2 Basic Research Activities and Research Strategies in Kansai Advanced Research Center

– An R&D Center with a Vision Toward the Future of Information and Communications –

MASHIKO Shinro

In April 2004, the National Institute of Information and Communications Technology (NICT) was established as an independent administrative agency and the Basic and Advanced Research Department was given a new start, with the aim of sowing seeds that will lead to fruition in Japan ten or twenty years down the road. The Kansai Advanced Research Center promotes research connected with the bio-ICT (Information & Communications Technology) program, the nano-ICT program, and the optical and quantum information program. The following introduces the areas of research promoted by the Basic and Advanced Research Department of the newly inaugurated NICT and the strategies formulated by the department.

The ever-increasing demand for information and communications is impacting society to such an extent that the phenomenon is often referred to as a “revolution.” The revolutionary changes brought about by advancing information and communications technologies extend beyond the manufacturing and distribution industries to education and the cultural aspects of our lives. This trend will surely accelerate its pace still further as optical communications become even more widespread and mobile phones more advanced. On the other hand, we hear about problems resulting from technological advancement, such as Internet crimes and intrusion of privacy, on a daily basis. Against this backdrop, the National Institute of Information and Communications Technology (NICT) was established as a unique organization in Japan which not only conducts research and development activities on its own but also energetically provides support activities to outside organizations and promotes cooperation between industry and academia. The Basic and Advanced Research Department promotes the NICT’s function of conducting its own R&D activities and is engaged in research activities based on a vision of the future of information and communications, with the aim of planting seeds that will bear fruit in Japan ten or twenty years down the road.

The Basic and Advanced Research Department consists of research groups located at the NITC’s Koganei Headquarters and the Kansai Advanced Research Center (KARC) in Kobe City (see Fig. 1). The following describes the history, current state, and future prospects of research at the KARC in line with the theme of this special issue. The KARC has been promoting projects focused on basic research, such as “electronic communications frontier R&D” and “information and communications basic research breakthrough 21,” since the time when its parent organization was called the Communications Research Laboratory. Spurred by rapidly growing social demands, the KARC reviewed its medium- and longterm strategies and visions from a flexible perspective and reorganized its research groups accordingly. As the organization became an independent administrative agency in fiscal 2001 and the NICT was established in fiscal 2004, its research activities were expansively restructured under three main programs, as shown in the diagram. The aim of the nano-ICT technology program is development of next-generation elemental information and communications technologies. The researchers of the bio-ICT program strive to create algorithms for information and communications of the future. The quantum information and communications program addresses ultimate information and communications technologies. This special issue introduces some of the research results obtained by groups in the nano-ICT and bio-ICT projects.

The purpose of the nano-ICT project is the development of technologies believed to be necessary for realizing greater performance and functionality of information and communications devices ten or twenty years in the future. It is undeniable that the current rapid development of information and communications has been made possible by the advancement of hardware based on semiconductor devices. Although further improvement of functionality and performance is essential for achieving continued growth in the area of information and communications, many of those in the field have pointed out the limits imposed by the functionalities of semiconductor devices and conventional materials as well as by the technologies used to manufacture the devices. As a result, nanotechnology has begun to attract greater attention. What effects will nanotechnology bring to information and communications, and what can be expected from it? Research on nanotechnology performed from this perspective is one of the most important topics at NITC, and is ranked at the top of the list of target fields for application of nanotechnology research results according to the report of the Council for Sci-

