Research & Development

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Advanced Model of the µ-chip and Latest Antenna Technology

Hitachi, Ltd. developed the world's smallest noncontact IC chip, called the "µ-chip (mu-chip)." Without a battery, the µ-chip converts antenna-received 2.45-GHz microwaves into energy and transmits 128-bit characteristic signals on a wireless basis. Hopes run high for utilizing the µ-chip for many applications, such as security, traceability, physical distribution, and production tracing & tracking, by taking advantage of its features of being very small, highly authentic, and noncontact. Hitachi has been promoting the development of technologies for finding even more possibilities for the µ-chip, recently succeeded in downsizing the µ-chip even more, and is now developing new antenna technology.

What are the Features of the Even Smaller µ-chip?

In July 2000, when we first confirmed that a µ-chip measuring 4 mm per side and 60-µm thick worked, we declared, "The µ-chip will continue to evolve." As promised, we developed a chip of 0.3 mm per side in February 2003, and then developed and confirmed the operation of an even smaller model, measuring 0.15 mm per side and 7.5-µm thick in February 2006. The latest model is very small, occupying one-seventh of the area and having one-eighth of the thickness of the currently available model that measures 4 mm per side and is 60-µm thick.

SOI (silicon-on-insulator) technology, employed for the first time in a noncontact IC chip, made such size reduction possible. SOI technology incorporates an insulator layer between devices, and is thus capable of achieving higher rates of integration than conventional silicon boards. We also developed a technology for completely removing the silicon layer from the back of the SOI board, thus making the board even thinner.

What are the Advantages of Size Reduction?

The µ-chip offers many advantages. Most prominently, it can be contained in ordinary paper as thin as about 100 µm. Consequently, the tiny µ-chip can be contained in paper without causing the user any anxiety about using it. You could say that this has paved the way for applying chips to prevent the forgery of securities, certificates, bank notes, and other paper-based commodities. Moreover, larger quantities of the latest µ-chip model can be made from each piece of wafer, so that about ten times the productivity of the currently available µ-chip is expected to be achieved.

What are the Latest Antenna Technologies and their Prospects?

One new technology increases communication distance. We discovered its principle of operation by chance. When conducting research in another field, we noticed that placing multiple µ-chip inlets (µ-chips with an external antenna) close together enabled a longer communication distance than that by one isolated µ-chip. We then applied this principle to develop a special-purpose label (62 mm by 76 mm) containing a thin-film antenna. This technology takes advantage of the µ-chip's characteristic high receptiveness to radio waves from outside. The µ-chips are the only kind of noncontact IC tag with such a characteristic.

Mitsuo Usami (left), Chief Researcher; Hisao Tanabe (right), Sensor Net Strategy Project, Central Research Laboratory, Hitachi, Ltd.

By simply attaching one of the µ-chip inlets now being mass-produced to a recently developed special-purpose label, the communication distance (which was previously no more than 30 cm) can be increased up to about 70 cm. Moreover, by using µ-chip inlets as labels for door-to-door delivery service, for example, the sorting of packages can be automated. The µ-chip will thus achieve a wider range of applications in the field of physical distribution.

Another point is the development of a small external antenna measuring 4 mm by 3 mm. Such an antenna achieves a longer communication distance than µ-chips with a built-in antenna and can be mounted on very small objects. The antenna can therefore be used to specifically control pharmaceutical drugs and other products.

Expectations run high for the use of µ-chips in various fields. To enhance these possibilities, we intend to continue upgrading the µ-chip and developing technologies for expanding the range of applications for currently available chips.

The current chip (left), the newly developed chip (middle), and a mechanical pencil lead (right). Newly developed chip is 0.15 mm per side and 7.5-µm thick. The new chip occupies only one-seventh of the area and one-eighth of the thickness of the current model, which measures 0.4 mm per side and is 60-µm thick.

Running Performance Simulator for Estimating Hybrid Propulsion Systems—a Device for Accurately Estimating the Effects of Hybrid Railcar Advantage in Advance

Railroad transport faces the challenge of how to save energy, one means of environmental protection against global warming. Hopes therefore run high for the development of fuel-efficient technology. Hitachi, Ltd. and East Japan Railway Company (JR-East) have been working actively to develop hybrid railcar by incorporating hybrid technology. The efficient control of hybrid propulsion systems requires accurate estimation in advance. To meet that need, the researchers have developed a running performance simulator for making estimation with an error rate of less than 5% as compared to the results of actual runs of hybrid railcar.

Yutaka Sato (left), Senior Researcher, and Tsutomu Miyauchi (right), Researcher, at the Railway Traffic Systems Unit, Third Dept. of the Systems Research, Hitachi Research Laboratory

What Prompted the Development of Hybrid Railcar?

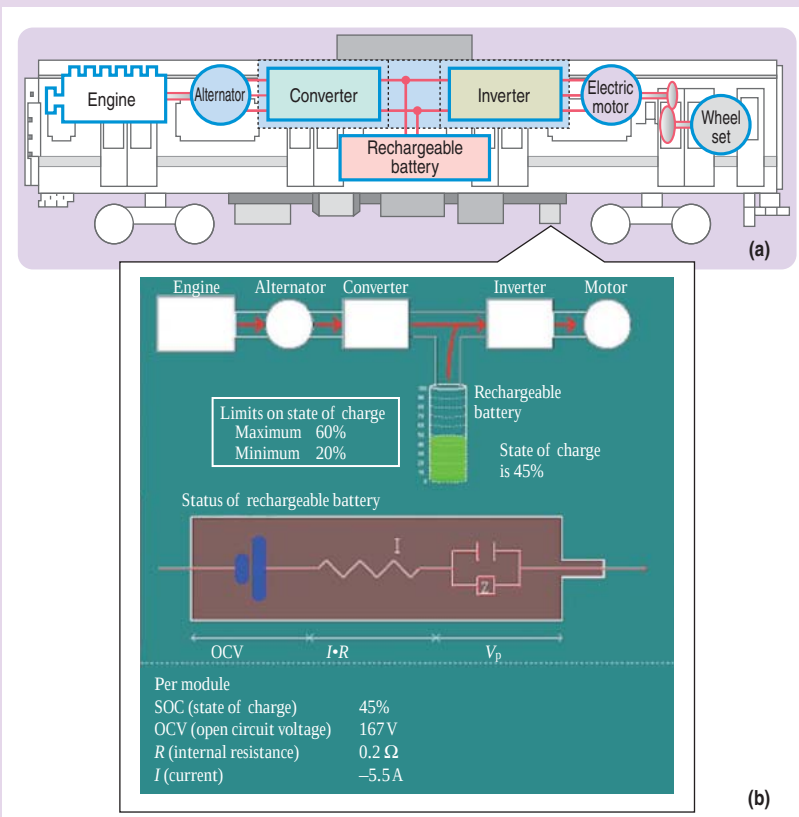
Of all railcars, diesel railcars still have much room for energy-saving improvement. In 2003, Hitachi, Ltd. and JR-East developed and tested a hybrid propulsion system (combining an engine power generator with a lithium ion battery) as the first step in developing power systems based on energy storage technology. That development was based on hybrid automobile technology.

