A.1 NFV ISG PoC Proposal

A.1.1 PoC Team Members

- PoC Project Name: **VoLTE Service based on vEPC and vIMS Architecture**

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A.1.2 PoC Project Goals

This PoC project is divided into a number of phases. The scope of this proposal focuses on the first two phases.

- PoC Project **phase#1:** The PoC will verify the **VoLTE service based on vIMS and vEPC VNFs running on a multi-vendor NFV environment**.
- PoC Project **phase#2:** The PoC will verify the **VoLTE service provided by vIMS and SDN-based vEPC xGW**[1] with control plane and user plane separation.

The goals of phases 1 are as follows.

- PoC Project Goal #1.1: Validate the ETSI NFV ISG architecture framework and functional blocks features, as described in ETSI GS NFV 002 v1.1.1 (2013-10) and ETSI GS NFV-MAN 001 V0.6.1 (2014-07).
- PoC Project Goal #1.2: Demonstrate the integration of a multi-vendor NFV environment.
  - HP BL460 Gen8 Blade Servers with advanced virtualization features, 4*10G Intel 82599 NICs.
  - NFV Orchestrator provided by HP.
  - VNFs (vEPC and vIMS) and their related VNF Managers and EMSs provided by ZTE.
  - Virtual Infrastructure Managers provided by ZTE, and HP, Openstack based.
  - Virtualized resources abstraction based on the Hypervisor software from ZTE, and HP.
- PoC Project Goal #1.3: Verify VoLTE services based on vEPC& vIMS VNFs deployed on a multi-vendor NFV environment.
- PoC Project Goal #1.4: Validate & Demonstration lifecycle management of vEPC+vIMS in a multi-vendor NFV environment.

The goals of phases 2 are as follows.

- PoC Project Goal #2.1: Validate the SDN-based separation of control plane and user plane of vEPC xGW.
- PoC Project Goal #2.2: Demonstrate the E2E VoLTE service supported by vIMS and SDN-based vEPC.
- PoC Project Goal #2.3: Validate the interoperability and migration across multi-vendor VIMs.
- PoC Project Goal #2.4: Validate & Demonstrate use of accelerators (DPDK, SR-IOV).

The latter phase of our PoC project is still under development and will be announced in future when clearly defined.

A.1.3 PoC Demonstration

- Venue for the demonstration of the PoC: The PoC network environment will be hosted and presented at **China Unicom R&D Lab** (Beijing, China).

A.1.4 (optional) Publication

- Currently, publication is not planned.

A.1.5 PoC Project Timeline

- What is the PoC start date? Oct 23rd, 2014 (already underway)
- (First) Demonstration target date: Jan 25th, 2015 (@ China Unicom's R&D Lab)
- PoC Report target date: Jun 15th, 2015

[1] Here, the vEPC xGW includes vSGW and vPGW.

- When is the PoC considered completed? Jun $15^{th,}$ 2015.

A.2 NFV PoC Technical Details

A.2.1 PoC Overview

The PoC will verify the end-to-end VoLTE service based on vIMS and vEPC VNFs running on a multi-vendor NFV environment..

A.2.1.1 The overall PoC architecture

Figure 1 shows the overall architecture of our PoC, which is built primarily upon the NFV reference architecture framework [4]. The NFVI ecosystem comprises of multiple vendors with a single orchestrator to provide, deploy and manage the vEPC and vIMS deployed on the COTS hardware infrastructures. This PoC will help identify the core functional requirements, including architecture framework, interfaces and information model structures that are required to support the end-to-end VoLTE service.

