MANO Technology Supports Implementation of Intelligent Network Operations Management

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Abstract

MANO (Management and Orchestration) is the technology of the total management/control and optimization (orchestration) of network services and resources in the Network Function Virtualization (NFV) architecture. As it is expected that NFV will be introduced in telecom networks and that such networks will be used in various industries, MANO technology must be capable of "total management and smooth migration" as well as "handling diverse services". NEC is responding to these requirements by commercializing MANO products that feature extensions of the orchestration target from NFV alone to the legacy environment. NEC is also conducting R&D for advancing optimization technologies in order to further improve the MANO technology.

Keywords

NFV, MANO, NFVO, VNFM, VIM, E2E service orchestration, optimization by feedback loop

1. Introduction

In recent telecom networks, the NFV (Network Function Virtualization) has been introduced as an active approach to separating the hardware and software of network functions and to implementing them on a virtualized platform of general-purpose servers. These network functions used to be offered in an integrated format by dedicated equipment. With regard to deliberations concerning the NFV, elaboration of the industry-standard architecture and specifications has been underway by the ISG (Industry Specification Group) of the ETSI (European Telecommunications Standards Institute) since November 2012.

It is the MANO (Management and Orchestration) technology that controls the total management/control and optimization (hereinafter also referred to as "orchestration") of the network services and resources in the NFV architecture. MANO technology is currently attracting attention because of its total orchestration capability. It enables intelligent operations management; including quick, flexible construction of network services and supports their policy-based automation and dynamic network optimization capability.

When the 5G mobile networking era arrives in the future and expands its application especially among IoT (Internet of Things) and M2M (Machine to Machine), it is expected that more advanced network control will be required to enable the efficient operation of the diverse network services that are deployed with different requirements and characteristics. The MANO technology is regarded as playing the central role in these undertakings.

NEC led the world, by proposing a MANO product featuring an extension of the orchestration target from the NFV alone to the legacy environments (NEC expanded MANO). Additionally, in the future we intend to advance the optimization technology in order to further advance the MANO technology.

Below, we introduce our approach toward the role of and the requirements of the MANO technology and outline its function in supporting NFV.

2. Outline of MANO

This section gives an outline on the role of MANO in

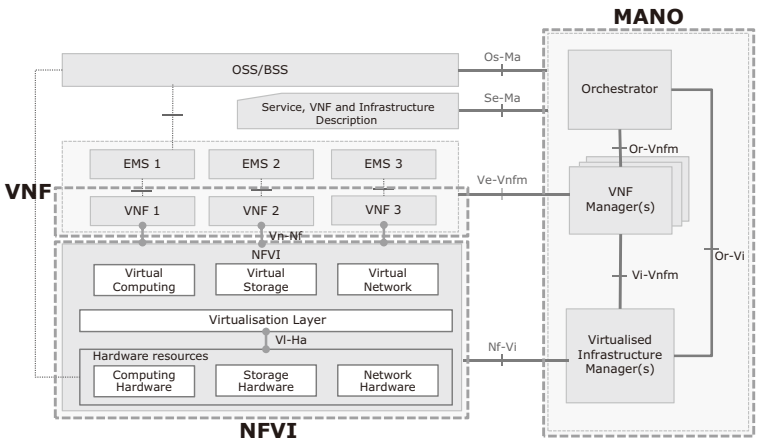

Fig.1 NFV architecture framework.

the NFV architecture. As shown in **Fig. 1,** the NFV architecture is composed of the NFVI (NFV Infrastructure), VNF (Virtual Network Function) and MANO. Standard interfaces are defined between them so that the NFV can be implemented using multi-vendor products.

The NFVI is the platform that makes it possible to handle the physical resources, including the computing, storage and network hardware flexibly as virtual resources, and the VNF refers to a group of virtualized network functions that run on the NFVI. Finally, the MANO assumes the most important role in the NFV operations management. MANO is composed of the following three components and controls the integrated orchestration of network services provided by the NFVI and VNF or of several VNFs.

