of investment efficiency with such features as improved analytical functions, increased throughput (shorter end measurement times), and a reduced footprint.

High resolution for processing dimensions as small as 0.13 µm

— How has this unit been improved over the previous model?

Semiconductor-based devices have entered a stage of 256-Mbit DRAM mass-production, and as a result, processing forms have become smaller, aspect ratios have increased, and the process overall has become more complex. Because increased yield in semiconductor processes dictates production efficiency, there is a need for inspection equipment that allow high-resolution inspection and highly accurate measurement of extremely fine pattern widths and contact holes with high aspect ratios. The previous model, the "S-8C40," which anticipated the era of the 300-mm diameter wafer, received extremely high evaluations for such features as stable and precise wafer transfer and exceptionally high pattern recognition. These appraisals were even backed up by the evaluation results of "I300I," an international consortium of semiconductor manufacturing companies. Resolution has been increased from the previous 5 nm to 3 nm with the S-9300,

The end-measurement SEM "S-9300" for 300-mm diameter wafers was developed by Minoru Shimizu (left) and Katsuhiro Sasada (right), both of whom are Senior Engineers in the Electronic Systems Division, Instruments Group.

allowing the new unit to handle minimum processing dimensions as small as 0.13 µm. In terms of investment efficiency, we have achieved increased throughput and a reduced footprint. We have also taken human engineering into consideration, adding features such as the easy-to-use GUI (graphical user interface), ensuring that the unit conforms to global safety and health standards. In addition, we have put considerable thought into the environment and reduced use of resources; for example, used coolant is recycled within the unit rather than being discharged outside of the system.

— What was the technology that made such a high resolution possible?

In order to observe the shape or the bottom of a contact hole with a high aspect ratio, when the hole is deep in comparison to its diameter, it is necessary to increase the efficiency of secondary electron detection at the bottom of the hole. To accomplish this, we developed a new type of secondary electron detector and object lens equipped with the ability to powerfully draw out the secondary electrons that were generated at the bottom of such deep holes. In this way, we succeeded in creating a function that could observe deep structures with an aspect ratio greater than three times that possible in the past.

Achieving increased throughput and reduced footprint

— How did you set about increasing investment efficiency?

Because of the larger surface area of 300-mm diameter wafers as compared to 200-mm wafers, there are many more measurement points, this demands an even higher throughput than was possible in the past. For this reason, we reduced the time required for focusing at each measurement point, and also increased the speed of movement from one measurement point to another in the sampling stage, in order to increase the throughput. To reduce clean room maintenance costs, we reduced the footprint so that less space was taken up by design area than in the past. At the same time, while wafers have traditionally been transferred using open cassettes, this system uses a sealed container called a FOUP (front opening unified pod). Through this linking up of "mini-environments," we have endeavored to reduce maintenance costs by having only the wafer transfer segment at the same level of cleanness as the main clean room.

— What are the issues for the future?

The mass of one FOUP containing 25 300-mm wafers is about 8 kg, so there is a growing need for automation of the wafer transfer process. From the point of view of consideration for human engineering and production efficiency, we can expect that the need for automation will continue to grow in the future, so we will put determined efforts into responding to these trends.

Measurement SEM "S-9300" for 300-mm diameter wafers

"U-622" Plasma Etching System for High-speed, Precision Processing of Dielectric Films for 0.13 µm or Smaller Devices

Kenetsu Yokogawa (left), researcher in the Advanced Technology Research Dept. of the Central Research Laboratory and Hironobu Kawabara (right), engineer in the Kasado Semiconductor Manufacturing Equipment Div. of the Power & Industrial Systems, who developed the "U-622" plasma etching equipment for insulation film processing.

With the increasing integration scale of semiconductor devices, the number of layers involved in device structures is increasing and the process ratio of interlayer insulation forming processes is also increasing. In addition, the use of compound insulation film materials has brought about a need for etching equipment that can be used in insulation layer processing that is capable of advanced control of the various particles and active species that are created by complex chemical reactions. To meet that need, we developed the new "U-622" plasma etching equipment, which is capable of high-speed, high-precision processing of insulation films for 0.13 µm or smaller devices. Hitachi, which has had high success with etching equipment for forming wafer wiring grooves, has made use of ECR (electron cyclotron resonance) technology and has newly entered the field of insulation film etching by the UHF-ECR method.