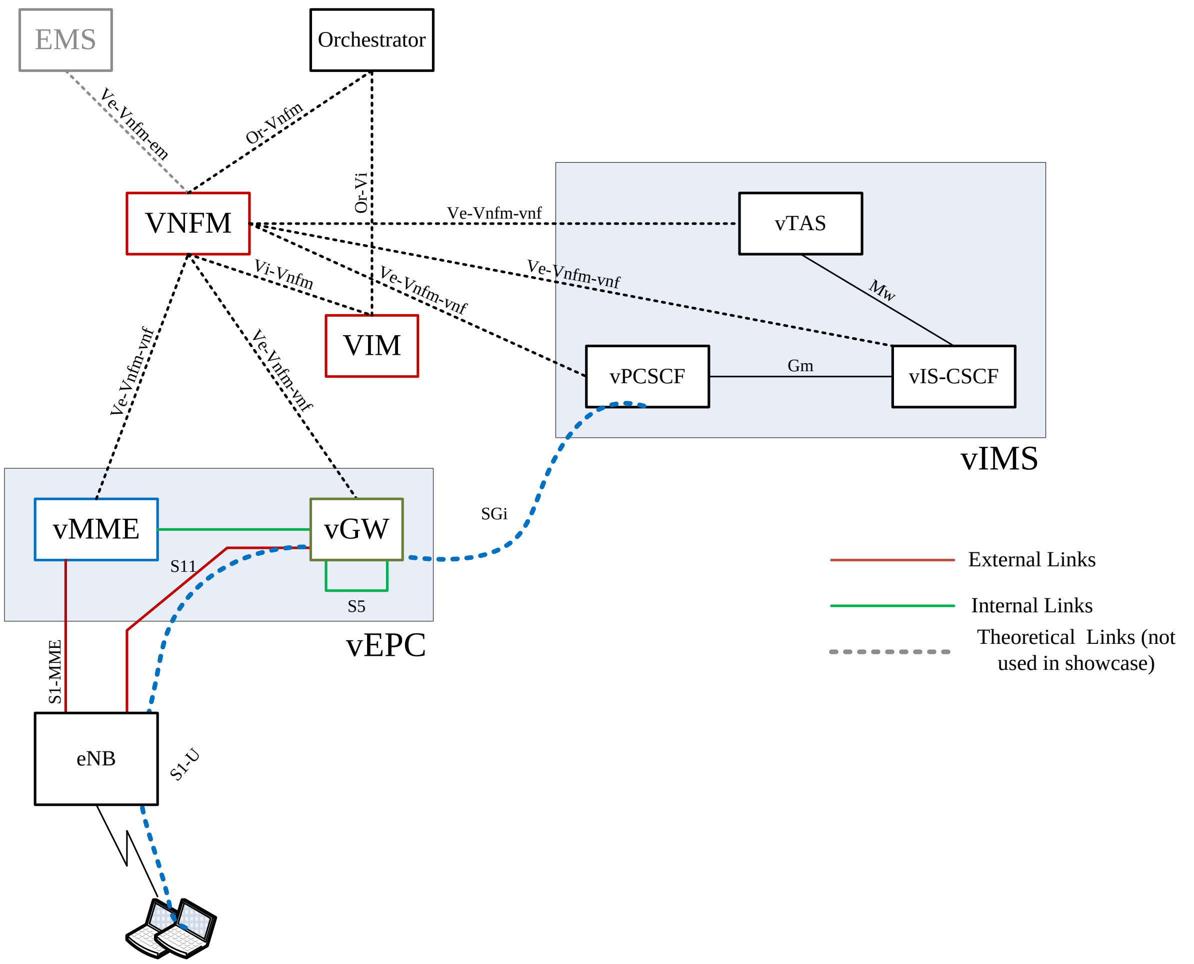

Figure 1. Architecture of VoLTE service based on vEPC and vIMS (Phase I)

The PoC Phase I includes VNFs implementing vEPC and vIMS, and each is potentially with its own VNFM and EMS. Each VNF may have its own EMS, or share the common EMS with other VNF(s).

Upon receiving requests from the OSS, the Orchestrator interacts with VNFM to validate and execute the requests, which include on-boarding VNF Packages, instantiating/updating/terminating VNF instances, VNF software image management, policy management, performance/fault management, etc. When there is a need, Orchestrator (or the VNF Manager depending on the policy) elastically scales in/out a given VNF.