What is the Purpose of Running Performance Simulator?

The hybrid propulsion system diligently supplies energy by using a engine and a rechargeable battery which charges regenerated brake energy, thus curtailing fuel consumption. To allow the system to exhibit its full capabilities, one must make an estimation in advance to determine how best to run the railcar, and under what conditions, for achieving the most efficient energy consumption and exhaust gas control possible, and then control the railcar according to the results. This prompted us to develop a running performance simulator for estimating hybrid propulsion systems. We forced on how to reproduce the action of the rechargeable battery. We actually ran rechargeable batteries used in hybrid automobiles and simulated the action of Lithium ions whose chemical properties change during repeated electrical charge and discharge. In so doing, we achieved very high performance of the simulator in its accuracy: an error rate of 5% from actual running results.

Future Prospects

Hybrid railcar is both environmentally friendly and people-friendly. Conventional diesel railcars require special work during maintenance. For instance, oily machine parts must be disassembled, inspected, and then reassembled. Hybrid railcar driven by an electric power system requires no such work. In addition to needing less maintenance, hybrid railcar offers yet another advantage in saving energy as well. The development of the running performance simulator enables the effects of hybrid railcar to be accurately estimated in advance. Moreover, we intend to make this technology useful in hybridizing diesel railcars that are widely used by many railways in the world.



System configuration of hybrid railcar (a) and example of simulation output (b)

Development of High-temperature, Lead-free Solder—New Material Contributing to Environmental Conservation

In view of ongoing worldwide campaigns promoting environmental conservation, restrictions are becoming increasingly stringent on the use of lead, a material highly toxic to humans and other living things. The "solder" used in electrical and electronic equipment is no exception, and lead-free solder is now replacing conventional types of solder. Under these circumstances, there is an urgent demand for developing an alternative material to high-temperature solder in particular. To address that challenge, Hitachi's Production Engineering Research Laboratory successfully developed a high-temperature, lead-free solder paste jointly with Senju Metal Industry Co., Ltd. This new material received the "Minister of the Environment's Prize" and "the First Rank of Environment Prize" in the Environment Prize in fiscal 2005, and has attracted much attention as a means of paving the way for completely lead-free electrical and electronic equipment.


Masahide Okamoto (left), Senior Researcher, Dept. of Packaging Technology Solutions; Yasushi Ikeda (right), Researcher, Mounted Solutions Research Dept., Production Engineering Research Laboratory

What is the Context of Development?

Lead is a substance that has been used in various areas and also widely used in "solder," which is used to connect the parts of electrical and electronic equipment. In recent years, however, as the toxicity of lead to humans and other living things has been revealed, restrictions on its use have intensified. In fact, the RoHS (Restriction of Hazardous Substances) Directive, which will be enforced in the 25 member states of the EU beginning in July 2006, designates lead as one of the certain hazardous substances to be prohibited in electrical and electronic equipment.

Solder is categorized by temperature (low, mid, and high temperature) depending on its melting point. Low- and mid-temperature solder is already being replaced by lead-free types. However, no practicable alternative has been found for high-temperature solder, which has a high lead content (of 90% or more). Consequently, it was excluded from the RoHS Directive, prompting an urgent need for a lead-free, high-temperature solder. Aiming to make its products completely lead-free for sustainability, Hitachi, Ltd. began materials research and development at an early stage. Senju Metal Industry Co., Ltd., Japan's largest solder manufacturer, undertook pasting and other technologies. That company and Hitachi then succeeded in jointly developing "high-temperature, lead-free solder paste."

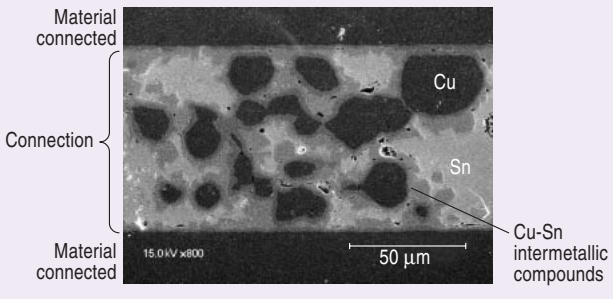
What are the Features of High-temperature, Lead-free Solder Paste?

The greatest feature of the product is probably that it has redefined the concept of solder. Versions of conventional solder are alloys consisting of tin and lead. These types generally melt when heated and harden when cooled, thus connecting the parts that they are supposed to connect. Conversely, "high-temperature, lead-free solder paste" is a mixture of copper powder and tin-based solder powder. When this solder is heated, only the tin (which has a low melting point) melts. The unmolten copper powder is then mixed in a copper-tin compound having a high melting point. The copper powder and copper-tin compound, along with the residual tin after the rest of the material melts, combine to connect the target parts. That is how it works.

We believe that the development of this next-generation solder material has been made possible through an original approach toward making connections by using different melting points and irreversible reaction, although the material only consists of a simple mixture of copper powder and tin-based solder powder.

What will Become of the High-temperature, Lead-free Solder Material?

The high-temperature, lead-free solder paste was recognized for having paved the way for making electrical and electronic equipment completely lead-free. Consequently, it received "Minister of the Environment's Prize" and "the First Rank of Environment Prize" in the Environment Prize in fiscal 2005, which is sponsored by The Nikkan Kogyo Shimbun, Ltd. and The Hitachi Environment Foundation, and granted each year to personnel engaged in technologies, studies, or other projects that have produced significant results for environmental conservation. Given the reliability of this material, along with its cost performance that affords high practicability, we are working to put the material to practical use in an attempt to make it a global standard for high-temperature solder, while addressing the challenge of optimizing solder paste so as to match the targets to be connected.



