NFV ISG PoC Proposal

SDN Enabled Virtual EPC Gateway

1 NFV ISG PoC proposal

1.1 PoC Team Members

- PoC Project Name: **SDN Enabled Virtual EPC Gateway**

- Network Operator/Service Providers:
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- Manufacturer B:
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- Manufacturer C:
  - **Mavenir** Contact: Carlos Molina (carlos.molina@mavenir.com)

- Manufacturer D:
  - **Redhat** Contact: Glenn Rudolph (grudolph@redhat.com)

- Manufacturer E:
  - **Hewlett Packard** Contact: Eric Gomes (eric.gomes@hp.com)

1.2 PoC Project Goals

- PoC Project Goal #1 – The PoC will verify that an ETSI NFV compliant infrastructure can support a 3GPP standards compliant next generation EPC S/P-Gateway VNF implementation where the data and control/management plane functions, as defined by 3GPP for the S/P-GW, are implemented using independently (scalable) data and control plane VNFs

- PoC Project Goal #2 – The PoC will demonstrate how a virtualized 3GPP standards compliant S/P-GW VNF implementation with independently scalable user and control plane components can utilize an ETSI NFV infrastructure so that the placement of the S/P-GW data and control VNFCs can be distributed and/or centralized across/in NFVI PoPs

- PoC Project Goal #3 – The POC will showcase how in a multivendor VNF environment a subscriber's traffic flows can be delivered entirely using S/P-GW components placed within a single NFVI-PoP or delivered using S/P-GW components placed in multiple NFVI-PoPs simultaneously

- PoC Project Goal # 4 – The POC will show by example how a ETSI NFV and 3GPP compliant P/S-GW solution with above virtualization characteristics can provide

  (a) Maintain the gateway's role as a mobility anchor

  (b) Provide charging information to 3GPP compliant infrastructure

(c) Standards compliant interfaces with existing and/or virtualized Gi-LAN Physical Network Function(PNF) and/or Virtual Network Function (VNF)

(d) Implement Local Breakout to Gi-LAN functions deployed at the edge

(e) Service Continuity maintained during UE Mobility

1.3 PoC Demonstration

The PoC will be demonstrated at Vodafone labs in Düsseldorf Germany and at Telenor ASA facilities in Norway. The scenarios described in this proposal will be tested in the demonstrations.at these facilities

Public demonstration will be organized at industry events as indicated below.

1.4 Publication

The PoC results will be published by Q4 2015 to the ETSI.

In addition to the listed public demonstrations, videos/webcasts of the PoC demos will be posted online.

1.5 PoC Project Timeline

The PoC is based on work that is well progressed, and a lot of the functionality in this PoC was already demonstrated at SDN Congress in Oct 2014 in Düsseldorf, DE. The PoC is divided into two phases – Phase 1 will focus on basic operations – orchestration of a split gateway, interoperability with existing elements (e.g. eNB), basic call scenarios including local breakout. Phase 2 activities will showcase handling of UE handoffs across eNBs etc.

- PoC start date : Dec 15, 2014
- Lab preparation and installation start (Oslo and Düsseldorf) : Mar 15, 2015
- First Stage demo target date (Oslo) : May 12-14, 2015
- First public demonstration date NFV World Congress San Jose : May 5-7 2015
- Second Public Demo ONS Summit (Phase1) : June 14-18, 2015
- First Stage demo target date (VF lab – Düsseldorf) : June 15-17, 2015
- Second Stage Demonstration target date (Oslo) : Nov 2015
- Second Stage combined demo (Düsseldorf – VF location) : Nov 2015
- Second Stage Public demo : Dec 2015
- PoC Report target date : Dec, 2015
- PoC completion date : Dec 2015

2 NFV PoC Technical Details

2.1 PoC Overview

3GPP Release 8 introduced the Evolved Packet Core architecture (Figure 1) in which the 4G (LTE) packet core entities like the mobile control entity (MME) and the S/P-GW entities were first introduced. A major consideration during the Evolved Packet Core (EPC) architecture design was to

provide a functional split between MME, P/S-GW elements so that the mobility management (control) and packet/user plane forwarding functions which have different requirements could scale independently. Earlier versions of 3GPP architecture included entities like the RNC, SGSN that had both mobility (control) and L2/L3 data path functionality.

