



# ALCATEL-LUCENT VIRTUALIZED EPC

DELIVERING ON THE PROMISE  
OF NFV AND SDN

APPLICATION NOTE

## ABSTRACT

Changes in the types of services and in their delivery over the 4G/LTE network are driving mobile network operators (MNOs) to network functions virtualization (NFV) and software defined networking (SDN). In their packet core, they want a virtualized Evolved Packet Core (vEPC) that is more flexible and can be quickly deployed and configured to meet changing customer demands. The new vEPC must also meet their capacity and performance requirements and interwork seamlessly with both the existing network and a new IT-managed operating environment. It's a difficult challenge.

The Alcatel-Lucent Virtualized EPC (vEPC), a deployment option of the Alcatel-Lucent IP Mobile Core offer, delivers on the promise of NFV/SDN by providing the scalability and performance that are needed in today's 4G/LTE networks. All of the EPC network functions are virtualized and operate on general-purpose server hardware. With the Alcatel-Lucent vEPC, MNOs can offer new services faster, ensure scalability and performance, and migrate to NFV and SDN at their own pace.

# TABLE OF CONTENTS

Market trends	/ 1
MNO challenges to deploying a vEPC	/ 2
Alcatel-Lucent virtualized EPC	/ 3
Alcatel-Lucent vEPC network function architecture	/ 4
Fulfilling the promise of NFV and SDN	/ 5
Deployment flexibility	/ 6
Operational elegance	/ 8
Operational elegance example: vPGW instantiation	/ 10
Service excellence	/ 11
Signaling control plane enhancements	/ 11
Data plane enhancements	/ 11
Packet processing	/ 12
High availability	/ 12
Alcatel-Lucent end-to-end vEPC NFV and SDN solution	/ 12
Conclusion	/ 14
References	/ 14
Acronyms	/ 15

# MARKET TRENDS

There are key changes in the types of services and in their delivery over the 4G/LTE network that are driving mobile network operators (MNOs) to network functions virtualization (NFV) and software defined networking (SDN). The most obvious is the increasing demand for mobile video, which is forecasted to grow to 66 percent of the total volume of traffic on the mobile network by 2017 [1].

With the popularity of larger screen smartphones, tablets and phablets<sup>1</sup>, and the LTE network's ability to support new video streaming capabilities such as evolved Multimedia Broadcast/Multicast Services (eMBMS), the EPC must support not only the bandwidth capacity but also the quality of service (QoS) latency and jitter requirements needed for a superior mobile video viewing experience. The EPC also needs to become more distributed so that it's closer to the caches of popular content stored in the network.

The second change is the adoption of voice services to Voice over LTE (VoLTE) or the emerging voice over Wi-Fi (VoWiFi) service. VoLTE now has strong market momentum, driven by the MNOs' desire to offer not only high-definition (HD) voice calls with VoLTE but also enriched voice communication services, over IP Multimedia Subsystem (IMS) and EPC all-IP networks, in order to maintain subscriber loyalty and reduce churn. VoLTE subscriptions are expected to increase significantly over the next few years, growing 145 percent annually through 2017 [2]. Unlike video, VoLTE packets are small, which requires the EPC to support high-speed packet processing with a guaranteed bit rate to meet the QoS requirements.

Voice over Wi-Fi® (VoWi-Fi) is now being offered by MNOs with new client capabilities that are built into the current generation of 4G/LTE smartphones. It gives MNOs the ability to fill in coverage holes with Wi-Fi and to create new voice service packages such as video calling that can augment IMS services. To support seamless and secure cellular/Wi-Fi services requires changes in the EPC to support both untrusted and trusted wireless (Wi-Fi) access.

Businesses are planning to take advantage of the ubiquity of wireless broadband access by giving their mobile employees remote connectivity to the corporate applications and tools they need to improve their productivity. This growing remote employee population, estimated to reach 1.3 billion by 2017 [4], provides MNOs with an opportunity to expand their enterprise virtual private networks (VPNs) offer to a larger set of corporate customers if they can provide a distributed EPC that is economically right-sized to meet the enterprise's scaling needs.

Finally, machine-to-machine (M2M) is one of a number of services that MNOs are looking to offer in a virtualized environment. It is estimated that M2M service provider revenues could triple to \$44 billion USD by 2018 [5]. With potentially millions of additional machine devices being connected to the network, MNOs need a low-cost and highly scalable EPC that can flexibly increase connection capacity wherever and whenever it's needed.

## VIRTUALIZED EPC GROWTH FORECAST

Dell'Oro projects that by 2018, 15% of the mobile operator's EPC software licenses will be for vEPC network functions [3].

<sup>1</sup> Phablets are mobile devices that combine the functions of a smartphone and a tablet.

# MNO CHALLENGES TO DEPLOYING A vEPC

While NFV and SDN bring the promise of a vEPC that delivers greater scalability and more flexibility to rapidly deliver new services, there are important technical and operational challenges that must be overcome before they can be commercially deployed in MNO networks. The key MNO challenges to deploying a vEPC are to:

- Maintain/exceed stringent service availability and real-time performance requirements
- Operate transparently across a mix of traditional and cloud-based infrastructure
- Operate in an open, multivendor environment
- Deliver event-driven, flexible service and capacity instantiation and scaling

Enterprise cloud and IT networks are not designed to meet the more stringent availability requirements of the mobile core network. In telecommunications networks, there are government and regulatory requirements that the network must be at least 99.999 percent available with the ability to continue to operate and maintain services even with a full nodal failure.

