NFV ISG PoC Proposal – virtual EPC with SDN Function in Mobile Backhaul Networks[1]

A.1 NFV ISG PoC Proposal

A.1.1 NFV PoC Project Participants

- PoC Project Name: virtual EPC with SDN Function in Mobile Backhaul Networks

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A.1.2 PoC Goals

- PoC Project Goal #1: This PoC will verify the entire virtualization of EPC (vEPC) and the benefits that Network Function Virtualization (NFV) brings to EPC. Virtualization allows to further separate data from control plane that can be moved to the cloud. We deploy the EPC network elements required to verify that the vEPC is effective for mobile networks.

- PoC Project Goal #2: This PoC will verify that vEPC can take full advantage of NFVs running on the cloud but still maintain the functionality of the core network elements (i.e. MME and HSS) and provide backwards compatibility. The PoC shows that EPC functionality could be simplified e.g. S/P-GW control functions are moved to the cloud. This PoC also verifies the flexibility that SDN allows the mobile operators to choose the granularity for the QoS provisioning to mobile users.

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[1] This NFV Proof of Concept has been developed according to the ETSI NFV ISG Proof of Concept Framework. NFV Proofs of Concept are intended to demonstrate NFV as a viable technology. Results are fed back to the NFV Industry Specification Group.

- PoC Project Goal #3: This PoC will verify that vEPC facilitates the integration of SDN as part of the mobile backhaul transport network. The PoC shows that with SDN vEPC is streamlined and some elements such as PCRF and the control part of the S/P-GW are entirely virtualized and integrated as a simple cloud service. The transport is replaced with SDN networks that provides additional flexibility and optimal usage of the resources.
- PoC Project Goal #4: This PoC will verify requirements for vEPC and usage of SDN for carrier networks, such as backwards compatibility, scalability and robustness. This PoC will verify the adjustments are needed in L2 or L3 connection to ensure the complete EPC functionality on mobility and QoS is supported to ensure proper integration of SDN with NFV.

A.1.3 PoC Demonstration

- Venue for the demonstration of the PoC: The PoC network environment will be hosted at Aalto University (Espoo, Finland). The Result of our test will be published in several papers and shown at CELTIC Plus events (http://celticplus.eu/), to be held during 2015.

A1.4 Publication

Publication of PoC results are shown at public demonstrations at CELTIC Plus event 2015.

A.1.5 PoC Project Timeline

- What is the PoC start date? December 1, 2014
- (First) Demonstration target date March 1, 2015
- PoC Report target date May 30, 2015
- When is the PoC considered completed? June 20, 2015

A.2 NFV PoC Technical Details

A.2.1 PoC Overview

On the environment where network functions are integrated into cloud servers as VNFs, each EPC network element (i.e. MME, S/P-GW) will be running on its own virtual machine. The fact of running the vEPC on different virtual machines allows the administrator to add new network elements when needed or increase the resources in the virtual machines to handle additional load. The vEPC is running in virtual machines as VNFs functions using OpenFlow controller as virtualization layer to manage the OpenFlow physical switches as depicted in Figure 1.