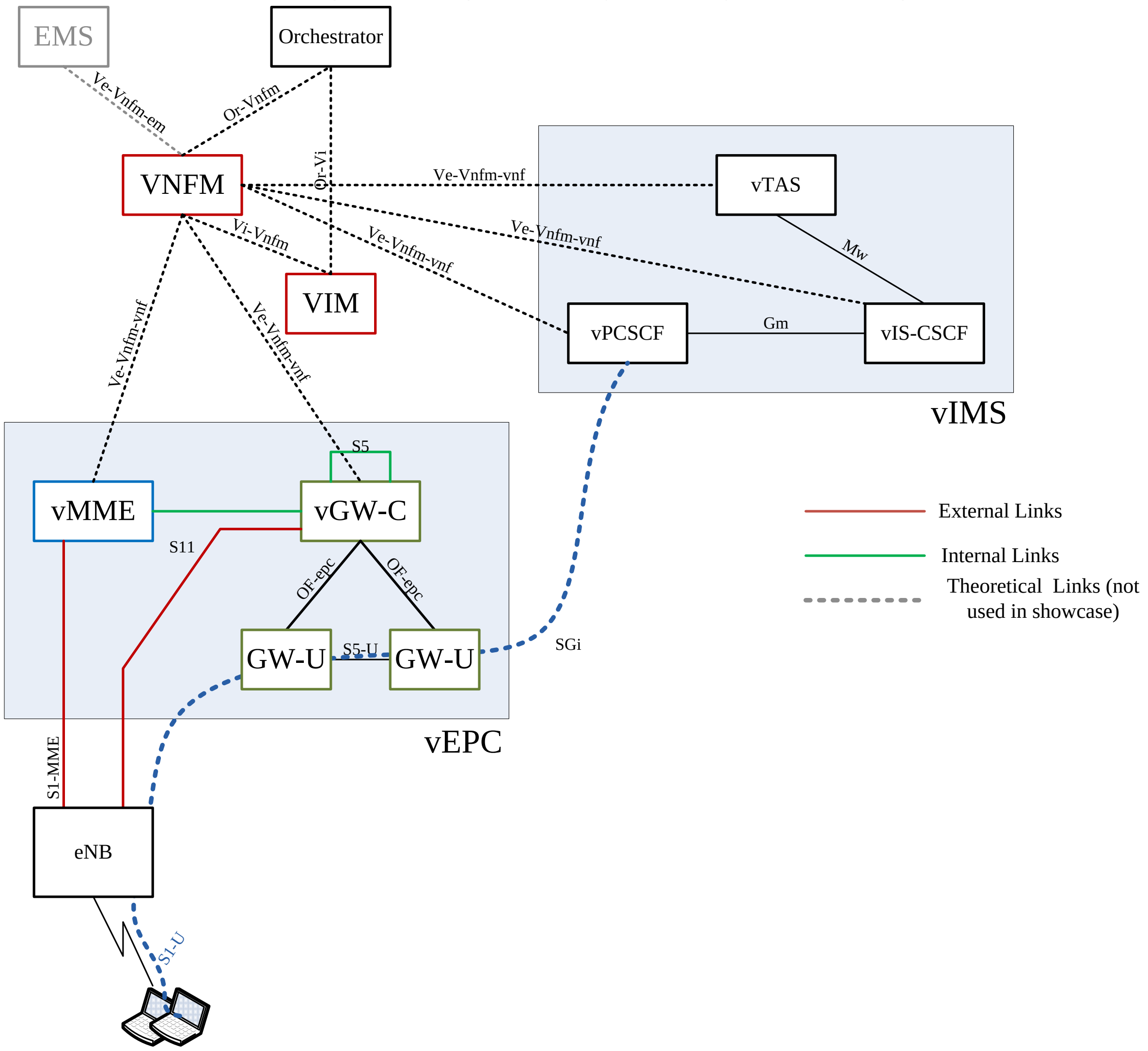

Figure 2. Architecture of VoLTE service based on vEPC and vIMS (phase II)

The PoC Phase II includes VNFs implementing control plane of the SDN enhanced EPC, and each is potentially with its own VNFM and EMS. The control plane of vEPC and vIMS is implemented on several VNFs (such as vGW-C VNF, vMME VNF, vPCSCF VNF, vIS-CSCF VNF, and vTAS VNF, etc.). The user plane of the SDN enhanced EPC is implemented on distributed GW-Us. The SDN controller is integrated into the vGW-C and interacts with vGW-Us based on OF-epc protocol[2].

A.2.2 PoC Scenarios

The following 6 scenarios will be demonstrated.

- Scenario 1 – Integrated NFV environment setup based on multi-vendor component provisioning.

  The PoC verifies the feasibility of one NFV environment constructed based on multi-vendor component provisioning, such as

[2] OF-epc is extended by ZTE based on the OF-mpc interface that is still in progress in ONF.

- The NFVI constituted on the HP COTS servers, high capacity switches and HP mass storages;
- The Orchestrator provided by HP;
- The VNFs implementing vEPC+vIMS, the related EMS and VNFM provided by ZTE;
- The VIMs provided by ZTE and HP, and each one managing its own NFVI-PoP, respectively.

