

Vision for a New Optical Generation

—Broadband Leading to the World of Resonant Communication—

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Abstract

NTT has announced its vision for the full-scale broadband and ubiquitous era that will be brought about by optics in the next five years. This paper introduces the “Vision for a New Optical Generation and R&D Initiatives” presented by Norio Wada, President of NTT, at the “NTT R&D Forum2002 in Musashino” held in November 2002.



1. Introduction

NTT has regularly outlined its concepts for the future, based on expected technological innovation, as NTT Visions. It has undertaken basic research and feasibility testing along the lines presented in these visions and provided new services as the fruits of these endeavors.

For example, in the INS Concept announced in 1979, NTT foresaw a departure from the telephony-centric society and carried out technical feasibility testing and exploration of diverse uses of ISDN (Integrated Services Digital Network) to meet the expected diversifying needs of the coming advanced information society. These efforts culminated in 1988 when NTT started its INS Net service, the world's first ISDN service based on the international standards.

In 1990, with a view to promoting digital networks, NTT announced its VI&P (Visual, Intelligent and Personal) Concept aiming at enabling an advanced global information society and accumulating a technology base through its comprehensive trials including broadband service trials using optical access technology and personal communication service trials using wireless access technology.

In 1994, NTT put flesh on the VI&P Concept and announced its Basic Concept for the Coming Multimedia Age to publicize the impact of the use of multimedia on the world. In line with this concept, NTT conducted joint utilization tests of multimedia communication, aimed at exploring and creating new uses

and new application technologies.

Based on the results of these trials, NTT developed and provided the OCN (Open Computer Network) service, a forerunner of IP-based services. In 1998, NTT put forward the Information Sharing Concept, and has been exploring new application areas made possible by the integration of technologies in different industries through the use of digital networks. In the last few years in particular, NTT has been meeting market needs by developing and providing new broadband services, such as FLET'S services (flat-rate broadband Internet access services) and wide LAN services, which are IP services for corporations.

Figure 1 shows how people's expectations for IT have changed over years. In the early 1990s, at about the time when NTT announced its VI&P Concept, the use of the Internet for commercial purposes began to take off in the U.S., and the first impacts were felt of the wave of transition from telephony-centric communication to computer networking over the Internet.

From around 1995, just after NTT had announced its Basic Concept for the Coming Multimedia Age, many corporations, generally known as “dot-coms”, sprouted and tried to start new businesses using the Internet. At about the same time, investors began to regard the potential of IT with high expectations, and these expectations peaked in 1999 when two new stock exchange markets, Mothers and Nasdaq Japan, were established in Japan. After that, the inflated expectations for IT shrank rapidly and the accumulated investment turned out to be excessive. As a result, many dot-com corporations were weeded out and

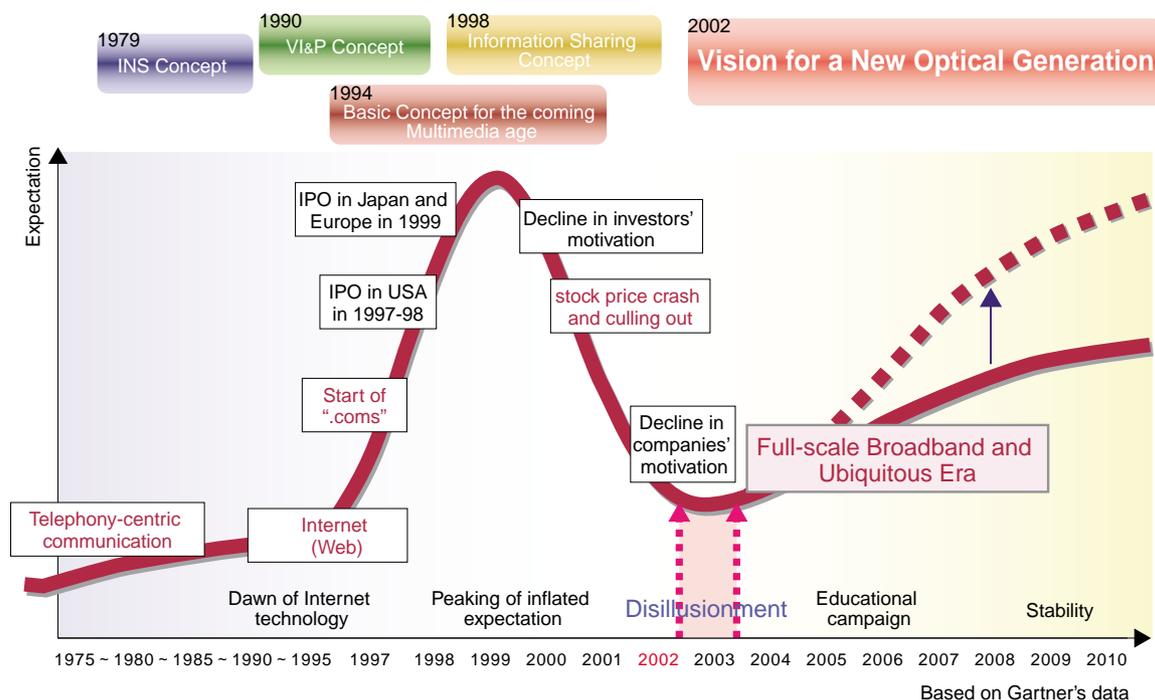


Fig. 1. Change in expectations for IT.

some large US telecom companies went bankrupt.

I perceive that we are now in the midst of a time of disillusionment with IT, but I also firmly believe that the activation of the market for the coming full-scale broadband and ubiquitous era will soon begin.

2. Vision for a New Optical Generation

Taking these historical changes into consideration, I will present the objectives and background behind developing the “Vision for a New Optical Generation” under three main headings.

First, I will describe how we are now at an important threshold as the Internet experiences a large wave of transition, from narrowband to broadband. We have just entered what may be called the second phase of the IT revolution. The mainstream services in the new phase will be interactive communication using video, with the logical conclusion that optical technology, excelling in high-speed and broadband capacity and offering permanent connection and interactive communication capabilities, is the way to go.

Second, I will explain how various applications based on interactive visual communication, which is possible with optical technology, will conquer the “barriers of time and distance,” and enable global sharing of “knowledge” and the conversion of “knowledge” into business. This can make people’s

lives safer and more fulfilling and strengthen the productivity and competitiveness of corporations. This could also be one of the crucial factors in resolving social issues in Japan today, such as the declining birthrate coupled with an aging population, and environmental problems.

Third, I will present the NTT Group’s approach to the New Optical Generation. We will press ahead with R&D aimed at achieving a “resonant communication environment using optics” and will, as a corporation involved in the global information sharing business, try to clarify our role and the direction of our mission.

The phrase “resonant communication”, which I used in the subtitle of my presentation, is the term we have coined to mean the new-generation communication environment using optics, which will evolve in resonance with developments in the world and will allow people, corporations, and indeed any objects in the world to be connected to anyone or anything, any-time and anywhere, ubiquitously through interactive broadband networks. It will also feature secure, reliable, and simple communication with high usability.

