Flexible Networking Technologies for Future Networks

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Abstract

In recent years, many researchers around the world have been tackling the Future Network, which should supplant the current Next Generation Network (NGN) and the Internet. This article issue describes some examples of research activities on flexible networking in NTT's laboratories; these examples have been selected because they involve important issues with future networks. Flexible networking aims to meet the changes in users' demands, permit easy development of new services, and reduce the capital and operating expenditure costs of existing services.

1. Introduction

In the last decade, the continuous stream of innovations in networking technologies, such as optical, wireless, the Internet, and the Next Generation Network (NGN), has had a huge impact on us and has significantly enhanced social value in combination with information-processing technologies. As a result, the purposes for which networks are being used have become diversified, and networks have become one of the key social infrastructures.

Based on the evolution of networking and information technologies, many studies on the design of the next-generation network, which they call the Future Network, New Generation Network, or Future Internet, have started. This includes the Network of the Future and Internet of Things (IoT) projects in FP7/EU, FIA (Future Internet Architecture) projects funded by the National Science Foundation (NSF) in the USA, and next-generation network research centered on the NWGN (New Generation Network Promotion) Forum Japan.

2. Key changes in network environments

When we attempt to create a new network concept, one of the important viewpoints must be the changes in the environment-hosting networks. This year is the 50th anniversary of the birth of the Internet. Over that period, the situation surrounding networks has dramatically changed. The main changes are listed in **Table 1**.

For example, the main purpose of network users has changed from peer-to-peer connection between two sites to data access to obtain information. The diversity of appliances, such as smartphones and tablets, is increasing rapidly, so the IoT and M2M (machine-to-machine) world will emerge in the near future. From the viewpoint of network traffic, data traffic from/to mobile appliances is increasing very quickly. Moreover, the energy consumed by information and communications technology (ICT) equipment is becoming a major problem. This problem is especially important for NTT because the massive earthquake in 2011 triggered serious energy shortages.

3. Four key flexibilities

Since networks are a social infrastructure, stability has been one of the most important requirements for them. However, to this we must add the ability to respond to the abovementioned changes. We think that *flexibility* is another key goal when developing future networks. Flexibility is enabled by virtualizing the networking and computing resources, such as bandwidth, routing functions, servers, and storage, and combining them dynamically in order to create new services, balance loads, recover from failures, and so on. Our proposed flexible networking

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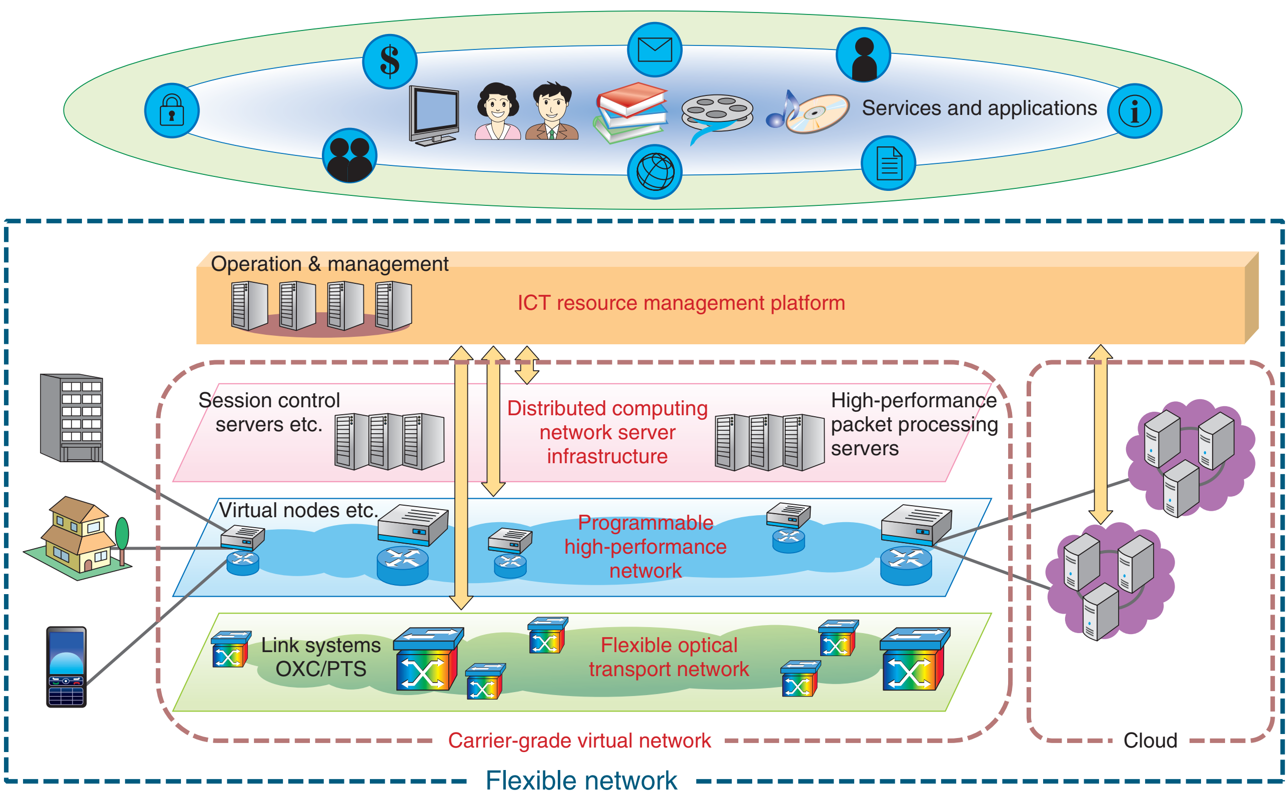
Table 1. Key changes in networking environment.

1. Traffic generated by information access is overwhelming 1-to-1 communication traffic.
2. Variety of appliances and sensors (IoT and M2M)
3. Explosive growth in mobile traffic
4. Problem of power consumed by network equipment
5. Requirements for recovery from disasters and large-scale failures



OXC: optical cross connect
PTS: packet transport system

Fig. 1. Flexible networking architecture.

architecture has four layers providing four types of flexibility (**Fig. 1**). These layers are outlined below and described in more detail in the other Feature Articles in this issue.

The lowest layer holds the flexible optical transport network [1]. This layer virtualizes the resources of the physical network layer and provides them to the higher layers. The network in this layer can dynamically change its topology and bandwidth to suit traffic changes, disasters, and so on.

The second layer is the programmable high-performance network [2], [3]. This is a virtualized network layer that uses the resources provided by the layer below. The virtual nodes include computing resources and combine them with network resources. A virtual node can be altered by software in order to implement new network functions, e.g., protocols.

The third layer is the distributed computing network server infrastructure [4]. This layer provides service functions such as the SIP (session initiation protocol) server in the NGN. The servers are distributed over the virtual networks and collaborate with each other to provide cloud computing. As such, this architecture can dynamically alter the server resources to meet changes such as the adoption of new services and a rapid change in service traffic due to a disaster. Moreover, some data-handling functions such as high-performance packet processing could be performed utilizing this architecture.

These three network layers aim to virtualize and abstract the resources in each layer. Of course, some of them are used together with existing network systems, but the architecture works well when all layers collaborate to combine the various resources available.

The top layer, the ICT resource management platform [2], serves the role of an orchestrator of network resources. This layer also coordinates with computing (information technology (IT)) resources in the cloud. As a result, the Flexible Network accelerates the creation of new network services in combination with IT resources.

References

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