Achieving "Resonance of Knowledge"

–NTT's R&D strategy to provide the basis for its envisaged resonant communications–

Yuji Inoue, Senior Vice President, Director, Department III, NTT

Abstract

This paper describes "NTT's R&D Strategy for Realizing the Vision for a New Optical Generation" presented by Yuji Inoue, Senior Vice President, Director, Department III, NTT, at the "NTT R&D Forum 2002 in Musashino" held in November 2002.

1. Bringing RENA to reality

"The Vision for a New Optical Generation [1]", announced on November 25, 2002, looks five years into the future, envisioning enhancements to personal security and quality of life, together with new ways of conducting business, in an age of ubiquitous broadband services supported by optical technology. This vision is intended to serve as a universal concept shared by NTT Group companies and to act as a guideline for the group's business direction. Here at NTT Laboratories, we are focusing our efforts on realizing a "resonant" communication network environment, nicknamed "RENA" (for resonant communication network architecture), which will become the development platform for a variety of sophisticated new services, leading to new business opportunities.

2. Impacts of NTT's Successive Visions

In October 1996, NTT announced its R&D objectives under the umbrella of "NTT to Provide Innovative R&D Geared to the 21st Century." This agenda was based on three pillars: an Electrum Cyber Society, Megamedia, and a Photonic Network. In the Megamedia Initiative, NTT declared that it would "accelerate its R&D with the target of offering, by the year 2005, a next-generation multimedia network service which could deliver a transmission speed of 10 Mb/s for around 10,000 yen per month." At that time, 56-kilobit-per-second (56K) modems had not yet hit the market, and most people were still using 28.8K modems. Combine that situation with the monthly fee of 980,000 yen for the 6-Mbit/s OCN always-on service that came on stream the following year (1997) and it is not surprising that not only the mass media but also some people inside NTT operating companies were openly skeptical about this declaration. NTT Laboratories later reaffirmed this objective in the "Global Information Sharing Business in the 21st Century", announced in October 1998.

As if to challenge the skepticism, the monthly fee was reduced to 18,450 yen in the "optical IP communication" trial optical access service launched by NTT at the end of December 2000. When the commercial B-Flet's service began operating in August 2001, the monthly charge, which included an ISP service fee, was further slashed to as low as 6500 yen–beating NTT's declared target date by four years! To top that achievement, a 100-Mbit/s service started up last June (2002) with a monthly fee of only 7300 yen.

The target declared some seven years ago was truly challenging at the time (Fig. 1), but the apparent hurdles were cleared steadily and much sooner than had been anticipated. Although this was not due solely to the results achieved by the Laboratories, but also owes greatly to the tremendous efforts made by people in the operating companies, it stands as a signal example of the effectiveness of establishing a bold and innovative objective.

3. Establishing objectives for R&D: Looking ahead to 2005

NTT Laboratories has established fresh objectives for realizing the “Vision for a New Optical Generation” and will pursue them vigorously. Some of the key R&D objectives are shown in Fig. 2. For RENA, we aim to build NTT’s next-generation network architecture, which is the nucleus of the Vision, by 2005. This network will provide high-quality end-to-end communication that is highly secure against external attack.

In the field of fundamental technologies for services, as a first priority, we plan to develop natural and high-quality video collaboration services capable of handling multiple languages by 2005. Although it is extremely difficult to achieve automatic translation on the semantic level, we believe that considerable progress can be made toward an acceptable level of translation if the translation is text-based, and if the number of languages is kept manageable.