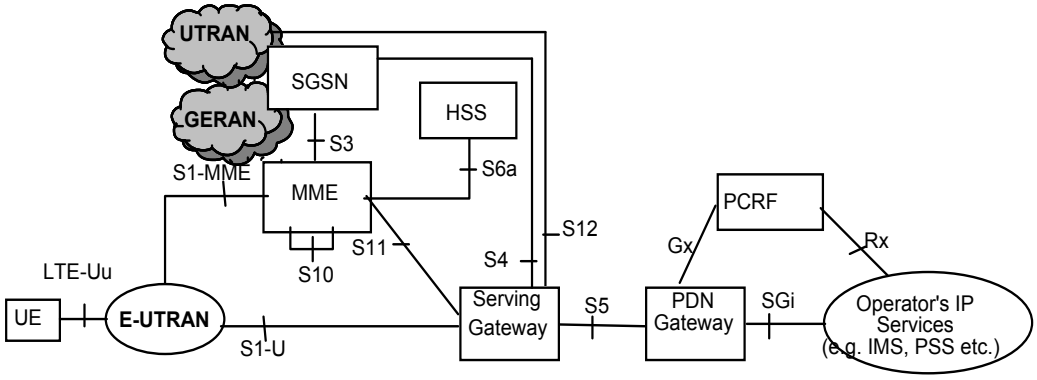

Figure 1 – 3GPP EPC Architecture (TS 23.301)

Since the development of the EPC architecture and deployment of 4G networks, the amount of traffic, number of devices has exploded. Operators are interested in leveraging NFV and related technologies like SDN to grow the EPC capacity cost effectively. One of the solutions for implementing a next generation S-GW and P-GW uses SDN and NFV technology to split the function further into S/P-GW-Control and S/P-GW-User Plane respectively. This type of implementation (Figure 2) leverages the original EPC design philosophy regarding data/control decoupling so that the functions within the gateways can scale independently.

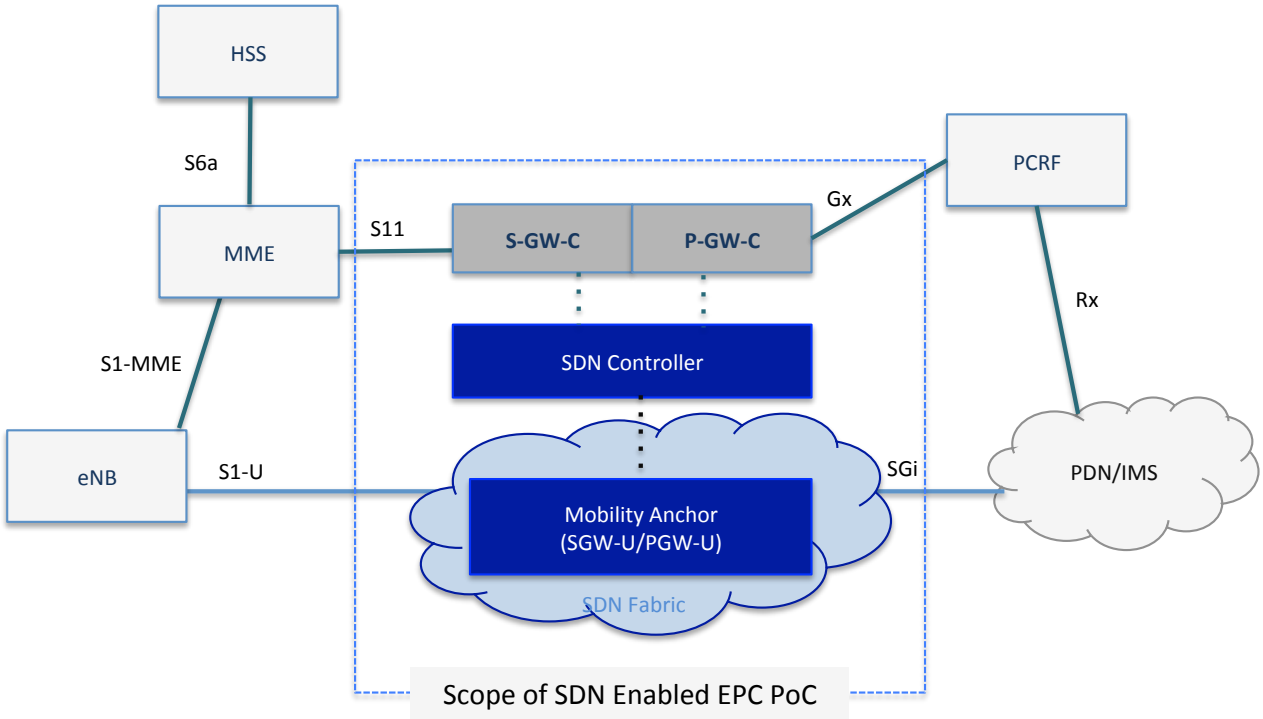

Figure 2 - SDN Enabled vEPC Gateway

Key capabilities and benefits of the SDN enabled virtual EPC (vEPC) implementation are:

