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Network Functions Virtualisation (NFV); Evolution and Ecosystem; Report on Connection-based Virtual Services

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Foreword

This Group Report (GR) has been produced by ETSI Industry Specification Group (ISG) Network Functions Virtualisation (NFV).

Modal verbs terminology

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1 Scope

The scope of the present document is to:

- describe use cases and identify gaps within the NFV Architecture Framework to support Connection-based Virtual Services; identify recommendations for interfaces of service user and virtual resources (e.g. VM, Containers), and interfaces between Cloud Service Providers (Cloud SPs) to support the Connection-based Virtual Services; identify recommendations for connection and connection end points to support the Connection-based Virtual Services; and
- identify recommendations for MANO to support Connection-based Virtual Services.

2 References

2.1 Normative references

Normative references are not applicable in the present document.

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] OCC 1.0 Reference Architecture, December 2014.

NOTE: Available at https://wiki.mef.net/pages/viewpageattachments.action?pageId=63185562&highlight=OCC+1.0+Reference+Architecture.pdf#OCC+Specifications-attachment-OCC+1.0+Reference+Architecture.pdf.

[i.2] OCC 1.0 Reference Architecture with SDN and NFV Constructs, August 2015.

NOTE: Available at https://wiki.mef.net/pages/viewpageattachments.action?pageId=63185562&highlight=OCC+1.0+Reference+Architecture.pdf#OCC+Specifications-attachment-OCC+1.0+Reference+Architecture.pdf.

[i.3] ETSI GS NFV 003: "Network Functions Virtualisation (NFV); Terminology for Main Concepts in NFV".

[i.4] MEF 6.2: "EVC Ethernet Services Definitions Phase 3", August 2014.

[i.5] MEF 61.1: "IP Service Attributes", May 2019.

[i.6] MEF Whitepaper: "Understanding SD-WAN Managed Services", July 2017.

[i.7] MEF 70: "SD-WAN Service Attributes and Service Definitions", May 2019.

[i.8] ETSI GR NFV-IFA 022: "Network Functions Virtualisation (NFV) Release 3; Management and Orchestration; Report on Management and Connectivity for Multi-Site Services".

[i.9] ETSI GS NFV 001: "Network Functions Virtualisation (NFV); Use Cases".

[i.10] ETSI GS NFV-IFA 014: "Network Functions Virtualisation (NFV); Management and Orchestration; Network Service Templates Specification".

[i.11] ETSI GS NFV-MAN 001: "Network Functions Virtualisation (NFV); Management and Orchestration".

[i.12] ETSI GS NFV-SWA 001: "Network Functions Virtualisation (NFV); Virtual Network Functions Architecture".

[i.13] ETSI GS NFV-INF 004: "Network Functions Virtualisation (NFV); Infrastructure; Hypervisor Domain".

[i.14] ETSI GS NFV-INF 001: "Network Functions Virtualisation (NFV); Infrastructure Overview".

[i.15] ETSI GR NFV-IFA 029: "Network Functions Virtualisation (NFV) Release 3; Architecture; Report on the Enhancements of the NFV architecture towards "Cloud-native" and "PaaS"".

[i.16] ETSI GS NFV 002: "Network Functions Virtualisation (NFV); Architectural Framework".

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the following terms apply:

Cloud Application: self-contained or a group of programs or a software package that performs a specific function directly for an end user or, in some cases, for another application that may be owned by a Cloud User or Cloud SP or Cloud Operator (i.e. cloud service components that are not associated with connectivity)

Cloud Application UNI: Cloud Application interface between User and Cloud Service Provider

Cloud Application ENNI: Cloud Application interface between two Operators

Cloud Connectivity UNI: Connectivity interface between an User and Cloud Service Provider

Cloud Connectivity ENNI: Connectivity interface between two Operators

Cloud Operator: entity that is responsible for making Cloud Applications available to Cloud Service Providers and/or Cloud Operators

Cloud Operator-Operator Interface: interface between two Operators which is composed of Cloud Connectivity ENNI and Cloud Application ENNI

Cloud Service: service comprising one or more of platform components such as compute and storage, applications, and connectivity among them, that may be accessed by the Subscriber from one or more locations

Cloud Service Packet: packet that is exchanged at Cloud Subscriber Interface or Cloud Operator-Operator Interface among parties involved in a Cloud Service

Cloud Service Provider: entity that is responsible for the creation, delivery and billing of cloud services, and negotiates relationships among Connectivity Operators, Cloud Operators, and Cloud Users