We will also drive R&D on i) technology that

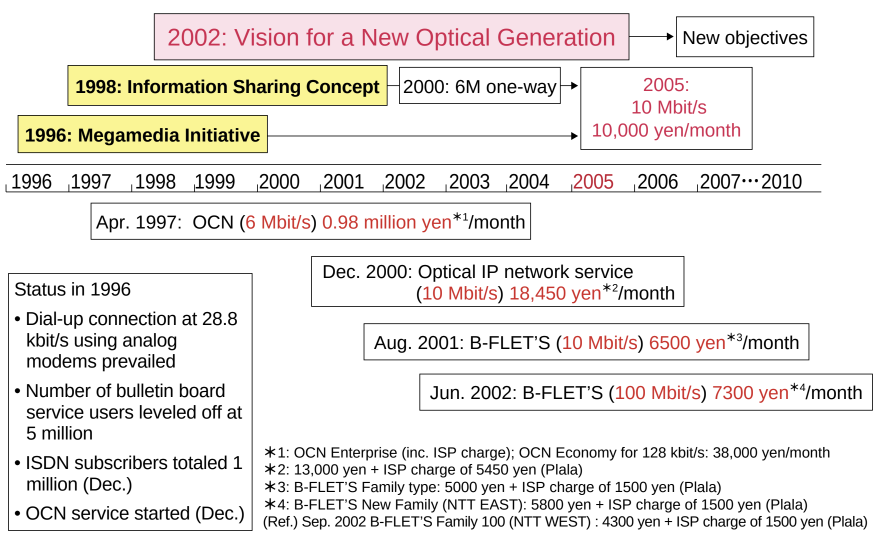


Fig. 1. Impacts of NTT’s Visions.

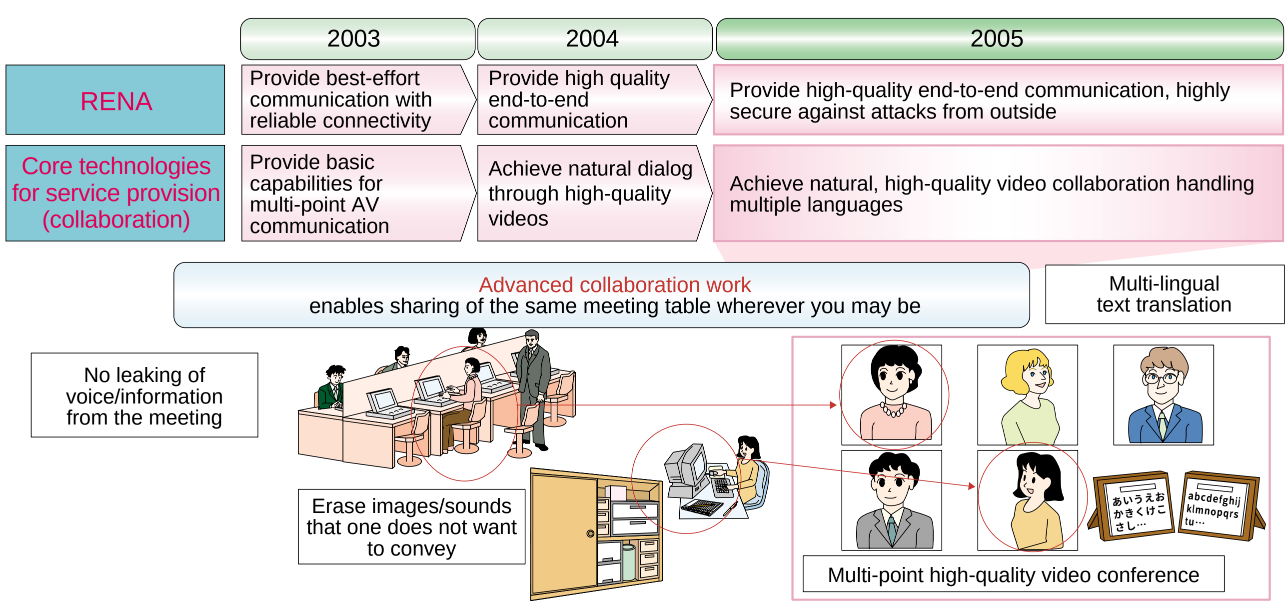


Fig. 2. R&D goals targeted for 2005.

allows a person to conduct a tele- or video-conference from his or her own desk without ambient noise (e.g., sounds from adjacent workstations) reaching the online participants in the conference and ii) image processing technology that enables a person to erase, in real time, images that he or she does not want others to see.