Coping with the expanding field of insulation film processing

— Background

The insulation film is a layer composed of a chemically inactive material that electrically insulates the different layers of a semiconductor device. The processing of these insulation films requires the use of high-energy particles to achieve reproducible and highly selective processing in which the areas to be processed are processed and the areas that are not to be processed are not processed. Furthermore, there is increasing use of organic system compounds instead of silicon oxidation layers as the material that is used for insulation layers between wiring layers. That has created the need for etching equipment that can totally control the various active species that are created by complex chemical reactions. The proportion of interlayer insulation film processing will increase with increasing integration scale and increasing number of layers in semiconductor device structures. For that reason, we developed the "U-622" plasma etching equipment for use in high-speed, high-precision processing of insulation films for 0.13 µm or smaller devices.

— Special features of the equipment

We achieved highly selective and uniform insulation film processing through highly accurate active specie control, in which of the various particles and active species that are created within a plasma, those that are required for etching are created in large numbers, while the creation of those that hinder reaction is suppressed. Consideration is also given to reducing component wear and operating costs.

Making use of a new low-pressure, medium-density plasma source

— How is active specie control achieved?

We achieved active specie control by newly developing a new, stable plasma source, the "UHF-ECR (ultra-high frequency electron cyclotron resonance)" and adopting a semi-gap flat antenna that is suitable for active specie control for the shape of the reactor. By using this new low-pressure, medium-density region "UHF-ECR" plasma source, which is suitable for obtaining the reactions that are needed for etching in insulation film processing, we were able to prevent excessive dissociation of molecules within the plasma and minimize the generation of unneeded particles. At the same time, increased active specie control by using a semi-gap that is somewhat wider than the narrow gap that is usually used between the plasma source and wafer in conventional etching equipment and placing various materials on the antenna surface on the plasma source side for reaction with the stabilized plasma source.

— Cost reduction measures

The parts of the etching equipment that are exposed to the plasma are subject to wear, so those parts must be replaced periodically. If the wearing is rapid, the frequency of part replacement is high, which also increases production cost. For that reason, the magnetic field is controlled so as to confine the plasma to an area such that it touches the reaction chamber walls no more than necessary, thus reducing wear in the parts within the chamber.

— Future development

We will collect specific data that demonstrates the superiority of this equipment for use in a highly persuasive appeal to customers. We intend to continue on with development of equipment for use with 300-mm wafers.

"U-622" plasma etching system for dielectric film processing

"SJ300 Series" Inverter — Achieving Super-torque and High Performance

Yutaka Araya (left), Section Manager, and Hiroshi Fujii (center), Senior Engineer, in the Product Unification Department of the Industrial Components & Equipment, and Kenichi Okuda (right), Group Leader, Senior Researcher and Doctor of Engineering of the First Power Device Research Dept. of the Hitachi Research Laboratory participated in planning and development of the SJ300 Series. In front is a 5.5-kW inverter that is 51% smaller in installed area than the J300 Series.

The SJ300 Series (0.4 to 55-kW motor) achieves a 200% increase in starting torque at 0.5 Hz with improved "sensorless vector control," which is independently-developed torque (motor turning power) calculation software technology. In addition to achieving powerful operation by on-line auto-tuning of the motor constants, etc., this inverter offers a strengthened output signal for meeting diverse needs, a bolstered monitoring function, reduced size, and simple operation, thus making it a multi-function inverter that is easy to use and maintain. This series is a world-standard product that conforms to the specifications of the US, Europe, and Canada and can be used widely abroad as well as in Japan.

Achieving stable and powerful operation from low speeds

— Hitachi's own "sensorless vector control" technology

Vector control is a very highly accurate control method that requires a special motor that is equipped with speed sensors, which increases the cost to customers. Therefore, to make vector control possible even without speed sensors, sensorless vector control, which makes skillful use of the voltage data output from the motor, was developed. The development of this technology began ten years ago, and it has now become an industry standard that has contributed to the widespread use of inverters. In the current SJ300 Series, further technological refinement has been applied to achieve stable and powerful operation even at low speeds.

— Specifics

In addition to making high starting torque of more than 200% possible at 0.5 Hz, when a large inverter of class 1 capacity is applied to the motor output, 150% high torque is achieved even at zero-level speed (0 Hz order speed) and strong rotational power is obtained even at low rotational speeds. Furthermore, technology that realizes high-torque multi-operation, in which two motors are controlled with a single inverter and stable and highly accurate operation with reduction in uneven rotation at low speeds is also being developed.

