NEC's Approach to Full Automation of Network Operations in OSS

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Abstract

An enormous amount of network equipment, including base stations, is being deployed worldwide by communication service providers (CSPs). It is not unusual for a single CSP to have more than a million pieces of equipment — which are built, updated, broken down, and repaired on a daily basis and which are also supported day and night by a large number of staff involved in infrastructure maintenance. The operations of such network equipment are carried out by a group of systems called operating supporting systems (OSS). This paper introduces NEC's next-generation OSS and orchestration products now being developed under the concept of autonomous networks with the aim of zero-touch operations by minimizing human contact and enabling networks to autonomously operate by themselves.

Keywords

E2EO, intent-driven orchestration, autonomous networks, operations automation

1. Introduction

In the networks of communication service providers (CSPs) in the Beyond 5G and 6G eras, edge data center are widely used and virtual resources will be distributed geographically and across networks in thousands of small-scale data centers (ranging from 1,000 to 10,000 locations in the case of Japan) throughout base stations, fixed access networks, and core networks. It is essential to optimize the configuration and placement of such distributed resources in terms of time, space, power consumption, and network performance. Achieving this optimization manually within the required time frame, however, is difficult from the viewpoint of computational complexity, because a vast number of variables need to be considered. The challenge is to thereby enable the network itself to autonomously change its configuration.

2. Initiatives in the world

The TM Forum has been focusing on autonomous networks that combine virtualization and artificial intelligence (AI) to automate operations in an effort to enable networks themselves to autonomously change their configurations. The TM Forum has defined this concept and identified six levels of automation from "no automation" to "full automation"[1] (**Fig. 1**). Currently, many CSPs worldwide have stated that they have achieved Level 1 or 2 in terms of automation and are looking forward to increasing their level to Level 3 or 4 within the next three years[2].

To achieve Level 5, which means full automation, it is crucial to work on intent-based technology. In other

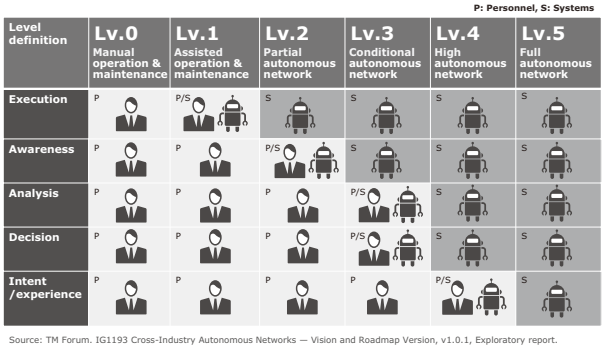

Fig. 1 Levels of Autonomous Networks.

words, it requires a sophisticated system that can include its interpretations of human "intent".

3. NEC's approach

3.1 Overview

To provide solutions to help achieve the autonomous networks of Level 5 and to achieve operational automation, we are developing the NEC operations support system (NEC OSS).

The NEC OSS has the necessary elements for network operation systems while also providing assurance, fulfillment, and orchestration. It is a framework product that combines microservices-based functionality to offer both the flexibility of building a product from scratch and the basic features of a packaged product (**Fig. 2**).

In recent years, emerging challenges in the Japanese market include the so-called "2025 Digital Cliff,"[3] which is a combination of human resource and technological risks for Japanese companies, and the need for faster service delivery. As a solution to these challenges, the trend towards the digital transformation (DX) of operations is growing, and CSPs are increasingly being expected to perform development and operations by themselves. To address these new requirements, the NEC OSS — in addition to its high customizability — uses no-code, low-code[*1] technologies, which are solutions with a support menu to accelerate in-house production efforts.

Details how the NEC OSS provides fulfilment, assurance and orchestration are described in section 3.2 and subsequent sections.

3.2 Assurance

The NEC Assurance system provides CSPs with monitoring capabilities essential for operational and maintenance tasks. It improves efficiency and facilitates maintenance operations, helping achieve reduced maintenance downtime and faster fault recovery.

The networks of CSPs are now becoming more and more complex due to the coexistence of multiple generations of networks, including 3G, 4G, 5G, and 6G, as well as the rise of network virtualization and cloud-native management layers. This complexity has resulted in increased maintenance operations and prolonged fault recovery times.

