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White Paper

Optimum Network Architecture for Full-scale IoT

NEC Corporation

Executive Summary

With the rapid development of software-defined networking (SDN) and network functions virtualization (NFV) in recent years, virtualizing carrier network functions is now a realistic proposition. In addition, this virtualization technology can be applied even more extensively to next-generation 5G wireless networks. With the introduction of cloud/centralized radio access networks (C-RAN), more sophisticated processing and computer resources are being pushed towards wireless network controllers, making it easier to deploy core network functions and service applications on them. Mobile network operators can offer advanced services by employing these resources and linking them to mobile-edge computing (MEC) to realize lower latencies and distributed processing for Internet of Things (IoT).

The number of IoT devices is expected to grow exponentially going forward, and the type of IoT devices will likely extend beyond current smartphones to automobiles, surveillance cameras, robots and a whole myriad of other items. NEC is showcasing new network architecture for the IoT era, along with tailored migration scenarios, and exciting context-aware control technology designed to boost the efficiency, reliability and real-time capabilities of dedicated IoT networks.

Architecture for the IoT Era

Architecture for the IoT era must guarantee three capabilities at high level: efficiency to accommodate massive numbers of devices, reliability to minimize pervasive interference between services, and real-time capability to facilitate high-speed information transmission for autonomous vehicles or remote control of robots. Such IoT architecture brings MEC closer to the base station, and assigns a virtual network to the precise area required for a specific service using advanced technologies such as dedicated core networks, or network slicing. Also, service capability exposure frameworks, which are currently being discussed by the 3rd Generation Partnership Project (3GPP), help optimize processing within the dedicated network for specific service requirements and device behaviors. This architecture can reduce pervasive interference between services, ensure time-critical, real-time capabilities when required, and optimize networks for the services and devices it accommodates (Figure-1).

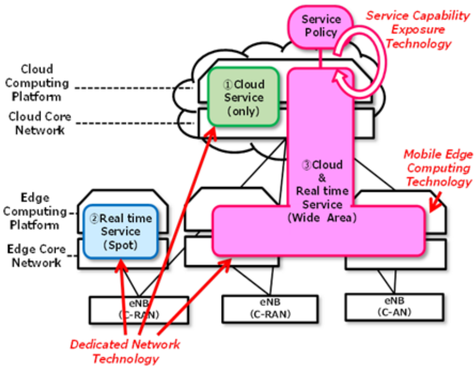

Figure-1: Network Architecture for the IoT Era

Migration Scenarios

It is important to migrate to IoT network architecture in stages in order to ensure uninterrupted provision of existing services. NEC recommends a three-step migration process.

The first step involves creating dedicated IoT networks separately from the existing smartphone networks. Dedicated networks can help mobile network operators minimize any interference with existing networks, and optimize networks for specific services.

The second step involves introducing local MEC to create dedicated spot networks for real-time services. Spot frameworks are the most appropriate given the gradual introduction of MEC that tightly cooperates with a core network. Service coverage can be extended by linking these spot networks through C-RAN.

The final step involves coordination between local MECs or between MEC and the cloud to facilitate the development of real-time services across much broader areas. This will improve the efficiency and reliability of overall networks by flexibly coordinating network and computing resources among MECs and the clouds.

Context-aware control Technology for the IoT Era

In order to achieve the additional efficiency, reliability and real-time capability that IoT-era networks demand, network providers will need to migrate to the type of architecture described above, and ensure flexible and optimum control of networks to suit the IoT devices they accommodate and the services they offer. NEC's optimum control technology focuses on context-aware control technology. This involves understanding device behaviors in their various contexts, including the way they move and communicate, and controlling IoT-dedicated networks dynamically to ensure optimum operation. Here are some of NEC's context-aware control technologies.

1) Connection control to reduce control signals of IoT devices:

As the number of devices communicating frequently with networks increases, so does the number of control signals required for connection and disconnection. That is a key consideration for this type of technology. NEC has been able to drastically reduce the number of control signals for mobile network connections by dynamically deciding appropriate disconnection timings for each device on the basis of its context (Figure-2).

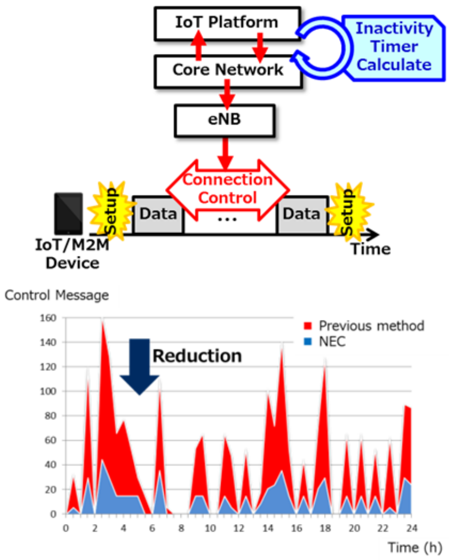

Figure-2: Connection Control

2) Paging area control to reduce paging processing for IoT devices:

There is a tradeoff between paging processing load and paging success rate, which depends on the size of the paging area. NEC's technology efficiently decides the optimum size of the paging area based on a device's likely travel range estimated from its past behavior. This can greatly reduce the number of control signals for paging processing while keeping required paging success rate (Figure-3).

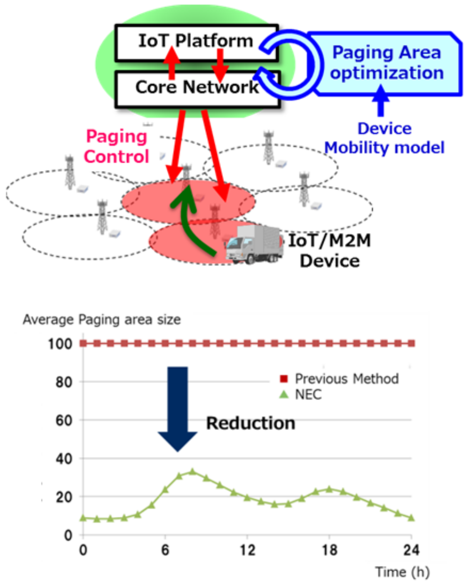

Figure-3: Paging area Control

3) Communication scheduling to smooth access traffic of IoT devices:

As massive numbers of IoT devices communicate in various cycles, mobile networks are likely to experience sudden surges in access traffic. NEC's technology enables networks to control each IoT device's communication schedule, based on its tolerable delay and access traffic per unit of time. This technology can help operators smooth access traffic for IoT devices in its mobile networks while maintaining tolerable delay levels for each device (Figure-4).

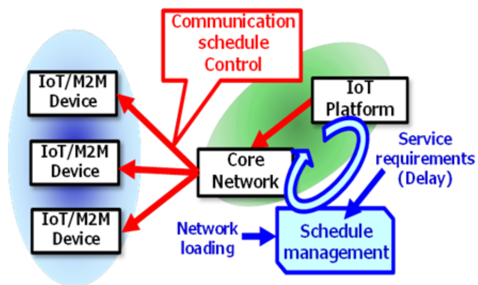

Figure-4: Communication Scheduling

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Abbreviations

SDN	Software-Defined Networking
NFV	Network Functions Virtualization
C-RAN	Cloud-RAN
RAN	Radio Access Network
MEC	Mobile-edge Computing
IoT	Internet of Things

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