The detailed NFV environment setup includes but not limited to

- ✓ Installation of VIM, NFVO and its related user interface (UI) software.
- ✓ Installation, auto-discovery, configuration and registration of compute node, storage node.
- ✓ Configuration of compute node, storage node and network device.
- ✓ Update/Upgrade VIM, NFVO, its related UI software without stopping the service provisioning.,
- ✓ Update/Upgrade compute node, storage node and network device without interrupting the service running.

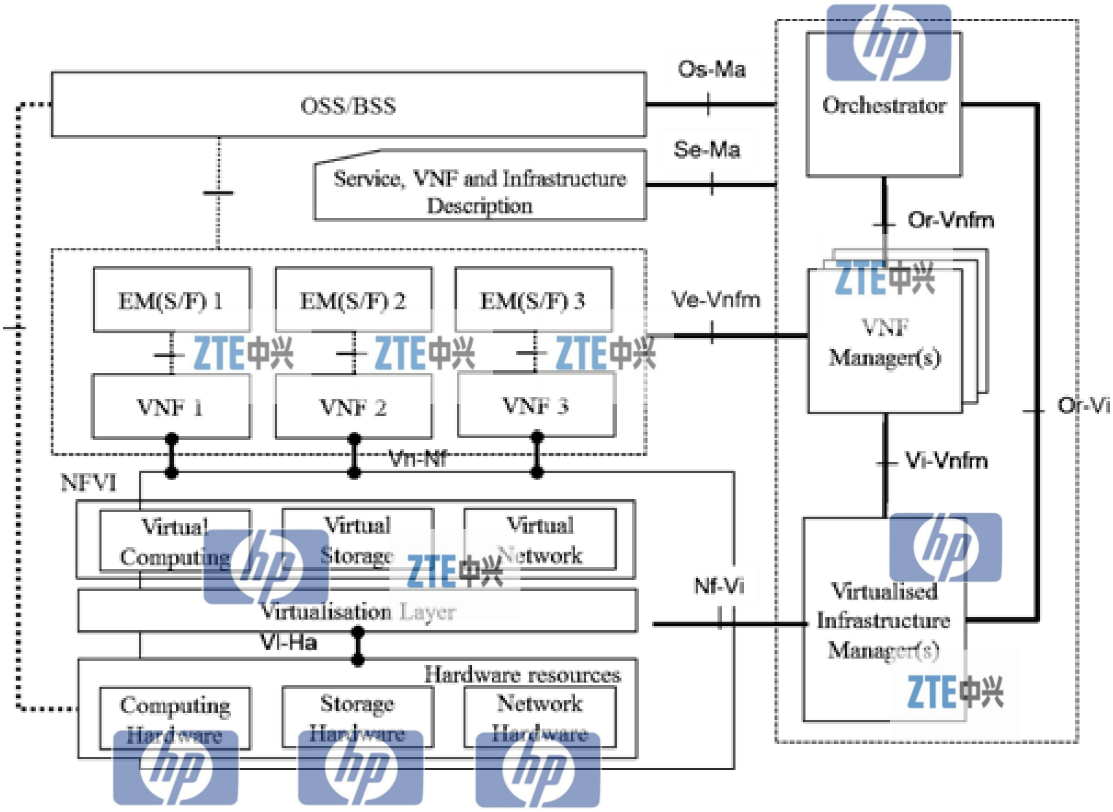

Figure 3. Integrated NFV environment based on multi-vendor provisioning

Note: The abstracted virtual resources (Virtual Computing, Virtual Storage and Virtual Network) can be provided by both HP and ZTE virtualisation software running on HP hardware resources.

- Scenario 2 – <u>VoLTE service instantiation</u>

The provisioning of VoLTE service includes the deployment of vEPC and vIMS network elements based on the registered vEPC and vIMS packages, the input from customer instantiation request and constraint, capabilities of the NFV environment. The deployment of vEPC includes the creation of vMME, vSGW and vPGW. The deployment of vIMS includes the creation of vPCSCF, vIS-CSCF, and vTAS.

The provisioning of VoLTE service supports auto and manual deployment of vEPC and vIMS based on the requirements recorded in VNF Descriptor or input manually by customers. Upon completion of the VoLTE service environment setup, the requirements in VNF descriptor (such as placement affinity) must be satisfied.