4. Key strategic R&D areas

If we look at the "Vision for a New Optical Generation" from the viewpoint of making R&D a vehicle for driving the NTT group's business, we can identify three important R&D areas: fundamental technologies for the provision of new services, network

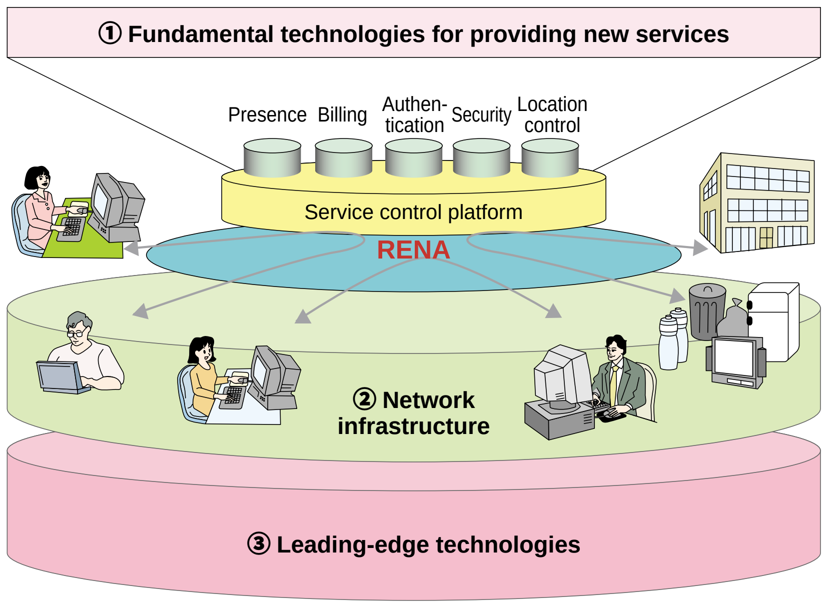
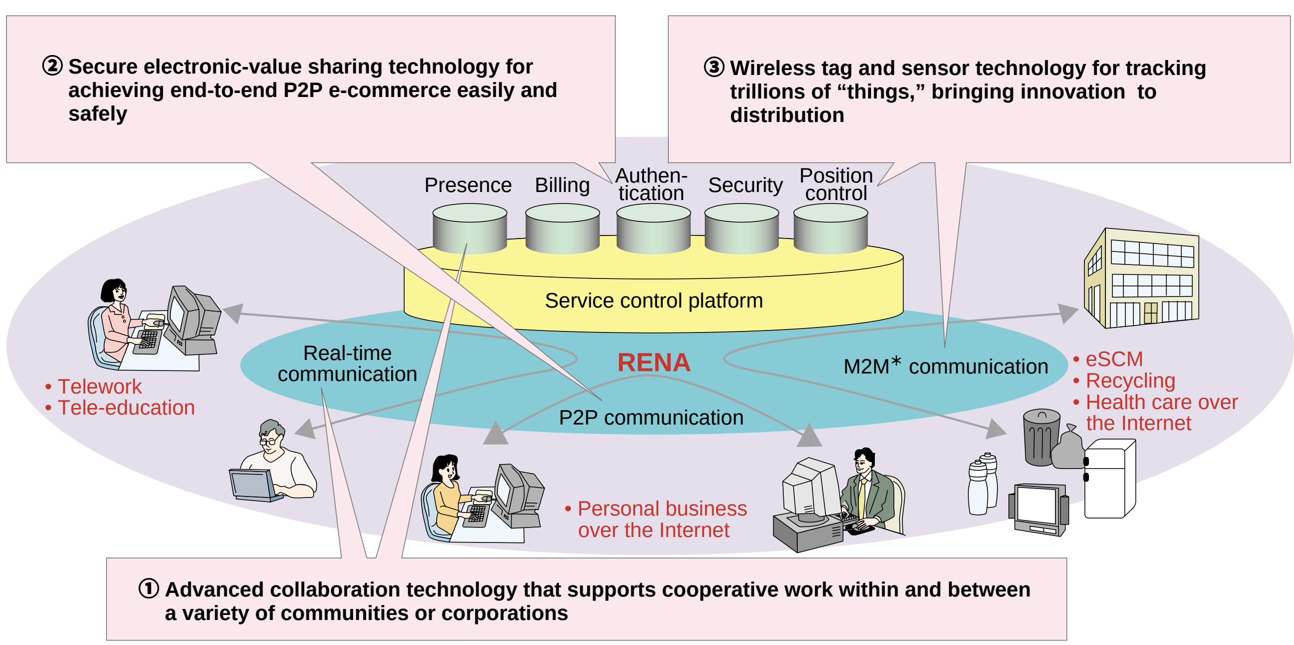


Fig. 3. Key strategic R&D areas.