Cross section of connection made by high-temperature lead-free solder

Organic Light-emitting Diode Display

OLED (organic light-emitting diode) displays are known as next-generation flat panel displays because they have many advantages such as thinness, lightness, ideal moving picture quality, wide viewing-angle reproduction, etc. To apply OLED displays to mobile applications, Hitachi has developed a peak-luminance driving technology and a low-power pixel circuit. These technologies have been demonstrated in 7- and 2.5-inch OLED prototype displays. The OLED displays perform up to 3 times of peak brightness without increasing the maximum power consumption. An OLED display consumes power according to OLED emission, so a brighter picture requires more power than a darker picture does. A natural picture with a peak luminance of 450 cd/m^2 consumes less power than an all white raster picture at 150 cd/m^2. The peak-luminance driving is maintained without any color balance degradation, thanks to the original pixel driving architecture. The pixel circuit also lowers pixel power consumption to almost half that of a conventional one. The demonstrated OLED displays consume almost half of the power that ordinary liquid crystal displays consume.

7-inch OLED display shown at 2006 International CES

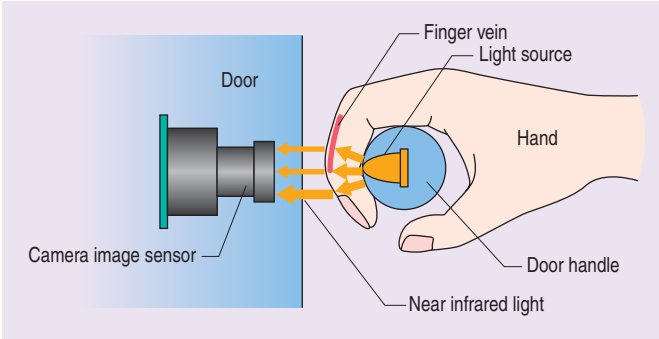
2.5-inch OLED display

Prototype OLED displays

Grip-type Finger Vein Authentication Technology

Hitachi has developed an advanced technology for personal identification using finger vein patterns. In this technology, identities can be authenticated by simply gripping a handle. The vein pattern of a finger is captured and checked during the gripping. No special maneuver is required for authentication. Vein patterns are observed by transmitting near-infrared light through the finger. As shown in the figure, the light source is incorporated in the door handle, and the camera is located within the door. While gripping, the backside of the finger faces the camera. The vein pattern on the backside is unclear when the finger is stretched due to the skin slackening. However, when the finger is bent, a clear and unique finger vein pattern appears that is enough to identify a person. If an authorized person grips and pulls the door handle, the door is automatically unlocked for entry. A user do not have to carry a key or any device such as a radio transmitter any longer. This technology is applicable to key-free systems for motor vehicles, home security, etc.

System prototype



Finger vein imaging principle

Prototype Wristband-style Sensor Node for New IT Services

Sensor nets provide new kinds of IT (information technology) services based on real-time and real-world sensing data from massive wireless sensor devices, called sensor nodes. A wristband-style sensor node is a powerful device for sensing human activities or one's physical condition. Hitachi, Ltd. has developed a prototype wristband sensor node that monitors a person's movement, blood pulse, or temperature through wireless communication. This compact sensor node, weighing just 50 g, integrates a micro-computer, a pulse sensor, a 3-dimensional acceleration sensor, a temperature sensor, push button switches, an LCD (liquid crystal display), RF (radio frequency) circuits, an antenna, and a Li-ion rechargeable battery in a space of 6 cm (h) × 4 cm (w) × 1.5 cm (d) and can be easily worn. This sensor node can intermittently measure the pulse or movement of the wearer and send these data to a server through the wireless network. It can also send an event of push button down to the server or receive short messages from the server. Of course, it can also be used as a watch. This sensor node is expected to be applied in services such as healthcare management and home support of the elderly.

Wristband-type sensor node (prototype)

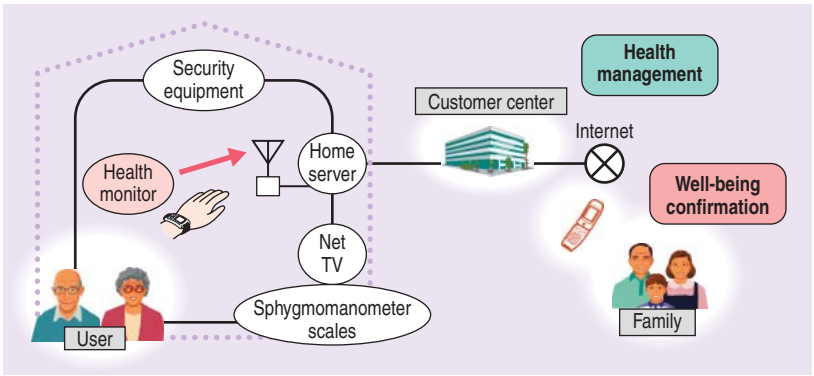
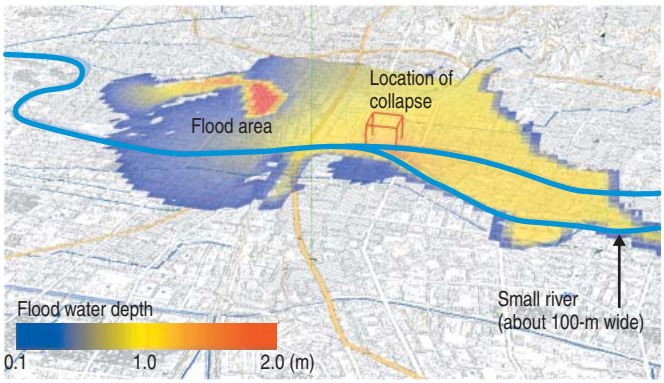


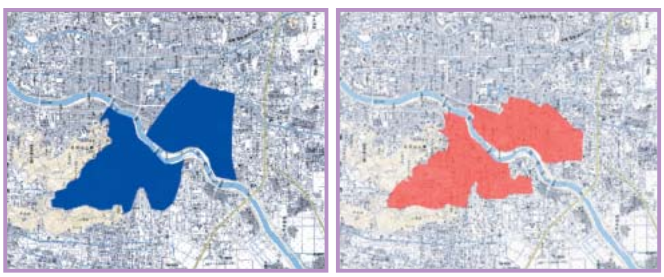
Image of home support service for the elderly

Technology for Quickly Simulating Floods on Three-dimensional Map

Hitachi has developed a fast flood simulation technology based on a three-dimensional geographic information system. The computing time of the simulation is considerably reduced by dynamically predicting the flood area shape. Thus, only few minutes are needed to simulate a flood water flow in an urban area using a personal computer. The simulation results can be instantaneously displayed on a three-dimensional map. The results have been compared to real data obtained from surveys of flood disaster sites; a high correlation has been found between them. This technology is used for forecasting of flood areas or flood water depths based on geographic information; thus, it contributes to municipal disaster prevention activities such as creating flood hazard maps or action plans.