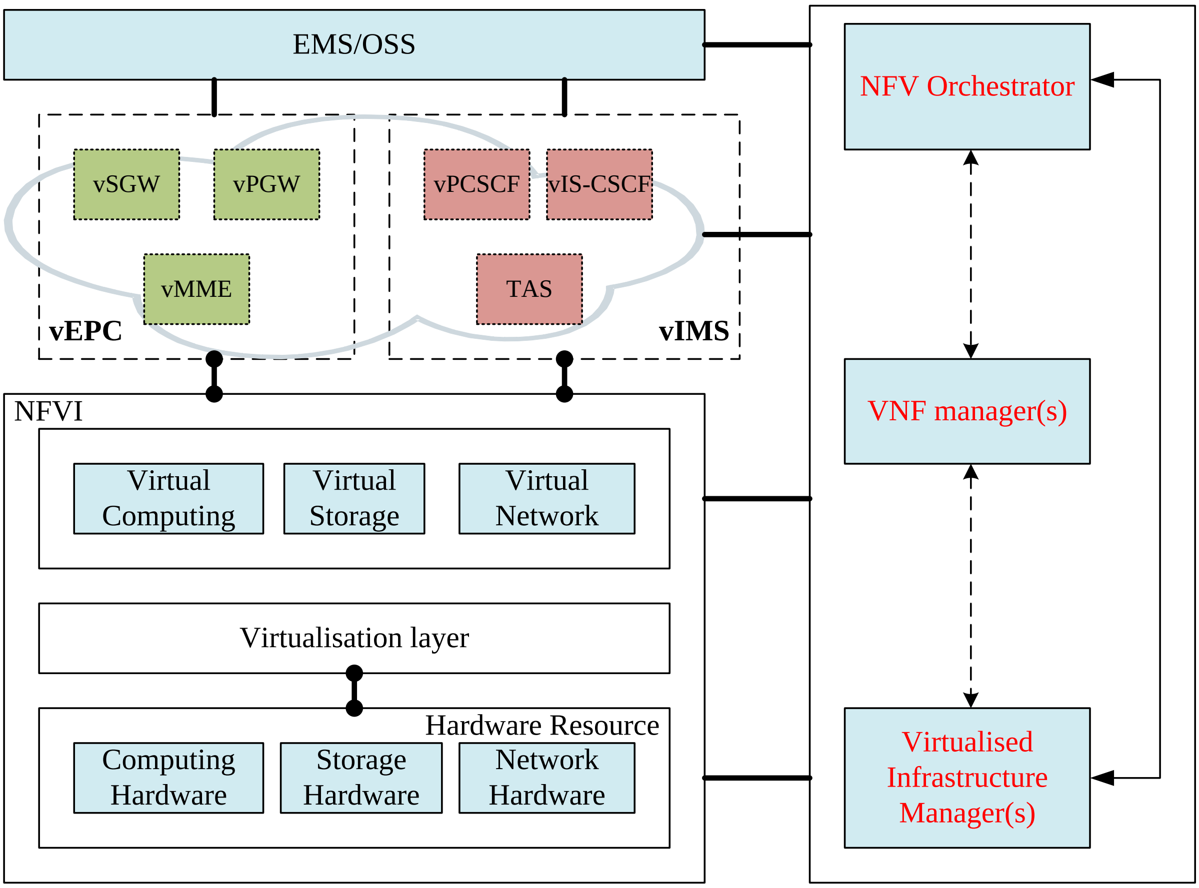

Figure 4. VoLTE service environment setup

As shown in figure 4, the VoLTE is a network service that is instantiated based on the Network Service Template. The VoLTE service is involved with vEPC type of VNFs and vIMS type VNFs. Both of the two types of VNFs can be regarded as VNF Set as described in the NFV Architectural Framework [NFV002], for both further includes their respectively constituted VNFs.

The integrated NFV environment includes VIMs provided by ZTE and HP, and each one manages its own NFVI-PoP. The VoLTE service can be implemented across multi-vendor NFVI-PoP environment.

- Scenario 3 – Lifecycle management of VNFs implementing vEPC and vIMS.

  The functional elements contained in EPC include MME, SGW and PGW, and in IMS the functional elements include PCSCF, IS-CSCF, and TAS. In NFV environment, each of these functional elements are implemented as VNFs, such as vMME, vSGW, vPGW, vPCSCF, vIS-CSCF, and vTAS. The lifecycle management of these VNFs includes the following supported operations, such as creation, deletion, update, migration, recovery, and scaling in/out.