* M2M: Machine to Machine

Fig. 4. Fundamental technologies for providing new services.

infrastructure (i.e., next-generation network architecture: RENA), and leading-edge technologies looking ahead ten years from now. Our ongoing R&D will focus on these three areas (Fig. 3).

Fundamental technologies for the provision of new services

The first fundamental technology earmarked for providing new services is "advanced collaboration technology" that supports cooperative work both within and between various communities or corporations in a way that will promote the "multiplizing of individuals*1." We aim to develop systems that will transform human interaction through telecommunication beyond the conventional framework of videoconferencing, and make it adaptable to a wide variety of situations (① in Fig. 4).

Next is technology for "sharing electronic value." In conventional e-commerce, client-server systems have been used to build e-marketplaces. Our objective is to develop a network that can be used securely and simply for P2P (peer-to-peer) e-commerce (② in Fig. 4).

Then there is "wireless tag-and-sensor technology", which embraces communication not only between people but also between "things" (M2M: machine-to-machine communication) (③ in Fig. 4). For example, a wireless tag could be attached to every PET bottle (this is not a pipe-dream if extremely cheap wireless tags can be developed). Then, we equip pavement trash bins with receivers that can read the wireless tags, thereby enabling the bins to prompt passers to deposit their empty drink bottles in those bins. Using the same principle, PET bottles can be automatically identified and separated from a pile of miscellaneous garbage. This would benefit communities by making recycling systems more efficient and effective.

These concepts are just the tip of the iceberg. NTT will drive its R&D on fundamental technologies for providing new services with potential for broad application.

Toward "resonance of knowledge"

A conceivable axis for the direction of technological development is a mechanism of exchanging "knowledge." Knowledge circulation and interaction are schematically depicted in three developmental stages in Fig. 5.

The first stage is the exchange of knowledge between specific individuals by such means as email and Internet chat lines. Since these are bilateral one-dimensional relationships, we can call this kind of

*1 Multiplizing of individuals: a term we have coined to mean that one individual can simultaneously play multiple roles, which will work to turn latent knowledge, hidden from others, into knowledge visible to others.