Three-dimensional view of flood simulation result

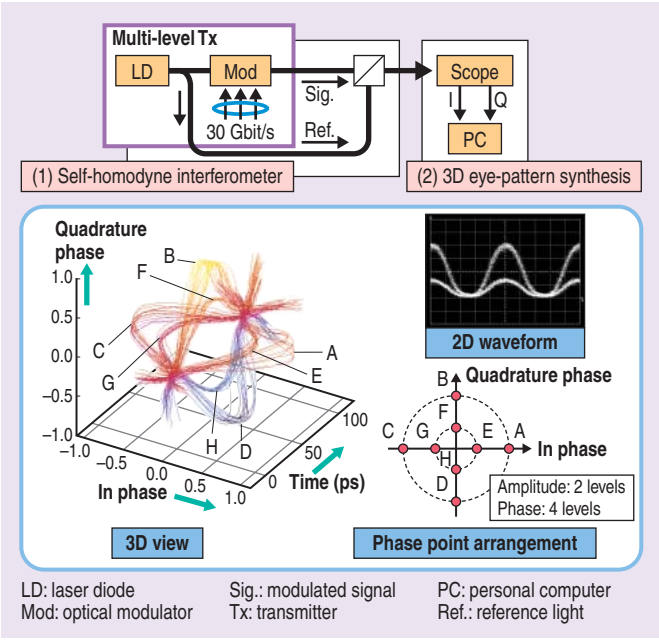


Actual flood survey result (left) and simulation result (right)

First 3D Visualization of Amplitude and Phase of High-speed Optical Signal

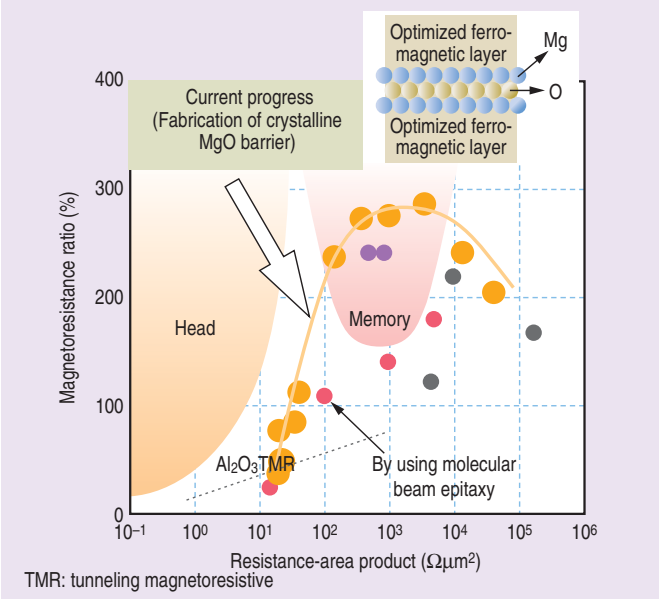
Hitachi has developed the technique for three-dimensionally visualizing the amplitude and phase of high-speed optical signals. This technique will be a key to increasing information traffic carried over the next-generation high-speed core (inter-city) and metro (intra-city) optical fiber networks.

Conventional high-speed optical communication systems, for example, 10-Gbit/s systems, use only two levels of "optical amplitudes" (high and low). To increase the information traffic carried by a single fiber to meet increasing demand of the next-generation networks, the modulation of "optical phases" (time delays of optical waves) is now being seriously considered. However, optical phases are invisible, and the precise assessment of such waveforms is a key to developing practical transceivers. Therefore, Hitachi has combined two techniques to overcome this problem: (1) a precise optical field measurement technique using self-homodyne interferometry to simultaneously visualize the in-phase and the quadrature-phase components of the optical signal, and (2) a technique of three-dimensionally visualizing optical field waveforms to enable intuitive interpretations of them. They will be used to analyze and improve phase-modulated and multilevel-modulated waveforms for the further development of next-generation high-speed optical transceivers.



First 3D visualization of amplitude and phase of high-speed optical signal

Magnetic Tunnel Junctions with Magneto-resistive Ratios around 300% at Room Temperature

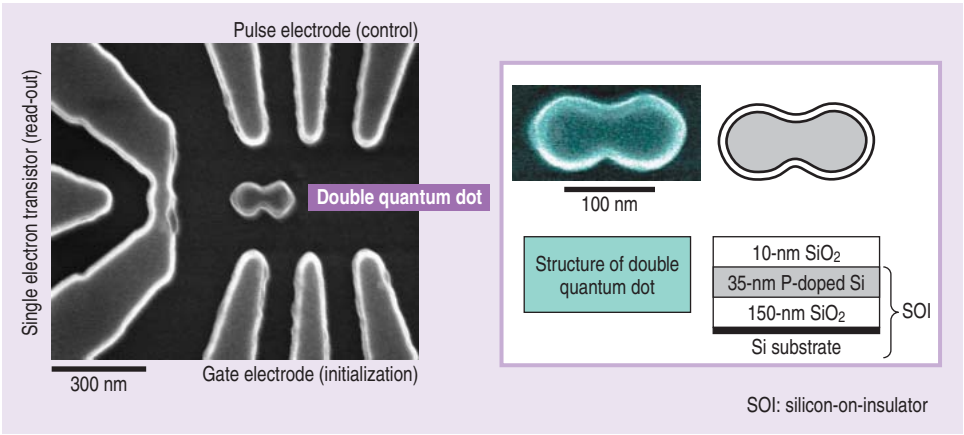


Signal strength from TMR device required to read magnetic data

To develop future spin memory [MRAM (magnetic random access memory), SPRAM (spin-transfer-torque random access memory)], MTJs (magnetic tunnel junctions) need to be improved. An MTJ basically consists of an insulating layer between two magnetic layers with different coercivities. Current flows perpendicular to the plane and the resistance changes according to the magnetic configurations (parallel and anti-parallel) of these magnetic layers. A well-known MTJ whose insulating layer is Al_2O_3 poly-crystal has an MR (magneto-resistance) ratio smaller than 60%. In this study, an MR ratio of 287% at room temperature was obtained by applying a MgO ordered insulating layer in an MTJ. Films were grown using a conventional UHV-sputtering apparatus. However, two important changes were applied: (1) The material of the magnetic layers was changed to CoFeB; (2) The adequate annealing temperature makes (100)-ordered MgO films. These giant-MR MgO-MTJ films are candidates for future memory applications after their spin-transfer torque phenomena are studied further. This information was released to the press on April 6, 2005. This study was supported by the IT program of Research Revolution 2002: "Development of Universal Low-power Spin Memory," MEXT of Japan.