The challenge that MNOs face is migrating to an NFV and SDN environment while still providing the required service availability. This situation will drive these networks to add network monitoring and self-healing capabilities with network redundancy and Virtualized Network Function (VNF) protection schemes to meet the high-availability requirements.

Virtualization of the network will happen gradually with MNOs deploying a mix of EPC virtualized and hardware-based functions as required to meet their evolution plans. But the management and operations of an NFV and SDN network is very different from the existing telecommunications network operating environment. The MNO challenge is to manage and maintain this hybrid network with each management domain receiving the network monitoring and analytic tools it requires.

Both the data center and IT operations must be kept in sync with the traditional telecommunications network view. This requirement drives the need for an NFV and SDN management and orchestration system that can interoperate seamlessly with the existing network operations and Operations Support System/Business Support System (OSS/BSS) infrastructure.

A key advantage of moving to NFV is that MNOs are no longer tied to proprietary hardware and software integrated solutions from vendors of purpose-built products that limit their leverage and flexibility. However, because NFV and SDN are relatively new technologies, MNOs might be tempted to deploy a proprietary solution from a single vendor to reduce the time to deployment and mitigate interoperability risks.

It's important that any vendor's NFV and SDN solution is based on open source software with open Application Programming Interfaces (APIs) that have been tested in a multi-vendor environment. Otherwise, the MNO runs the risk of being locked into a proprietary solution.

An important benefit that MNOs expect from NFV is the ability to rapidly develop and deploy new services with a more agile network that can easily add or move capacity wherever and whenever it's needed. Adding capacity in the traditional MNO product-based network is slow, with long lead times to engineer, order and install new hardware to support a forecasted demand that may not materialize. However, simply virtualizing the functions of the network will not improve the speed or agility to deliver new services either. The challenge MNOs face is being able to extract the benefits of flexibility and service agility that NFV brings to dynamically increase capacity in a few simple automated steps.

Each of these challenges is addressed by the Alcatel-Lucent vEPC solution.

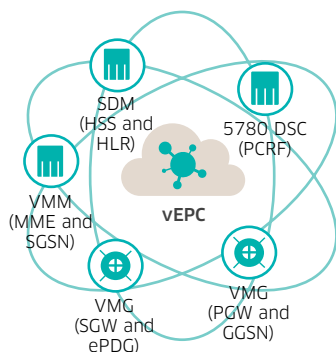
## ALCATEL-LUCENT VIRTUALIZED EPC

Alcatel-Lucent is committed to NFV and SDN and is transforming its portfolio to support this strategy, enabling MNOs to become more flexible and responsive to customer demands. In early 2014, Alcatel-Lucent unveiled the first of its NFV mobile applications, including the Alcatel-Lucent vEPC (see Figure 1).

The Alcatel-Lucent vEPC solution consists of software applications that perform the following network functions:

- Mobile gateways: The Alcatel-Lucent Virtualized Mobile Gateway (VMG) provides the Serving Gateway (SGW), Packet Data Network Gateway/Gateway GPRS Support Node (PGW/GGSN), Evolved Packet Data Gateway (ePDG) and Trusted Wireless Access Gateway (TWAG) functions.<sup>2</sup>
- Mobility management: The Alcatel-Lucent Virtualized Mobility Manager (VMM) provides the Mobility Management Entity (MME), Serving GPRS Support Node (SGSN) and Session Restoration Server (SRS) functions.<sup>2</sup>
- Policy control and charging: The Alcatel-Lucent 5780 Dynamic Services Controller (DSC), built on patented Agile Rules Technology (A.R.T) rules engine, provides the Policy and Charging Rules Function (PCRF) and Diameter Routing Agent (DRA).
- Subscriber management: The Alcatel-Lucent Subscriber Data Manager provides the Home Subscriber Server (HSS) and Home Location Register (HLR) functions.
- Element and network management: The Alcatel-Lucent 5620 Service Aware Manager (SAM) performs element and network management.

Figure 1. Alcatel-Lucent vEPC



<sup>2</sup> TWAG and SRS virtualized functions will be provided in a future release.

The Alcatel-Lucent vEPC solution is a deployment option of the widely deployed Alcatel-Lucent IP Mobile Core. The software applications of the Alcatel-Lucent vEPC solution share a common software code base with the IP Mobile Core hardware-based products to ensure feature parity and consistency across the virtualized and physical dedicated hardware options. This shared base gives MNOs the ability to migrate their networks to NFV and SDN at their own pace with the confidence that the EPC functions across a hybrid virtual and physical network will deliver consistent and predictable behavior. Each of the vEPC network functions are stand-alone software applications that can be deployed individually or together as a complete virtualized solution.

The vEPC solution is multivendor and open, enabling it to operate on any NFV infrastructure platform. This openness gives MNOs the flexibility to choose the hardware (compute, storage and network hardware) and software (host operating system [OS] and virtualization layer) suppliers that best meet their business and technical requirements. In addition, Alcatel-Lucent has partnered with several industry-leading NFV hardware and software vendors to provide pre-integrated packages that give MNOs another purchase option.

