# NFV: State of the Art, Challenges, and Implementation in Next Generation Mobile Networks (vEPC)

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**Abstract**

This paper contains an overview of Network function Virtualization (NFV) framework and how NFV could be used to virtualize mobile networks.

## 1 Introduction

As of 2018, over half of world's population that is approximately 4 Billion [11] are subscribed for internet services and then we have Internet of Things. Over the last decade we have seen this drastic increase in demand for network services in terms of quality of service, speeds and reliability due to drastically improving technology from 2G to 3G, now 4G and we are already looking forward for 5G which has led network service providers to invest more on infrastructure [4] .

There are four main factors to be considered before investing in infrastructure.

- **Capex and Opex:** There is a huge cost involved in purchase, deployment and maintenance of hardware.
- **Deployment time:** due to complexity in setup it takes from few weeks to months until the purchased hardware can be actually used.
- **Efficiency:**if it is not used efficiently it is simply waste of resources and in reality it is hard to achieve efficiency.
- **Competitive market:**the service providers cannot expect a huge returns due to competitive market and the profit percentage is very narrow.

This shows that constantly investing is infrastructure is not a feasible option and an alternative is required. As designed and proposed by IT specialists Virtualization is a viable alternative[3].

# 2 Network Function Virtualization

The network infrastructure consists of various specialized hardware such as firewall, deep packet inspector, router and switches. NFV is focused on decoupling of these hardware dependencies and transferring these network functions to software based applications which run on high volume servers, storage and switches without affecting the network functionality. This provides an open platform for multiple parties to constantly improvise on the software based function and also provide greater scalability and flexibility along with reducing the Capex, Opex, space and power consumption[9].

**NFV and SDN simplified:** NFV serve SDN by implementing its network functions in a software manner on a COTSs servers. It can virtualize the SDN controller to run on cloud, which could be migrated to best fit location according to the network needs[2].

**Proposed framework:** The management tools such as Virtualized infrastructure manager (VIM) keeps track of hardware resources, VNF managers keeps track of various VNF deployed and its requirements and functionality and the orchestrator sits communicating and managing between various VNF managers and VIM's to meet the service requirements by OSS/BSS are deployed on the hypervisors. As hypervisors are deployed directly above the hardware it can efficiently manage resources and assist in migration, fault and fault tolerance[10]. Upon the hypervisor a cross platform deployed which provides portability and flexibility for VNF independently of the hypervisor and above the cross platform we have VNF and EMS[1].

**NFV Challenges and Requirements:**

Though NFV is a promising solution it still faces some challenges in terms of below parameters as described in the paper.

1. **Security**: As the orchestration tools are deployed on the hypervisor it should prevent any unauthorized access or data leakage and other processes such as data communication and VM migration should run in a secure environment [3]. and NFV provides a API for programmable orchestration which introduces higher security threats[2].

2. **Computing Performance:** Though the properties of underlying hardware impacts VNF performance, VNF software design also plays a major role in its performance.

3. **VNF interconnection:**

   In a virtualized environment, virtual machines can be connected in different scenarios [8]. Two VNF have to communicate only through Vswitch weather or not they are running of the same physical server or different servers

4. **Portability:** deploying VNF on a Hypervisor allows underlying hardware to be viewed uniformly by the VNF and take benefits of Hypervisor's features. This deployment also enables each VNF to be executed on its specific operating system while remaining unaware of the underlying operating system.

5. **Operation and management:** templates of VNF should formed to easy use and orchestration should behighly automated.

6. **Existence with legacy networks:** VNF should be able to coexist with legacy network equipment. It means that it should be able to interact with legacy management systems with minimal effects on existing networks.

7. **Carrier-grade service assurance:** Carrier-grade service is a service in which hardware, software, and system components ensure high availability and reliability.

# 3 Mobile Network Virtualization

Virtualizing mobiles network involves virtualizing the core network that is Evolved packet Core.

The Evolved packet core contains components such as [7] The Home Subscriber Server (HSS) which is a central database that contains information about all the network operator's subscribers.The Packet Data Network Gateway (P-GW): communicates with the outside world. The serving gateway (S-GW): acts as a router and forwards data between the base station and the PDN gateway.The mobility management entity (MME): controls the high-level operation of the mobile by means of signaling messages and Home Subscriber Server (HSS).The Policy Control and Charging Rules Function (PCRF): is responsible for policy control decision-making, as well as for controlling the flow-based charging functionalities. MME, HSS and PCRF form the control plane and PGW and SGW form the data plane.

**Proposed working of vEPC:** To achieve vEPC, the core elements of EPC is placed in groups so that we can reduce signaling traffic in control plane and congestion in data plane Four sectors or groups are formed as below

1. MME and HSS-FE: HSS-FE has same functionality as that of HSS[7] but does not contain user database, once it downloads the user data it forms a complete HSS. This group can achieve authentication and authorization internally.

2. SGSN and HLR-FE: SGSN and HLR[7, 6] has similar role as that of MME and HSS and is used in GPRS technology. This group is formed with scope to support 2G and 3G along with 4G.

3. PGW and SGW: This is bring the data plane together so that we can achieve centralized processing in the data plane and it helps overcome the processing and network bottlenecks. Now once the user data has been served, it can directly connect to external networks[7].

4. UDR, PCRF, OCS and OFCS: This is policy enforcing group which can efficiently track session details and charge the users accordingly[7, 6].

# 4 Conclusion

The analysis shows that the proposed grouping can reduce network control traffic by 70 percent[12, 5]. NFC not only improves the present situation of the telecom industry

but also provides a ready platform for development and improvisations. but IT organizations, network enterprises, telecommunication, equipment vendors, and academic researchers should be aware of the NFV challenges and explore new approaches to overcome them.

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