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| Network Function Virtualization |
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Abstract

This document proposes text and figures for the chapter 6.8ff to cover the agreed network function virtualization based on comments on the contribution omniRAN-16/0029. This contribution also addresses the comment #8 and #9 in omniRAN-16/0006 and provides the resolution for that.

**Comments on D0.0:**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| CID | Category | Page | Sub-Cause | Line# | Comment | Proposed Change | Resolution |
| 8 | Technical | 25 | 7.1.4.7.2 | 688 | After Service Discovery, the AN needs to join (or associate with) the Service Provider network so that the Service provider network could be able to CreateAN later.  | It needs to add a section of Join Service Provider's network before CreateAN. Suggest to add back of original text for that section. See the separate contribution  | Revised.See proposal below. |
| 9 | Technical | 26 | 7.1.4.7.2 | 691 | In the Fig 13, the AN Orchestrator is not defined in the NRM. In addition AN Orchestrator is a function of ANC, and does not have a ID. | Suggest to change AN Orchestrator to AN or ANC. In addition, change the AN Orchestrator in the paragraph accordingly. | Revised.See proposal below.  |

**Discussion:**

The IEEE802.1CF D0.0 omniRAN implementation guide line document introduces the AN Orchestrator in section 7.1.4 for the access network setup. Normally the AN Orchestrator is the term associated with network function virtualization feature which is used to manage the virtual networks. However, there is no virtual access network and/or virtualized network function described in the draft D0.0.

To address these issues, the contribution omniRAN-16/0025 proposed to modify the network reference model by adding a new network functional entity (Network Management System) and introducing the concept of virtual access networks. To further address the comment #9 for virtual access network setup, the contribution onmiRAN-16/0017 and 0029 proposed the network function virtualization to solve the comment about the virtual access network setup. According to the recent discussion, it was suggested to create a new section 6.8 for the network function virtualization, see omniRAN-16/0025.

The contribution is to provide the text for the new section and address comments during the discussion.

**Proposed Text Changes:**

Instruction to Editor:

Please add the following text to the sub-cause 6.8 of IEEE802.1CF D0.0 omniRAN specification.

------------- Begin Text Changes ---------------

## Network Function Virtualization

Network Function Virtualization (NFV) is a network architecture concept that virtualizes functions of entire network nodes into software building blocks that may connect together for communication services. NFV has been originally used in the data centers and the cloud computing. Now it can be used to realize access networks as well.

NFV technology, in combination with Software Defined Networking (SDN), provides a way for access network operators to operate their access networks on a hardware cloud platform the same way as operating in a dedicated access network.

### Basic concepts of NFV

NFV intends to decouple network functions from underlying hardware so that it could encapsulate the complexity and difference of hardware and provide a generic software interface to the service management entities.

The NFV is to encapsulate the complexity of the physical network entities with a software model of two layers:

* Network Function Virtualization Infrastructure (NFVI) layer represents the underlying access network infrastructure. As the access network infrastructure could be implemented by different infrastructure vendors, the NFVI would represent some hardware difference in the access network.
* Virtualized Network Function (VNF) layer abstracts the network functions of NA, ANC and BH from NFVI to provide a generic view and interface to the service management in upper layer so that the access network operators would be able to operate access services over different hardware infrastructure in the same way.

The virtualized access network functions could consist of

* the network management functions of access network control, node of attachment, and backhaul network,
* the fault management and diagnostic functions and performance management functions for the network elements of the access network.
* the user data path control functions which is used to control and manage the data path establishment and tear-down.

According to the Network Reference Model, the entities in the access network, such as NA, ANC, or BH could be virtualized as manageable resources in the NMS and accessible as network functions. The NMS can manage such virtualized network resources through the generic NFV interfaces via the reference point R11.

NFV provides a way to dynamically create a virtual access network for new services with same network functions so that access network operator can operate the access network in the same way as in real network through the virtualized network functions.

### VNFs of the IEEE 802 access network

NFV is used in the IEEE 802 access network to provide a common software based framework of the access network and the network function interface to encapsulate the operation of PHY and MAC of IEEE802 access network, such as IEEE 802.3, IEEE802.11, IEEE802.15, or IEEE802.16. The NFV network protocol model for IEEE 802 is shown in Figure 8.2.1.