Our NEC Assurance system supports multi-vendor equipment and includes functions for network monitoring, such as fault management, performance management, and IT Service Management (ITSM) areas such as ticket management and change management. It also features automation capabilities to streamline a series of maintenance flows comprised of monitoring, inspection, and diagnostics. It is also capable of executing automated controls triggered by a combination of alarms and performance information as well as executing a correlation analysis that automatically identifies root causes of alarms using device topology and alarm information. The functional configuration of the NEC Assurance system is shown in **Fig. 3**.

We are working on the advancement of maintenance operations through the use of artificial intelligence (AI) and machine learning (ML). We have already successfully been able to detect silent failures where no alarms are activated as well as successfully used predictive anomaly detection by comparing prediction data with actual data to detect conditions that differ from the usual normal conditions. What is more, we also provide a big data storage platform for AI/ML-based analysis and an AI/ML

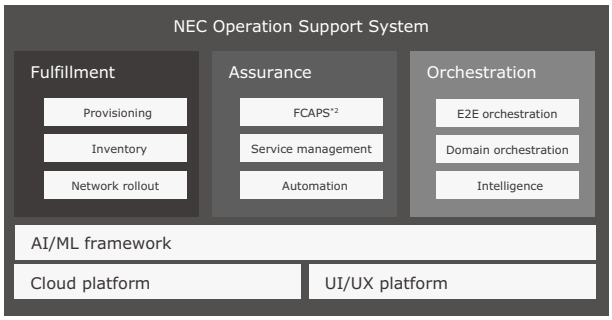

Fig. 2 NEC OSS portfolio.

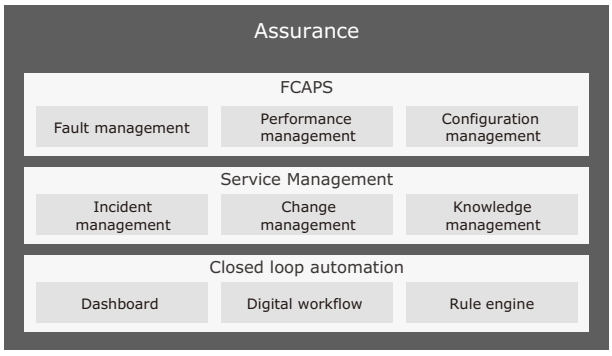

Fig. 3 Functional configuration of the NEC Assurance system.

[*1] Enables users to develop apps by using GUI and other tools but requires no coding or low coding experience.
[*2] Acronym for the five working levels of network management: fault, configuration, accounting, performance, and security. It is a common framework used in the design of the open systems interconnection (OSI) network management model.

engine management platform capable of managing AI/ML engines from multiple vendors. This enables CSPs to select and carry out AI/ML solutions that are best suited to their needs.

3.3 Fulfillment

The NEC Fulfillment system provides the functions of network design, configurations, and testing that are required to build telecommunication networks managed by CSPs.

In recent years, the need for the rapid construction of base stations has become an issue for CSPs to expand their coverage areas because of the transition to 5G. Also, as networks are becoming more and more complex, carriers are required to diversify services, ensure quality, and reduce power consumption, and carriers are promoting the automation of fulfillment operations. It is expected that Beyond 5G and 6G networks will be required to provide data communications with higher speed, higher capacity, and lower latency than 5G networks. For this reason, it will be necessary to further advance operations in network construction.

The NEC Fulfillment System is equipped with provisioning functions for the construction of base stations and facility management as well as the network rollout functions required for station construction. It performs a centralized management of the introduction, establishment, and reduction or expansion of both physical and virtual network facilities to achieve resource efficiency. **Fig. 4** shows the functional configuration of NEC's Fulfillment System.

In addition, we are working to automate planning and design tasks in collaboration with the AI that was developed using our proprietary technology for automated design. We are also working to achieve a technology for automated construction that uses cloud services to deliver full automation of everything from network configuration to testing.

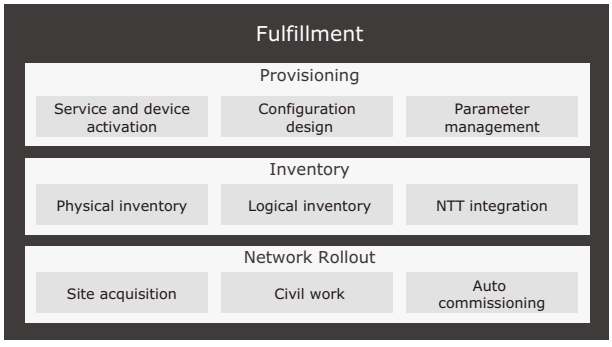

Fig. 4 Functional configuration of the NEC Assurance system.