3. Resonant communication environment

In the age of resonant communication, we hope to enable realistic and natural communication using video and other modes of communication, which the



narrowband environment previously could not handle and “conquer time and distance,” which is the true mission of telecommunication (Fig. 2).

“Conquering time” will increase people’s “disposable time,” and “conquering distance” will phenomenally expand the range of activities of people and corporations. People and corporations will be increasingly able to share their disposable “knowledge” and “reality,” and business will progressively become borderless, not limited by country, region, industry, or generation.

Consequently, individuals and corporations will be able to choose and combine the most suitable “knowledge” existing in the world. In other words, they will be able to “co-create” their “knowledge.” As a result, two types of new behavior models that will transform people’s lives and corporate activities are expected to emerge.

The first behavior model is the “multiplying of individuals.” This is a term we have coined to mean that one individual can simultaneously play multiple roles. It is characterized by the following:

- Visual “face-to-face” communication, allowing for realistic exchanges between individuals;
- Creation of a new breed of global communities that span regions and generations;
- Participation of individuals, such as housewives and senior citizens, in social and economic activities, which enable the “knowledge” and “value” owned by these individuals to take on business value.

Figure 3 shows the case of a stay-at-home housewife, who will now be able to make the most of her time and knowledge as a business woman and mother.

Figure 4 shows an example of senior citizens participating in social activities. The husband in this model couple is a retiree, an ex-fine arts teacher at a senior high school in Miyazaki Prefecture. Their son’s family lives in Tokyo. The husband is enrolled in a virtual university in France and is studying the history of art over the net. He does not face a language barrier because automatic interpretation and translation are available. He also continues to paint and enters his works in virtual exhibitions. He teaches painting twice a week, for a fee, over the net to people interested in painting living in different parts of Japan. His wife is good at local cookery and, at the request of the members of a network community formed by young housewives interested in cooking,

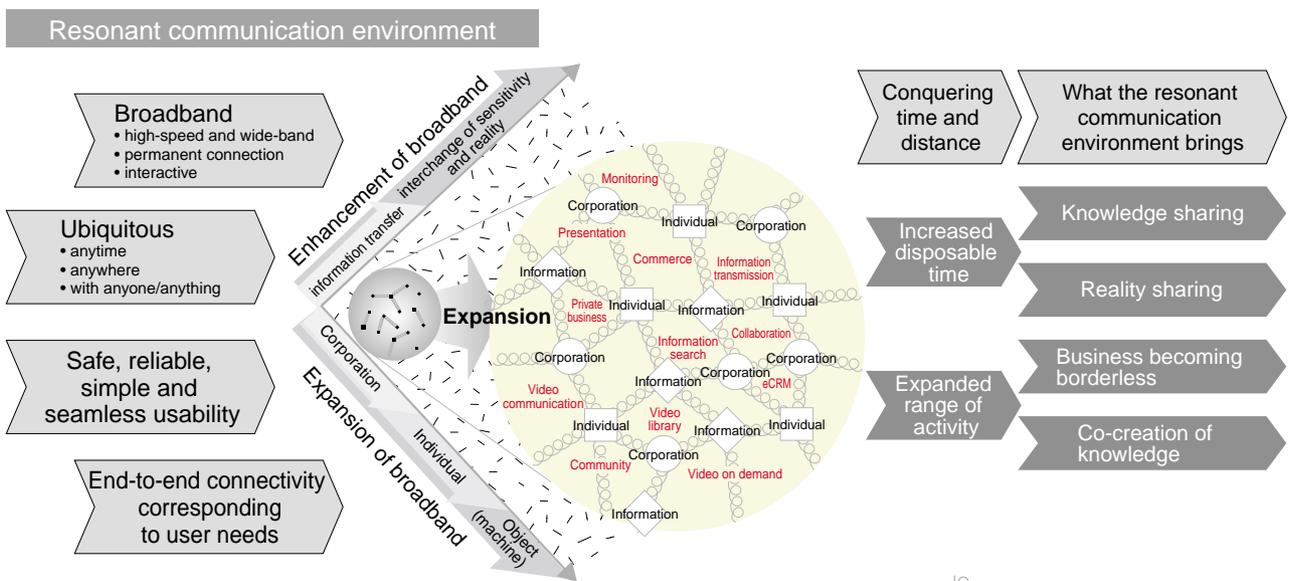


Fig. 2. Resonant communication environment.

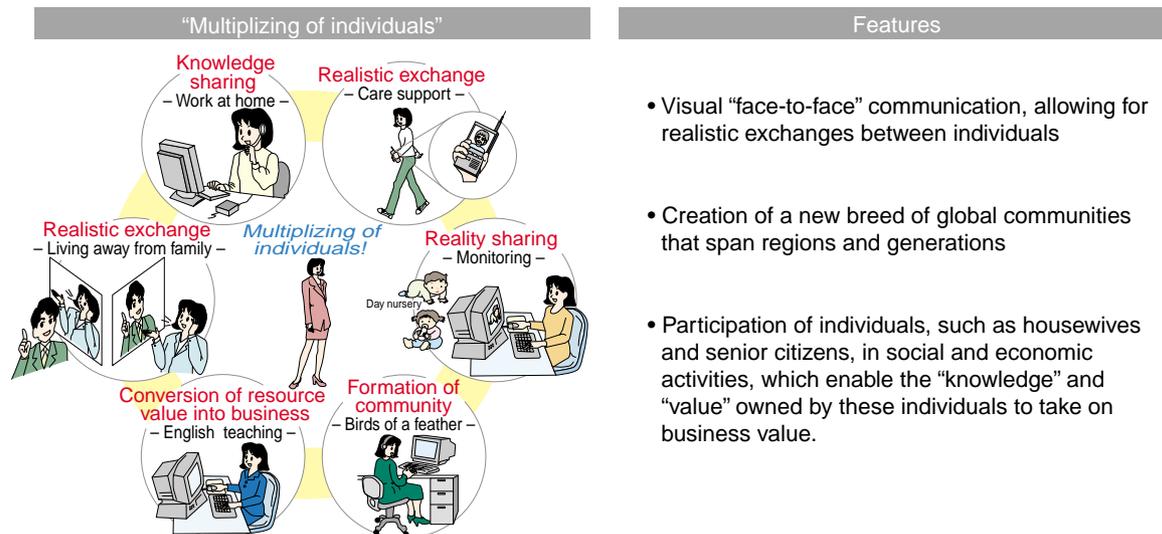


Fig. 3. Emerging new behavior models for individuals (“multiplizing of individuals”).