1) Due to SDN based architecture that splits EPC gateway control and user plane functions for both S-GW and P-GW, those planes can be scaled independently (refer Figure 3).
2) Removes the need for a centralized mobility anchor from a data/user plane perspective. The data/user plane anchors (S-GW-U along with P-GW-U and related Gi-LAN) can be

distributed with some nodes placed closer to the access edge or centralized, as per needs. This can reduce congestion in both the backhaul and the centralized EPC nodes. SDN enabled vEPC can also enhance QoS bearer management capabilities (for e.g. local switching/hair pinning of latency sensitive IoT or even VoLTE traffic).

3) Selection of mobility anchor point based on a per flow basis, rather than on an APN basis. This for instance enables flows to be broken up and treated differently from both a routing and mobility perspective. Thus traffic can be selectively diverted for processing from local resources (e.g. cache)
4) Preserves existing procedures/protocols (GTP-C and GTP-U) from eNB and MME perspective
5) Maintains accounting role/interfaces at P-GW

Virtualizing the S-GW and P-GW elements, within the ETSI NFV framework in this manner, also implies that the NFVI and MANO infrastructure can be used for placing the underlying VNF components like S-GW-U and P-GW-U as desired in edge or central PoPs.

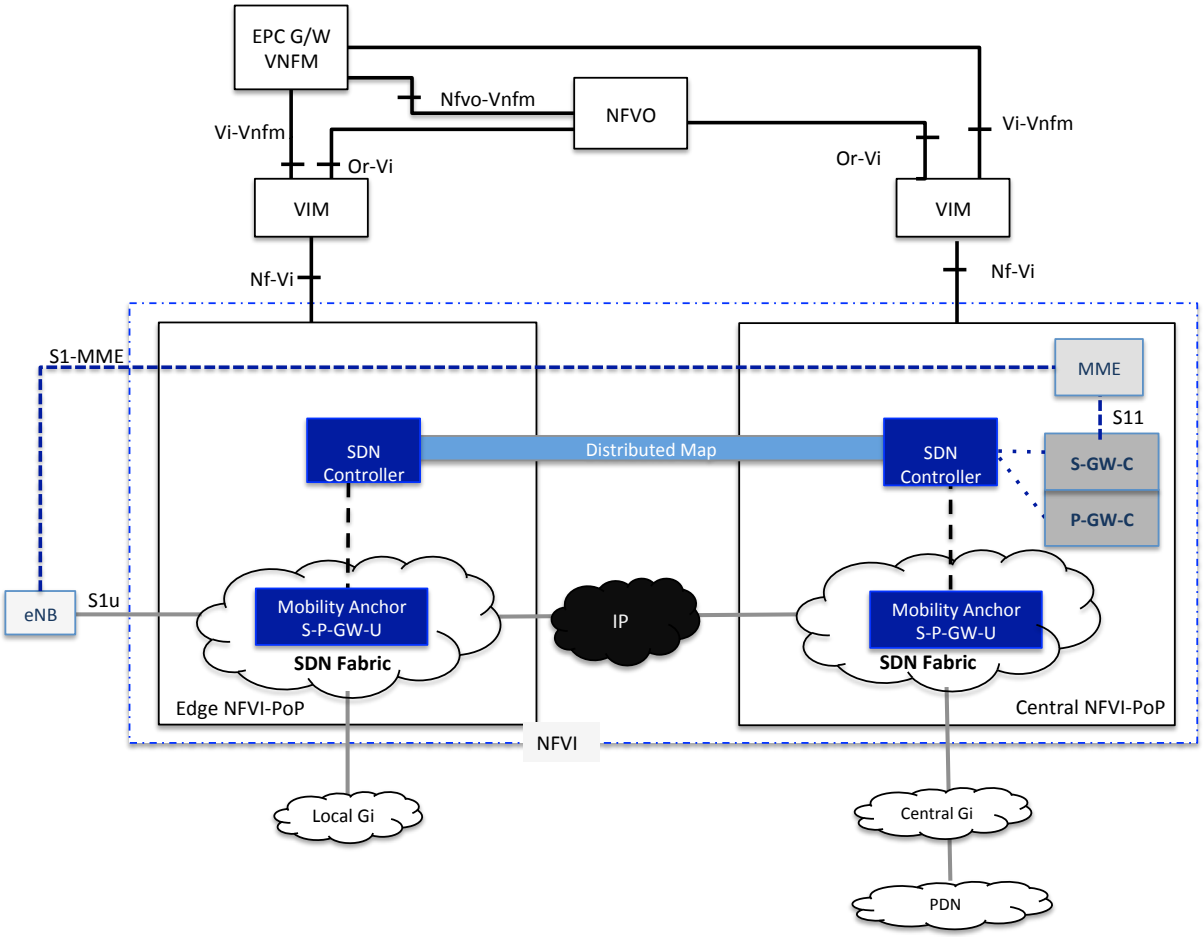

Figure 3 - SDN Enabled Virtual EPC in ETSI framework

As shown in Figure 4 the split SDN infused EPC gateway can enable traffic flows like:

- Flow 1: Subscriber #A: UE – eNB – edge Mobility Anchor (SDN Fabric) - central S-GW-U/ P-GW-U to central Gi LAN elements
- Flow 2: Subscriber #B: UE – eNB – edge S-GW-U/P-GW-U to edge Gi LAN elements

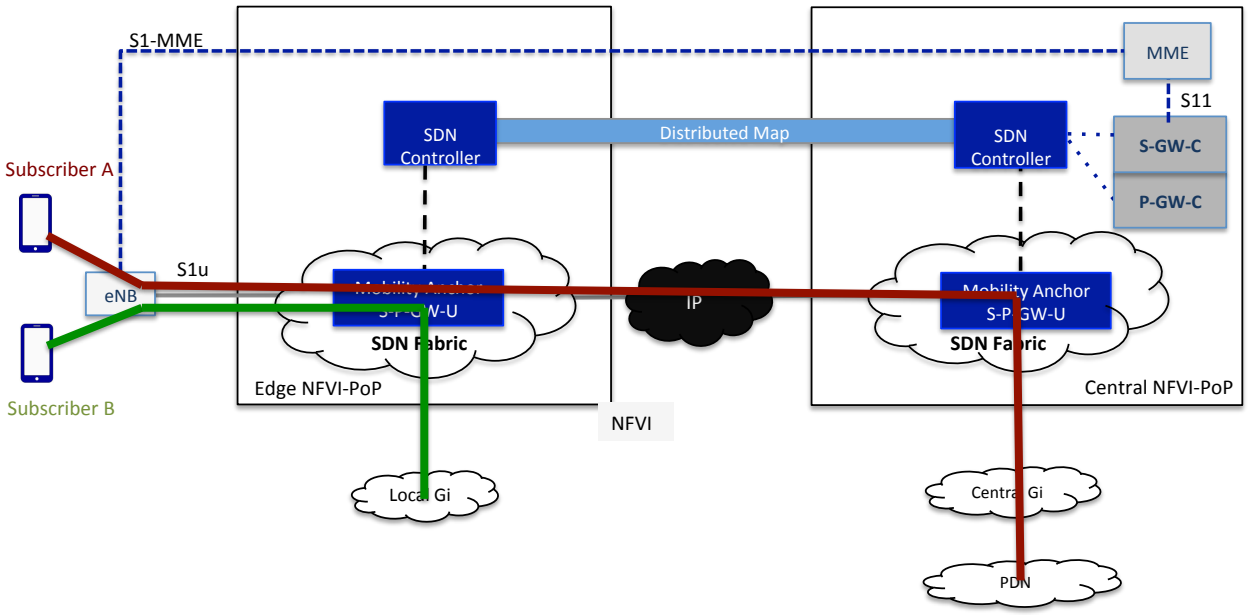

Figure 4: Traffic flows in SDN enabled EPC

2.2 PoC Scenarios

The elements to be used in the PoC are:

- NFVO/VIM Virtual Network Infrastructure -
- VIM – Redhat OpenStack
- NFV Orchestrator/VNF Manager– Hewlett Packard (NFV Director)
- Hypervisor - KVM
- SDN Controller – ConteXtream
- VNF – S/P-GW-C (Mavenir);
- VNF – MME – (Mavenir)
- VNF/PNF – HSS/PCRF/CS etc. – Vodafone/Telenor lab 3GPP infrastructure
- VNF – S/P-GW-U (ConteXtream)
- VNF – Cache – OpenSource component (CDN vendor partner may be added later)
- VNF – Live Video Edge Proxy - ImVision
- PNF – eNB - Vodafone/Telenor lab 3GPP infrastructure
- High Performance Carrier-Grade Hardware Resources – Hewlett Packard

For PoC demo purposes there will be a Portal to manage how the EPC flows are delivered.

