Research and Development at Fujitsu Laboratories

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Fujitsu Laboratories continues to advance R&D in meeting the challenges of a new era in line with its mission of being "the research laboratory for the 21st century." In order to create a future ubiquitous information society sensitive to the needs of people while also being gentle to the earth's environment, we have been developing technologies that will define the future by focusing our efforts on materials, devices, networks, and computer systems. Fujitsu Laboratories also participates in a wide range of activities to realize safe and comfortable solutions for people. We must develop and expand our leading-edge technologies on a global basis. Toward that end, research bases established in the U.S., Europe, and China are working in collaboration. In terms of R&D management, individual laboratories share roadmaps for technology. This paper briefly introduces the R&D management and activities being conducted at Fujitsu Laboratories, with particular focus on the theme taken up by this special edition.

1. Introduction

The amount of information being exchanged over the Internet has increased dramatically. Our ubiquitous information society has entered a new stage where information sent instantaneously by individuals worldwide is having a large impact on corporate activities. Supported by the progress made in leading-edge device and material technology, Information and Communication Technology (ICT) has taken root and advanced as one infrastructure that supports our ubiquitous information society. As a result, the use of ICT in wide-ranging areas has accelerated. ICT is also bringing about new social impact. For example, an attempt has been made to use ICT to analyze actual corporate activities and simulate various flows of activities in a virtual society in order to make those activities "visible". The results of such simulation can then be fed back to corporate activities actually undertaken in society. An attempt has also been made to create new rules regarding copyrights. The environment involving ICT has been changing at an ever-increasing rate and the ways of using ICT are also quickly becoming globalized.

To meet the challenges of a new era in line with its mission of being "a Model Research Lab for the 21st Century", Fujitsu Laboratories has continued to advance R&D toward a ubiquitous information society by being user-friendly while also conscious of the earth's environment. We have been striving to improve the levels of performance and develop novel products in various fields of research including materials, devices, networks, and computer systems. Fujitsu Laboratories also participates in wide-ranging activities to realize safe and comfortable solutions for people. We must develop and expand our leading-edge technologies on a global basis. Toward that end, research bases estab-

lished in the U.S., Europe, and China are working in collaboration. In terms of R&D management, individual laboratories share roadmaps for technology.

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2. Technology value chain and strategic technology roadmap

The mission of Fujitsu Laboratories is not only to make essential contributions to the Fujitsu IT solutions offered to customers worldwide, but also to achieve landmark advances in scientific research, as the central pillar of the Fujitsu Group's R&D organization.

Together with "technology-push" type of R&D conducted based on seeds, Fujitsu Laboratories in its R&D theme has placed emphasis on "demand-pull" type of R&D conducted based on market needs and customer desires. By creating a technology value chain as shown in **Figure 1** to provide customers with the creation of value on a global scale, Fujitsu Laboratories aims at contributing to future businesses.

The areas of research conducted by Fujitsu Laboratories can roughly be divided into the following four categories:

1) IT system and service technology
2) Network technology
3) Ubiquitous technology
4) Device and materials science technology

In terms of R&D management, we accumulate the technologies achieved in individual fields of research, plan strategic roadmaps for technology based on market, social, and technological trends envisioned ten years into the future, and then conduct R&D based on these roadmaps. **Figure 2** shows an overall outline of these roadmaps for technology in the form of a single roadmap.

The following sections summarize the contents of this R&D for each area.[1)-3)]