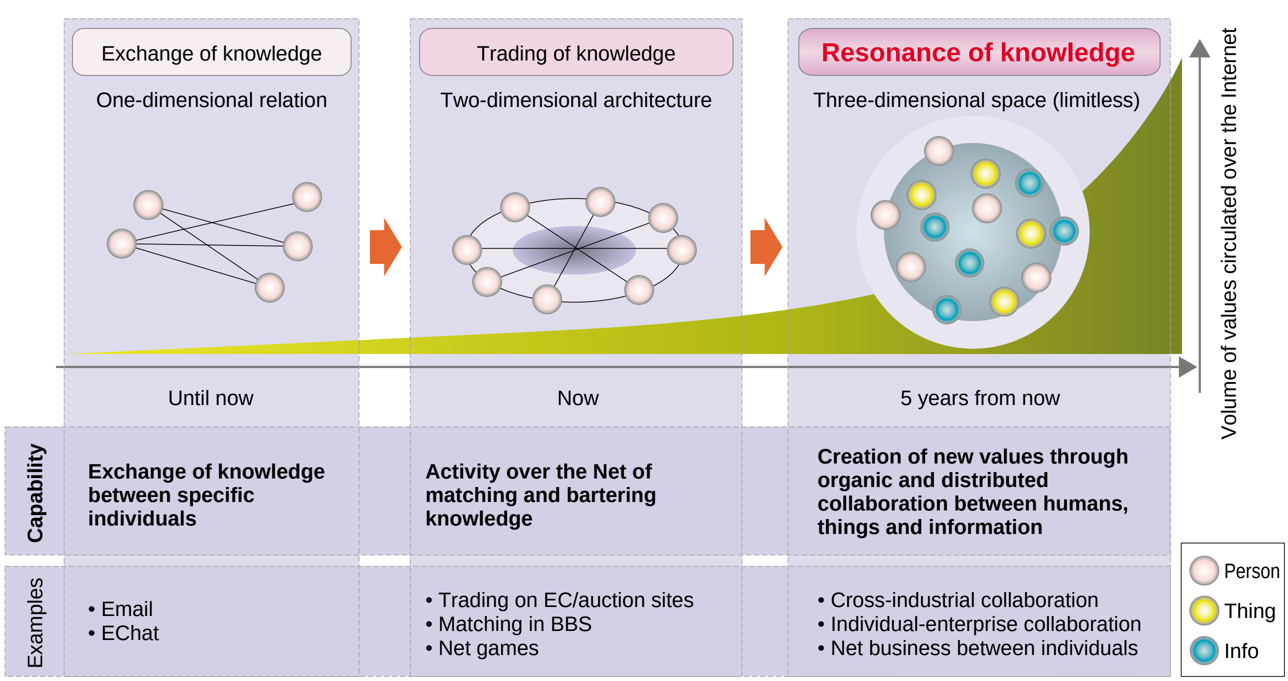


Fig. 5. Three stages toward "resonance of knowledge."

mechanism an “exchange of knowledge.”

The second stage includes e-commerce, trading through Net auction sites, and online gaming in their present forms. This can be represented as a two-dimensional architecture consisting of a hub and spokes. Let’s call this “trading of knowledge.”

The final stage is what we are aiming for in a “resonant” communication environment. This is the stage where “resonance of knowledge” takes place. Not only people but also objects and items of information are organically linked to each other in a three-dimensional space, which is a potentially limitless space not achievable through a hub-and-spoke architecture. Specific models of the third stage will vary depending on each application area. Let’s take a hypothetical example of collaboration in the area of personal pastimes, rather than the world of corporate business.

In music, we find the concept of the “jam session,” which is an impromptu performance by a spontaneously formed group of usually jazz musicians, who decide on the spot what music to play and how to play it. In the same way, it should be possible to create a virtual “live venue,” in which various people on the network collaborate to perform a Net “jam session.”

We can imagine a situation like this: Mr. A is hooked up to the network and playing piano. Ms. B is playing bass at a different location. Mr. C is singing somewhere else. Ms. D is mixing all these parts in her

home studio and delivering the result over the network for anyone to listen to. Then, a metronome connected to the network may autonomously discover this session and begin to beat time, and a recorder on the Net may record this performance and convert it into a score or a midi file.

We still have to overcome many technical issues to make this kind of Net jam session a reality. NTT is undertaking R&D on a range of fundamental technologies to provide these new kinds of network services.

Next-generation network architecture (RENA)

In the area of next-generation network architecture, our main R&D target is to build a network which can provide secure, interactive, real-time, end-to-end con-