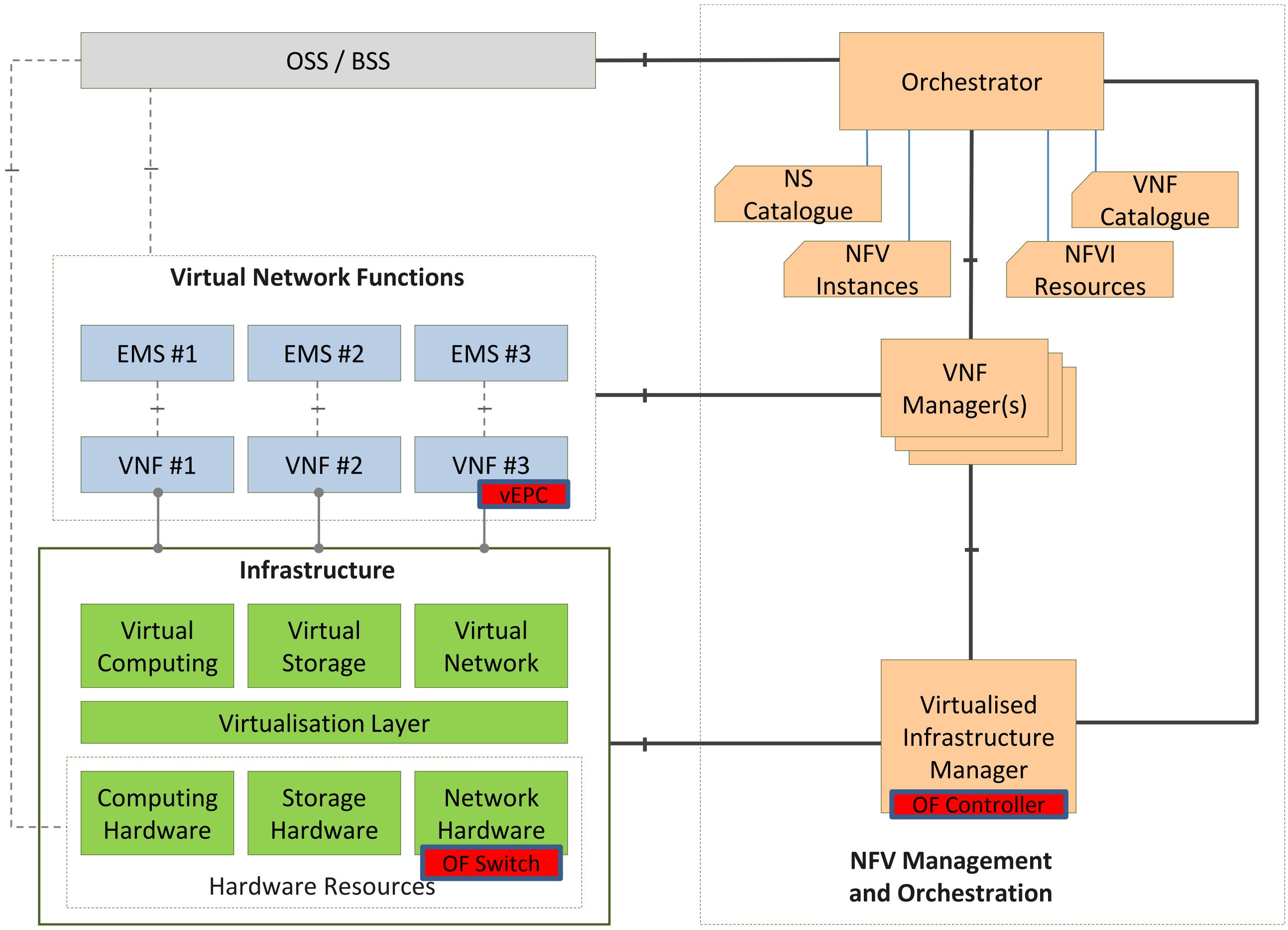

Figure 1. Mapping of PoC components into NFV architecture.

In our PoC we will demonstrate several use cases of vEPC where progressively we move from the usage of VNFs of existing EPC network elements in the first scenario (UC1 in figure 2) and in following scenarios 2 and 3 (UC2 and UC3 in figure 2) we integrate SDN as part of the transport network used in the mobile backhaul.