3.4 Orchestration

Orchestration plays a crucial role in achieving advanced operations and the full automation of wide-ranging tasks by combining various types of information and functions such as those providing assurance and fulfillment as well as those of adjacent systems.

Several types of orchestration are used in various layers and domains, such as an end-to-end orchestrator (E2EO) across the entire network, a domain orchestrator at the network domain level, and a resource orchestrator at the resource level within domains. The NEC Orchestration system provides multi-layer, multi-domain orchestration through a common platform.

The NEC Orchestration system is also highly customizable and scalable, making it possible to change external connection interfaces and flow controls without the need for development. This enables deployment and continuous evolution of flexible orchestration functions that work with a variety of functions and systems in accordance with the state of the network, services, and resources.

Furthermore, intent-driven orchestration has attracted attention in recent years and is being discussed in many standardization organizations such as the TeleManagement (TM) Forum, the European Telecommunications Standards Institute (ETSI), the 3rd Generation Partnership Project (3GPP), and the International Telecommunication Union Telecommunication Standardization Sector (ITU-T). Intent-driven orchestration enables users, operators, and other people to declaratively communicate their intent (intention, goal, expectation, etc.), and the system operates autonomously in accordance with the intent (**Fig. 5**). Intent and intent-driven orchestration are considered essential technologies for Level 5 automation of network operations, or fully automated operations. Because it is a new technology, however, many issues still need to be addressed. We at NEC have been

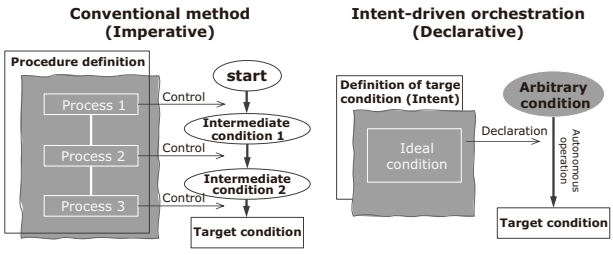

Fig. 5 Concept of intent-driven orchestration.

working to achieve intent-driven orchestration by conducting technological research, product development, and proof-of-concept (PoC) tests since the late 2010s.

3.5 Digital transformation and in-house production

At most Japanese companies, a significant portion of the personnel involved in existing operational systems (legacy systems) will soon reach retirement age, posing the risk of the so-called "2025 Digital Cliff" in which the expertise these people have acquired will be lost and operational systems will thereby become black boxes. So, transitioning to automation is now a matter of immediate concern at many companies.

As we enter an era of uncertainty referred to as VUCA (volatility, uncertainty, complexity, and ambiguity), we will need more and more operational systems that can respond flexibly and swiftly to shifts in the environment, technology, and business changes in rapidly changing system operation environments.

For this reason, many companies are currently seeking to shift from the conventional approach of outsourcing system development to in-house production, in which systems are speedily built, operated, and developed in-house.

Many companies, however, have not yet considered or made the transition to operational automation because of organizational and cultural challenges, such as a shortage of IT personnel or a lack of internal mechanisms for developing R&D talent. Consequently, we are taking three major approaches to achieve operational automation in the OSS field through the promotion of digital transformation (DX).

One approach is to promote organizational transformation through training and human resource development with the aim of leveraging our knowledge and experience in international standardization activities to transform existing operations, to apply best practices, and to establish standard architectural technologies.

Another approach is to support the development of an engineering culture where we collaborate closely with engineers from CSPs to develop operational systems with the aim of enhancing development skills based on the system requirements for operational automation and accumulating know-how.

Our last approach is to focus on legacy migration through the introduction and provision of the aforementioned NEC OSS no-code, low-code development platform.

Through these activities, we support the full automation of operations by promoting digital transformation within companies.

4. Conclusion

In this paper, we introduce our efforts in operational automation with regard to the NEC OSS, focusing on the Assurance, Fulfillment, and Intent-Driven Orchestration systems as well as focusing on digital transformation and in-house production. We at NEC will continue to push forward R&D to achieve autonomous networks in the Beyond 5G and 6G eras.

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