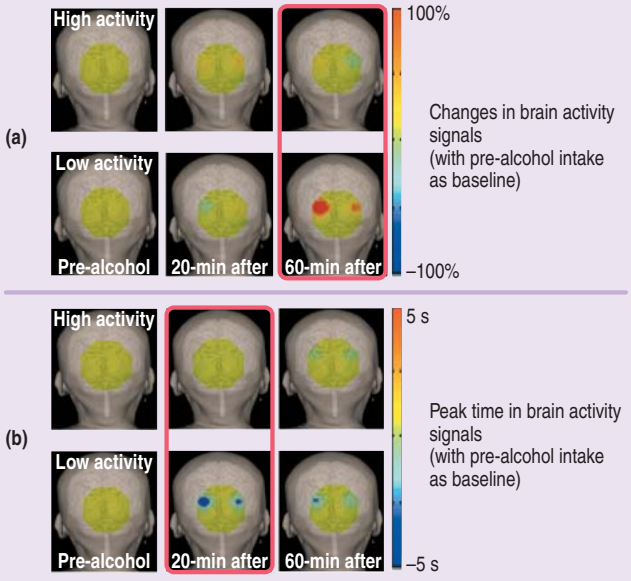
Si Qubit—Breakthrough for Quantum Computing

Collaborative research between the University of Cambridge and Hitachi Europe Ltd., has resulted in the development of a silicon device for quantum computing: a quantum-dot charge qubit. The research team comprised of researchers from the Cavendish Laboratory and the Hitachi Cambridge Laboratory, achieved significant breakthroughs in what previously were considered the weak points of semiconductor quantum-dot systems: short coherence time and scalability. Using an isolated double quantum dot as a qubit, all operations were achieved using electrodes for initialization and manipulation and a single-electron transistor for measurement. The scheme provides a long coherence time (100 times longer than in other solid-state implementations) and flexibility in design because the qubits may be combined in a variety of two-dimensional circuits, as in conventional microprocessors. The team demonstrated qubit operation of a silicon circuit made using standard fabrication techniques. This structure, based on years of work on single-electron devices, is the first step in the development of a quantum computer based on conventional silicon technology.



Silicon qubit developed

Successful Imaging of Brain Activity after Alcohol Intake Using Optical Topography



Reference: Obata, et al., Psychiatry Research: *Neuroimaging* 139 (2005) 65-72.
Collaboration with Osaka University Graduate School of Medicine.

Hitachi has developed OT (optical topography) equipment that can visualize regional hemodynamic responses (henceforth, brain activity signals) induced by brain activity by using near-infrared light. Research teams used OT to measure the changes in brain function following a visual stimulus before and after alcohol intake. In people of East Asian descent, three genotypes of aldehyde dehydrogenase 2 are known to metabolize acetaldehyde, an intermediate metabolite of alcohol: a high-activity type, a low-activity type, and a non-active type. The results showed that with the low-activity type subjects, brain activity following a visual stimulus differed significantly before and after alcohol intake. This is the first finding that shows that changes in brain activity signals are influenced by the genotype related to alcohol metabolism and that the effect of metabolites on brain function can be measured using OT. This may be an important achievement in the development of pharmaceutical drugs for individual constitutions and in furthering studies on the effects of pharmaceutical drugs and metabolites on brain functions.

Changes in brain activity signals (a), peak time in brain activity signals (b)

Human Symbiotic Robot EMIEW in The 2005 World Exposition, Aichi, Japan

Hitachi is developing robots capable of helping people, i.e. human symbiotic robots. These kinds of robots must be able to coexist with people, be user friendly, and be capable of supporting people. As a step toward this final goal, Hitachi developed an autonomous mobile robot named EMIEW* (excellent mobility and interactive existence as workmate), and it appeared in The 2005 World Exposition, Aichi, Japan.

Human-symbiotic robot EMIEW

[Main features]

(1) Collision avoidance capability for moving safely through complex environments, developed from joint research of Tsukuba University and Hitachi, Ltd.

(2) Self-balancing two-wheel mobile system and a body side-swing mechanism to shift the center of gravity. This allows the robot to move nimbly, at a clip of 6 km/h.

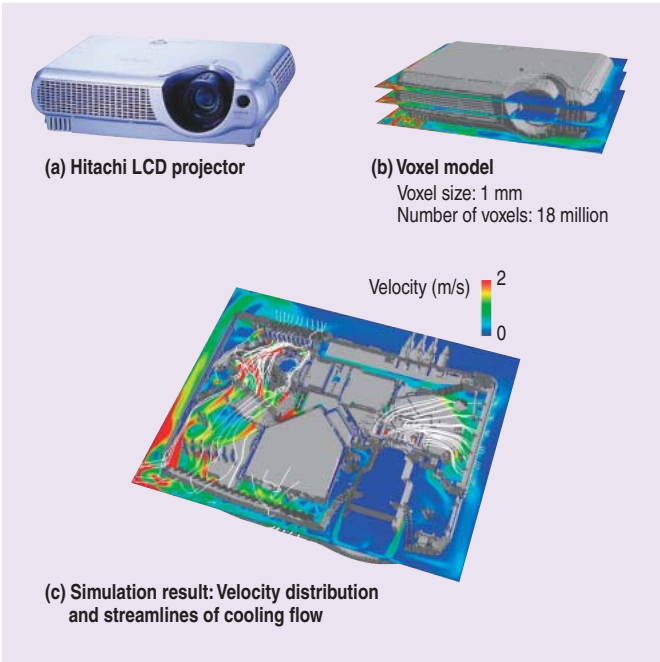
(3) Ability to interact with people naturally without special tools by means of distant speech recognition technology and high-quality speech synthesis technology.