Cloud User: end-user (i.e. a person or organization) that maintains a business relationship with and uses services from a Cloud Service Provider

Cloud User Interface: interface between a Cloud User and Cloud Service Provider which is composed of Cloud Connectivity UNI and Cloud Application UNI

Cloud Virtual Connection: association of two or more Cloud VC End Points (Cloud VC EPs)

Cloud Virtual Connection End Point: construct at a Cloud User Interface that selects a subset of the Cloud Service Packets that pass over the interface

Connectivity Operator: providing connectivity services between Cloud Operators, Connectivity Operators and Users

3.2 Symbols

Void.

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in ETSI GS NFV 001 [i.9], ETSI GS NFV 003 [i.3] and the following apply:

CE	Carrier Ethernet
CMaaS	Communications as a Service
CPE	Customer Premises Equipment
CSUI	Cloud Service User Interface
EM	Element Management
ENNI	External Network Network Interface
EP	End Point
IaaS	Infrastructure as a Service
LAN	Local Area Network
MPLS	Multiprotocol Label Switching
NaaS	Network as a Service
PaaS	Platform as a Service
SD-WAN	Software Defined Wide Area Network
SECaaS	Security as a Service
SP	Service Provider
UNI	User Network Interface
VC	Virtual Connection
VPN	Virtual Private Network
WAN	Wide-area Network

4 Use Cases for Connection-based Virtual Services

4.1 Introduction

Connection-based Virtual Service term is used to describe Cloud Service given Cloud Service always has a connection between an application and a user, and virtual components. Therefore, both terms are used synonymously in the present document.

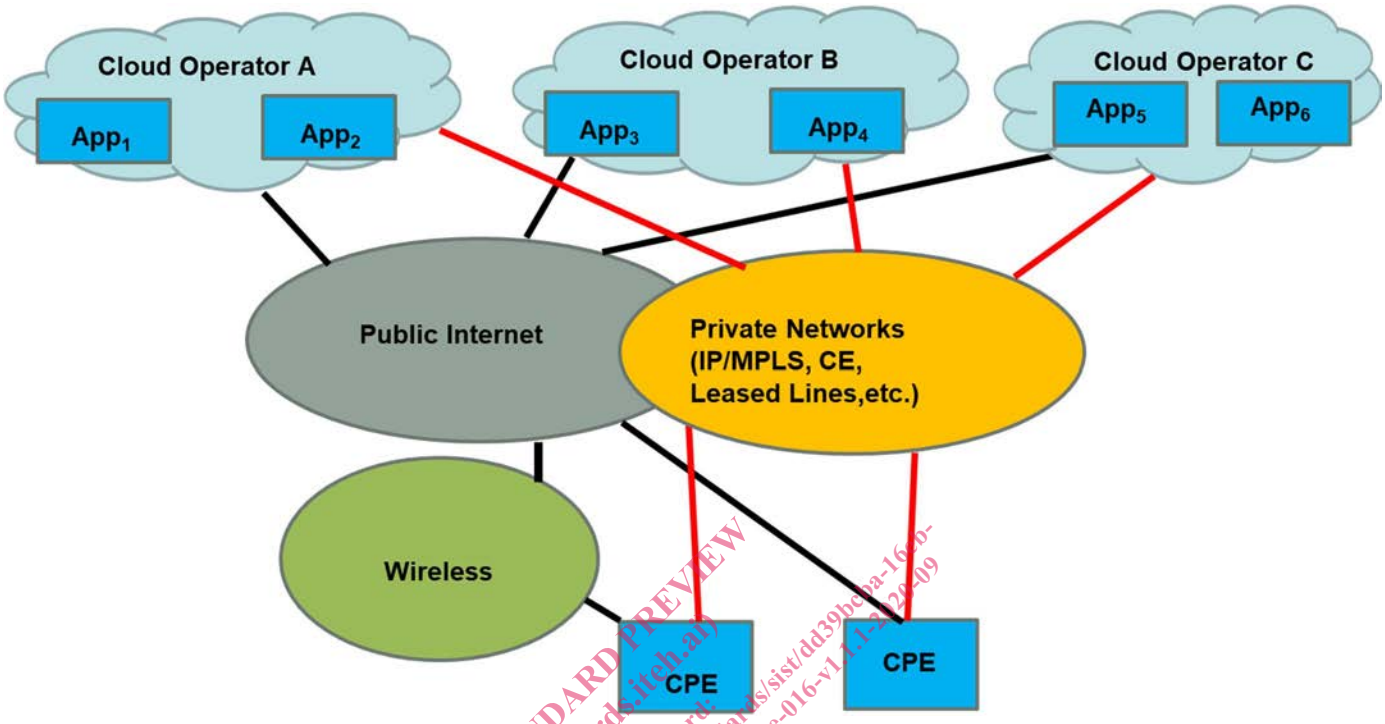
A Cloud Service can include application entities (e.g. VNFs), Cloud Virtual Connection (Cloud VC) and associated resources such as NFVI in ETSI GS NFV 003 [i.3]. For example, a connectivity service for an application can be a Cloud Service. Similarly, computing applications, computing resources and virtual network collectively can form a Cloud Computing service or just the computing applications together with computing resources form a Cloud Service where internet connection is used for the application access as depicted in Figure 4-1.