— Auto-tuning of motor constants

For execution of accurate vector control, it is necessary to know the circuit constants of the motor. The circuit constants of general-purpose motors, however, vary with the manufacturer and the motor type. To cope with that situation, on-line auto-tuning was developed, which makes optimum vector control possible by automatic measuring of the circuit constants during motor operation and adjusting to changes in those values. For the off-line case, too, this is a new technique that makes stable and powerful operation possible by determining the motor constants before operation.

High-performance, multi-function inverter

— Ease of use

Based on the development policy of attaining both superior performance and ease of use, we have incorporated those design elements in various places. Also, to meet the requirements of an expanded range of application, many new functions have been added, including use of the intelligent terminal method to strengthen the input/output signal, a PID (proportion, integration and differentiation) control to eliminate the need for a separate PI (proportion and integration) controller, and an augmented monitoring function. Maintainability was enhanced by simplifying the replacement of the cooling fan and smoothing capacitor, which are short-life-expectancy components. A quick-disconnect terminal board is used so that it is not necessary to redo the control circuit wiring when the inverter itself is replaced.

— Future issues

As environment improvement measures, we are would like to develop an inverter that does not require a noise filter and high-frequency suppression unit, which we believe would be well received by customers. We will also work on further improving the sensorless vector control technology.

The SJ300 Series inverter

"BIG SLIM 52" Achieves a Bright, Pleasant-to-view Large-screen Image with a Liquid-cooled Short Focal Length Projection System

In the year 2000, Japan, too, begins digital broadcasting, and various kinds of video equipment are being developed for the upcoming video era. Digital Media Systems Division has developed a liquid-crystal rear-projection TV to the commercial product stage as a large-screen television that is suitable for the digital era. This 52-inch screen has about the same area as four newspaper pages yet features a slim body that is only 51 cm deep. Furthermore, this unit achieves twice the brightness of conventional displays and higher contrast as well. This product employs a single liquid-crystal panel for the display device and has been brought to completion by the development of advanced optical technology.

"BIG SLIM 52" was developed by Masahiko Yatsu (left), Senior Engineer Kazunari Nakagawa (center), Senior Engineer, and Katsunobu Takeda (right), Senior Engineer, all from the Digital Media System Div. of the Digital Media.

High brightness and contrast through use of a liquid crystal panel

— A new projection system

Conventional projection televisions combine projected images from three cathode ray tubes into a single image, a process that always results in some unevenness in color and color bleeding. Instead of the conventional cathode ray tubes, this product uses a single liquid-crystal panel and the light from a high-brightness lamp directed through an independently designed optical system to project an enlarged high-pixel-density image. A short focal length projection system in which eleven spherical plastic lens and glass lens are combined was also developed. The result was a reduction of the distance between projector and screen to realize the slim body design.

— Direct contact liquid cooled projection system

When a lamp is used as the light source, the liquid-crystal panel must be cooled to protect it from heat damage. Forced-air cooling by a fan is the usual cooling method, but here cooling is accomplished by filling the space between the lens and the liquid-crystal panel with a liquid coolant. In an air-cooled system, reflection occurs at the interface between the air layer and the surface of the liquid-crystal panel, which reduces image contrast. However, because the refractive index of this coolant is close to that of glass, no reflection occurs at the coolant-glass interface and high image contrast is obtained. Although this cooling method has been used previously in cathode ray tube projection systems, this is the first time that it has been used for a liquid-crystal projection system.

Energy conservation, recycling, and other environmental considerations

— Problems in development

Because this cooling system places components in the liquid coolant and the conventional components are easily affected by that, the development of this product required replacement of those components by a process of trial and error. Also, obtaining a bright red color required much effort. Differently from cathode ray tubes, it is difficult obtain bright red from a liquid-crystal, but a good balance was gradually achieved through trial and error.

— Other special features

Because the progressive scanning method, in which twice the normal number of scan lines is displayed, is employed through use of a special progressive LSI chip, a low-flicker image that is easy on the eyes has been achieved. Furthermore, the reduced size of the optical system made it possible to give the back of the unit a triangular shape, with the result that this 52-inch display takes up no more space than a convention 29-inch unit (Hitachi product) in a corner installation. This unit is designed with energy conservation in mind and consumes approximately 30% less power than a cathode ray tube display. Giving consideration to the environment, also, materials that are easily recycled are employed. The unit is equipped with special terminals for digital broadcasting and products that can be connected to personal computers are also being developed. The "BIG SLIM 52" can thus be called a large-screen TV that holds a variety of possibilities.