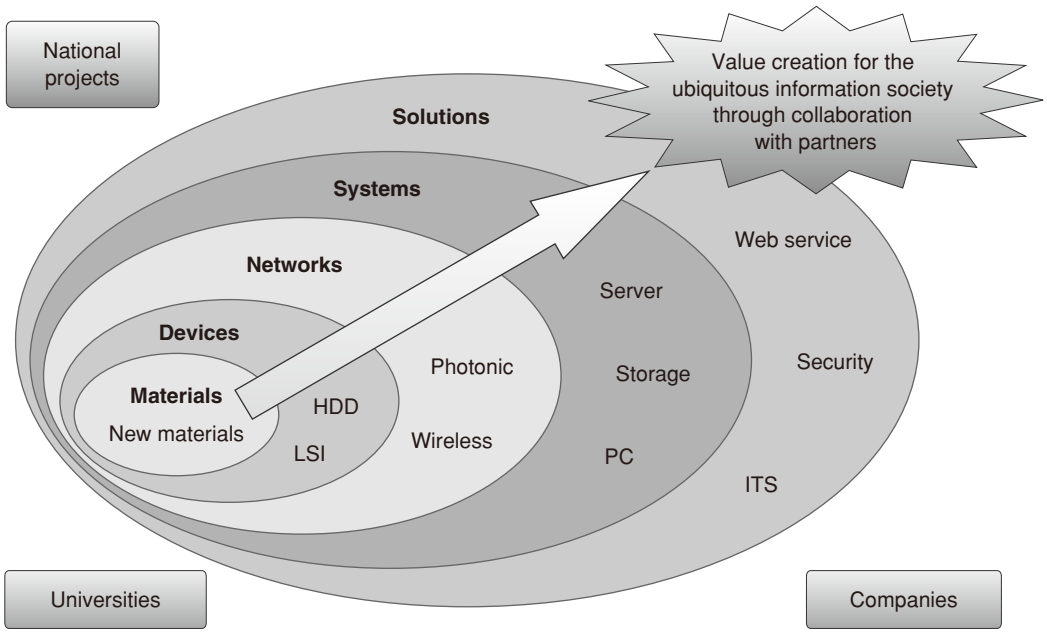

Figure 1
Technology value chain.

3. IT system and service technology

Fujitsu Laboratories has been conducting R&D of computing technology concerning systems that can continue working together autonomically in order to support more efficient management and comfortable society.

For example, we are creating tools and methodologies for developing high-quality software more quickly and efficiently by automatically generating Web applications and business system programs from the diagrams of specifications described in Unified Modeling Language (UML).

We are also researching Business Process Management (BPM) technology used to continuously monitor and improve business processes executed on IT systems, and advancing research on next-generation Web services in order to integrate services and information on the Web to be provided to customers.

Furthermore, research and development is being conducted on service and IT platforms (Organic, Grid, and Utility computing) that will become the basis for the next-generation IT infrastructure, organic storage technology that autonomically links multiple magnetic disk drives, enabling customers to safely store enormous volumes of data and quickly access required information whenever the need arises, and CAD/VPS (Virtual Product Simulator) that enables virtual simulation on computers.

4. Network technology

Fujitsu Laboratories is conducting technological research and development to make things

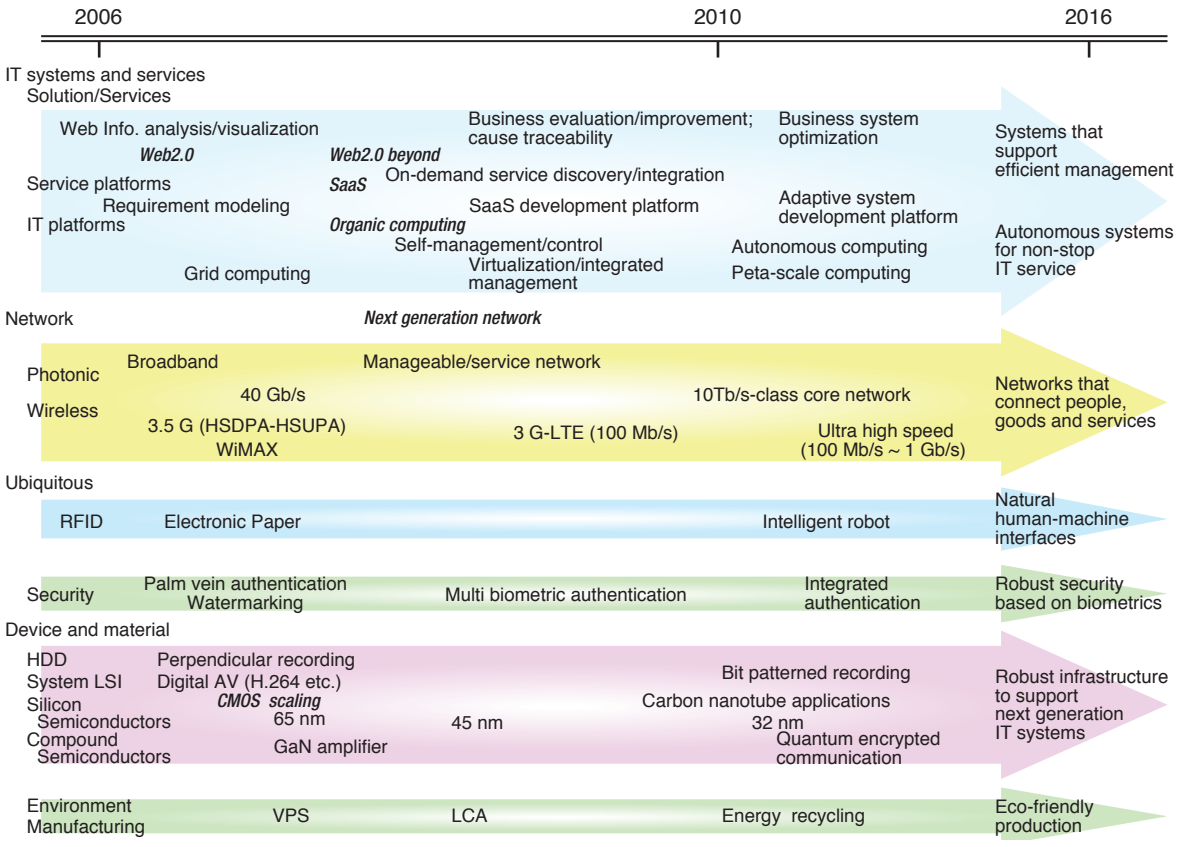

Figure 2
Roadmap for research and development.