In the Expo, EMIEWs played roles as waiters in a futuristic robotic café. They accepted orders from the audience, brought the orders to a property man, and carried the goods to the audience while avoiding obstacles.

* EMIEW was developed in a project entrusted by NEDO (The New Energy and Industrial Technology Development Organization).

A System of CFD with Heat Transfer for the Entire Bodies of Products Using the Voxel Method

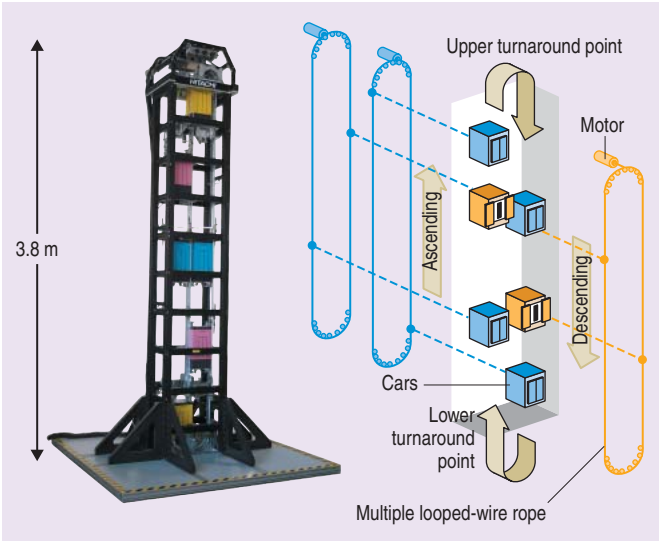
A system of CFD (computational fluid dynamics) with heat transfer has been developed. This system enables predicting and checking flow-field problems for the entire body of a product, which is almost impossible using conventional individual simulations of the sub-units of parts. This system is based on the voxel method. A voxel is a "volume cell" that is a uniform space in a Cartesian grid system. In the voxel method, a mesh is generated depending on whether a body element is inside or outside a cell. Therefore, this system significantly reduces time and can be used to automatically generate meshes from CAD (computer-aided design) data, even if the geometries are highly complicated. Although this simulation solver increases the total number of meshes, it is designed for parallel computation and reduces total computation times. Hitachi has applied this simulation system to design LCD (liquid crystal display) projectors, which are too complicated to generate meshes using conventional simulation methods, and has shortened the period needed to design cooling systems and reduced the necessary number of trial products. This simulation system will be applied to design other information and electronic products.



Hitachi LCD projector, voxel model, and simulation result

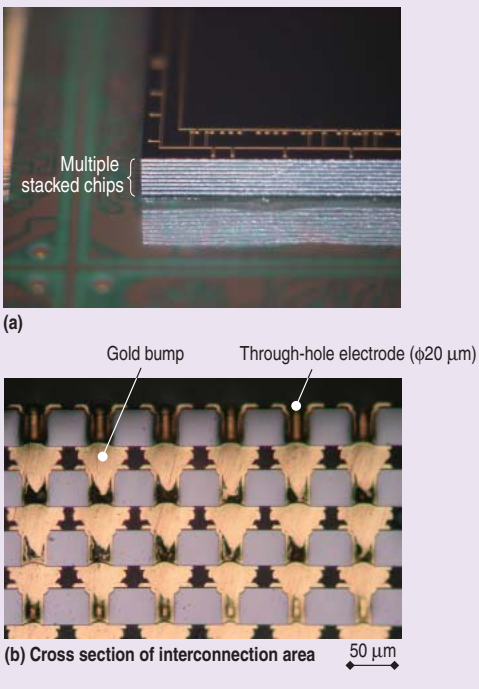
Circulation-type Multi-car Elevator

Hitachi's Mechanical Engineering Research Laboratory has developed the basic drive technology for a circulation-type multi-car elevator and has checked its effectiveness using a 1/10-size prototype. As buildings become taller, more elevators are required because of increasing human vertical traffic, so office and residence space is decreased to make elevator space. A circulating multi-car elevator makes it possible to expand the usable space of buildings by decreasing the number of elevator shafts without raising congestion and waiting times because of its significantly high transport capacity, which is more than double that of conventional elevators. This technology enables multiple cars to be circulated independently within the space of only two shafts. A multiple looped-wire rope drive system has been developed to enable the independent operation of each car. Due to this flexibility, the waiting time caused by passengers getting on and off is dramatically reduced. Combining this technology with that of conventional elevators and optimizing the layout is expected to reconcile the increase of income from rentable space and the convenience of vertical transportation in high-rise buildings.



1/10-size prototype and its drive technology

Si Through-hole Electrode Technology Enabling Interconnection of Stacked Chips at Room Temperature



Ten-chip stacked 3D-SiP using room-temperature bonding

In rapidly growing market sectors such as mobile information devices, SiP technology, in which multiple LSI chips are stacked three-dimensionally, is attracting attention as a means of greatly reducing the mounting area of electronic components to improve system performance while reducing system size.

Hitachi, Ltd. and Renesas Technology Corp. developed a way to interconnect stacked chips using through-hole electrodes with a lower cost and shorter turnaround time. Stacked chips are electrically interconnected by simply applying a compressive force at room temperature to a conventional chip with multiple gold stud bumps. Gold stud bumps on the upper chips are pressed into the through-hole electrodes on the lower chips by applying a compressive force, which causes plastic to flow into the gold bump. That is, the use of a "mechanical caulking" technique makes possible electrical connections between stacked chips at room temperature. Compared with conventional through-hole electrode interconnection (at more than 200˚C), this new method drastically reduces the production cost and the environmental load. By using this technology, the package thickness can be 1.0 mm or less even in ten-chip layers, compared with two-chip layers using wire bonding, which are approximately 1.25-mm thick.

Li-ion Battery Control Technology for a Vehicle

Around a hundred single cells are connected in series in Li-ion secondary battery systems for HEVs (hybrid electric vehicles) or FCEVs (fuel cell-powered electric vehicles). These cells tend to disperse in performance according to their individual self-discharge rates and deterioration grades. Equalizing the capacities of the cells using an electric circuit called a cell controller is essential to make use of their excellent intrinsic performances such as the high energy density and high power capability of the cells. The cell controller detects cell conditions such as voltage and temperature, equalizes the charge level among the cells, and communicates with the battery controller, which monitors and controls the whole battery system. Because cell controllers have many circuits such as cell voltage monitoring circuits and equalizing circuits, making them compact is difficult. In particular, many isolators are required for each certain number of cells because the cells are connected in series and their voltage potentials are different. These isolators prevent both the miniaturization and the reduction of the costs of cell controllers.