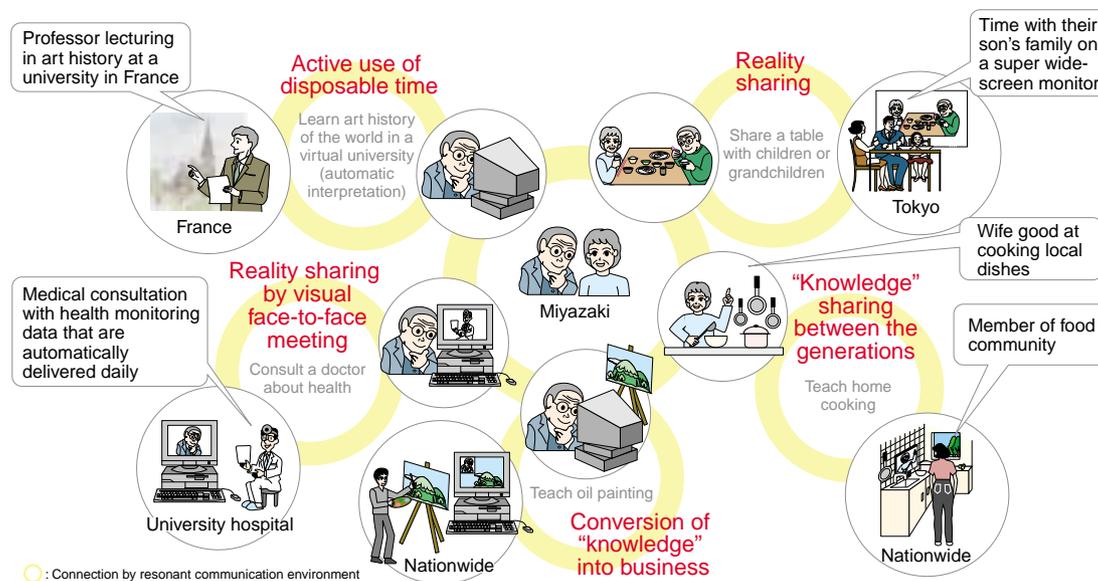


Fig. 4. Social participation model for senior people.

gives instruction about her recipes and shows her actual cooking visually over the net. They not only see their son’s family when they visit Miyazaki during the summer vacation, but also share some meal times together using wide-screen displays to show each other’s home. So, they communicate with each other on a regular basis. Information on the health of the senior couple is automatically sent to their home doctor every day, and the couple and the doctor hold a consultation session regularly using interactive video communication.

The second behavior model has to do with business activity. The increase in the sharing of “knowledge” and “reality” that exist globally and in borderless

business will bring about what may be called a “Web-chain” (Fig. 5). This is a chain linking the values of the diverse resources held by consumers and corporations. It will not only increase the productivity of corporate activities, but also give rise to new types of service and business model. Web-chains will:

- i) produce greater effectiveness and competitiveness as a result of changes in the business processes (value chain) of corporations;
- ii) generate new business opportunities as virtual corporations supported by SOHO-type management increase; and
- iii) create new global business models that span different industries.

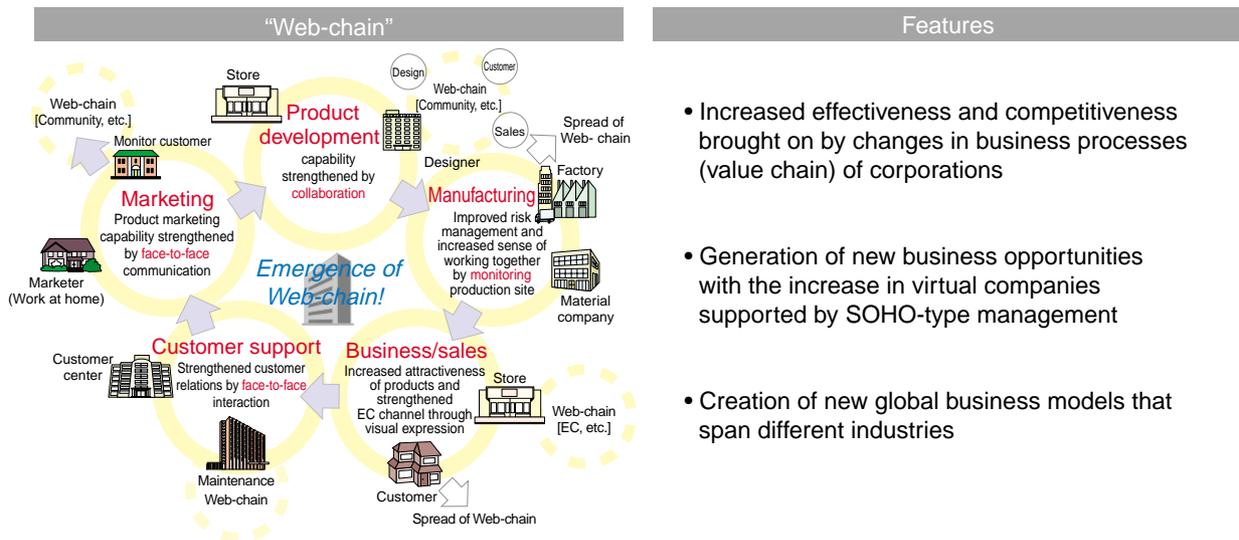


Fig. 5. Emerging new behavior models for corporations (“Web-chain” of corporations).