The "BIG SLIM 52" liquid-crystal rear-projection TV is also suited for corner installation

Entire "Shirokuma-kun" Quick Refreshing PAM Air Conditioner Series Conforms to the Year 2004 COP Energy Conservation Law

Hitachi's residential-use cooling/heating/dehumidifying room air conditioner has won "The Energy Conservation Grand Award" (sponsored by the Juridical Foundation of the Energy Conservation Center, Japan) for five consecutive years. The newly released "Shirokuma-kun" Quick Refreshing PAM (pulse amplitude modulation) air conditioner series features a "wide-range PAM control" that has a 33% wider voltage range than the previous PAM, a high-efficiency "digital DC scroll compressor" designed for use with a new, ozone-friendly refrigerant, a "cool air on bare skin" function that controls temperature and humidity, and an "at-a-glance remote control" that displays the room temperature, room humidity, and outside temperature. These new technologies not only enhance the user's comfort and health, but also allow all units of the series to conform to the year 2004 COP (coefficient of performance) Energy Conservation Law. In addition, the 2.8-kW model in the series is the most energy efficient in the industry in terms of annual energy consumption.

Developing hardware for even higher energy efficiency

— Wide-range PAM control

PAM control technology efficiently operates a DC motor that drives a compressor from low to high speeds. "Wide-range" refers to the voltage-range expansion from the previous 150–330 V to 140–380 V. PAM control increases energy efficiency at low and medium speeds and boosts performance. This technology contributes greatly to COP improvements.

— Digital DC scroll compressor

The Shirokuma-kun series uses the new R410A refrigerant, which has an ozone depletion potential of zero. Because R410A is under roughly 1.5 times greater pressure than that of the previously used R22 refrigerant, maintaining pressure in the compressor is a concern. However, thanks to developments that prevent distortion of the fixed scroll unit and the orbiting scroll plate, plus a new shaft (which transfers motor rotation to the scroll unit) that reduces sliding resistance and a super-high-efficiency motor in which 16 rare-earth magnets are arranged in a star configuration in the motor rotor, all units in the series can use the new refrigerant.

Increased energy efficiency through new software technology

— Temperature & humidity control: "cool air on bare skin"

By further refining the "crisp and dry" dehumidification technology, which was developed six years ago, Hitachi has produced air conditioning devices that can create a healthy living environment that is not excessively cool by simultaneously controlling the temperature and humidity. Previously, if you set your air conditioner at 28°C so as not to be too cool compared to an outdoor temperature of 33°C, the humidity would still be an uncomfortable 75% and you would have to lower the temperature even more. With one push of the "cool air on bare skin" button, however, the temperature setting of 28°C automatically lowers the humidity to 50%. Thus you can feel comfortably cool without having to lower the temperature and you can enjoy an energy saving of about 10% as well.

The "Shirokuma-kun" quick refreshing PAM air conditioner series was developed by Kimimasa Shishido (left), Section Manager in the Refrigeration & Air Conditioning Div. of the Consumer Products Gr., Hitachi, Ltd. and Motoo Morimoto (right), Senior Engineer in the Air Conditioning System Design Dept. of Hitachi Tochigi Technologies Co., Ltd.

—"At-a-glance remote control"

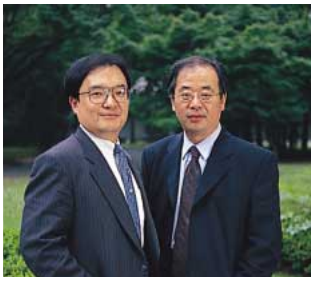
In earlier models, the remote control displayed only the desired temperature, so users sometimes impatiently lowered the setting. The "at-a-glance remote control," however, displays the room temperature, the room humidity, and the outside temperature, so users can see when the room reaches the desired temperature and humidity levels. This new remote control works together with the power lamps on the indoor unit (a red lamp for temperature and a green one for humidity indicate the degrees by which they have reached their settings) to operate the air conditioner with high energy efficiency.