  The demonstrated scaling action can be taken may include automatically based on load or sessions of the runtime VNFs, or based on the scheduled time preconfigured, or manually.

The demonstrated migration includes moving VNFs (or VNF set) of the VoLTE service from one NFVI-PoP to another.

- Scenario 4 – Verifying the E2E VoLTE service in multi-vendor NFV environment.
  VoLTE service verification is to test that those functions provided in traditional non-virtualized VoLTE service environment can be running normally in virtualized environment, and that the performance of the service can be guaranteed as in traditional way. The functions needed to be verified includes but not limited to
  - ✓ User registration/de-registration normally when EPC and IMS of the VoLTE service are deployed as vEPC and vIMS in NFV environment.
  - ✓ The call is established normally when one or both of the call parties are attached on the virtualized network elements. The quality of the voice need be checked and compared with the traditional call going through the physical functions.
  - ✓ The attached users can be migrated from virtualized VoLTE service to traditional VoLTE service environment, or vice versa.

- Scenario 5 – VoLTE service environment monitoring, management and maintenance.
  As VoLTE service is running in a virtualized environment, that is, in NFV environment, the mapping between virtual machines (VMs), network elements (NEs), and physical servers need to be clearly described and shown in the management UI (that is the service portal) for service users/customers to check them as needed. API may also be provided for other systems, i.e. OSS.
  - ✓ Correspondence between VMs and NEs.
  - ✓ Correspondence between VMs and physical servers.
  - ✓ Correspondence between NEs and physical servers.
  - ✓ Monitoring the usage of VMs and statistics (such as occupancy rate of CPU, memory and vNIC, etc).
  - ✓ Monitoring the usage of physical servers and statistics (such as occupancy rate of CPU, memory and NIC, etc).

- Scenario 6 –VoLTE service running on vIMS and SDN enhanced vEPC.
  The control plane and user plane of the VoLTE service are separated in this scenario, that is, the control plane runs in virtualized environment, and the user plane runs in SDN-based forwarding equipments. Control plane of the enhanced EPC is deployed as VNFs in NFV environment, and interacts with user plane of the EPC using SDN-based protocols, which is OF-EPC protocol.