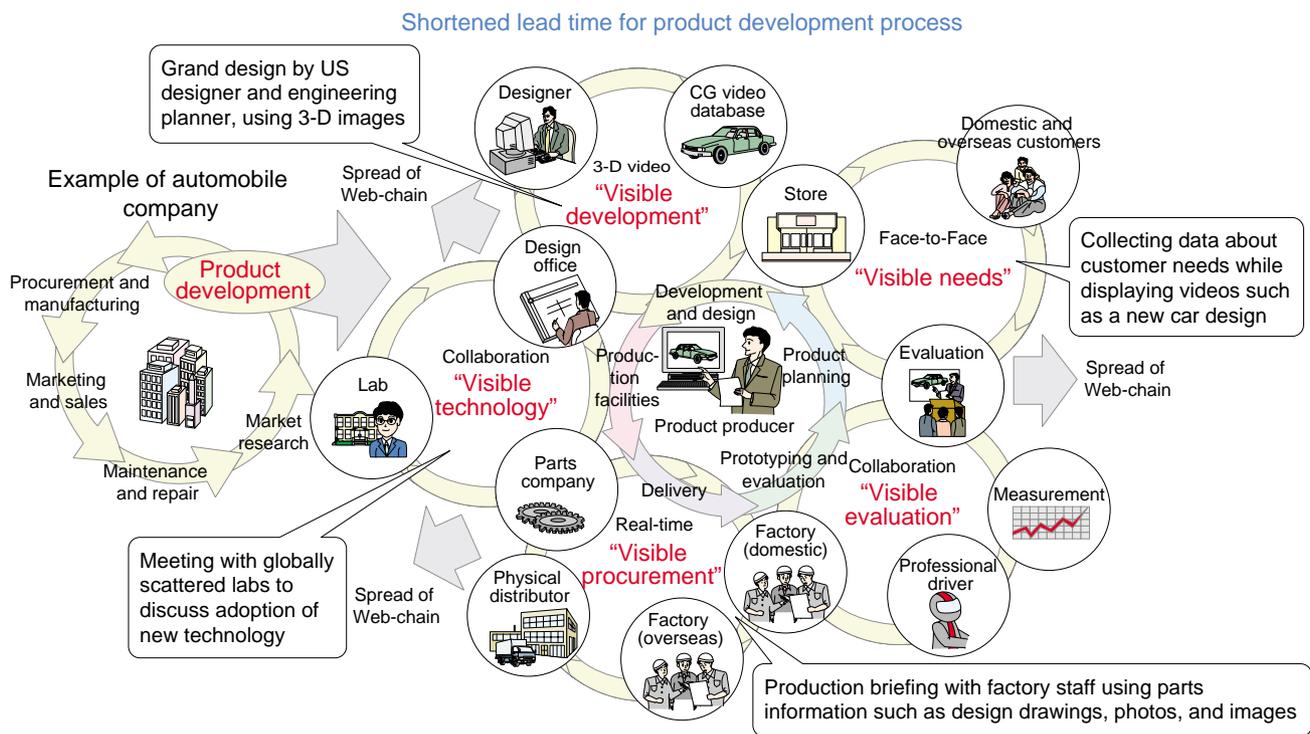


Fig. 6. High-efficiency model of business process in a corporation.

Figure 6 considers the example of an automobile manufacturer to show how a corporation’s business process can be made more efficient than it is today. All the processes of developing a new car model, processes that are said to take two years at present, from the conceptualization, design, prototype development, and evaluation, to final development of a commercial model, will be handled under the super-

vision of what is called a product producer. During the planning process, specific conceptual designs can be shown by video to customers and car dealers to gather the information about the specific needs of customers. During the design and development process, contracted designers living in different parts of the world and design engineers and development engineers in charge of new technology hold meetings

Table 1. Applying the resonant communication environment for economic development.

Fields to contribute	Expected effects by applying the resonant communication environment
Increasing industrial competitiveness	<ul style="list-style-type: none"> Increasing industrial competitiveness through global collaboration between a variety of corporations and people, which will cause innovation in value-chains, diversification in employment opportunities and creation of new business opportunities.
Revitalizing the Japanese economy	<ul style="list-style-type: none"> Time, talent and capital that previously had not been utilized will be channeled into economic activities. Boundaries between industries and between departments within a corporation will be eliminated, and collaboration will increase between individual parts of processes, individual employees, and individual pieces of knowledge or technical know-how. Through such dynamic changes in corporate activity, new businesses will be created, whose impact on the Japanese market is expected to have reached about 64 trillion yen in the year 2007.

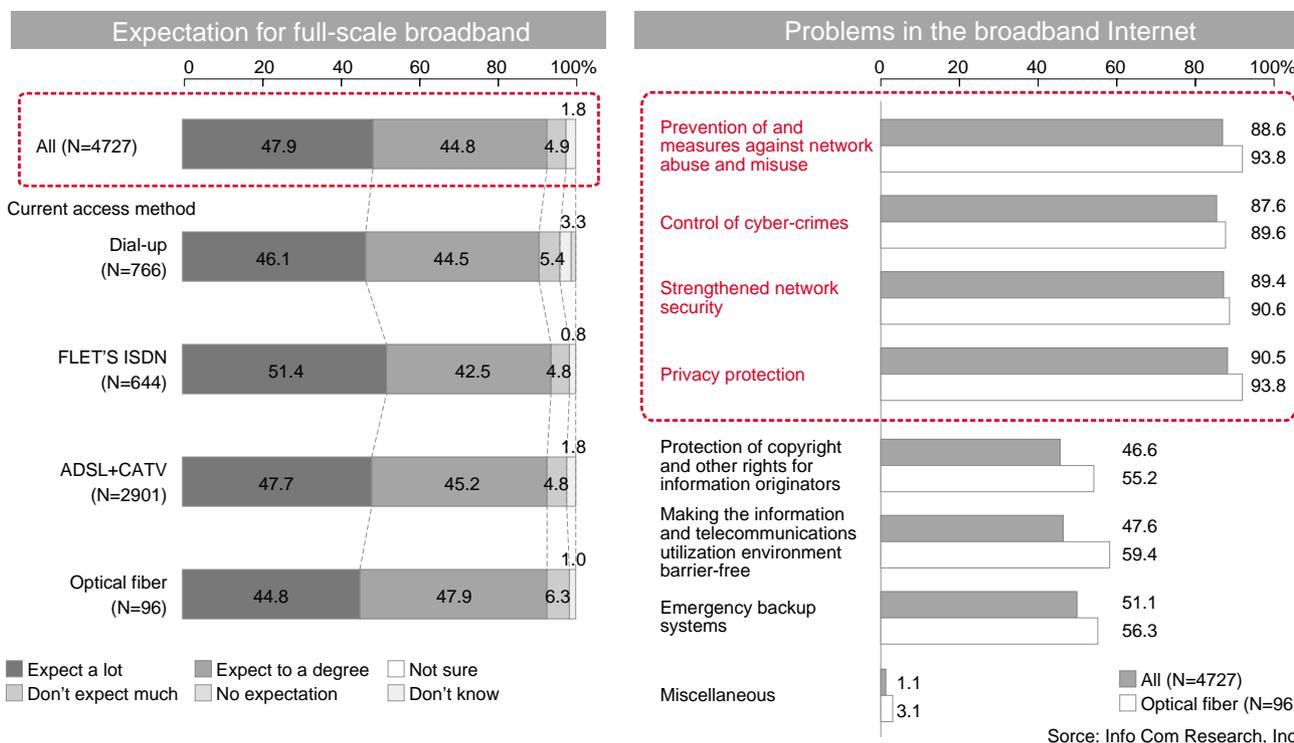


Fig. 7. Results of questionnaire survey on broadband services (1).

using a visual database or mock-ups in 3D videos. This will eliminate the traveling time for attending meetings and lead to efficient product development. During the production preparation phase, people in laboratories scattered across the world hold virtual face-to-face meetings to discuss the application of new technologies to the production of the new car model. In this way, the resonant communication environment will allow the knowledge of the people involved in product development to be shared global-

ly, resulting in a dramatic reduction in the lead time for product development.

4. Applying the resonant communication environment to resolve social issues

The resonant communication environment will bring considerable benefit to people's lives and business activities and can be instrumental in solving a large number of problems that Japan now faces.