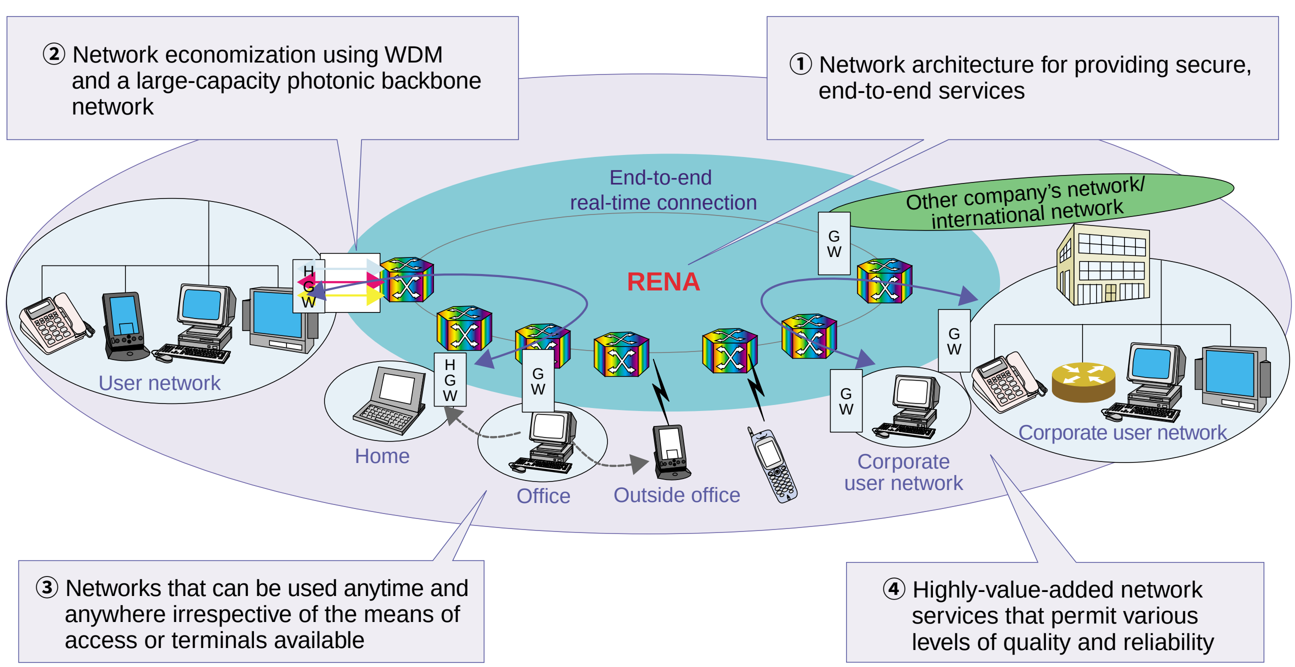


Fig. 6. Next-generation network architecture: RENA.

nectivity (① in Fig. 6). Once broadband services are in widespread use, there will be an "explosion" in the volume of information used by each customer, and the backbone network will have to be able to handle information on the order of terabits per second. By developing optical wavelength division multiplexing (WDM) technology, and technology for building a large-capacity photonic backbone network, we can further reduce the network cost, so that services can be provided at reasonable rates (② in Fig. 6).

Network services that can be used anywhere, irrespective of the means of access or terminals available, will constitute the nucleus of future ubiquitous services (③ in Fig. 6). We will be concentrating considerable effort into the development of highly usable services, which can be accessed anytime and anywhere from diverse types of terminals, and which will allow each customer to use the network according to his or her specific usage environment.

Another imperative is the provision of high-value-added network services that permit varied levels of quality and reliability depending on the requirements of individual users (④ in Fig. 6). In particular, business users will increasingly demand network services with guaranteed security and quality.

Future progress in information communication technology

Figure 7 shows how information communication technology is expected to progress. For example, we are aiming at high-speed wireless access at a rate of 1 Gbit/s five years from now. This is a really challenging rate. If the price of that PET bottle wireless tag can be whittled down to 5 yen within the next five years, I would expect wireless tags to be attached to a significant number of products.

Leading-edge technology looking ahead 10 years from now

The above-mentioned network and network service technologies must be backed by advances in basic and leading-edge technologies. Research subjects of leading-edge technologies can be plotted on a plane of two axes: overcoming the barrier of communication technology and overcoming the barrier of network technology. Let me introduce some results from just a few of the many wide-ranging leading-edge technologies (Fig. 8).

Our aim is to use leading-edge technology to overcome a variety of "barriers" to communication. The first of these is a "language barrier." Language processing technology will form the nucleus for the previously mentioned collaboration involving multiple languages. A computer, as it stands, cannot understand speech. No dialog with a computer can take place without running a variety of programs for speech recognition, speech understanding, *etc*. NTT has long pursued R&D on language processing. This work has progressed to the stage of interpreting meanings based on context and background information. As a result, it is now possible for a computer and a human to conduct a dialog. Our ultimate goal is a system in which a computer receives intellectual information from a human, interprets it, and responds in an appropriate manner based on the most likely behavior pattern.