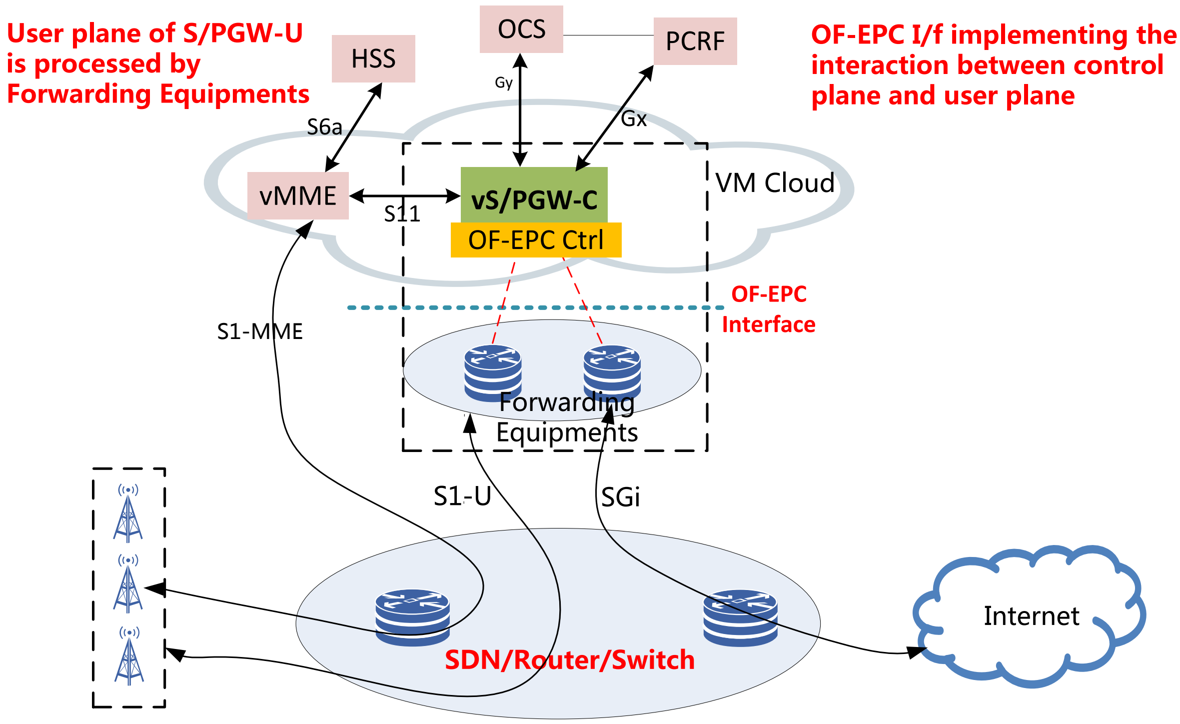

Figure 5. SDN enhanced vEPC with control plane and user plane separation (phase II)

The control plane of the SDN-enhanced vEPC can control one or more forwarding equipments, so the forwarding equipments can be distributed. The control plane is responsible for the generation of flow tables and action list, and sends them to the forwarding equipments in user plane. The forwarding equipments in user plane only deals with packet switching/forwarding, header encapsulation/de-encapsulation, etc.

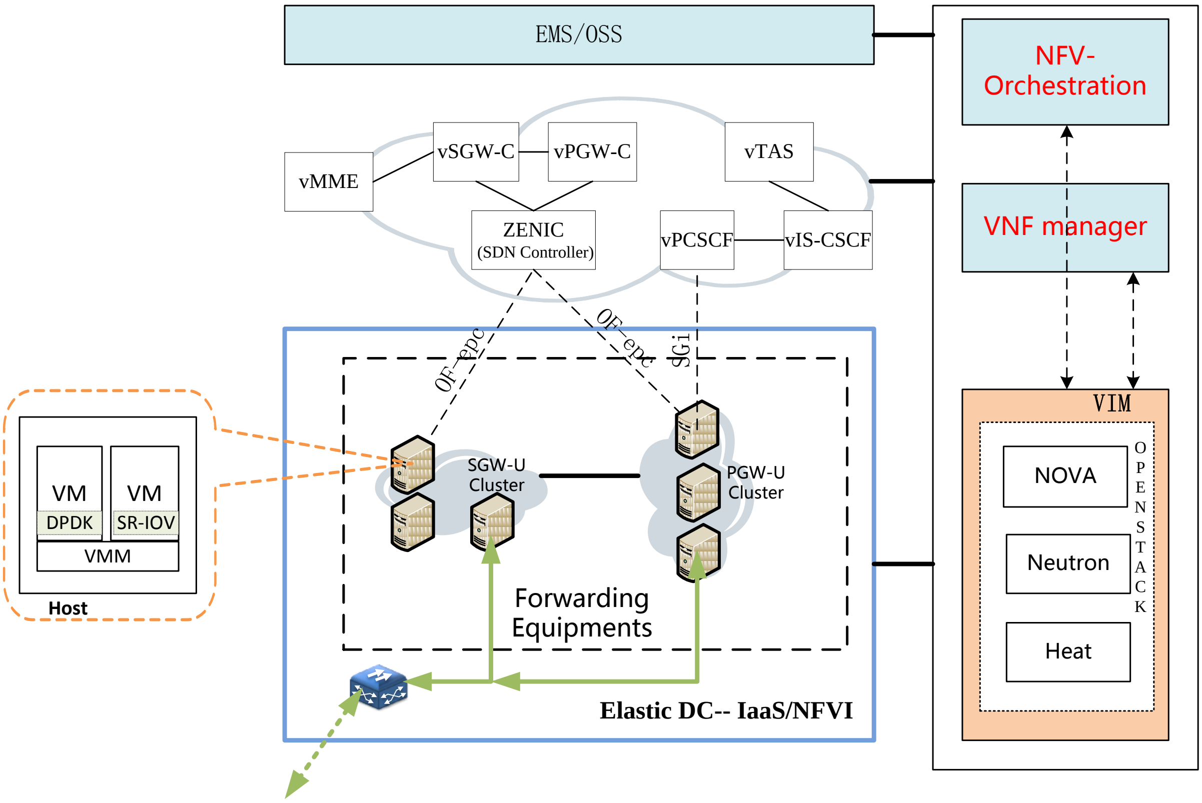

Figure 6. SDN-based VoLTE service mapping to NFV architecture (phase II)

As shown in figure 6, an SDN controller is introduced into Gateway equipment (SGW/PGW) to decouple the control plane and user plane of the vEPC in VoLTE service.