The vEPC application software is highly reliable and field-proven. It has been deployed in over 80 core (2G/3G/LTE) networks with many of the largest LTE mobile networks in the world.

Both the VMG and VMM and their respective hardware-based EPC functions are managed by the 5620 SAM, the combined Element Management System/Network Management System (EMS/NMS) that provides fault, correlation, accounting, provisioning and security (FCAPS) and monitoring of the network functions in the NFV and SDN operations network. The 5620 SAM also manages the LTE radio access network (macro, metro and small cells) and the mobile backhaul products in the Alcatel-Lucent LTE network solution.

## **ALCATEL-LUCENT vEPC NETWORK FUNCTION ARCHITECTURE**

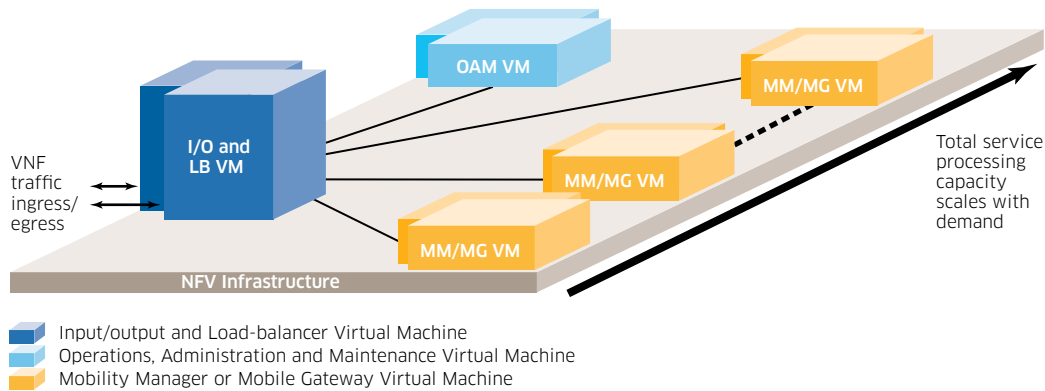
In the Alcatel-Lucent vEPC, the software applications perform the same 3GPP™-defined EPC functions (for example MME, SGW, PCRF) as the Alcatel-Lucent IP Mobile Core solution but without the requirement of dedicated, purpose-built hardware. Instead, the vEPC application software runs on commercial off-the-shelf (COTS) Intel® x86-based server hardware.

Each EPC VNF is composed of several virtual machines (VMs) with each VM instance performing a set of specific functional tasks (see Figure 2).

The Alcatel-Lucent VMM and VMG are architected to scale efficiently in capacity while providing stable peering relationships. This is accomplished through the use of different types of VMs to build a VMM or VMG.

A single node interface to the management plane through an Operations, Administration and Maintenance (OAM) VM provides system configuration, system assurance and alarm management. A set of input/output (I/O) and load balancer (LB) VMs terminate the 3GPP control and data plane packets. The subscriber capacity of the VMM or the VMG is scaled out through the addition of mobility manager (MM) VMs in a VMM or mobile gateway (MG) VMs that are sufficient to handle the traffic demand at any given location. All VM types support hot, stateful, 1 + 1 redundancy to ensure recovery from any single failure.

**Figure 2. Alcatel-Lucent vEPC Network Function Architecture**



## FULFILLING THE PROMISE OF NFV AND SDN

Alcatel-Lucent is an industry leader in all of the key technologies that MNOs need when they are ready for NFV and SDN. Alcatel-Lucent has the experience and field-proven, industry solutions and expertise in all parts of the network, including:

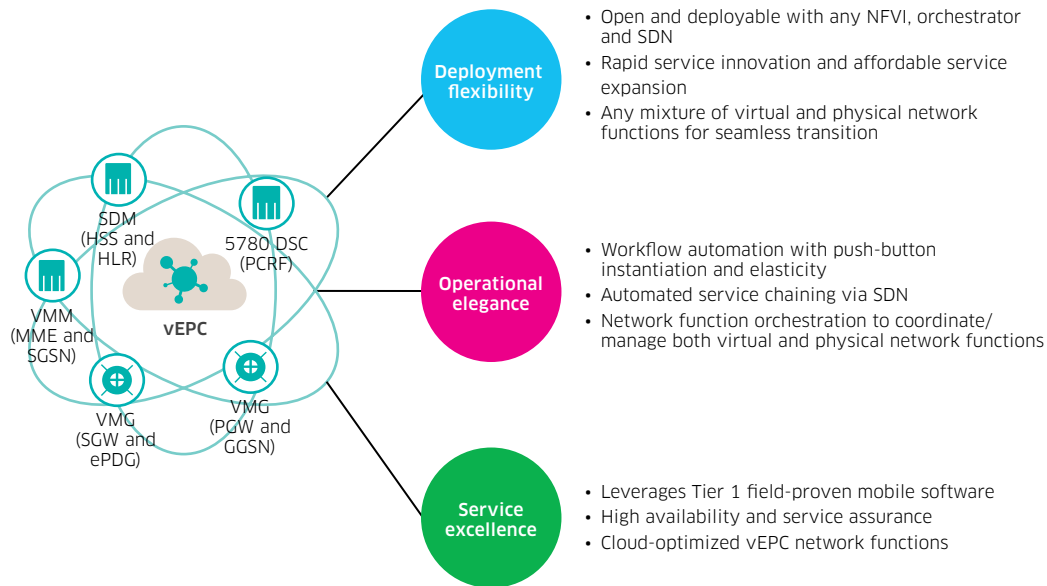
- Wireless (LTE and small cells): Over 55 LTE radio access network customers and 45 small cell customers in some of the largest Tier 1 mobile networks in North America and China.
- Evolved packet core: 3G/LTE core network deployments in over 80 MNO/MVNO (mobile virtual network operator) networks, including large Tier 1 mobile operators in the United States and China.
- IP: IP edge router market leadership (#2 rank) with over 440,000 service router-based units shipped to over 650 customers.
- NFV: Alcatel-Lucent is a pioneer in NFV with Alcatel-Lucent CloudBand™, a multi-vendor NFV platform that is in trials with over 19 service providers and has won numerous industry awards.
- SDN: Nuage Networks™ Virtualized Services Platform (VSP) supports programmable, policy-based networking that addresses the data center and WAN inter-connectivity scaling problem. Nuage Networks has won numerous industry awards and is commercially deployed in multiple networks.



