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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 entire network node functions into building blocks that may connect together, to create communication services. NFV is initially used in the data centers and the cloud. Now it can be used to manage the radio access network as well.

NFV technology, in combination with Software Defined Networking (SDN), provides a different way for the network service providers to manage and control their carrier grade networks and to enable service providers to reduce costs, increase business agility, and accelerate the time to market of new services.

### 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 upper layer control and management entity.



FIG 6.x1 the basic concept of Network Function Virtualization

FIG 6.x1 shows an example of basic concept of network function virtualization for the wireless access network. The top of figure shows the network reference model of omniRAN. The access network consists of nodes of attachment, access network controller, and backhaul network. The network management system is an network entity used by the service provider to manage the access network. The terminals could be considered as a part of access network from the network management point of view.

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

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

The virtualized network functions could consists of

* the virtualized network management function which includes the configuration management functions for access network and terminals, the fault management functions and performance management functions.
* the control plane (CP) functions and user plane (UP) functions which is used to control and manage the data path establishment and tear-down.

According to the onmiRAN network reference model, the physical resources in the access network could be virtualized as manageable resources in the NMS via network functions through the reference point R11. The NMS can manage such network resources through the NFV interfaces.

NFV provides a way for service providers to optimize networks to dynamically respond the market demands for new services. With NFV, it would be easier to support the access network sharing which allow each service provider to operate its virtualized access network in the same way as real networks. In addition, with NFV, it would be easier to implement the network load balance among virtualized access networks.

### VNFs of the IEEE 802 access network

The IEEE802 NFV is 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 IEEE802.11, IEEE802.15, or IEEE802.16. The IEEE802 NFV network protocol model is shown in Figure 6.x2.

 Figure 6.x2 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.
* VNF layer: it provides the common platform and interface of network functions to allow the upper layer service to invoke and control the operation of the access network.

The virtualized network functions are the abstracted network functions built on the top of NFVI layer (i.e. PHY and MAC) to control and manage the operation of each network entity of IEEE802 access network. The terminal subscription service management function (SSM-F) would be used to configure and manage the operation of terminals. The network provisioning management function (NPM-F) is used to control and manage the operation of access network node, like NA or BH. The fault and diagnosis management function (FDM-F) is used to monitor and track the abnormal or failed network entities in the IEEE802 access network. The virtualized network management functions are distributed through the interfaces between Virtualized Network Function (VNF) layer and Network Function Virtualization Infrastructure layer (NFVI).

With the functions of NFV, the service providers could be able to manage the IEEE802 access network with its services like NMS.

The NFV Management and Orchestration (NFV-MANO) is the central control of the network function virtualization. It provides network service capabilities through the virtualized network functions such as

* Instantiating a virtual access network instance and assigning physical and virtual resources
* Configuring the virtual access network for services via updating the attributes of access parameters through virtual ANC.
* Invoking the corresponding network procedure for system operation’s authentication, authorization; user’s authentication, authorization, and accounting (AAA), and law enforcement procedure.

The IEEE802 NFV could be implemented through IEEE802 layer management shown in Figure 6.x3, to manage the operation of PHY and MAC. The NFV-MANO can be mapped into a part of virtualized network management in the IEEE802 layered network management. The management of IEEE802 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 of PHY and MAC to change the operation behavior of IEEE802 access networks.



 Figure 6.x3 IEEE802 layered network management for network function virtualization

The virtualized IEEE802 access network needs to establish the physical link connection first and then instantiate a virtualized network instance via the virtualized network functions. Once the access network is powered on, the NFV-MANO instantiates a network instance to perform the discovery of service provider network and acquire the configuration parameters for the virtualized access network. Upon receiving the response from the service provider, the virtualized network instance (ANC) is responsible to configure the virtual access network for the service provider.

### NFV deployment considerations for IEEE 802 access network

The NFV can be used for single service provider to configure and manage the operation of IEEE802 access network, and user data path establishment. In the high dense access network, the IEEE802 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 service providers to share the access network infrastructure and operate the access network in the same way. Each service provider can operate on its own slice of the shared IEEE802 access network.

Figure 6.x4 shows an example of NFV protocols in the sliced IEEE802 access network. It contains three network slices, each of which represents a virtualized network for each service provider.

In the service layer of sliced network, it contains NMS and SS that are used for service provider 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 TE, NA, ANC, etc.

NFV-MANO creates an instance (or slice) of virtual access network for each service provider to allow its operation independent from other service providers. Therefore multiple service providers could be able to share the same physical access network infrastructure, but with its own unique virtual control and management functions.

NFV-MANO can fast control the entire virtualized access network operation through the VNFs to adapt to network service needs.

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

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