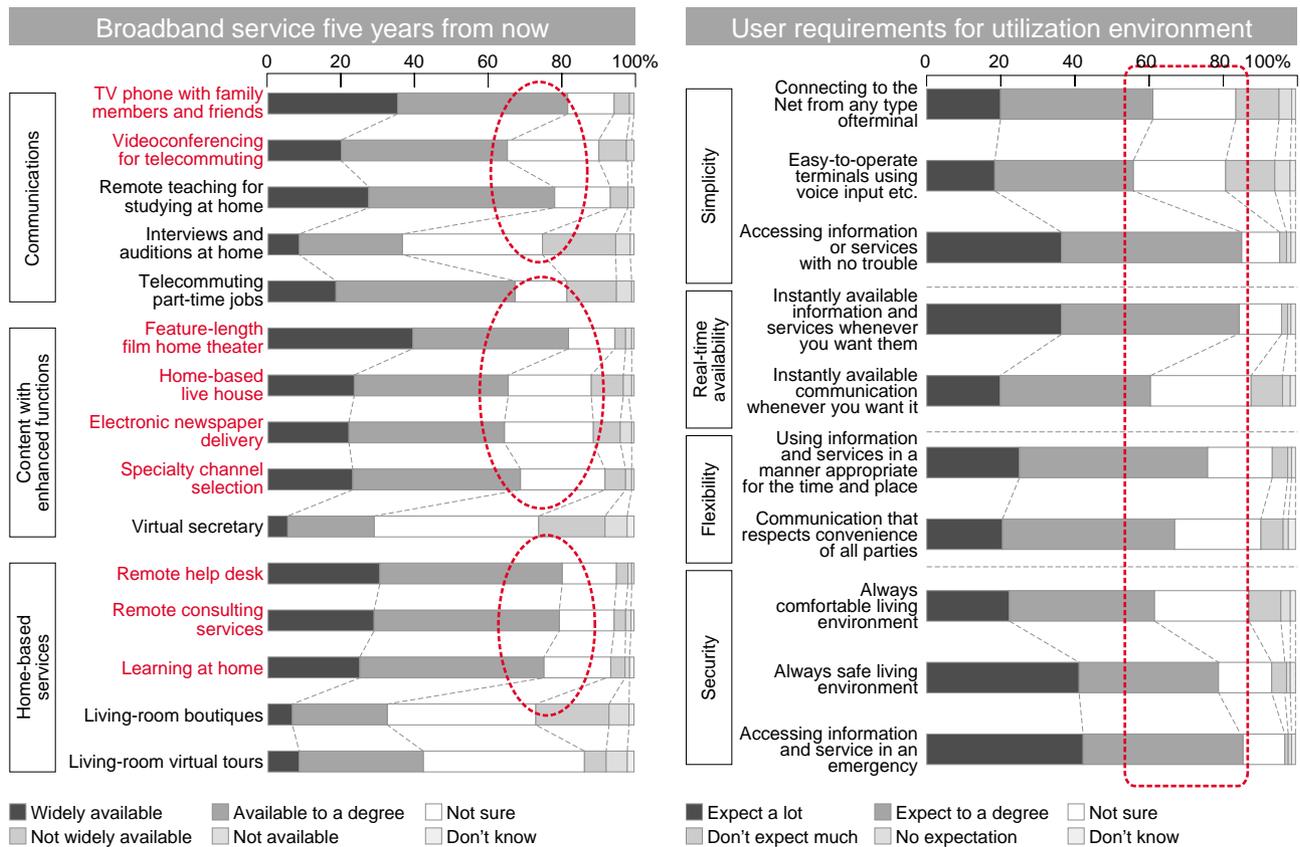


Fig. 8. Results of questionnaire survey on broadband services (2). Source: InfoCom Research, Inc.

Regarding the issue of declining birthrate coupled with an aging population and employment, those who could not previously participate in economic activities, such as senior citizens, housewives, and people who could not move away from the area they live in for various reasons, will be able to participate from home. This will reduce the mismatch between labor demand and supply, secure a large working population, and revitalize the economy. (The population of Japan is expected to peak in 2006 and then decline.)

Regarding environmental and energy issues, large amounts of energy traditionally required for transportation will be saved, which will decrease the load imposed on the environment. Eliminating the need for physical proximity will also ameliorate the concentration of population in the Tokyo area.

The resonant communication environment is expected to solve issues related to safety, peace of mind, and security. The use of interactive video will support the care of senior people, the use of various sensors will improve the quality of preventative medicine and thus reduce insurance costs, and video monitoring will help prevent crime. The resonant communication environment is expected to rectify the dispar-

ities in education levels between cities and rural areas as well as diversifying educational opportunities.

5. Applying the resonant communication environment for economic development

By increasing industrial competitiveness, propelling collaboration across industries, creating new businesses, and so on the resonant communication environment will have an impact on the Japanese economy which is expected to have reached about 64 trillion yen per year by the year 2007 (Table 1).

6. NTT Group's approach to the resonant communication environment

Surveys about broadband services (Figs. 7 and 8), based on questionnaires, reveal emerging needs for services that take advantage of the full-scale broadband network using optics, such as realistic interactive communication, strong security and protection of personal information, and superior usability with ubiquitous availability. Figure 9 presents NTT's basic ideas for realizing a resonant communication envi-

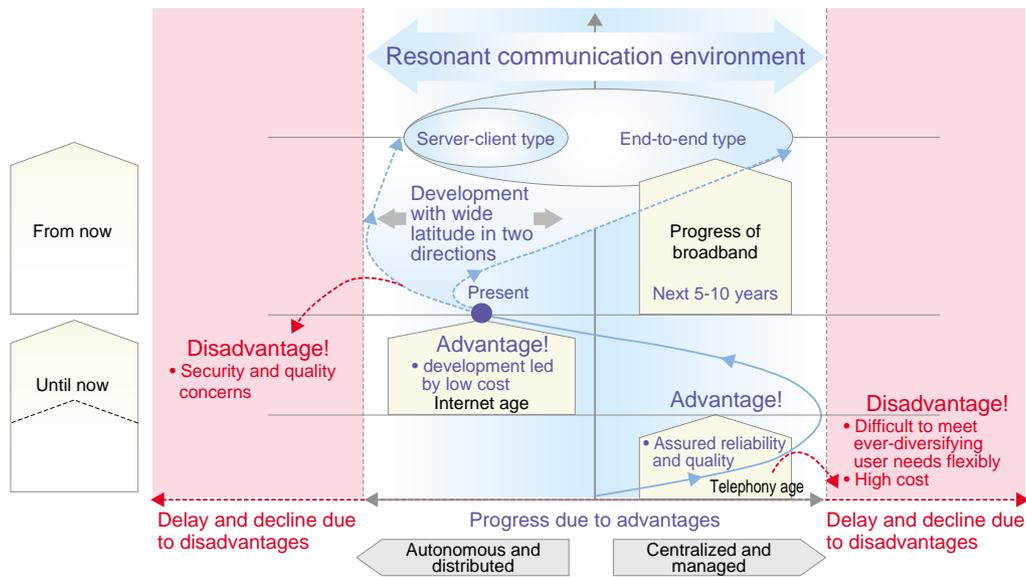


Fig. 9. NTT Group's approaches towards the resonant communications environment.