- **NFVO (NFV Orchestrator)**
  This component performs the lifecycle management (generation, surveillance, operation, deletion, etc.) of network services provided by several VNF components. It controls the integrated operations management of the entire system.
- **VNFM (VNF Manager)**
  This component controls the management of the resource requirements and lifecycle of the VNF.
- **VIM (Virtualized Infrastructure Manager)**
  This component controls the operations management of the physical and virtual resources. OpenStack has become the de facto standard in ETSI NFV implementation.

The three components of NVFO, VNFM and VIM enable automation of the VNF launch and software setting, quick construction of new network services, flexible equipment change according to service demands and auto release in case of a fault, etc.

3. Requirements for Telecom Network, Approach Taken by NEC

3.1 Total Management and Smooth Migration

(1) Requirements for telecom network

The telecom network is composed of complex linkages of transport SDN (Software-Defined Networking) and data center SDN in addition to the NFV. In some cases, it is compose of multi-vendor products. To operate an entire network that is so complicated and hierarchical, MANO is required to perform total management and control of the entire network.

Ultimately, NFV is expected to be introduced in whole networks of telecom carriers including base stations and mobile core networks as well as in the virtualization of home network equipment. However, this does not mean that the existing system will be replaced by NFV immediately, and it always needs a certain period of time to relocate it to the NFV. MANO is, then, required to implement a smooth migration, while attempting integration with the existing network.

(2) NEC's approach: E2E Service Orchestration

NEC has been dealing with the requirements mentioned above by leading the world with the "E2E Service Orchestration" in collaboration with NetCracker Technology, who have rich expertise in the TOMS (Telecom Operation and Management Solutions) field. This has been achieved via solutions such as the OSS (Operation Support System) and BSS (Billing Support System).

As shown in **Fig. 2**, the E2E Service Orchestration extends the MANO's orchestration targets from NFV alone to the transport network, data center SDN and the legacy environments. The main purpose of

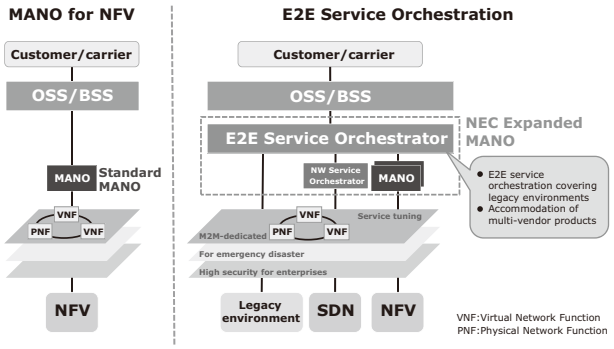

Fig.2 Outline of E2E Service Orchestration.

the E2E Orchestration is not to optimize individual targets, but it optimizes the whole network system and integrates the management and control of the end-to-end network services. It thereby enables the integrated management and control of the entire complex, diversified networks in order to achieve smooth migration from an existing network to the NFV network.

3.2 Handling of Diverse Services

(1) Requirements of the telecom network

In the future when the era of 5G mobile networking arrives and expands mainly among IoT/M2M, networking will be applied to businesses in all of the industries and network services for which diverse requirements are expected to coexist. In addition, the situations surrounding the network services are also expected to be changing continuously. To operate network services efficiently in such an environment, the orchestration using the MANO will be critical. In doing this, MANO is required to provide networking flexibility and swiftness.

- **Agility: Quick building of new network services**

  In an environment where situations surrounding network services change from hour to hour, it is required that deployment of new network services should be performed easily and smoothly. To make this possible, the time spent on the design and construction of network services should be reduced significantly.

  MANO is therefore required to be capable of allocating the abstract requirements for a network service automatically into specific function deployment.

- **Flexibility: Flexible equipment changes according to service demands**

  In an environment where network services with diverse requirements coexist, it is required that the entire network is optimized in order to guarantee the service quality required for each network service such as the performance, availability and security.