Accelerator technologies (such as DPDK, SRIOV) are introduced to implement high speed data forwarding at SGW-U/PGW-U. With the accelerator technologies introduced into the NFV architecture and adopted in the data plane of VoLTE service, the I/O performance can be optimized. The detailed performance evaluation will be conducted in this PoC testing.

A.2.3 Mapping to NFV ISG Work

Describe how this PoC relates to the NFV ISG work:

1) Specify below the most relevant NFV ISG end-to-end concept from the NFV Use Cases [2], Requirements [3], and Architectural Framework functional blocks or reference points [4] addressed by the different PoC scenarios:

	Use Case	Requirement	E2E Arch	Comments
Scenario 1 *Integrated NFV environment setup based on multi-*	UC#5 *Virtualisation of Mobile Core Network and IMS*	[Port.1], [Port.2] [Sec.1], [Sec.2], [Sec.3], [Sec.4], [Sec.5], [Sec.6], [OaM.1], [OaM.2], [OaM.5], [OaM.6], [OaM.8], [OaM.11] [Mig.1], [Mig.2], [Mig.3], [Mig.4]	Sec 5.1 Sec 5.2 Sec 7.2	NFV environment setup based on multi-vendor provisioning, such NFVI, VIM, Orchestrator and their connections, NSD and VNF package on-boarding.

vendor component provisioning.		[Mod.1]		
Scenario 2 *VoLTE service instantiation*	UC#5	[Gen.1], [Gen.2], [Gen.3], [Gen.4], [Port.1], [Port.2], [Port.3] [Perf.1], [Perf.2], [Elas.1]	Sec 6.1 Sec 6.2	VoLTE service instantiated on the NFV environment includes on-boarding vEPC/vIMS VNF packages constituting the VoLTE service, and the instantiating vEPC/vIMS VNF process, configuring connectivity of VNFs to satisfy the topology requirements of VoLTE service.
Scenario 3 *Lifecycle management of VNFs implementing vEPC and vIMS*	UC#4 *VNF Forwarding Graphs*	[Gen.4] [Port.1], [Port.2], [Port.3] [Elas.1], [Elas.2], [Elas.3], [Elas.4], [Elas.5], [Cont.1], [Cont.2], [Cont.3], [Cont.4], [OaM.1], [OaM.2], [OaM.3], [OaM.4]		
Scenario 4 *Verifying the VoLTE service in multi-vendor NFV environment.*	UC#5	[Gen.4] [Mod.2]		
Scenario 5 *VoLTE service environment monitoring, management and maintenance.*	UC#5	[Gen.2], [Perf.3],[Perf.4], [Cont.1] ~ [Cont.4] [OaM.1]~[OaM.14] [Maint.1]~ [Maint.16]		
Scenario 6 *VoLTE service running on vIMS and SDN based vEPC.*	UC#5	[Per.1] [Port.3], [Cont.1] ~ [Cont.4]		Control plane and user plane are separated from each other. Control plane is deployed on NFV environment, and interact with user plane through SDN protocol.

A.2.4 PoC Success Criteria

This proof-of-concept will be considered successful when all scenarios have been successfully implemented, integrated and demonstrated and findings published in the PoC report.

A.2.5 Expected PoC Contribution

One of the intended goals of the NFV PoC activity is to support the various groups within the NFV ISG. The PoC Team is therefore expected to submit contributions relevant to the NFV ISG work as a result of their PoC Project.

List of contributions towards specific NFV ISG Groups expected to result from the PoC Project:

- PoC Project Contribution #1: This PoC will demonstrate VNF set concept used for VoLTE service orchestration and management. NFV Group: MAN WG

- PoC Project Contribution #2: This PoC will demonstrate the VoLTE service implemented across multi-vendor NFV environment, including the VNFs (or VNF set) of the VoLTE service migrating across different NFVI-PoPs. NFV Group: MAN WG

- PoC Project Contribution #3: This PoC will demonstrate higher performance of the SDN-enhanced vEPC in VoLTE service. NFV Group: PER EG

- POC Project Contribution #4: This POC will illustrate some gaps and requirements for Openstack and SDN applied in NFV environment. NFV WI: Gap Analysis