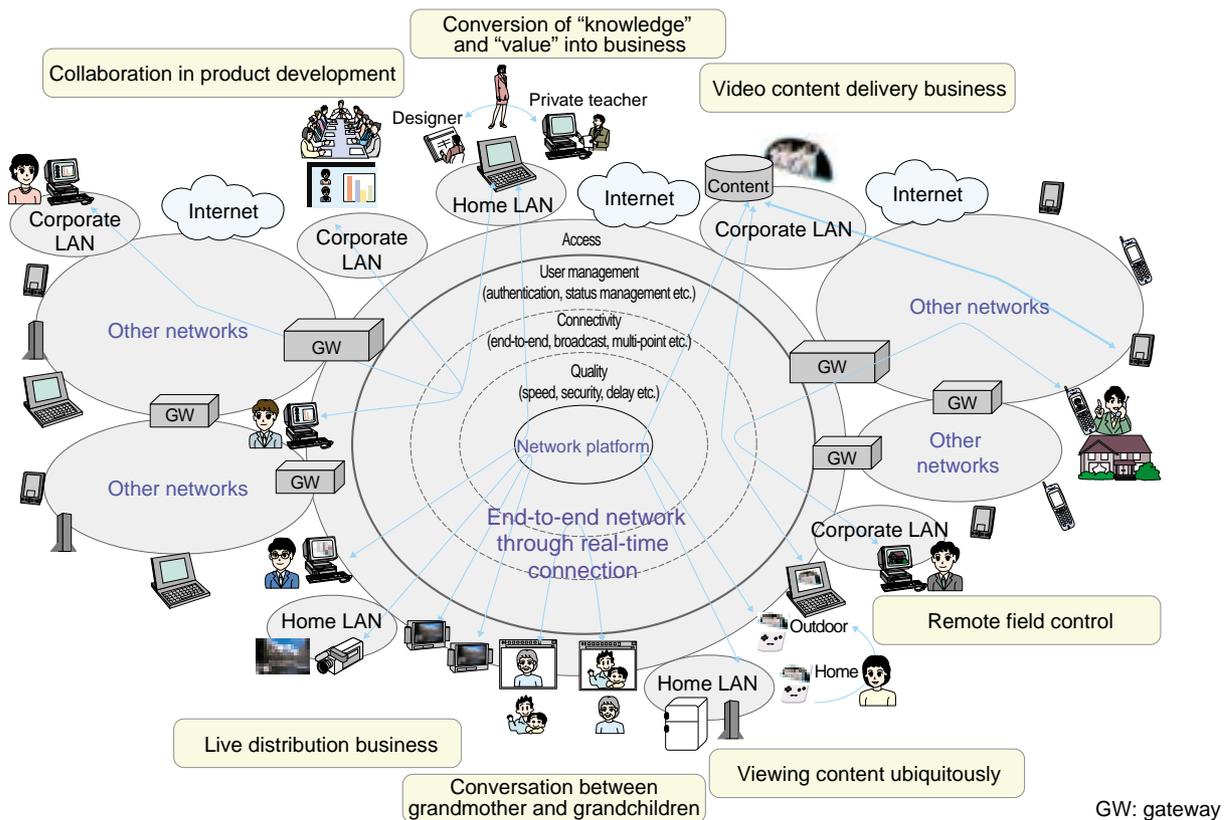


Fig. 10. Conceptual network for the resonant communication environment.

ronment. Although the telephone network has been highly regarded as being reliable and of high quality, it is expected to experience a decline due to its high cost and inability to adapt to diversifying user needs. The Internet, on the other hand, has been expanding

due to its availability at low cost. However, as user needs become more sophisticated, the issues regarding security, quality, and usability remain unsettled. The survey results show that users want the properties of both the telephone network and the Internet in

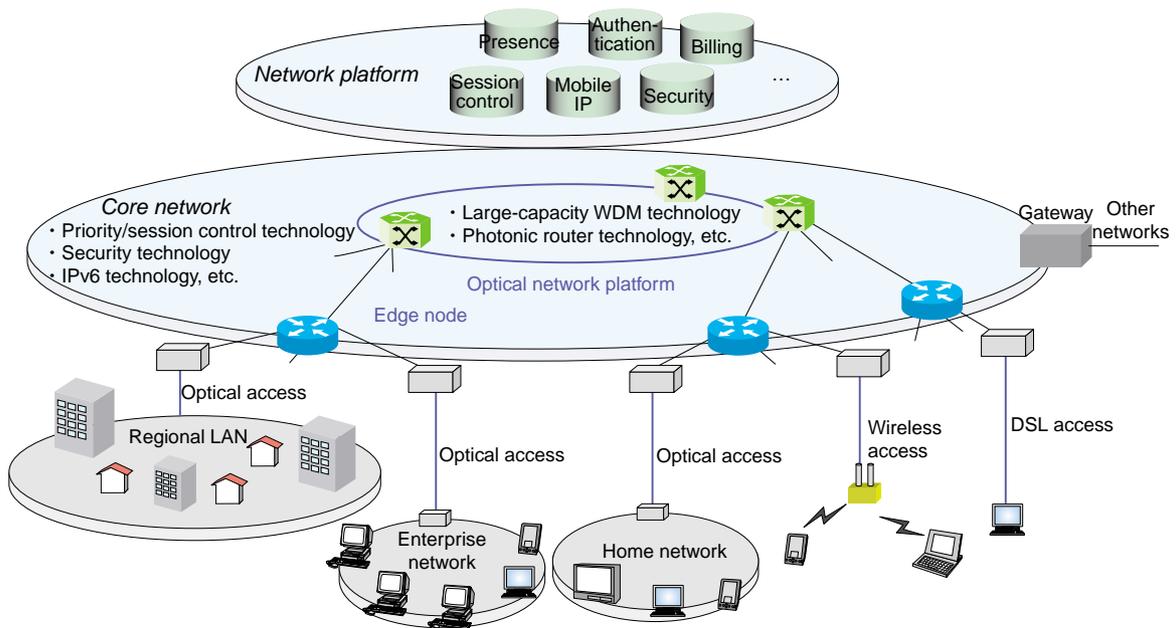


Fig. 11. Conceptual network configuration for the resonant communication environment.