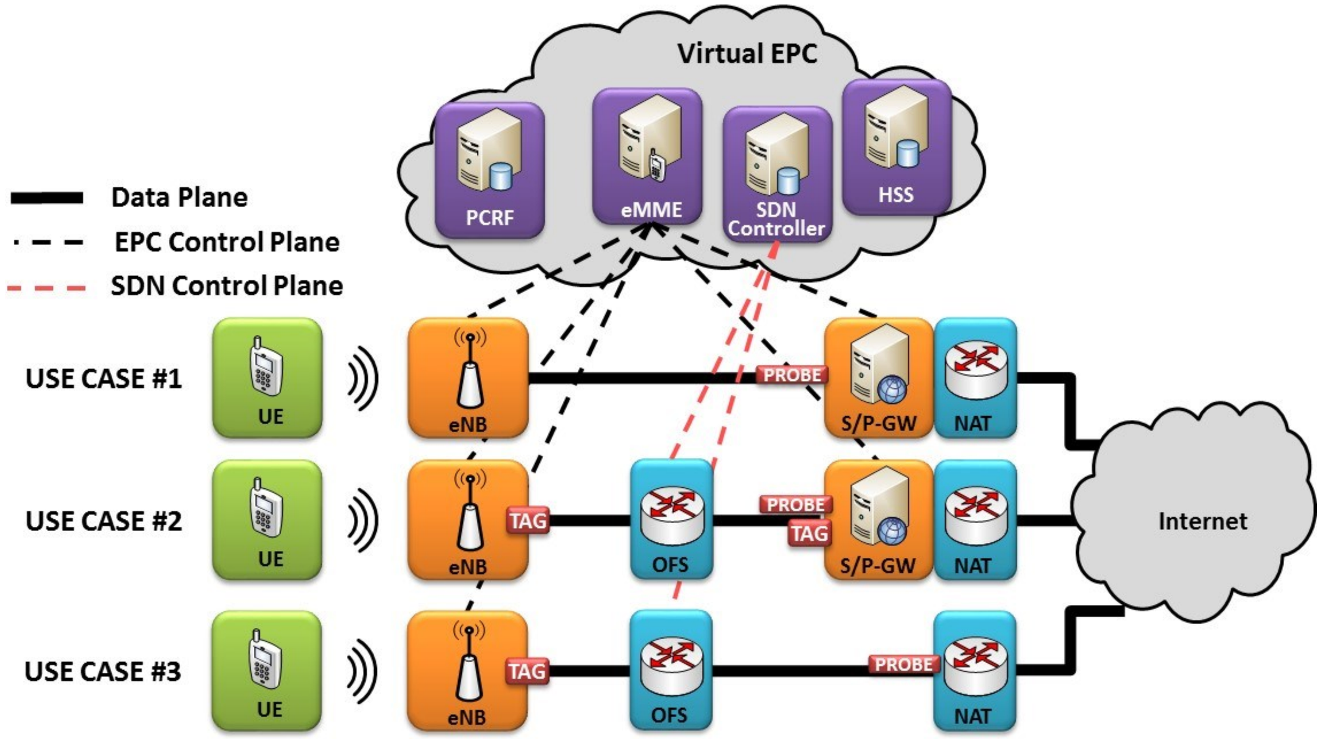

Figure 2. Abstract of our PoC.

A.2.2 PoC Scenarios

- Scenario 1 –We demonstrate how to deploy vEPC based on current standard network elements where each of them are running on different VNFs. Each of the different NW functions (i.e. MME, S/P-GW and FW) will be running on their own virtual machines in the cloud. The eNodeB will be running either as an emulator or a real eNodeB installed in Aalto premises with own network connection between the eNodeB and the data center where the rest of the NW functions are running. There is GTP tunneling between the eNB and the S/P-GW in UC1 but TAG component removes the GTP in the mobile backhaul for UC2 and UC3. The TAG maintains QoS using MPLS tagging for identifying the flows in the OpenFlow switches (OFS). As a result, in UC1, the UE data packets are routed between the eNB and the S/P-GW following current 3GPP specifications based on GTP tunnels.

  Figure 3 shows the abstract of scenario 1.
  Appliances used in this scenario are:
  - eNodeB: emulator or eNodeB model Flexi Zone (Nokia Networks)
  - vMME: eMME SW module (Aalto University)
  - vS/P-GW: Open Source nwEPC (SAE Gateway) with Aalto University's patches
  - vHSS: SQL database co-located with vMME
  - NAT: Customer Edge Switching (Aalto University)
  - SDN-Crtl: SDN controller based on RYU (SDN controller that supports OpenFlow 1.3)
  - OFS: OpenFlow enabled MPLS switch 8615 Smart Router (Coriant Oy)
  - PROBE: Traffic monitoring probe (EXFO)

  Following, UC2 and UC3 we use OFS and MPLS tagging to replace GTP but still maintain the required QoS.

