## DOCOMO Today

## **Creating a New Network from a Clean Slate**



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"Next generation" and "new generation" are well-known expressions used to indicate the stepwise evolution of network technology, but they can also be found in discussions of other established technologies. However, the word "generation" is not used to describe research on something totally new-when "first generation" technology is under study, no one calls it "first generation." "Next generation" and "new generation" usually indicate relatively major advancements from current technical achievements, so their use requires long-term and continuous evolution with a good technical foundation. Mature technology with a solid foundation has many widely accepted results, so subsequent developments, which often bear the label "next generation" or "new generation," must consider many compatibility issues and migration requirements that hinder the creation of disruptive new technologies. In the 2000s, internet technology, which had rapidly evolved in the 1990s, faced similar difficulty-it had matured and discussions on its development had become stagnant. To break the status quo, a new research movement was started to create a new network technology for the Internet from a "clean slate" without the burden of compatibility issues and migration requirements. This movement began around 2005 in the United States as a major research project of the National Science Foundation (NSF)\*1, an advocate of the clean-slate approach. It has since expanded throughout the world.

The challenge of creating new technology from a clean slate may look very attractive to a researcher, but it is not easy to study something without any requirements. In the early stage of the clean-slate project, researchers struggled with this difficulty. In the first five years or so, researchers were exploring various technical possibilities without a clear view of what the new network technology should be. In looking for direction, many of them focused on problems with existing technology as a basis for establishing requirements. Regrettably, these requirements were neither requested by actual users nor helpful in determining a direction for their research. Then, around 2010, cloud computing systems brought about a significant change in network research, enabling researchers to determine what problems truly needed to be solved. The cloud, which is a large network of cooperating computers, was expanding dramatically at that time and was on its way to becoming a massive system on an unprecedented scale. At the same time, cloud operators were eager for more efficient operations to deal with such a massive system since network equipment, e.g. routers, in the cloud still concealed functions not controllable from the outside. Operators felt frustrated at this lack of full control and were looking for a solution to this problem. Thankfully, Software-Defined Networking (SDN)\*2, which provided better programmable network control decoupled from data forwarding functions, offered the right solution at the right time. Studies on SDN in conjunction with the cloud began to take shape and accelerate, and network equipment vendors including startups and telecommunications carriers began to climb aboard one after another. It took only a few years for SDN to became a major trend in network technology, and in 2012, the standardization of Network Functions Virtualisation (NFV)\*3 covering the virtualization of the network nodal system began at the European Telecommunications Standards Institute (ETSI)\*4. NTT DOCOMO has been deeply engaged in these ongoing studies and activities and has made many contributions to NFV standardization. These efforts led to NTT DOCOMO's commercial launch of an NFVcompliant network nodal system in March 2016.

At present, most people think of 5G (5th Generation) as the promised new and advanced network technology. Originally, 5G referred to the evolution of radio access technology, but nowadays, it appears to cover network evolution on the whole. Some studies on this new network that have chosen the clean slate approach present a variety of possibilities, but they have yet to find a proper research direction. Fortunately, changes in the end system are taking place thanks to rapid progress in the development of the Internet of Things (IoT)\*<sup>5</sup> and Artificial Intelligence (AI) applications. We can expect these changes to show the way for new network studies in much the same way that the cloud opened the way for SDN. Aiming for a commercial service launch of 5G in 2020, NTT DOCOMO is committed to driving major trends in new network technology in conjunction with the evolution of IoT and AI.

- \*1 NSF: A United States government agency that grants research funds in a wide range of science and engineering fields for the advancement of science and technology in the United States. NSF supports many innovative research projects.
- \*2 **SDN:** A new approach to network technology that decouples network control from data forwarding functions and performs network control by software.
- \*3 NFV: A technology that allows implementing communication processing functions with hardware-independent software and enables dynamic reconfiguration of those functions and flexible resource allocation by use of virtualization technology.
- \*4 ETSI: A European standardization body engaged in the development of international telecommunications standards.
- \*5 **IOT:** General term for the paradigm of collecting real-world information and controlling real-world entities via networks and connected devices ("things").