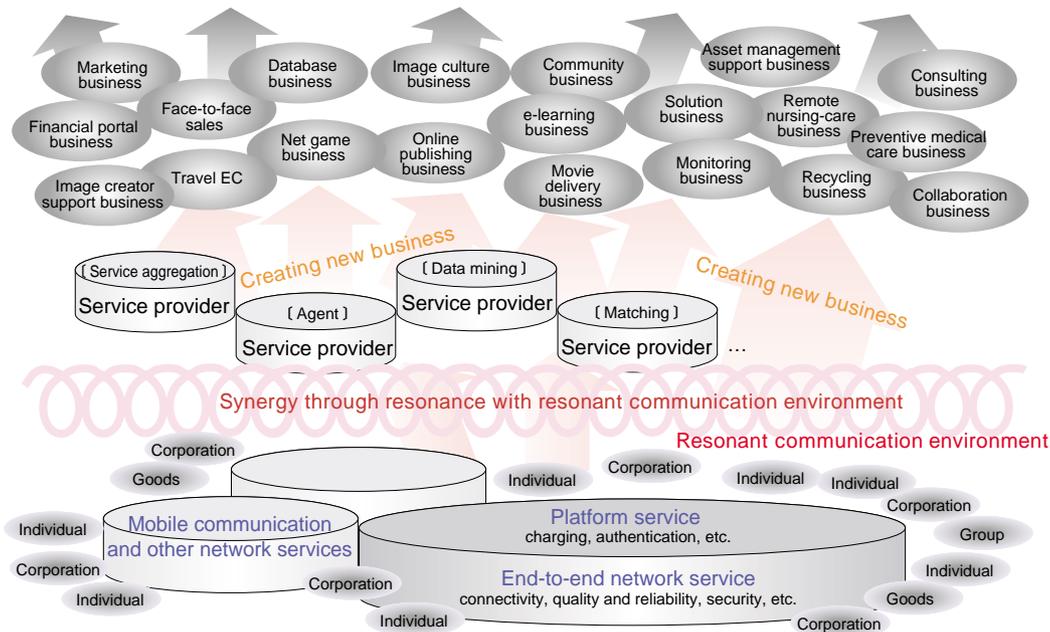


Fig. 12. Creating advanced business models.

broadband services. The resonant communication environment is intended to satisfy all these demands.

7. Conceptual network in the resonant communication environment

The resonant communication environment, as envisioned by the NTT Group, allows safe, reliable, and

simple connection to anyone. It provides network services that enable information sharing, regardless of the user environment (i.e., whether the user’s terminal is a personal computer, cellular phone, or home information appliance, all of which will continue to evolve) and whether a regional or wireless LAN is used for access (Fig. 10).

To achieve these goals, in addition to the existing

Table 2. R&D approaches.

Targeted areas	Approaches
Next-generation network architecture (RENA)	<ul style="list-style-type: none"> Promote R&D on next-generation network architecture (RENA) that will be appropriate for interactive communications and quality control. Security guarantees and the diversification in terminals and services through "end-to-end" real-time connectivity. Take the initiative in optic-related technology and network service control technology to increase network capacity and improve economic viability while accelerating development through cooperation and the utilization of partner technology. (Resonant communication network architecture: RENA)
Fundamental upper layer technology	<ul style="list-style-type: none"> Promote R&D on platform services that support diverse business solutions based on basic technologies, such as human interfaces, agents, cryptography & security, and distributed databases.
Cutting-edge technologies	<ul style="list-style-type: none"> Promote R&D on cutting-edge technologies, looking 10 years ahead.

high-speed, broadband, best-effort-based telecommunication (Internet) services, we will offer new services and capabilities (including advanced end-to-end connection (real-time connectivity)) that are difficult to provide with the server/client communication model that the current Internet is based on; highly reliable network services with guaranteed quality and security; and platform services, such as billing and agent services, that support corporations and individuals in creating new business opportunities. Furthermore, we will study terminals that closely interwork with the network and examine new access network configurations that allow the flexible expansion of service areas and provide high-quality and highly reliable services. In addition, we will provide services that offer a selection of network functions and a range of low and varied price plans.

8. Conceptual network configuration for the resonant communication environment

The NTT Group will make the most of its existing optical-fiber network infrastructure. We will enhance it by applying our R&D results, such as high-capacity WDM technology, which increases both transmission capacity and distance, and GMPLS (Generalized Multi-protocol Label Switching)-based photonic router technology, which achieves high-speed data transfer at the light-wave level. This will increase the capacity of the existing network infrastructure and allow the construction of easily expandable and cost-effective networks (Fig. 11).

We will offer highly usable end-to-end connectivity by equipping the network with a presence function, which recognizes and manages a user's communica-

tion environment; a session control function, which interconnects users; and an IPv6-technology-based Mobile IP function, which enables ubiquitous communication. In addition, technology for per-connection priority control and session control, based on interworking between the network and the user terminal, will make it possible to secure high speed, high quality, and high reliability from end to end, including the user network. Furthermore, the use of a dynamic secure channel to deter impersonation and protect communicated information will enable secure communication. This will lead to services that can meet diverse user needs.

9. Exploration of advanced business models

The NTT Group is actively exploring advanced business models through the cultivation of demand for optical network-based services, the provision of

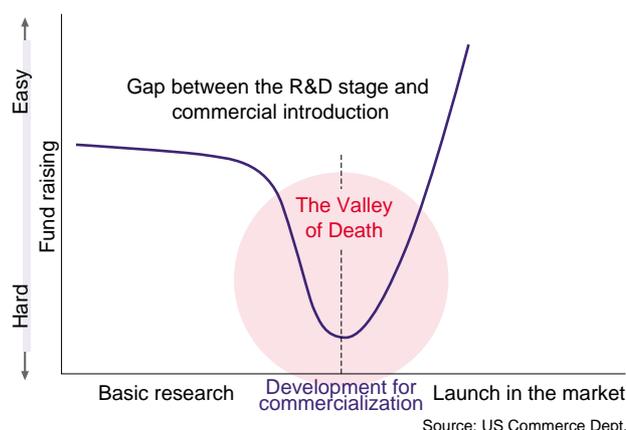


Fig. 13. The Valley of Death.

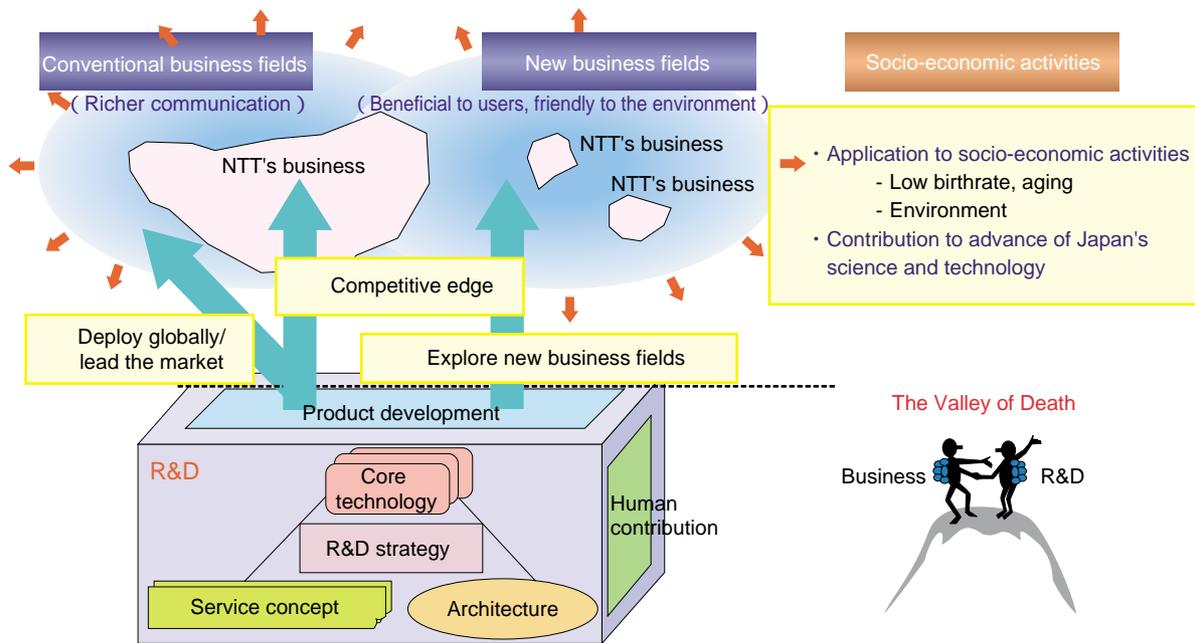


Fig. 14. Role of R&D that supports the resonant communication environment.