The scenarios to be demonstrated are:

- Scenario 1 - Add/remove an edge/central S/P-GW VNF instance and see the virtual network get programmed and instantiated
- Scenario 2 – Show a subscriber attach using 3GPP compliant procedures and programming of S/P-GW user plane switch entities using SDN controllers
- Scenario 3 – Insert operator network rules via SDN that identify which flows shall be diverted to local resources (e.g. to live video edge proxy and cache)
- Scenario 4 – Show endpoint mobility across eNBs in various anchoring scenarios
- Scenario 5 – Show offline-accounting backward compatibility
- Scenario 6 – Measure improvement in terms of latency/speed for edge vs centralized delivery

of traffic

- Scenario 7 – Show independent scalability of the control and user plane elements of SDN enabled vEPC

The scenarios defined above will be demonstrated in a phased manner, based within the timeline indicated above. The exact scope of the individual phases will be determined by discussion among the PoC team members.

2.3 Mapping to NFV ISG Work

This section describes how this PoC relates to the NFV ISG work:

1) Summarized in table below the most relevant NFV ISG end-to-end concept from the NFV Use Cases [GS NFV 001 – NFV Use Cases], Requirements, and Architectural Framework functional blocks or reference points addressed by the different PoC scenarios:

	Use Case	Requirement	E2E Arch	Comments
Scenario 1 - Add/remove an edge/central S/P-GW VNF instance and see the virtual network get programmed and instantiated	*Use Case#5 (Virtualisation of Mobile Core Network and IMS)*	*Gen 1, 4* *Elas 1* *Elas 4-5*		*Shows capability to instantiate virtualized SDN enabled EPC and Gi-LAN infrastructure at desired NFVI-PoP in the 3GPP network based on multi-vendor NFVI, VIM, Orchestrator, and VNF package on-boarding.*
Scenario 2 – Show a subscriber attach using 3GPP compliant procedures and programming of S/P-GW user plane switch entities using SDN controllers	*Use Case#5 (Virtualisation of Mobile Core Network and IMS)*	*GS NFV 004 v1.1.1* *Gen.1-3*		*Shows ability of virtualization infrastructure to support split EPC implementation without impact to UE's or eNB.*
Scenario 3 – Insert operator network rules via SDN that identify which flows shall be diverted to local resources	*Use Case#5 (Virtualisation of Mobile Core Network and IMS)*	*GS NFV 004 v1.1.1* *Gen.1-4* *Per 2* *Res 1*		*Scenario will demonstrate benefits of subscriber aware SDN infrastructure to improve QoE*
Scenario 4 – Show endpoint mobility across eNBs in various anchoring scenarios	*Use Case#5 (Virtualisation of Mobile Core Network and IMS)*	*GS NFV 004 v1.1.1* *Gen.1-4*		*Shows ability of SDN in virtualization infrastructure to support split EPC implementation without impact to UE's or eNB*
Scenario 5 – Show offline-accounting	*Use Case#5 (Virtualisation of Mobile Core*	*GS NFV 004 v1.1,1 Port 1-3*		

backward compatibility	*Network and IMS)*			
Scenario 6 – Measure improvement in terms of latency/speed for edge vs centralized delivery of traffic	*Use Case#5 (Virtualisation of Mobile Core Network and IMS)*	*GS NFV 004 v1.1,1 Per 1-3*		*Scenario will measure QoE improvements delivered by split EPC with SDN infrastructure*
Scenario 7 – Show independent scalability of the control and user plane elements of SDN enabled vEPC	*Use Case#5 (Virtualisation of Mobile Core Network and IMS)*	*GS NFV 004 v1.1,1 Elas 1-4*		

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.

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 SDN Enabled EPC PoC Team is therefore expected to submit contributions relevant to the NFV ISG work items as a result of their PoC Project.

- PoC Project Contribution #1: This PoC will provide a contribution to the EVE WG on the architectural usage of SDN in implementing EPC VNF, since EVE WG discusses the integration of SDN in NFV architecture. NFV WI: DGS/NFV-EVE005
- PoC Project Contribution #2: This PoC will provide a contribution to the EVE WG discussing the relationship and requirements between Openstack and SDN interface in NFV environment NFV WI: DGS/NFV-EVE005
- PoC Project Contribution #3: This PoC will provide a contribution to the EVE-WG to present PoC findings and implications on NFVI Physical Node Architecture: NFV WI: DGS/NFV-EVE003