Hitachi, Ltd. and Hitachi Vehicle Energy, Ltd. have co-developed a dedicated control IC to solve the problems described above.

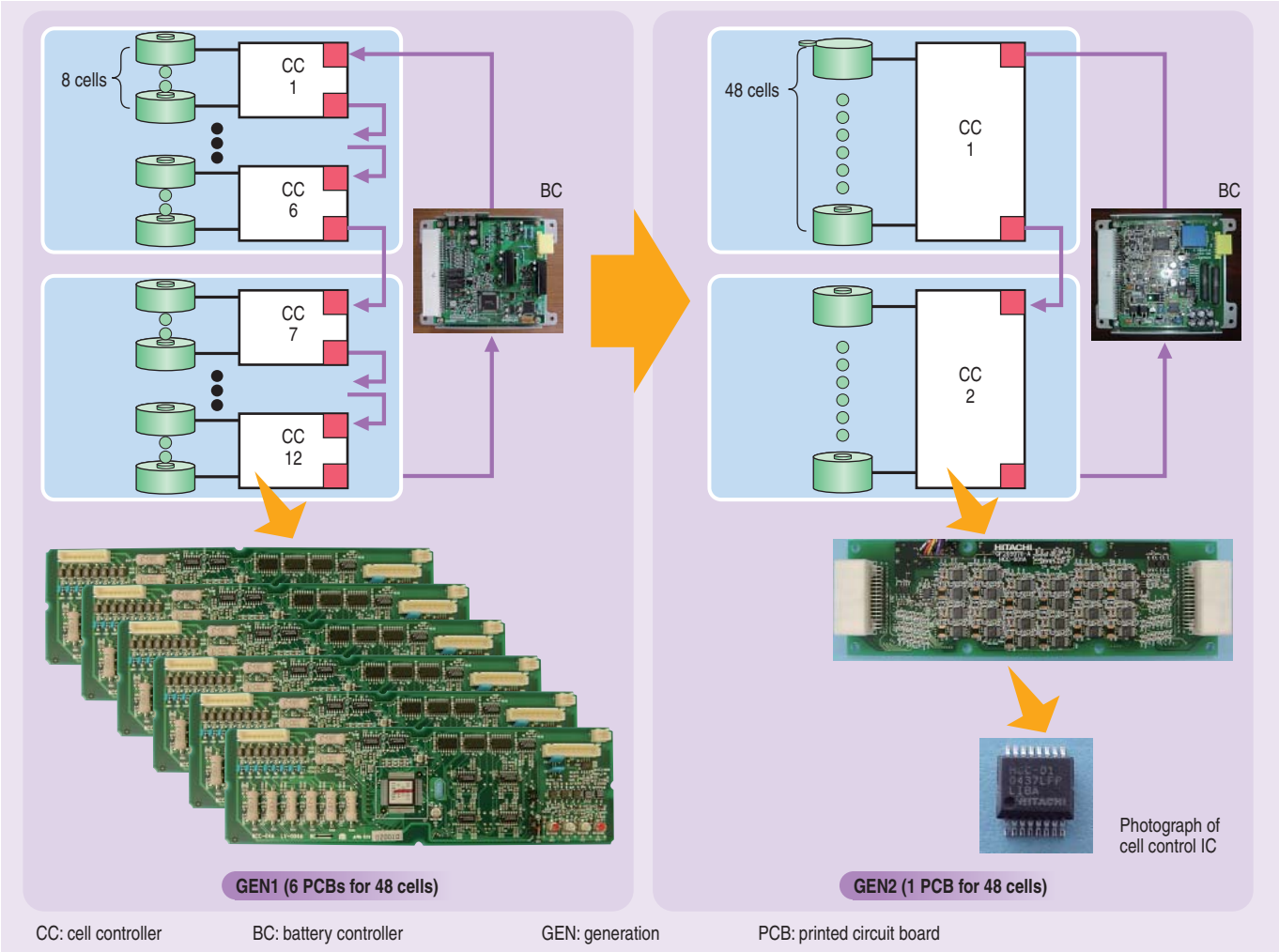
[Key technologies]

(1) The functions and circuits of a cell controller are integrated into a single IC that is based on a high-voltage, mixed-signal process.

(2) An architecture was devised featuring "high-voltage isolationless daisy-chain" signal transmission between ICs, and this architecture was implemented using dedicated control ICs.

As a result, a cell controller using the above ICs has reduced its cost to 1/8, volume to 1/10, and failure rate to 1/30 of the previous model. We have started sample work for a Li-ion secondary battery module using the cell controller of the dedicated ICs. The battery system is designed for HEVs and FCEVs, but will also be applicable to hybrid railway vehicles, power storage facilities, and the like.

This work is supported in part by NEDO (The New Energy and Industrial Technology Development Organization).



Comparison of battery modules

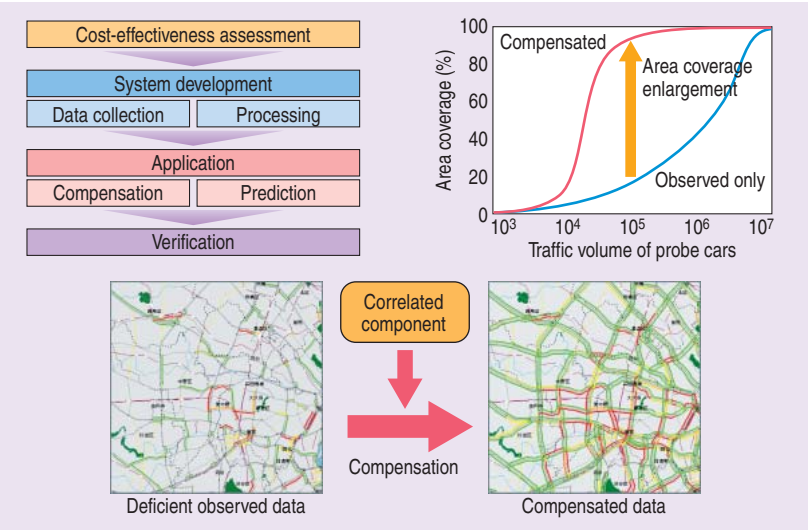
Probe Car System for Enlarging Area Coverage of Traffic Information Services

Hitachi provides a total solution for probe car systems for traffic information services. The solution consists of a cost-effectiveness assessment, data processing technologies for large-scale data handling, and statistical methods for useful applications.