With this knowledge and expertise, Alcatel-Lucent delivers on the promise of NFV and SDN with a vEPC solution (see Figure 3) that provides MNOs the following benefits:

- Deployment flexibility
- Operational elegance
- Service excellence

**Figure 3. Alcatel-Lucent vEPC: Delivering on the promise of NFV and SDN**



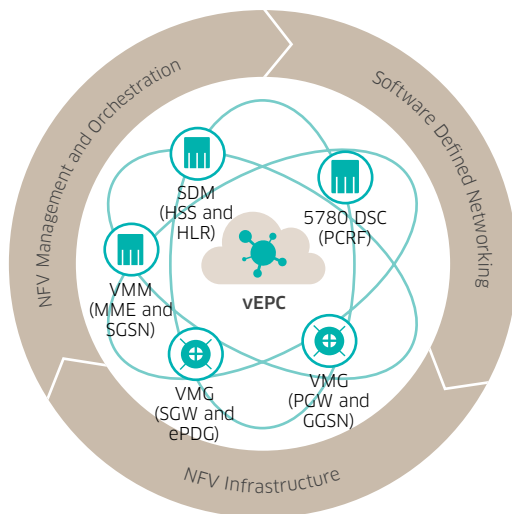
## Deployment flexibility

The Alcatel-Lucent vEPC provides MNOs with increased deployment flexibility through its design-optimized NFV and SDN architecture and its multivendor, open design. Alcatel-Lucent’s vEPC utilizes cloud ecosystem compute and networking hardware, OSs and hypervisors for the NFV and SDN infrastructure to allow industry economies of scale to be realized. The NFV and SDN infrastructure is controlled through open interfaces provided through OpenStack® and OpenFlow to allow industry collaboration for ever-improving capabilities.

Alcatel-Lucent’s field-proven mobile gateway and mobility management software has been adapted to run as a set of VMs on top of any generic NFV or SDN platform, enabling MNOs to keep pace with the latest computing and networking offerings in the industry.

To fully realize all the benefits of automation and to allow the NFV and SDN infrastructure to scale to support a large number of network functions, NFV orchestration and SDN need to be part of the solution. The Alcatel-Lucent vEPC can interoperate with any NFV orchestrator or SDN offering in addition to any NFV infrastructure, so MNOs can choose their preferred suppliers in each domain (see Figure 4).

**Figure 4. Alcatel-Lucent vEPC: Open and interoperable**



Scalability and capacity expansion is another dimension of the vEPC deployment flexibility. Because all of the vEPC network functions are virtualized, MNOs can quickly add scale and capacity wherever and whenever they are needed.

For example, an MNO could add an additional VMM-MME to an existing pool where signaling load has suddenly increased, perhaps due to the release of a new device or application. This VMM-MME can interwork seamlessly with the previously deployed MMEs in the pool to ensure that existing assets are maximized.

An MNO also has the option of decentralizing the VMG and VMM, placing them closer to the actual end user of the services to improve the user’s quality of experience.

The Alcatel-Lucent vEPC also facilitates new and innovative service deployment. For example, for a new enterprise customer, a dedicated VMG-PGW can be rapidly provisioned at the optimal location for a given enterprise. In addition, the rapid growth of new M2M services can be supported with rapid growth of a dedicated M2M packet core consisting of the Alcatel-Lucent VMG and VMM.

The capacity and performance of the M2M packet core can be tailored to service uptake as it occurs. This reduces risk for MNOs because they no longer need to make detailed forecasts for which specific types of M2M services will be most in demand or in what regions that demand will occur.

The VMG and VMM use the same network function application software from the field-proven Alcatel-Lucent 7750 Service Router Mobile Gateway and the Alcatel-Lucent 9471 Wireless Mobility Manager (WMM). This commonality ensures that the vEPC delivers the identical features and capabilities that exist in the deployed EPC networks today while migrating to a new platform to deliver innovative capabilities going forward.