When a Cloud Service is an end-to-end service between external interfaces of a Cloud Service Provider (Cloud SP), it can include non-virtual and virtual resources such as VNFs and NSs or all virtual resources. For example, a user may use a non-cloud based network, cloud based network, or hybrid network to access cloud computing applications.

The services can be grouped under Network as a Service (NaaS), Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Software as a Service (SaaS), Communications as a Service (CMaaS) and Security as a Service (SECaaS). For example:

- SD-WAN providing application aware routing can be considered as NaaS;
- server, desktop, database, LAN and WAN can be categorized as IaaS;
- development environment and test environment can be categorized as PaaS;
- security services via virtualised firewalls and/or security services can be considered as SECaaS;

- WAN Optimization providing efficient utilization of network resources can be considered as SaaS;
- business, consumer, network and communication applications can be categorized as SaaS; and
- virtual PBX, audio and video conferencing and telepresence can be categorized as CMaaS.



CE: Carrier Ethernet
CPE: Customer Premises Equipment
IP/MPLS: Internet Protocol/Multiprotocol Label Switching

Figure 4-1: Various access mechanisms for accessing Cloud Applications

In this clause, SD-WAN is described as an example.

4.2 SD-WAN

SD-WAN is a network connectivity service, NaaS, providing secure, IP-Based virtual overlay networks that typically uses IPsec tunnels over Internet or MPLS underlay networks. SD-WANs support any topology, e.g. full/partial mesh and hub and spoke. IP-Based SD-WAN implementations often use the public Internet as one of their WANs in which case they need to support firewall and Network Address Translation (NAT) capabilities.

The SD-WAN tunnel is initiated or terminated by the SD-WAN Edge which provides the SD-WAN service demarcation. The SD-WAN Edge creates and terminates encrypted tunnels over different types of wired or wireless underlay networks, such as T1s/E1s, broadband Internet (DSL, Cable, and PON), Wi-Fi™ and LTE™ wireless access networks, and IP (Internet) and MPLS core networks.

The SD-WAN Edge also performs application-based QoS and security policy enforcement, application forwarding over one or more WAN connections, and QoS performance measurements over each WAN to determine WAN path selection. The SD-WAN Edge may also perform WAN optimization functions such as packet buffering/reordering, data duplication, data compression, and forward error correction as described in MEF Whitepaper [i.6].

The SD-WAN Edge functionality may be implemented as a VNF which may run on a virtual CPE (vCPE) at the customer premises or in a data centre, which is managed by cSP. The SD-WAN Edge functionality can be also provided by a physical CPE device resident on the customer premises and managed by cSP.

The SD-WAN Controller provides physical or virtual device management for all SD-WAN Edges and SD-WAN Gateways (if used) to connect sites interconnected via alternative VPN technologies such as Carrier Ethernet. The management function includes configuration and activation, IP address management, and pushing down policies onto SD-WAN Edges and SD-WAN Gateways, and maintains connections to all SD-WAN Edges and SD-WAN Gateways.

The SD-WAN Controller communicates northbound with its Orchestrator. The Orchestrator provides the end-to-end SD-WAN management and interfaces to an OSS/BSS for service order and billing.

Two SD-WAN examples are depicted in Figures 4-2 and 4-3. These implementation examples do not follow ETSI-NFV standards.

In Figure 4-2, the SD-WAN configuration enables the user to use an encrypted SD-WAN tunnel over the Internet to augment their site-to-site MPLS VPN bandwidth and achieve higher resiliency using two WANs.