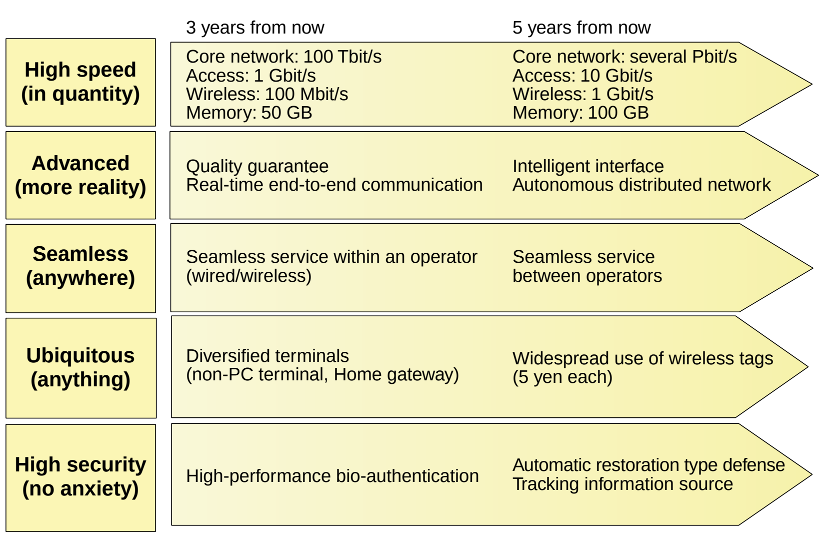


Fig. 7. Future trends in information communication technology.

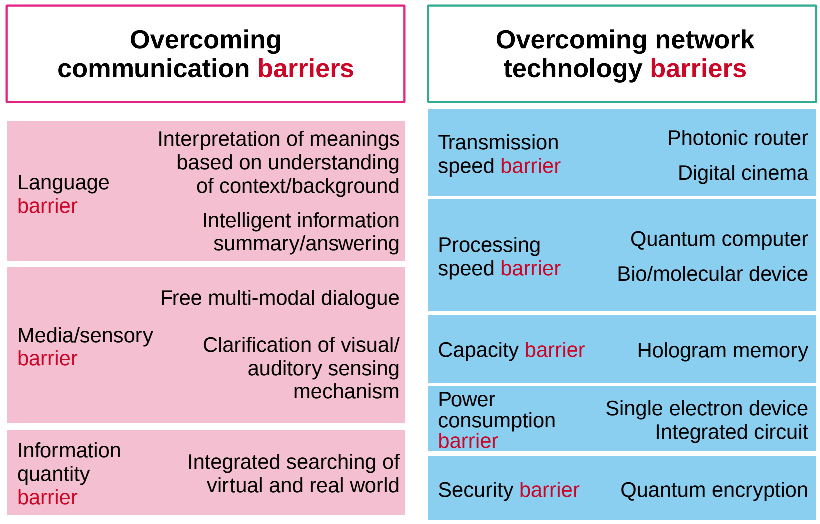


Fig. 8. Leading-edge technologies ten years from now.

The second barrier is a “media and sensory barrier.” For example, humans recognize three-dimensional objects by processing the azimuth difference information in the brain, but we have gradually found that human visual sense is not as simple as that. In our research into the mechanism of this sense, we are trying to understand the error mechanism that is present in it and to apply that knowledge to information compression and encoding technology.

The third barrier is an “information quantity barrier.” For example, if a person is asked whether there is a vase in the room, he or she can just look around and give a correct answer, immediately. If you ask the same question of a computer, which is based on sequential calculation, it cannot answer as easily. We are conducting research into algorithms for quickly finding a requested object from among a large volume of information.

Under the theme of “overcoming the barriers of network technology,” we are accelerating our R&D to overcome the barriers to communication speed, processing speed, capacity, power consumption, security, *etc*. For example, to overcome the barrier to processing speed, we are conducting R&D on the basic technology for quantum computing. Although a quantum computer will not be available any time soon, computation using quantum effects has been achieved at the laboratory level. Although this computer can do only simple arithmetic at this stage, some people believe that it will be possible to develop a computer one trillion times faster than what we currently have.

5. Comprehensive producer function

In order to traverse the “Valley of Death” that lies between basic research and commercial development, we will introduce a “comprehensive producer function” within the NTT holding company. This will operate as a mechanism for facilitating efficient, practical commercialization of the fruits of R&D (Fig. 9).

NTT Laboratories have a large repository of wide-ranging elemental technologies. The comprehensive producer function will explore various ways of combining these technologies with those already in the market, with the objective of translating them into commercial products and services. The extent of the required integration efforts will not be limited to within the NTT group, and may include alliances with other corporations and organizations. We hope to move ahead through a variety of beneficial partnerships, based on positive cooperation as well as fair and friendly competition.