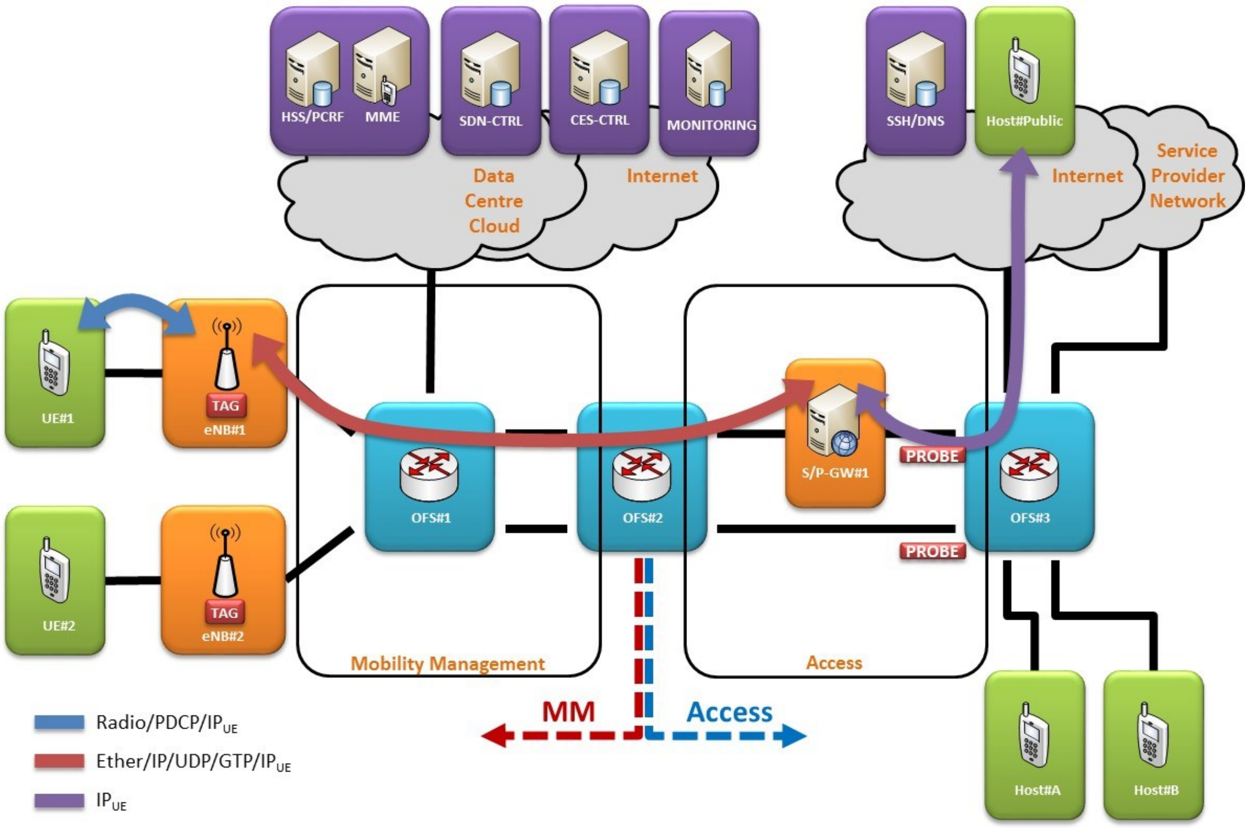

Figure 3. Abstract of PoC scenario 1. vEPC with traditional GTP tunnel eNB - S/PGW

- Scenario 2 – We demonstrate a scenario where we integrate the SDN controller with the eMME. In this scenario we use SDN to add L2 MPLS tagging to the GTP packets so we can perform traffic engineering in the backbone. UE data packets are switched from the eNB to the S/P-GW across the core network using several paths. Load balancing between OFS#1 and OFS#2 links is possible based on the MPLS identifiers. QoS can be provided using the L2 tag QoS bits. In this scenario we are still using standard NW functions such as eNodeB and S/P-GW for the data plane.

  Figure 4 shows the abstract of scenario 2.