Re-use of the application software removes any interoperability concerns for mixed virtual and physical network function EPCs, facilitating a smooth migration that's determined by the MNO's business drivers.

Therefore, an MNO can easily deploy Alcatel-Lucent vEPC network functions to support their existing packet core network whenever and where ever they are needed. Interoperability with other MNO EPCs is ensured through Alcatel-Lucent's field-proven, 3GPP-compliant software. Based on an MNO's specific business needs, either the existing network capacity can be supplemented with growth through new VMG and VMM deployments or dedicated overlay vEPC networks can be deployed for specific opportunities such as M2M or enterprise services.

### Operational elegance

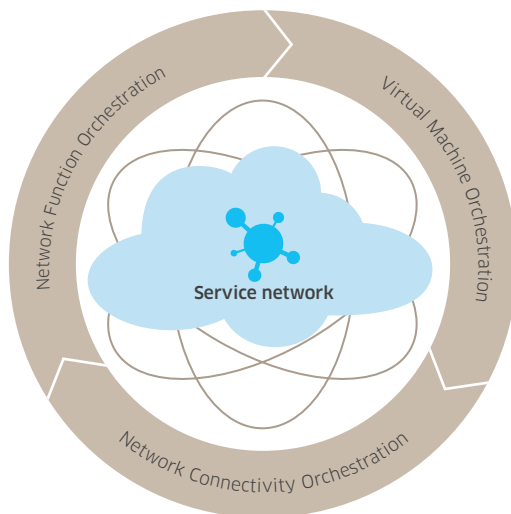
For MNOs who want to reduce the operational complexity and time to deploy a vEPC, and ultimately open the door for innovation with new services, Alcatel-Lucent offers a complete, integrated NFV and SDN operations management solution. This operationally elegant solution provides:

- Workflow automation with push-button instantiation and elasticity
- Automated network service chaining through SDN
- Network function orchestration to coordinate end-to-end network service deployment

The solution is divided into three well-defined management domains that provide a simple, seamless solution for vEPC operational requirements (see Figure 5):

- Virtual machine orchestration and VNF/VM life cycle management through the Alcatel-Lucent CloudBand™ Management System, which provides overall coordination and adaptation between the NFV infrastructure and the EMS/NMS
- Network connectivity orchestration with our Nuage Networks VSP that delivers SDN for intra-VNF network connectivity between VMs, VNF network interfaces and service chaining applications
- Network function orchestration through the 5620 SAM, the EMS/NMS that supports a wide variety of both physical and virtual network functions; examples of this service-aware network function orchestration include multiple element coordination of capacity augmentation and end-to-end network service deployment

Figure 5. Alcatel-Lucent vEPC: Open and interoperable



A key MNO benefit expected from the deployment of NFV is the ability to automate operations to rapidly deploy new, innovative services as well as scale existing services. This requires automation of the vEPC network to add and modify capacity as demand for new services occurs and demand for existing services grows.

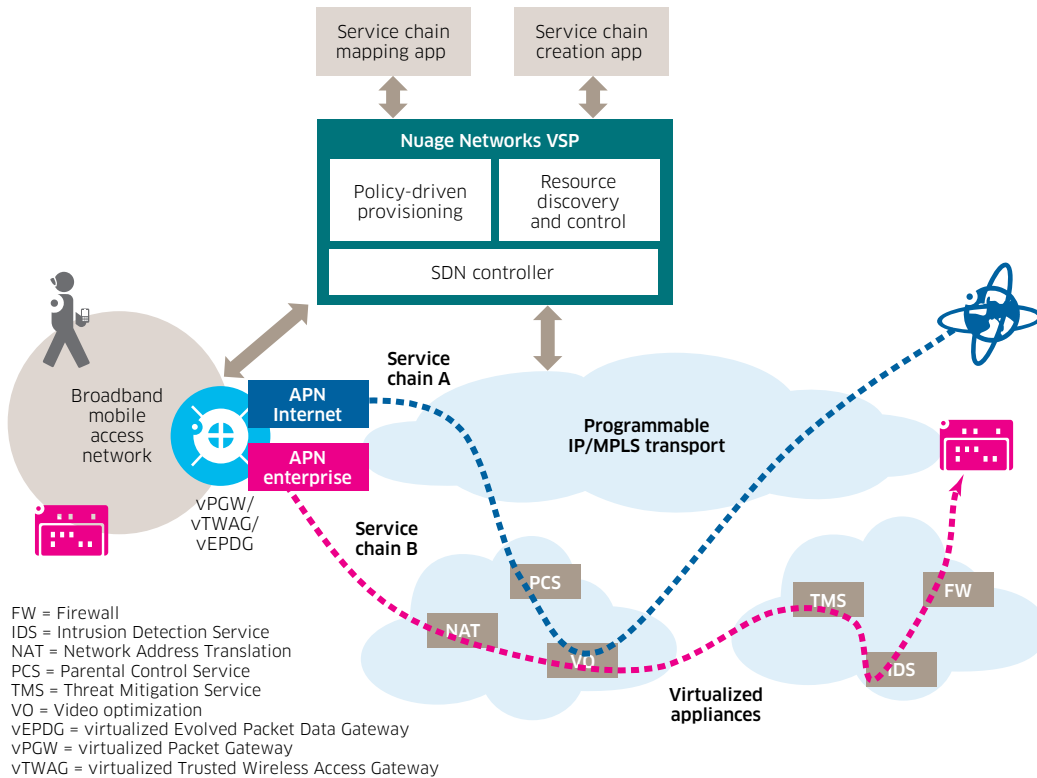
Workflow automation of the VMG and VMM is available with push-button instantiation and elasticity through the 5620 SAM working autonomously or in concert with the VNF Manager (VNFM), NFV orchestrator and SDN.