business solutions, and other initiatives. In parallel, it is moving ahead with the creation of new services and new business models through alliances with both domestic and foreign business partners in various fields (Fig. 12). Specific action plans include the following:

- We will actively participate, from the early stages, in research and development in policy making and feasibility testing by the national and local governments, and we are pursuing solutions for social problems.
- We will explore new solutions and business models in cooperation with corporations in various industries.
- We will promote the global deployment of resonant communication environments in cooperation with the U.S., Europe, and Asian countries.
- We will undertake initiatives for the creation of business opportunities by supporting community activities.
- We will provide new services, together with associated platforms, by combining digital broadcasting and optical technology in cooperation with the broadcasting and other industries.

10. R&D initiatives

With the resonant communication environment in mind as a goal, the NTT Group is undertaking research and development on the next-generation network

architecture, which is based on comprehensive software design from the upper layer functionality to the terminal, and in the fundamental technology required for providing a wide range of services. In parallel, we are actively pursuing cutting-edge basic technologies, looking forward about ten years (Table 2).

11. NTT's R&D endeavors

While it goes without saying that it is extremely important to drive R&D towards realizing the resonant communication environment, it is also necessary to innovate how we conduct R&D in order to be able to cope with rapid technological innovation and swift changes in the market environment. Next, I discuss how NTT pursues innovation in R&D to meet the needs of the time.

12. Overcoming the "Valley of Death"

At the stage of development for commercialization between basic research and market launch, it is often hard to find financing from the market because the business viability of new technology is difficult to assess. Fig. 13 draws on a publication by the US Department of Commerce. The highlighted gap is called the Valley of Death in the U.S. To overcome this gap and restore competitiveness, the US aims to support R&D for commercialization and promote technical development projects. In Japan, the Council

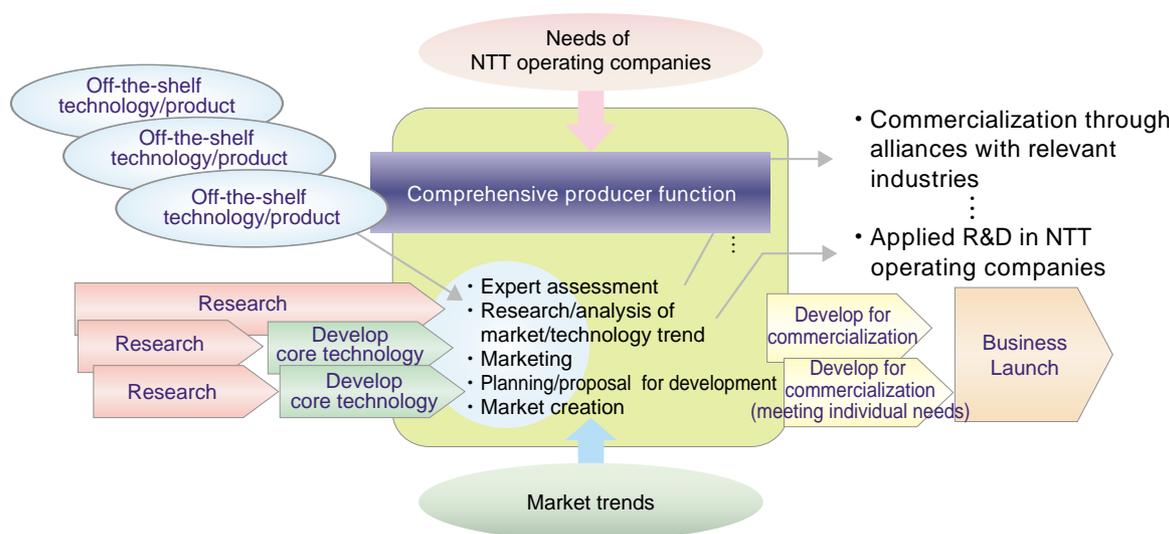


Fig. 15. Overcoming “The Valley of Death” through the comprehensive producer function.

on Fiscal and Economic Policy has been discussing the Valley of Death and considers it to be an important issue for the revitalization of the Japanese economy. I perceive that, in NTT, R&D activities for creating new technology do not always progress in accordance with the activities of operating companies for creating new businesses. In other words, the process of linking R&D results to business is missing. So, the Valley of Death does exist within the NTT Group. I consider this to be the most crucial issue in driving NTT’s R&D, and NTT is implementing measures to overcome its Valley of Death.

13. Roles of R&D in supporting the resonant communication environment

As the source of the cohesive force within the NTT Group, NTT’s R&D has produced numerous results and has been a driving force for the Group’s business. However, in view of the drastic changes in the environment surrounding the Group, such as the paradigm shift from telephony to IP technology, it is necessary to review the role of NTT’s R&D within the Group. Specifically, it will play four roles (Fig. 14):

- i) Supporting the business of group companies through an increased emphasis on the development of fundamental core technology that will afford a competitive edge,
- ii) Utilizing R&D results to explore new business opportunities extensively in fields other than telecommunications,
- iii) Deploying services in the global market and being a leader in the market,

- iv) Helping to solve social issues (such as declining birthrate coupled with an aging population, and environmental problems), revitalize the Japanese economy, and advance science and technology.

14. Overcoming the “Valley of Death” by using a comprehensive producer function

For NTT’s R&D to play these roles, a “comprehensive producer function” will be introduced in the NTT holding company (Fig. 15). It will be a good reviewer and critic of the core technologies created by NTT Laboratories and the technologies and products available on the market. Also, it will plan and propose cutting-edge developments for commercialization or businesses that can be created by combining these technologies and products, will promote practical development for commercialization and business launches, and will actively pursue market and technical trend research as well as marketing. This function will overcome the most crucial R&D issue—the Valley of Death—and will act as a bridge between R&D results and business. As the needs of each operating company become more individualized and diverse, it is important to clarify who will assume the risk and responsibility of development for commercialization and to ensure the steady and efficient development of technology. NTT will move ahead with the exploration of new businesses by reaping the benefits of its R&D, which may include products and services developed through alliances with relevant industries.