Goals of R&D on New-Generation Network Project

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It was 10 years ago that NICT started research and development for NWGN (New-Generation Network) project. The author was involved in the project from the start.

1 Introduction

Ten years have passed since the National Institute of Information and Communication Technology (hereinafter referred to as NICT) initiated its research and development activities on the New-Generation Network (NWGN). As for the preparation phase for NWGN development, starting in 2006, the NICT's implementation of the "AKARI" Project for researching and developing seed-technologies and prototypes of NWGN, formulating the concept and visions of NWGN and setting up its five challenge-targets, went forward in 2011 as full-scale development under the name "NWGN Projects." One of the objectives of the NWGN project is to review and redefine the Internet—the Internet, although having been accepted as a social infrastructure, a role it has played through many years since its birth, has been pointed out to have limitations as an infrastructure—and to establish a new architecture. Hence, NICT's activities so far—setting the research and development directions through defining visions of networks—are very effective and critical. In addition, NICT's activities have offered important suggestions on the following issues of how a so-called national research agency promotes research and development:

* Role sharing with other sectors: how to share developmental roles with other entities such as private corporations or universities than NICT
* International collaborations and competition: how to build-up the schemes for international collaboration and competition while considering the status of Japan's technical competence
* Overall strategies even covering market penetration: how to promote technical development while considering market acceptance—standardizing the developed technologies, proving the concepts through a PoC (Proof of Concept) project, and then penetrating the market.

NICT's activities and achievements (and what NICT could not afford to do), seen from a different direction, will constitute answers to the questions just mentioned above—the answers will be mentioned later. In the following sections, the outline of the status of the NWGN project is introduced. The technological aspect will be introduced first.

2 New-Generation NW R&D status: progress and challenges

The objective of the NWGN project is to redefine the network architecture of the Internet starting from a clean state for the purpose of solving a broad array of technical problems that the Internet is facing and overcoming its limitations. However, of course, it would be unrealistic to re-construct the net from scratch, because a huge volume of investment in the various fields of the Internet—base technologies, application technologies, or human resources—has been made and the Internet has been acquiring the status of social infrastructure. Therefore, building a virtualization technology-based experimental platform enabling research and development of new architectures is indispensable; so, NICT has put efforts into developing such platforms earlier than other countries, under the industry-academy-government collaboration scheme. At present, the industry sector is attracted to the potentiality of virtualization technology as an enabler of operation/management cost. However, when virtualization technology has been established in the future as the meta-architecture for realizing more flexible network configurations—even covering network functions virtualization (NFV) as well as network-resources virtualization (Software-Defined Network: SDN)—, the cultivation of advanced network architectures or services will expectedly expand.

The first for promoting such technological development is to reconfigure the network research and development

methodologies from a clean slate. This means wiping out the ways of thinking of network engineers/researchers that they have accepted consciously or unconsciously, sometimes without having any doubt about them; that will be the key to the creation of technologies leading to innovations.

Such brand-new design concepts, undoubtedly, are emerging—for example, such new network architectures as Information Centric Network (ICN)/Content Centric Network (CCN). One of ICN's advantages—technical details will be introduced in the special edition—is the adoption of the fundamental design principle of the Internet, which is often called the "hourglass" model; it places a "name layer" instead of an IP layer at the core to enable, and at the same time encourage the creation of various services on the upper layer, and to absorb various communication-technology developments that will be applied to the lower layer. It is also notable that ICN clearly defines the security layer as a component in its layer configuration—the feature is evidence that ICN aims to explicitly embody security features, different from the conventional approaches to security issues, such as adding security-countermeasures each time a security incident occurs."

Another key research field is the creation of information-communication platforms for the collection/processing of information obtained from the real world, for encouraging information utilization such as the "Internet of Things" (IoT) concept, and the utilization of actuators based on such platforms is undoubtedly the future challenge—against the conventional trend that attention is paid to sensor-network-based information collection and processing. The conventional networks working according to external communication requests can be called "open" networks; however, the development of IoT suggests that networks could be controlled by external feedback. This means that for information-flow behaviors or internal network controls, research or technology development should be conducted, possibly in a heretofore unknown field. The future problems that may arise along with the growth of the scale or complexity of such systems, particularly, will require quite different research approaches. Such challenges as mentioned above are what SDN/NFV (or SDI; Software-Defined Infrastructure) are now facing. For example, the virtual resource allocation in SDN/NFV is defined as

(1) measuring resource utilization status;
(2) collecting and analyzing necessary information; and
(3) achieving total optimization through solving the optimization problem.

However, when the problem of scale is considered, it is clear that conducting feedback controls with time granularity compatible with that of the variation of information flow is difficult. IoT researchers are facing similar difficulties, too. Solving such problems will be the field where more advancement of research is required.

As described so far, the real challenge we are facing now is how to free ourselves from the idea that "the mission of networks is to provide a duct for information flow." Hence, the first thing we must do for tackling the challenge is to realize a network having a service provision function. In addition, we are required to embed an "object-oriented" network feature for ensuring users (and programmers) handle network functions and information as an object. The objective of such a network is to provide service enablers—meaning that network-related services are available on the network so that service developers, through combining the network-available service enablers, are able to create their own services—for example, resource/cost efficient or sophisticated functions. The idea of such a network would be described in the following way: each network node should be a cloud component, and cloud-computing resources should be allocated to each node as well as to a data center—such an idea is the key to the new network configuration. Therefore, for the research and development of such a network, such a way of thinking that all things related to a network—from transport-related functions to services—should be included in the design of the network is required. The network must be so defined that the whole of the related components, functions, services, resources and services are integrated into a single network.

3 Expectations to NICT: their mission

As already stated at the beginning of this chapter, the NICT's activities on the NWGN Project have revealed what great expectations have been and will be placed on the NICT's activities. The following is what NICT is expected to do:

1) Identify key fields of the next-generation technology field through establishing visions

   Offering visions or ideas on "desired" services available on networks and how to make them accepted in human society; and promoting large-scale projects following the visions—selecting high priority technology fields and concentrating research funds on them.

2) Playing the hub role in industry-academy-government collaboration activities

Promoting, as well as 20-to-50-year range basic research, its projects and playing the central role in industry-academy-government collaboration, covering a broad range of research and development—from basic research to implementation and industry cultivation (and promoting social acceptance). In addition, NICT is expected, with regard to the activities for standardization, to perform central roles.

3) Providing a "base" for exchanging ideas and knowledge

Creating a forum for the broad range of researchers and engineers—from those working on basic/application research to those working on implementation technology—to participate crossing borders of academy or industry; such a forum will never be built by a single university or a single corporation because any consortium built in such a way will have limitations in its activities coming from conflicts of interest among members.

4) Cultivating human resources for global cooperation and competition

Offering OJT opportunities to the researchers/engineers have potential for contributing to global activities, particularly standardization.

Although such expectation might be too idealistic, academia and industry are seriously considering the issues and largely expect NICT to accomplish such a mission.

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