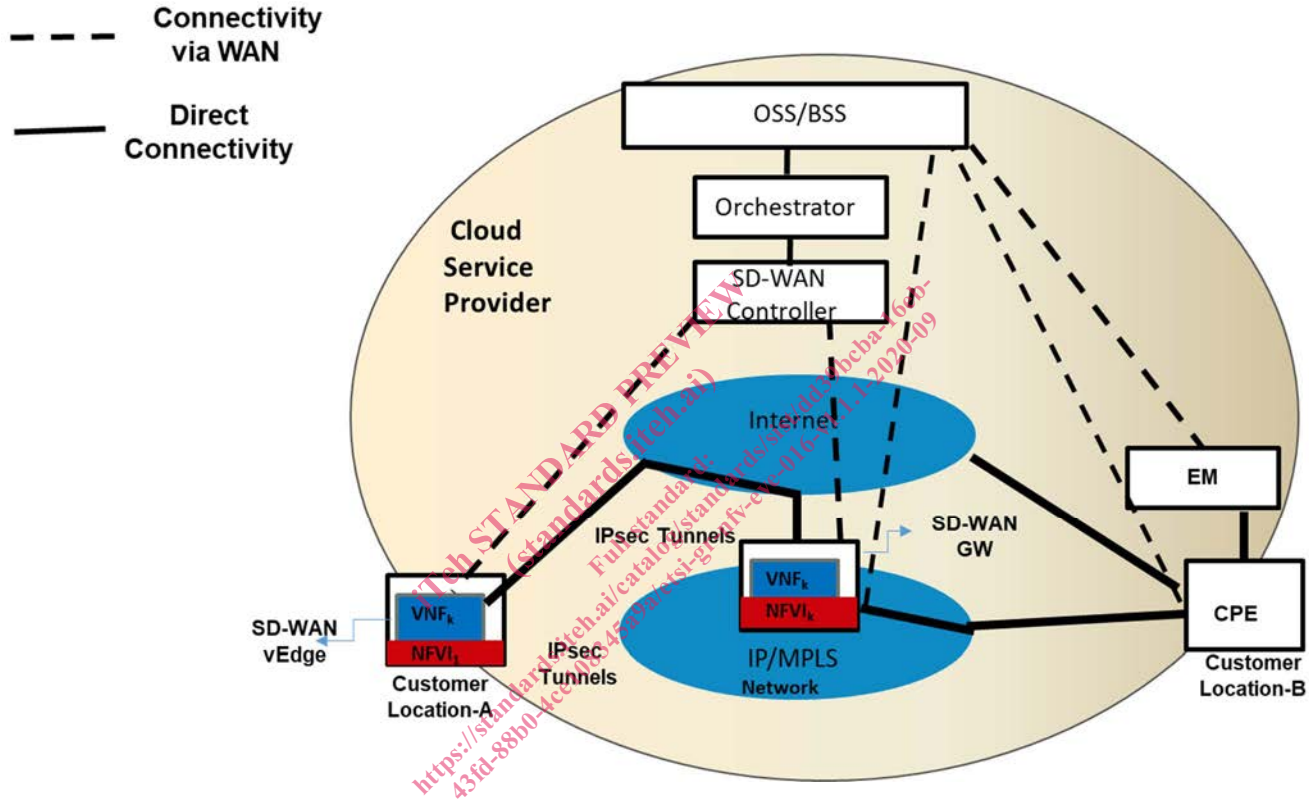


Figure 4-2: SD-WAN service tunnelled over Internet and MPLS WANs

Figure 4-3 illustrates an SD-WAN configuration where an SD-WAN Gateway interconnects sites connected via an SD-WAN over the Internet and sites connected via a MPLS VPN. An SD-WAN Gateway enables sites interconnected via the MPLS VPN to communicate with sites interconnected via SD-WAN tunnels over the Internet. The sites interconnected via MPLS VPN are expected to use legacy CPE which does not have virtualised components.