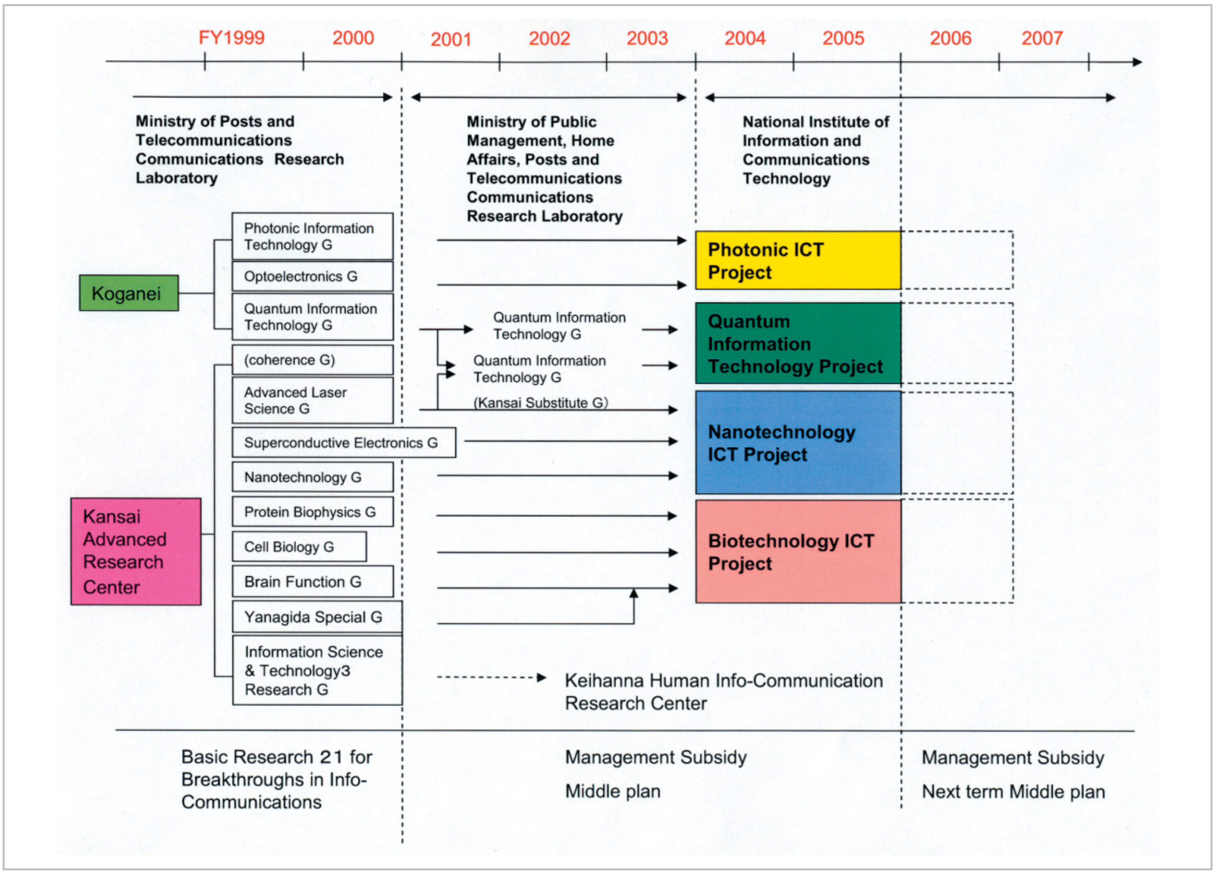

Fig.1 *Past projects of the Basic and Advanced Research Department*

ence and Technology Policy, Cabinet Office. Against such a background, the KARC has initiated nanotechnology-related research projects quickly. Its projects aim to create information and communications devices with advanced functionality capable of achieving ultrahigh speed and large capacity with low power consumption by using safe materials with minimal environmental impact, and to develop elements able to configure networks that are capable of adapting to their surrounding environments, such as self-organizing and self-repairing networks. Specifically, the Nanotechnology Group is engaged in the development of device technologies using molecules as building materials, the Superconductive Electronics Group specializes in the development of communications devices using superconductive materials, and the Advanced Laser Science Group aims to utilize atoms in information and communications devices. These are the three groups involved in nanotechnology research at the KARC.

The bio-ICT project seeks to develop networks that differ conceptually from the conventional ultrahigh-speed and large-capacity information and communications networks that have seen rapid development and growth thus far in the 21st century. The researchers study biosystems from the perspectives of information and communications. Living organisms' highly advanced and flexible information processing systems are obviously based on different principles and mechanisms from those of present-day silicon and digital technologies. Living organisms transmit various types of information using materials such as molecules and trigger selective reactions at desired locations to initiate action. As a result, they can communicate types of information that cannot be handled by today's communications systems, such as "ambience" and "sensitivity." Even though individual reactions occur in living organisms at a relatively slow speed, taking several milliseconds to complete, a baseball batter can hit a ball traveling at a speed of 140 km per hour. The KARC conducts research on information communications in living organisms based on three different tiers in the structural hierarchy—the molecular level, the cell level, and the brain level. Based on these research results, models are created and new information communication algorithms proposed.

Presently, the KARC is busy formulating new research strategies for its next medium-term plan, to be initiated in fiscal 2006. The KARC is planning to take past research results to the next stage of development and is also examining new research topics in an attempt to respond to social needs and exploring new research domains created at the boundary areas formed between projects carried out in the past. These include information communication between individual living organisms and the formation of societies, five-sense networks based on human sensory systems, and chemical reaction networks formed by the exchanges of substances (molecular communications). The researchers at the KARC strive to create new academic knowledge and develop new information communications technology with the ultimate goals of preventing the various network crimes being highlighted today and contributing to the creation of a humane and rich information-oriented society.

MASHIKO Shinro, *Dr.Eng.*

Director of Kansai Advanced Research Center, Basic and Advanced Research Department

Laser Spectroscopy, Nanotechnology