6. Looking at the future

In pursuing the “Vision for a New Optical Generation,” NTT will base its R&D program on the following four strategic principles:

- Further refining fundamental technology priorities, clarifying who will be responsible for each development project, and liaising more closely with operating companies on each project;
- Exploring new business opportunities by applying

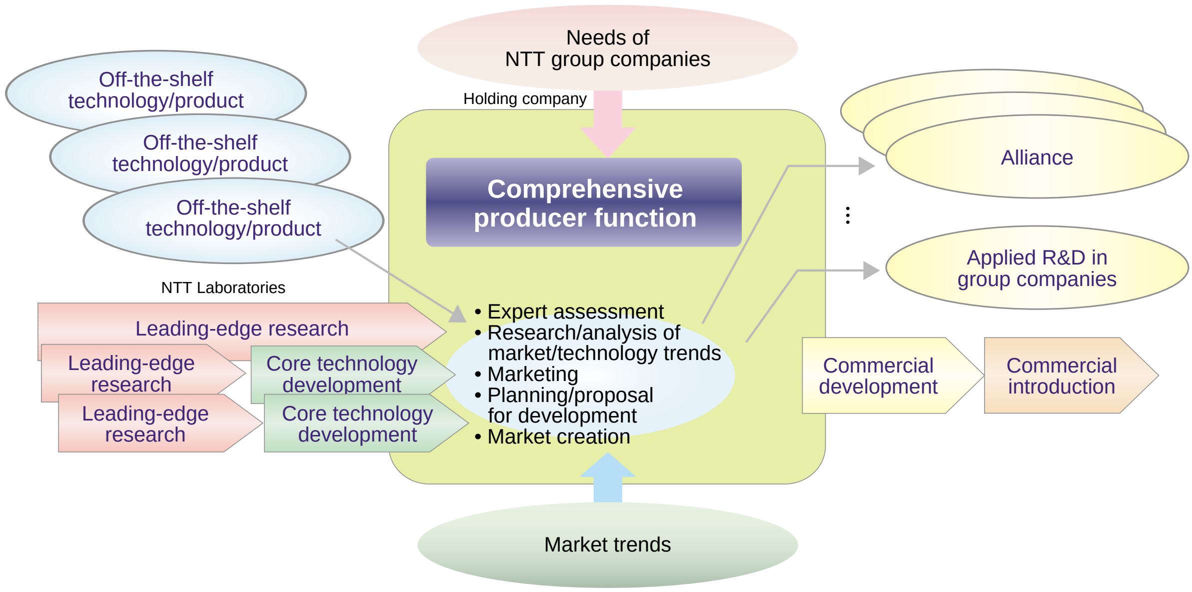


Fig. 9. Comprehensive producer function.

the fruits of R&D even to those areas not related to communication;

- Emphasizing basic research on leading-edge technology, and enhancing the motivation of researchers;
- Introducing a comprehensive producer function to stimulate the flow of R&D results to business, and exploring advanced business opportunities in open alliances with customers.

As mentioned above, we will efficiently overcome the "Valley of Death" lying between basic research and commercial development and link R&D results to business, by narrowing down technical development areas to those that will constitute our core competence and by strengthening liaison with operating companies for commercial development. We also hope to cultivate new business opportunities in areas not covered by NTT's current business. From among the wide-ranging basic technologies for which we have expertise, we will place priority on those technical development projects that will sow the seeds of future business opportunities for the NTT Group. Basic research is the lifeblood of NTT's R&D. While many communication carriers worldwide have moved to concentrate on commercial development, NTT will continue to retain sufficient resources for basic research. In this area, we will aim at advancing Japanese science and technology and training and encouraging young researchers. By taking full advantage of the comprehensive producer function, we will form open alliances with customers to explore advanced types of business. We are committed to ensuring that the R&D results produced through our efforts to realize the "Vision for a New Optical Generation" give NTT Group businesses a competitive edge and contribute to the further development of society and the economy at large.

Reference

[1] N. Wada, "Vision for a New Optical Generation—Broadband Leading to the World of Resonant Communication—," NTT Technical Review, Vol.1, No.1, pp. 6-17, 2003.