Because of the random routes and timing of probe cars, the quality of probe car data is not in linear proportion to the number of cars. To address this problem, we clarify the relationship between the data quality and the traffic number of probe cars based on theoretical analysis of a probability model.

In addition to the fundamental data processing methods necessary for accurate traffic information, we also provide a realtime application that compensates for deficient probe car data. The method enlarges the covered traffic information area to more than five times that of the observed data, based on the correlation analysis of probe car data on multiple road-links. Furthermore, by using a prediction application with the compensated information, we can maximize the value of probe car systems and extend traffic information services to be available anytime, anywhere.

We are now applying our solutions to large-scale experiments in Beijing, China (2004–) and Tokyo, Japan (2005–), which demonstrate the performance of probe car systems.



Solution for probe car systems

Mild Torque Control Technique Raises Efficiency and Reduces Noise of Compressors of Air Conditioners and Refrigerators

Compressors used for air conditioners and refrigerators generate periodic load variations. These variations cause the noise of the products. It can be reduced using a conventional technique, but this technique increases the motor current pulsation. As a result, the motor efficiency slightly falls.

Hitachi developed the “mild torque control technique.” This technique can control both the noise and motor current loss, which can be adjusted to optimal conditions.

This new technique can be used to reduce the noise and raise the efficiency of air conditioners and refrigerators.

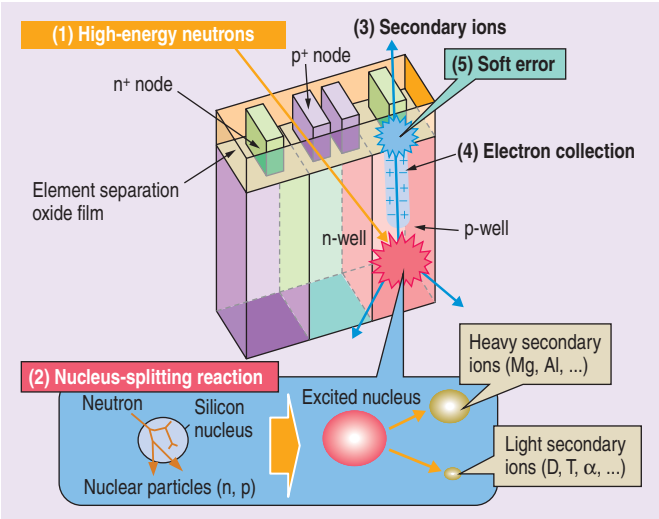
Mild torque control technique increases efficiency and reduces noise of compressors of air conditioners and refrigerators.

Integrated System for Evaluating Tolerance to Soft Errors Caused by Cosmic Ray Neutrons in Semiconductor Memory

As a result of nuclear reactions between cosmic rays and the earth's atmosphere, high-energy neutrons reach the earth and cause soft errors in semiconductor memory. An integrated system for evaluating these soft errors has been developed and has become the core method for assessing the influence of this phenomenon and for evaluating countermeasures.

The system is composed of: (1) measurement technology for monitoring the neutron environment on the earth, (2) high-energy neutron beam acceleration testing technology, (3) technology for simulating the behavior of a nuclear spallation reaction between a neutron and device component material and for simulating the resulting production of secondary ions, and (4) technology for simulating the reactions that occur in a device as a result of these secondary ions. This system can duplicate the details and predict soft errors.

The primary component of the experimental evaluation method has been accepted as the standard testing method in Japan and the USA. Furthermore, the method includes simulation technology for establishing countermeasures for soft errors.



Simulation model of occurrence of soft errors associated with bombardment of high-energy neutrons on semiconductor memory cell [Phenomenon sequence: (1) → (5)]

Network and Platform for Audio-visual Equipment

Aiming at development of AV (audio-visual) equipment—which is becoming more complex in order to handle networks—efficiently while taking reliability and extendibility into account, we are developing a platform that can flexibly handle changes in environment and accommodate new technologies.

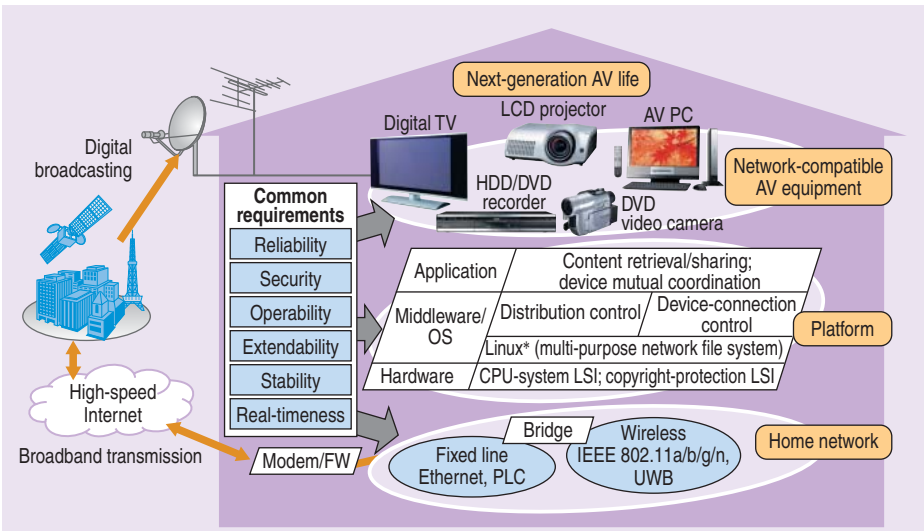
[Main specifications]

(1) Linux is adopted, and technologies made highly reliable by Hitachi's accumulated business systems and security-enhancing technologies for network capability are applied.

(2) Component sharing is achieved by introducing component technologies, and efficiency of developing AV equipment—which has become more complex by network compatibility—is improved.

(3) AV content-sharing technology for sharing content among devices and copyright-protection technology for preventing data leakage to the Internet and stopping fraudulent copying are applied.

From now onwards, it is considered that this platform will be utilized to realize a industry-leading development speeds.



FW: firewall LCD: liquid crystal display PLC: programmable logic controller UWB: ultra-wide band
HDD/DVD: hard disc drive/digital versatile disc OS: operating system CPU: central processing unit
LSI: large-scale integration

AV equipment network and platform

* See "Trademarks" on page 94.