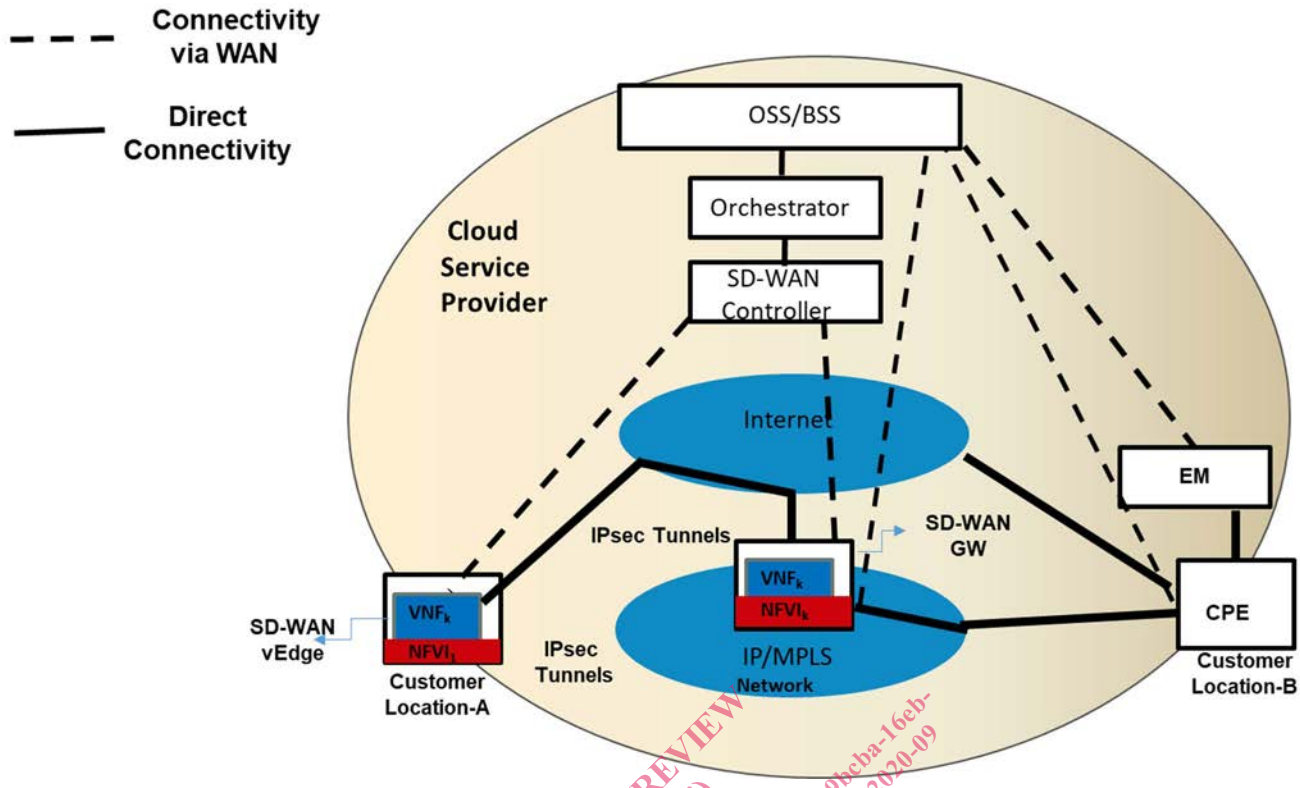


Figure 4-3: SD-WAN sites interconnecting with MPLS VPN sites

In Figures 4-2 and 4-3, the network that SD-WAN Edge units are connected to is managed by an Operations Support System (OSS) and various Element Managers (EMs). The OSS may consist of multiple systems. These systems along with EMs provide configuration management, fault management, performance management, security management and testing of network elements and facilities connecting these network elements.

The legacy CPE in Figure 4-3 is likely to be managed by an EM. Similarly, elements of the IP/MPLS network in Figures 4-3 and 4-4 are likely to be managed by EMs that are not shown in the figures.

Figure 4-4 redraws the network configuration similar to that in Figure 4-2 using ETSI NFV constructs. Per [i.8], [i.9], VNF represents vCPE. IPsec tunnel forming a Cloud Service Connection (or SD-WAN Connection) is mapped to a Virtual Link despite of the fact that there could be multiple connections in a given link.

SD-WAN vEdge VNFs are managed by VNFM. WIM provides the necessary multi-site connectivity to connect the SD-WAN vEdge islands that are instantiated over the NFVIs. The WIM may be responsible for underlying WAN.

In contrast to WIM, a VIM manages network resource as well as NFVI compute and storage resources within the domain of an NFVI-PoP where SD-WAN vEdge resides.