MNOs have the option to either maintain operator control or alternatively to enable auto scaling through application attribute monitoring on the 5620 SAM, such as monitoring the number of simultaneously attached users.

Another key benefit of NFV is the ability to rapidly connect multiple network functions in a pre-ordered sequence that creates a network chain to deliver customized services. These service chains extend beyond the MNO’s wireless network (SGi/Gi) and include additional network functions such as Intrusion Detection Services (IDSs), firewall (FW) capabilities, Network Address Translation (NAT) and video optimization that could be deployed as NFV applications or dedicated appliances.

Software defined networking (SDN) technology, such as the Nuage Networks VSP, can automate the service function chaining process and optimize the network path to deliver customized services (see Figure 6).

Figure 6. Alcatel-Lucent service chaining example



## Operational elegance example: vPGW instantiation

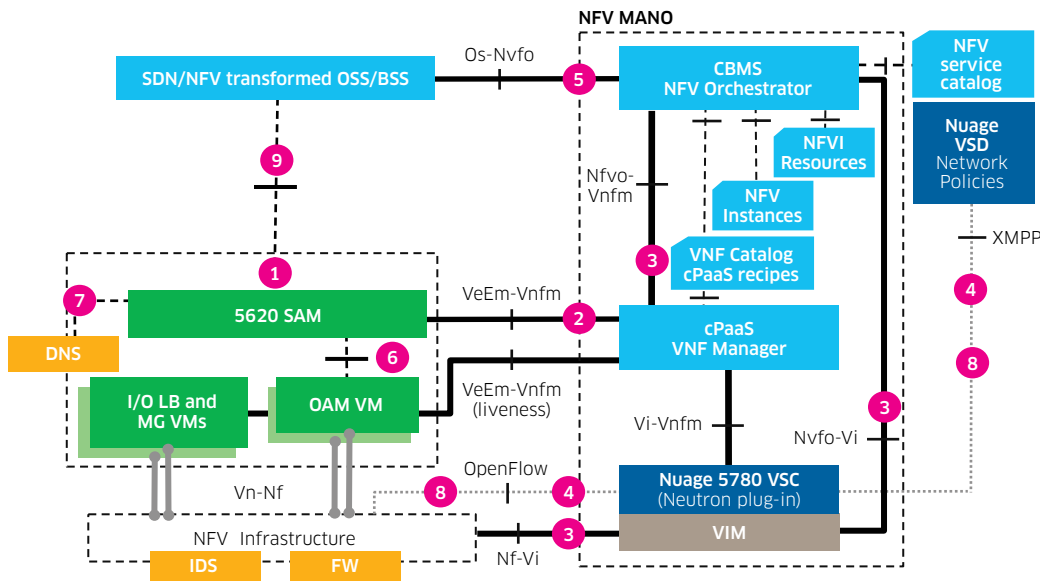
The following example demonstrates how Alcatel-Lucent has developed a complete and integrated NFV and SDN operations management solution for network function service creation. The 5620 SAM performs the role of network function orchestration to coordinate end-to-end network service deployment between the NFV Management and Orchestration (MANO) and SDN.

To deploy a dedicated virtualized PGW (VMG-PGW) in response to a new enterprise customer service request, the following steps would be performed (see Figure 7).

1. In an operator controlled NFV process, the MNO creates and configures an enterprise VMG-PGW using the 5620 SAM GUI.
2. The 5620 SAM, as the network function orchestrator, sends a VMG-PGW instantiation request to the VNFM through VeEm-Vnfm.
3. The NFV Management and Orchestration system (MANO), in coordination with the 5620 SAM, automatically creates the VMG-PGW VMs (OAM, Input/Output Load balancer, Mobile GW) based on VNF Descriptor carrier Platform as a Service (cPaaS) instantiation recipe, and download and boot software images.
4. The NFV MANO, together with the SDN controller, automatically creates the VMG-PGW VMs connectivity based on Virtualized Link Descriptor (VLD) network policies.
5. The NFV Orchestrator indicates successful VMG-PGW creation to the OSS/BSS through Os-Nvfo and to the 5620 SAM through the VeEm-Nvfm.
6. The 5620 SAM discovers the newly created VMG-PGW and automatically provisions the VNF parameters through OAM VM.
7. The Domain Name Server (DNS) is provisioned to direct enterprise Access Point Name (APN) users to use this dedicated VMG-PGW.
8. A VMG-PGW Service Chain is automatically created, based on the VNF Forwarding Graph Descriptor in the SDN controller, to add intrusion detection and firewall services for this enterprise vPGW.
9. The 5620 SAM indicates that the enterprise vPGW is in service through its northbound Interface to the OSS.