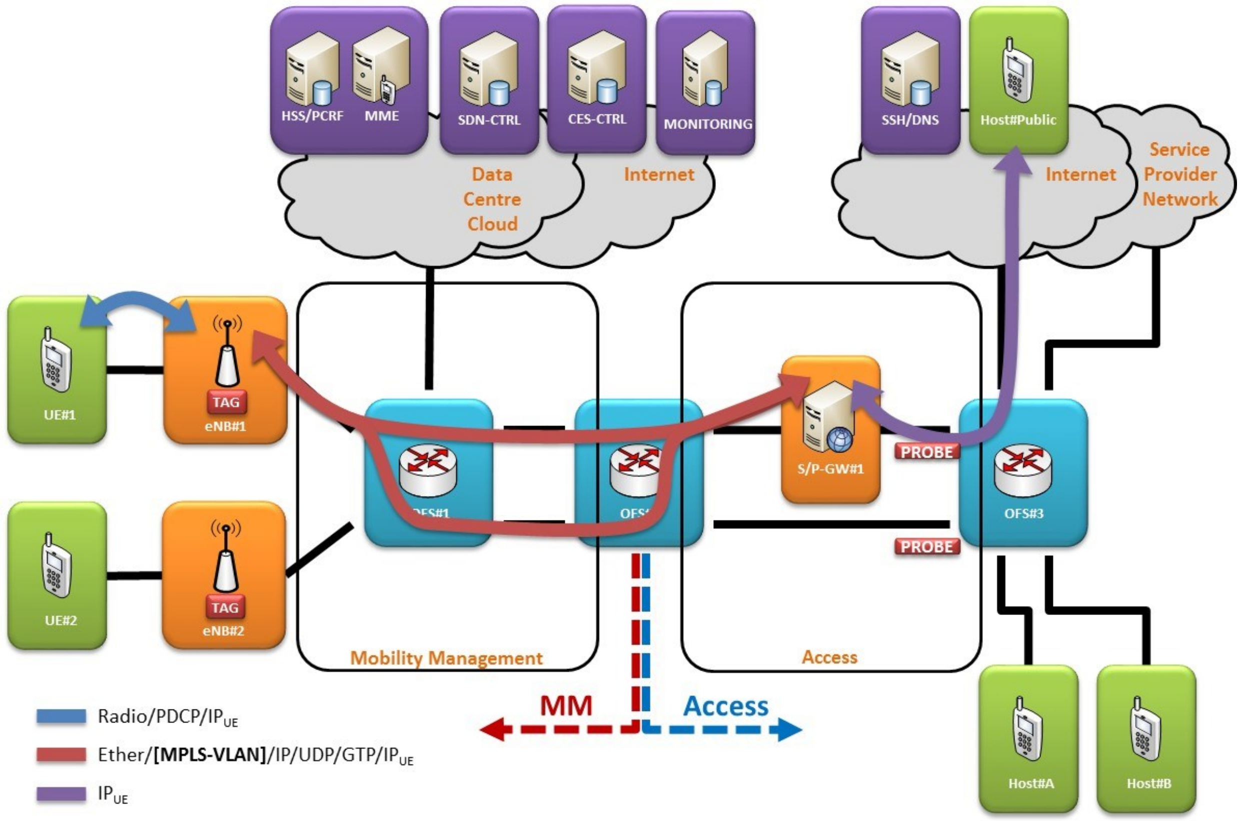

Figure 4. Abstract of PoC scenario 2. GTP tunnel eNB - S/PGW and SDN backhaul with L2 tags

- Scenario 3 – We demonstrate a scenario where the usage of SDN replaces completely the data plane part of standard NW elements such as S/P-GW. The NW elements such as PCRF are also replaced with a SDN application that provides similar functionality on top of the SDN controller. This scenario also shows how additional virtualized middle boxes could be added to provide NFV functions for managing specific flows. These middle boxes could deflect HTTP packets to proxy servers for optimal caching or the middle boxes could identify suspicious flows and redirect them to firewalls or honeypots. In this scenario we integrate the control part of the S/P-GW with the SDN controller. The S/P-GW functionality is limited to control in the cloud, if any. We completely remove GTP tunneling and use the eNB for sending the data packets in a specific formatting that in this case is supported by OpenFlow. The backbone network switches packets based on MPLS/VLAN identifiers leading to better utilization and traffic engineering. QoS can be defined in the L2 tag QoS bits. This scenario can also help with Caching in SDN as we have the UE data packets available in the eNB and they can be deflected to proxy servers. The network can be optimized at run time based on information collected from the monitoring probes.

  Figure 5 shows the abstract of scenario 3.