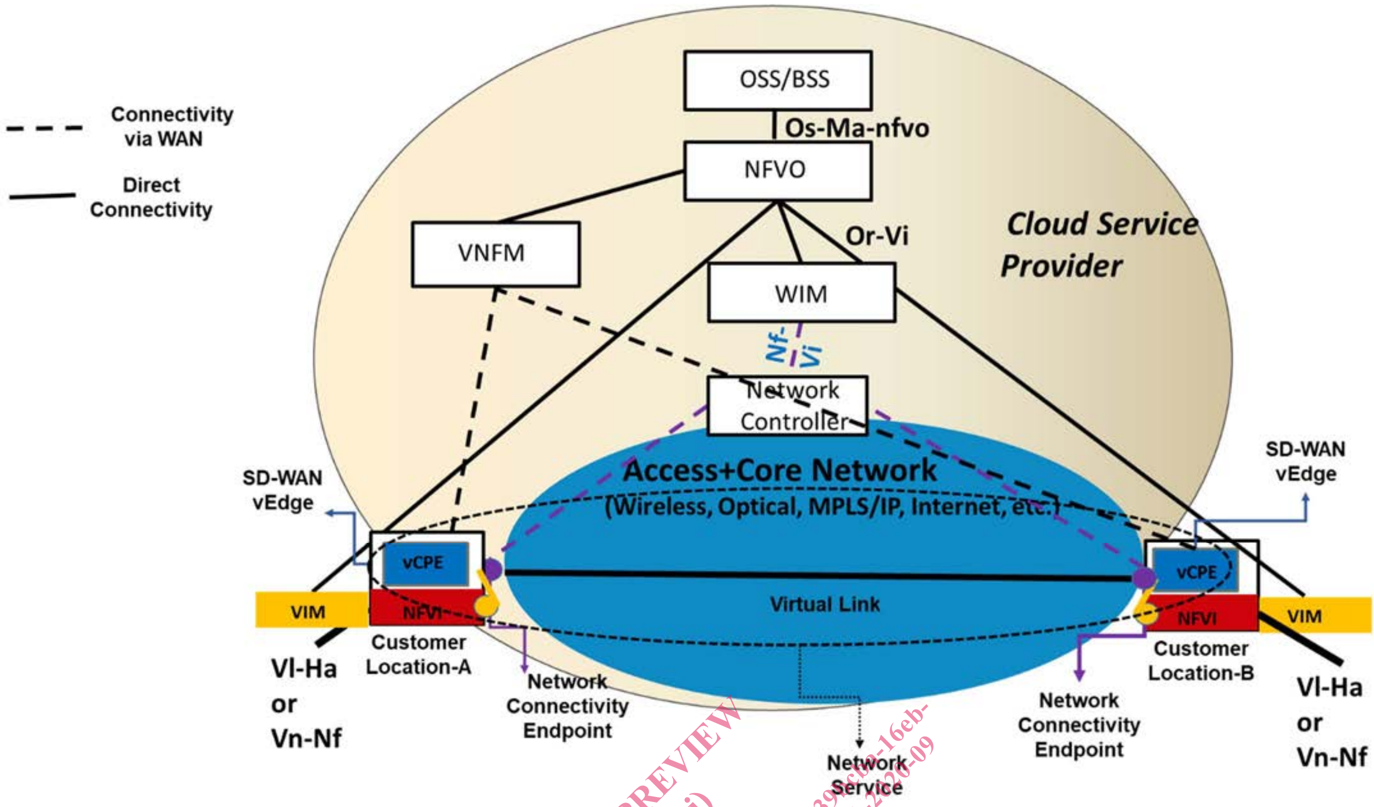


Figure 4-4: SD-WAN service components represented by ETSI NFV constructs

In Figure 4-4, a Network Service (NS) consisting of two VNFs (vCPE) is instantiated. These two VNFs are installed at two customer sites, Customer Location-A and Customer Location-B, and connected across the WAN infrastructure.

The virtualised network resources assigned to the vCPE VNFs are terminated at virtual network ports which are attached to the WAN infrastructure. As a result, a unified Virtual Link is created by combining the virtualised network resource for Customer Location-A, Customer Location-B and WAN.

5 Actors of Connection-based Virtual Services

5.1 Introduction

The key actors of Connection-based Virtual Services (i.e. Cloud Services) are depicted in Figure 5-1 where a Cloud Service Provider (Cloud SP) is responsible for providing an end-to-end Connection-based Virtual Service to a Cloud User using resources of Connectivity Operator (s) and Cloud Operator (s) [i.1] and [i.2]. The connectivity can be provided by networks of Connectivity Operator (s) as well as by the Internet.