— Design and ease of operation

In deference to the preferences of women, a pearl white color was chosen as the color of the main unit. Also, how-to-use and other operating tips are concisely summarized in the "quick guide" set in the control holder, so the functions of this series can be used effectively. In addition, the time required to reach the desired temperature in heating mode has been greatly reduced, which increases energy efficiency.

"Shirokuma-kun" quick refreshing PAM air conditioner "RAS-2210LX"

New PLEDM Semiconductor Memory Device Achieves Double the Memory Density of DRAM and Low Manufacturing Cost



Kazuo Nakazato (right), Chief Researcher, and Hiroshi Mizuta (left), Laboratory Manager and Senior Researcher, from the Hitachi Cambridge Laboratory, who are involved in the development of the new semiconductor memory, PLEDM.

In 1993, the Hitachi Cambridge Laboratory of Hitachi Europe Ltd. succeeded, in collaboration with the Cavendish Laboratory of Cambridge University, in demonstrating a new method of controlling individual electrons so as to record one bit of data with a small number of electrons. This "single-electron memory" is a first-in-the-world invention. Now, collaboration between the same two laboratories has resulted in the development of PLEDM (Phase-state Low Electron-number Drive Memory), an entirely new concept for high-density memory that combines the speed and memory density of DRAM with the non-volatility of flash memory. In May 1999, the researchers succeeded in verifying the basic operating principle of this new device.

Joint development with Cambridge University

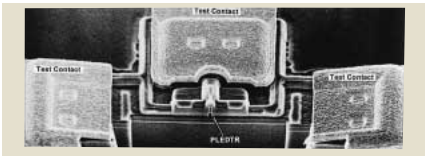
— Background to the creation of "PLEDM," a new type of memory device

Although the integration scale of the DRAM that currently serves as the main memory for computers has been increasing year-by-year through the application of finer process rules, it is getting difficult to meet contradiction requirements of further reduction in size and maintenance of performance for memory cells that record a signal for each bit of information. Also, because DRAM production requires a huge investment in facilities that extends into the future, the need to quickly establish a substitute technology has been felt. The Hitachi Cambridge Laboratory, which has expertise in device technology, and Cambridge University, which has been the birthplace of many progressive concepts, including the discovery of the electron, began collaboration in 1989, taking advantage of complementary strengths, and took up the challenge of developing new technology. In 1996, the idea of forming a thin insulation layer within a silicon layer and using it as a channel to control electron flow was born, and that became the basic concept for the PLEDM.

Combining the complementary merits of DRAM and flash memory

— Special features of PLEDM

The structure of this new PLEDM transistor consists of a channel that is formed by three extremely thin tunnel insulation layers that are on the order of a few nanometers ('nano' means one-billionth) thick. The height of the tunneling barrier can be changed by an external voltage so as to control the flow of electrons. Also, while a DRAM memory cell consists of a transistor and a capacitor for storing electrons, the PLEDM uses a transistor with gain instead of the capacitor and integrates the two solid state transistors, thus reducing cell size by half and realizing twice the memory density. Because the cell has a gain, the number of electrons stored in by one cell is reduced by a factor of 1/100, from a hundred thousand for the case of a DRAM cell to 1,000. Also, because the data writing transistor, which is the tunnel structure, stores electrons firmly, refresh (periodic supply of charge) load for maintaining the signal is lighter and the power consumption is greatly reduced. Furthermore, the fast 10 ns (nanosecond) or less read/write time of the PLEDM compares favorably with current DRAM and it is possible, in principle, to make the memory non-volatile by further optimization of the transistor structure. That is to say this new type of memory has the possibility of eliminating, in future, the need to choose between the two types of memory, i.e., high-speed, volatile DRAM and low-speed, non-volatile flash memory.



Electron photomicrograph of the experimental PLEDM transistor

— Is new investment in facilities needed?

Production of PLEDM devices does not require new materials or ultra-advanced processing technology. Not only can the current standard silicon process technology and fabrication lines can be used without modification, but we believe that the number of processes can actually be reduced by about 10% because fabrication of the capacitor is not required. Furthermore, as process technology improves, we expect that device voltages will be further reduced and the integration scale will increase.

— Future development

To begin with, we are aiming at achieving a commercial product that will replace high-speed, large-capacity DRAM in from three to five years. As the next step, we would like to proceed with R&D toward a PLEDM that will also replace hard disks and other such data storage devices.

Collaboration members from Hitachi Cambridge Laboratory and the Cavendish Laboratory, Cambridge University