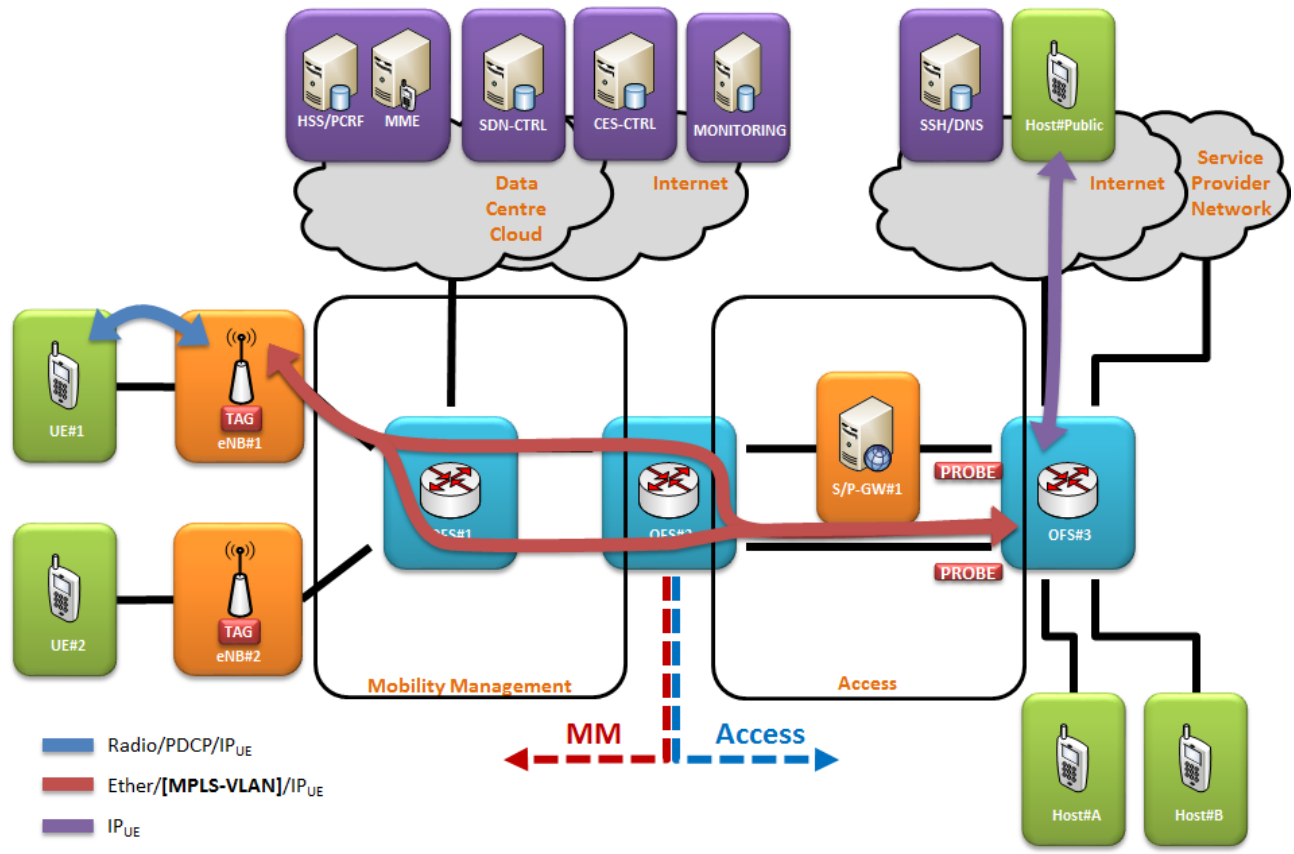

Figure 5 Abstract of PoC scenario 3. SDN backhaul without GTP tunnelling

A.2.3 Mapping to NFV ISG Work

	Use Case	Requirement	E2E Arch	Comments
Scenario 1	*UC#1 UC#6*	*Gen.1 Gen.4*	*Service, VNF and Infrastructure Description*	*Implementation of virtual EPC as a service.*
Scenario 2	*UC#1 UC#6*	*Gen.1 Gen.4*	*Service, VNF and Infrastructure Description*	*Implementation of virtual EPC as a service and integration with SDN for backhaul transport, which allows adding, deleting or migrating NFV to manage flows on demand and with defined QoS.*
Scenario 3	*UC#1 UC#6*	*Gen.1 Gen.4*		*Implementation of evolution of the previous scenarios with virtual EPC as a service and integration with SDN for backhaul transport.*

	INF	SWA	MAN	REL	PER	Comments
Scenario 1	*x*		*x*			*This scenario will contribute to the improvement of VNF and integration with SDN functionality.*

Scenario 2	x		x			*This scenario is an evolution of previous scenario 1, thus contributing to the integration of SDN in VNF following a logical migration path.*
Scenario 3	x		x			*This scenario is an evolution of previous scenario 1 and 2, thus contributing to the integration of SDN in VNF following a logical migration path.*

A.2.4 PoC Success Criteria

The success criteria is that our demonstration shows the feasibility of integrating SDN with NFV and identifies further considerations to be considered to provide the required flexibility, robustness and requirements of QoS and delays.

A.2.5 Expected PoC Contribution

- PoC Project Contribution #1: This PoC will contribute to the MANO WG, since MANO WG discusses the description of VNFs. This POC will prove the integration of SDN in NFV architecture.
- PoC Project Contribution #2: This PoC will contribute to the INF WG. For example, a use case "Network Service Provider obtains and operates a VNF on the NFV Infrastructure" in the NFVI documents requires virtual EPC functionality. The PoC using real eNodeBs, MPLS switches and SW based EPC network elements will provide measurements from the usage of SDN and vEPC functions fully integrated to identify bottlenecks when providing the required mobility, and resource manage functionality.