Figure 8.2.1 the network function virtualization protocol for IEEE802 access network.

The network function virtualization contains two layers:

* NFN Infrastructure layer: it represents the physical resources of the IEEE802 access networks, including NA, and BH.
* VNF layer: it provides the common platform and interface of virtualized network functions to allow the upper layer service to invoke and control the operation of the virtual access network.

The virtualized network functions are the abstracted network functions built on the top of NFVI layer. It consists of

* network configuration functions for virtual access network entities: NA, ANC and BH.
* fault and diagnostic management functions
* data path control functions

The virtualized network functions work like dedicated network functions to control and manage the operation of each network entity of IEEE802 access network.. The network configuration function is used to control and manage the operation of access network entity, like ANC, NA or BH. The fault and diagnosis management function is used to monitor and track the abnormal or failed network entities in the IEEE802 access network. The virtualized network management functions are distributed in the access network entities.

NMS and SS are in the service layer in the NFV model. Through the interfaces of virtualized access network functions, the access network operator can manage the virtual access network via NMS in the same way as a dedicated network. The user can establish its data path connection under the control of SS.

The NFV Management and Orchestration (NFV-MANO) is the central control of the network function virtualization. It is responsible to instantiate the virtual access network entities such as virtual NA, virtual ANC, virtual BH and/or virtual AR with default configuration parameters. Once the virtual access network is instantiated, it shall perform the virtual access network initialization through the virtualized network functions, which is similar to the regular access network initialization.

The NFV used for IEEE 802 access network could be implemented through IEEE 802 layer management shown in Figure 3 in section 6.1.3 , to manage the operation of PHY and MAC. The virtualized network management function can be mapped into a part of IEEE 802 network management. The management of IEEE 802 PHY and MAC layer operation is through the management information (or managed objects). In the virtualized access network, the NMS can manage the access network through virtualized network management function of PHY and MAC to control the operation behavior of IEEE 802 access networks.

To establish a virtualized access network, it is needed to instantiate a virtualized access network instance and initialization via the virtualized access network functions. When the access network is activated, the NFV Management and Orchestration instantiates an access network instance to perform the discovery of access network operator’s network management service and acquire the configuration parameters for the virtualized access network. Upon receiving the response from the access network management service , the virtualized access network control instance (ANC) initializes and configures the virtual access network elements like NAs and BHs. .

### NFV deployment considerations for IEEE 802 access network

The NFV can be used by a single access network operator to configure and manage the operation of IEEE 802 access network, and user data path establishment. For the very dense access network, the NFV could be able to provide the easy and flexible way to configure the entire access networks on different hardware infrastructure.

In the shared deployment environment, the NFV can support network slicing of IEEE 802 access networks which allows multiple access network operators to share the access network infrastructure and operate the access network in the same way. Each access network operator can operate on its own slice of the shared IEEE 802 access network infrastructure.

Figure 8.2.2 shows an example of NFV deployment for the sliced IEEE 802 access network. It contains three network slices, each of which represents a virtualized access network for a different access network operator.

 Figure 8.2.2 Multiple slices of NFV used for IEEE 802 access network

In the service layer of sliced access network, NMS and SS are used by access network operator to manage and control its access network, and user subscriptions and data path establishment respectively.

The NFV layer offers the common interfaces of access network functions for the service layer to manage the access network. The service such NMS could be able to manage its virtual access network through the NFV.

The virtual network functions in NFV layer represent the functions of physical network entities such as NA, BH, ANC, etc.

NFV-MANO creates a slice of virtual access network for each access network operator. Through the virtualized network functions, the access network operator can manage and control its virtual access network using its NMS. Therefore access network operators could be able to share the same physical access network infrastructure, but with its own unique virtual control and management functions.

NFV-MANO provides control of the entire virtualized access network operation through the VNFs to quickly adapt to network service needs.

NFV-MANO can dynamically balance the resource of virtual access network based on real-time demand of access service change. This capability allows some virtual access network to release unused physical resource for other access services of different access network operators . Therefore it could be able to optimize and use the shared access network infrastructure resource efficiently.

-------------- End Text Changes ----------------