and services available to people anytime and anywhere. For example, we are now developing photonic network technology as typified by high-reliability Dense Wavelength Division Multiplexing (DWDM) optical transmission systems that can transport immense traffic volumes at high speed, such wireless network technology as the base stations of mobile phones and multiple-antenna systems to facilitate higher data transfer rates, network dimensioning and planning for WiMAX, and IC tag systems.

We have also developed a high performance, low-loss broadband Surface Acoustic Wave (SAW) filter that facilitates high-clarity, low-noise communications on mobile phones. Regarding optical switching devices for photonic networks, we have successfully developed a low-power, high-speed three dimensional Micro Electro Mechanical Systems (MEMS) optical switch that can switch optical paths without electrical conversion as shown in **Figure 3**. We are currently working on reducing the size of the switching system and improving its performance even further.

5. Ubiquitous technology

Fujitsu Laboratories is conducting research and development of user-centric ubiquitous technology so that anyone can easily use ICT. A computer that enables natural communication with the user is one such example.

In order to realize communication anytime and anywhere, we are developing IP network systems and quality control technology for open wireless networks. We are also developing network services for mobile terminals that enable voice and data multicast communications, or allow users to securely access and operate home electronic appliances remotely while on the road.

In the field of image technology, we are developing technology compliant with the latest H.264/AVC compression standard that improves image quality while reducing processing loads to more efficiently store and transmit video images.

In addition, we are developing signal processing technology to enhance voice quality for mobile phones and VoIP (Voice over Internet Protocol) systems, and voice recognition technology for voice-based computer operation. We

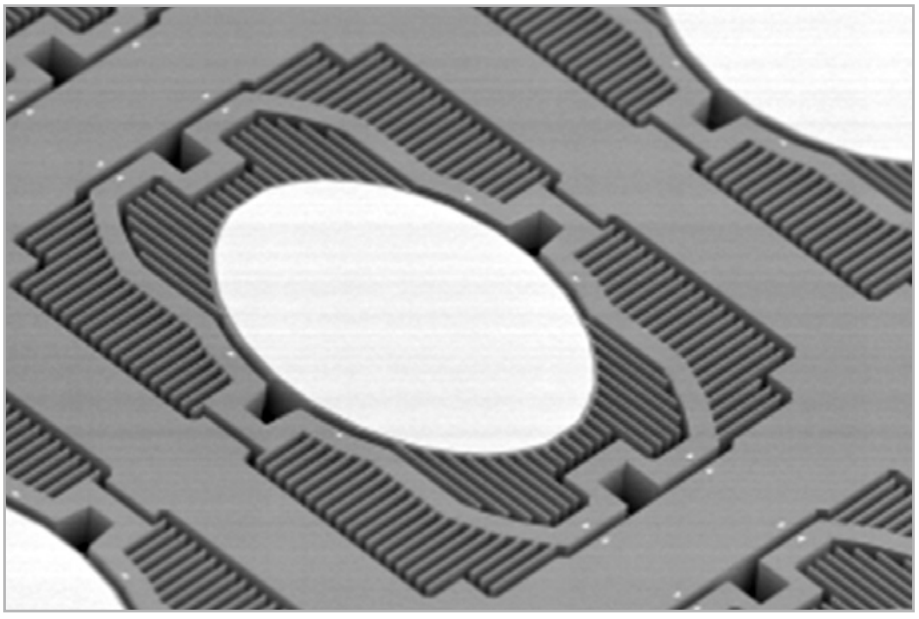

Figure 3
MEMS mirror with world's fastest switching time.

are involved in other research and development projects as well, including Intelligent Transportation Systems (ITS) technology that uses the latest information communication technology to connect people, roads, and automobiles, electronic paper technology whereby color images can be bent and images continuously displayed even with the power supply turned off, and robot technology to support people both at home and in the office.

We are also researching and developing security technology to help people enjoy safer and more secure daily life. From encryption technology for computer and network safety to biometric technology and systems that confirm an individual's identity based on physical feature of his or her own body, we are carrying out wide-ranging R&D in the area of information security. In the field of biometric authentication, we are creating new innovations that will replace conventional ID and password systems — innovations like the world's first contactless palm vein pattern authentication technology as shown in **Figure 4** and a compact, high-speed, highly accurate fingerprint authentication device for notebook PCs and mobile phones.