  MANO is therefore required also to be capable of optimizing the resource and function deployment of the entire network dynamically and according to the prevailing circumstances.

(2) NEC's approach: Optimization by feedback loop

To meet the flexibility-related needs of MANO, we are conducting R&D for advancing the optimization technology. One of our approaches is "optimization by feedback loop" which forms a cycle of dynamic optimization of the entire network by feeding back the actual situations of network services.

This technology performs dynamic optimization of the entire network by means of; 1) collection of network service data; 2) analysis and calculation of collected data; 3) control based on the analysis/calculation results, as shown in **Fig. 3**.

The most important process in the optimization by feedback loop is "2) Analysis and calculation of collected data". In this process, the collected data is first analyzed to identify situation changes in the entire network such as load fluctuations and fault occurrences. Next, the necessary performance, functions and optimum function layout are calculated so that the entire network can fulfill the service quality against the situation changes. Finally, the procedure for changing the configuration according to the calculated results without affecting the current service is developed. Nevertheless, there is a problem with the NFV to implement the optimization by feedback loop. It is derived from one of the NFV features, the configuration of network services using multi-vendor products. Since the network functions that compose network services have different internal structures depending on vendors, it is difficult to identify the actual value of each performance, etc., accurately in real time. As a result, the accuracy of the optimization by MANO tends to fall due to the impossibility of accurate identification of the types, quantities and deployment locations, etc. of the network functions. Such information is necessary to continuously meet the service level agreements (SLA) at end-to-end network services.

In order to deal with this problem, we have developed a unique technology for real-time simulation of the network status in a multi-vendor environment. This technology applies statistical analysis to the observed information such as the processing

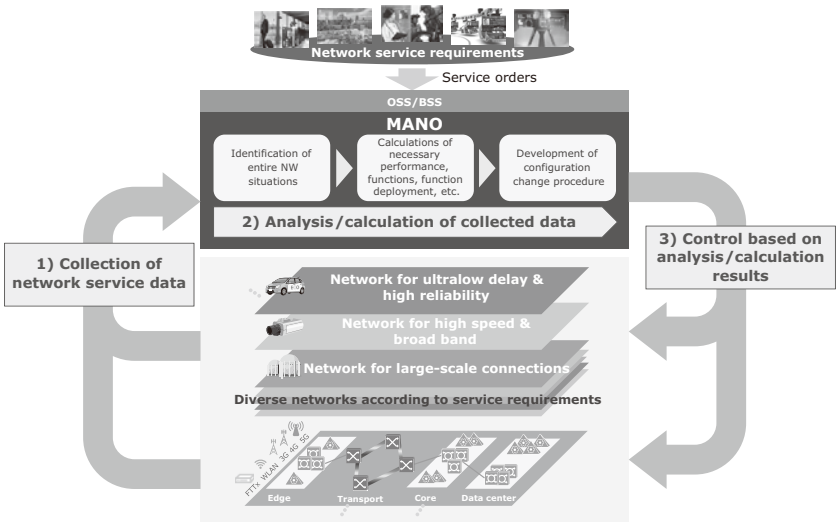

Fig.3 Optimization by feedback loop.

time and resource consumption amounts of network functions and generates a network performance model. This enables to estimate the performance of internal network functions structured by various vendors that is hard to identify in most cases. The results of the performance estimations can be used to allow MANO to perform more appropriate judgments and control. This technology enables highly accurate identifications of the performances of the entire network services, even in a multi-vendor environment, and thereby achieves efficient operation of the entire network.

4. Conclusion

In the above, we outlined the role of the MANO technology in supporting NFV, and discussed the requirements for achieving this role. We also outlined NEC's approach to this issue.

Our E2E Service Orchestration supports smooth migration from existing legacy environments and enables early implementation of NFV. We intend to promote efforts for advancing optimization technology, such as the optimization by feedback loop. We will thereby aim at the implementation of intelligent operations management and the provision of new network services based on the MANO technology.

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