Figure 4
Contactless palm vein pattern authentication for ATMs.

In addition, we are developing electronic watermark technology to make it easier to trace the leakage routes of information contained in printed materials, and Fine Picture (FP) code technology for enabling portable cameras to read, for example, URLs and telephone numbers embedded in color images without compromising image quality.

6. Device and materials science technology

To support the next-generation ICT systems, Fujitsu Laboratories has been conducting research and development on secure, common device and materials science technology as typified by the latest cutting-edge devices.

As shown in **Figure 5**, we continue to achieve breakthroughs in a broad range of semiconductor technologies, including new film materials for interlayer dielectrics and ultrahigh-density processing technology. We have also been researching and developing High Electron Mobility Transistor (HEMT) device technology for compound semiconductors to achieve lower power consumption and higher amplification efficiency, and such semiconductor technologies as System-on-a-Chip (SoC) devices to combine multiple system functions on a single silicon chip, making possible power savings, faster processing speeds, smaller size, and lower costs for all sorts of electronic equipment.

Moreover, we are making advances in developing magnetic heads and next-generation perpendicular magnetic recording media with ultrafine crystal grains for hard disk drives with world-class capacity, nanotechnology such as quantum-dot-based photonic devices and carbon nanotubes, "innovative manufacturing and engineering" technology such as mounting technology, and analysis technology to support the miniaturization and higher reliability of such leading-edge devices as LSI and magnetic disk heads.

Moreover, as shown in **Figure 6**, we were

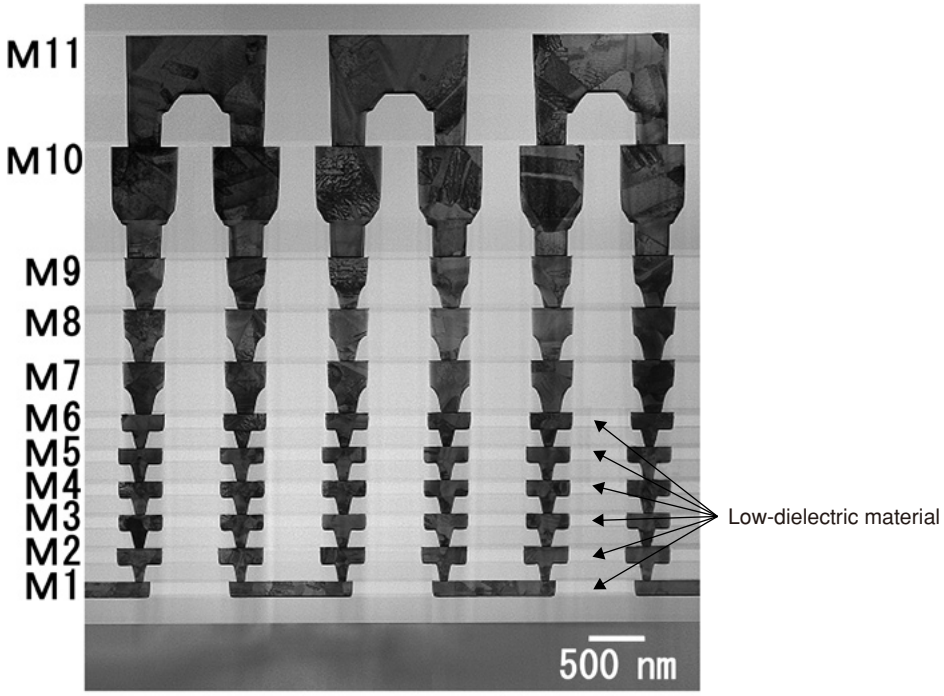

Figure 5
Multi-layer interconnect using copper and low-dielectric material.

Figure 6
Fujitsu was the first to utilize bio-based polymer made from corn and other plant starches in fabricating notebook PC housings.

the first to commercially introduce notebook PC models featuring housings made with an environmentally friendly bio-based plastic that requires less oil to produce and which exhibits good structural strength and fire resistance characteristics. We have also developed methods of evaluating the extent to which deploying particular IT solutions can reduce the burden on the environmental burden.

7. Conclusion

This paper briefly introduced the R&D management and activities being conducted at Fujitsu Laboratories. Fujitsu Laboratories will continue working closely on a global basis with the four research bases established in the U.S., Europe, China, and Japan in concert with industry, government, and university research and development institutions in order to integrate and assist in the development of leading-edge technology. We are thus conducting research and development of platform technology to create a future ubiquitous information society. While being involved with individual research activities ranging from system products to service solutions together with further improving the ease of use, performance, and creation of systems in line with our challenge of "making dreams real", we will continue contributing to the creation of new value for our customers by integrating and merging various technologies from a market perspective.

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