A new, hardware-based PGW that could typically take weeks or months for an MNO to deploy and bring into service can now be created automatically in just hours through the use of NFV, SDN and the 5620 SAM. This automation enables MNOs to quickly respond to customer service requests and to reduce the operational expense associated with bringing the VNF into service.

Figure 7. Network function orchestration example for new Enterprise VMG-PGW



### Service excellence

The Alcatel-Lucent vEPC leverages all the field-proven product software of the IP Mobile Core solution. This software is commercially deployed in the world’s largest LTE networks with over 50 million LTE subscribers currently operating on it in 2014. These large-scale deployments have led to product enhancements and features that improve the vEPC network function’s performance and enable the delivery of new services.

### Signaling control plane enhancements

In the signaling and control plane management, Alcatel-Lucent has developed smart LTE signaling capabilities in its MME that reduce the paging and tracking area management signaling load while also extending user equipment (UE) battery life. Prioritized paging for different types of services based on QoS Class Identifier information contained in the downlink network messaging improves subscriber services QoS and can reduce network signaling.

Unique subscriber session restoration capabilities preserve UE contexts when network links or an MME node fails, eliminating a flood of signaling reattaches that could result in a signaling storm and overload the HSS if not properly paced.

### Data plane enhancements

In the data plane, Alcatel-Lucent has developed mobile application assurance (AA) that is integrated into its mobile gateway function. Mobile AA performs 3GPP application detection and control (ADC) in the PGW/GGSN without the requirement of external appliances or additional equipment. It gives the MNO the ability to look into the subscribers’ bearer contexts and IP payload at the per-service application level (layers 4-7) to apply appropriate policy enforcement and deliver predictable performance even during network congestion.

With its ability to identify and charge for individual packet flows, mobile AA enables the MNO to easily create new services and service bundles with flexible business logic from a simple operations interface. Because these capabilities are built into the mobile gateway, there is a coupling of bearer-level control with application level control all from the same network enforcement point, thus guaranteeing charging simplicity and accuracy.

Since the mobile gateway also supports both trusted and untrusted wireless (Wi-Fi) access, the MNO is guaranteed that subscriber charging for services across access networks is accurate and consistently applied to its customers.

## **Packet processing**

The vEPC application software in each of the VNFs has been design-optimized to take advantage of the advancements in NFV and SDN technologies. For example, packet acceleration techniques such as the Intel® Data Plane Development Kit (DPDK) and Single Root-Input/Output Virtualization (SR-IOV) have been incorporated into the user data plane virtualized network function components to increase throughput capacity and packet processing performance.

## **High availability**

High availability and reliability are provided at both the VNF and VM level. Features such as in-service software upgrades and hot standby failover capabilities that are inherent to the IP Mobile Core software are supported on the vEPC. For example, stateful 1 + 1 VM redundancy in addition to the stateful geo-redundant VNF redundancy are supported.

The ability to rapidly recover from VNF and VM failures to reduce mean time to repair is greatly improved through a combination of inherent EPC functional software together with NFV life cycle management and orchestration features.

Because the EPC software code is derived from a common base, all of the features and capabilities of this software are available for deployment in a virtualized operating environment. Each software release has undergone rigorous acceptance testing from multiple Tier 1 MNOs, ensuring consistency in delivering services and network operations management.

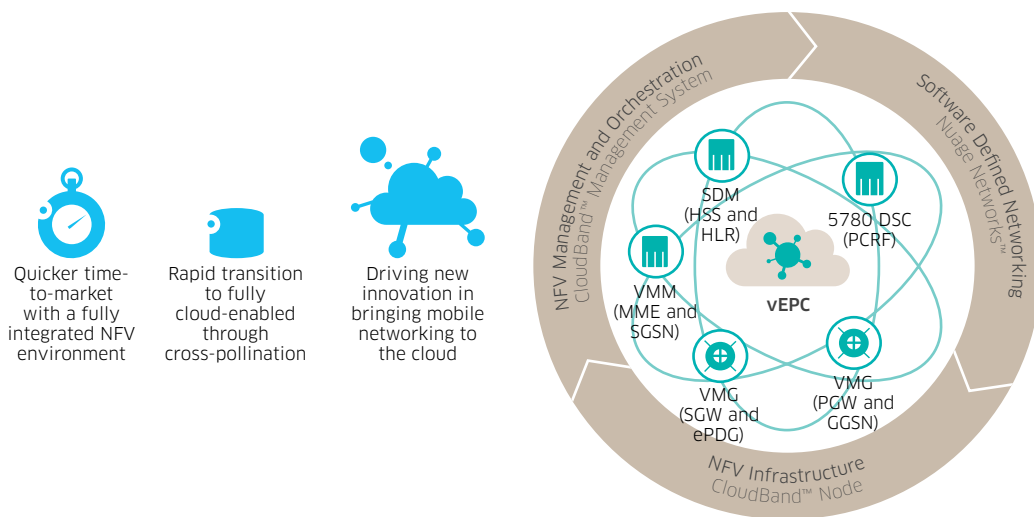
# **ALCATEL-LUCENT END-TO-END VEPC NFV AND SDN SOLUTION**

Alcatel-Lucent offers its vEPC application software stand-alone which gives the MNO the freedom to deploy it using their own NFV and SDN platforms. Alternatively, Alcatel-Lucent also can provide a complete, end-to-end vEPC NFV and SDN solution (see Figure 8). This integrated solution consists of:

- vEPC network functions software
  - Field-proven in large-scale networks
  - Feature parity and consistency with the physical, hardware-based products
- CloudBand Management System
  - VNF and VM life cycle management
  - NFV orchestrator with overall coordination and adaptation role between distributed NFVI and the EMS/NMS

- Nuage Networks VSP
  - Intra- and inter-VNF network connectivity
  - Inter-NF service chaining across virtual and physical network functions and across VNF network interfaces
- 5620 SAM
  - Network function life cycle management for both physical and virtual functions
  - Service-aware coordination and assurance across multiple physical and network functions
- CloudBand Node™
  - HP-based COTS hardware
  - Multi-vendor, open source software (Red Hat® Enterprise Linux®, KVM [Kernel-based Virtual Machine], OpenStack)
  - Monitoring and operations software

Figure 8. Alcatel-Lucent vEPC end-to-end NFV and SDN solution



By deploying the Alcatel-Lucent end-to-end vEPC NFV and SDN solution, MNOs can reduce their time to market for new services while mitigating the risks of deploying and integrating new technologies into their existing network.

Alcatel-Lucent offers a full range of professional services to assist in making the network migration to NFV and SDN as simple as possible.



## CONCLUSION

The Alcatel-Lucent vEPC addresses all the key challenges that MNOs face when they are ready to evolve their packet core network to NFV and SDN.

The Alcatel-Lucent vEPC meets or exceeds stringent service availability and real-time performance requirements of 4G/LTE core networks. With high-availability features such as stateful failovers with hot standby and network resiliency features such as geo-redundancy, this solution can meet customer Service Level Agreements (SLAs). The vEPC software architecture is also design-optimized to take advantage of NFV and SDN to provide new protection schemes and faster recovery response times for failed functions, and to improve mean time to repair.

The vEPC operates transparently across a mix of traditional and cloud-based infrastructure. It uses the same field-proven, IP Mobile Core software of its hardware-based solution, which ensures feature parity and operational consistency. The 5620 SAM manages both options, providing a uniform and consistent operations view across the hybrid network.

The vEPC software can operate on any NFV infrastructure hardware and virtualization layer software. It is agnostic to the NFV cloud management and orchestration system and the SDN controlling it. This gives MNOs the maximum choice in designing and architecting their NFV and SDN networks with their preferred suppliers. Alternatively, Alcatel-Lucent can provide a complete NFV and SDN vEPC solution with its award winning CloudBand and Nuage Networks platforms. This gives an MNO the option of quickly deploying a pre-integrated vEPC solution that supports a multivendor, open environment.

New services and the ability to dynamically modify or change them are provided through the vEPC software together with the 5620 SAM. Together, they deliver event-driven, flexible service and capacity instantiation and scaling. The 5620 SAM provides the vEPC network function coordination and the management interface to the NFV platform. Virtual EPC network function creation, modification or removal is either operator controlled or automated in coordination with the life cycle and NFV orchestration manager.

The Alcatel-Lucent vEPC delivers on the promise of NFV and SDN.

For more information the Alcatel-Lucent IP Mobile Core solution, go to <https://www.alcatel-lucent.com/solutions/ip-mobile-core>

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## ACRONYMS

2G/3G/4G	second-generation/third generation/fourth generation
3GPP	3rd Generation Partnership Program
5620 SAM	Alcatel-Lucent 5620 Service Aware Manager
5780 DSC	Alcatel-Lucent 5780 Dynamic Services Controller
7750 SR	Alcatel-Lucent 7750 Service Router - Mobile Gateway
9471 WMM	Alcatel-Lucent 9471 Wireless Mobility Manager
BSS	Business Support System
COTS	commercial off-the-shelf
cPaaS	carrier Platform as a Service
EMS	Element Management System
EPC	evolved packet core
ePDG	Evolved Packet Data Gateway
FCAPS	Fault, Configuration, Accounting, Performance and Security
FW	firewall
GGSN	Gateway GPRS Support Node
GPRS	General Packet Radio Service
HLR	Home Location Register
HSS	Home Subscriber Server
I/O	input/output
LB	load balancer
LTE	Long Term Evolution
M2M	machine-to-machine
MANO	Management and orchestration
MG	mobile gateway
MM	mobility manager
MME	Mobility Management Entity
MNO	mobile network operator
MPLS	Multi-Protocol Label Switching
NAT	Network Address Translation
NFV	network functions virtualization
NSC	network service chaining
NSP	Network Services Platform
NMS	Network Management System
OAM	Operations, Administration and Maintenance
OS	operating system

PCRF	Policy and Charging Rules Function
PGW	Packet Data Network Gateway
OSS	Operations Support System
QoS	Quality of Service
SDN	software defined networking
SGSN	Serving GPRS Support Node
SGW	Serving Gateway
vEPC	virtualized Evolved Packet Core
vHSS	virtualized Home Subscriber Server
vMME	virtualized Mobility Management Entity
VoLTE	Voice over LTE
vPCRF	virtualized Policy Control and Charging Function
vPGW	virtualized Packet Data Network gateway
vSGW	virtualized Serving gateway
VM	virtual machine
VMG	Alcatel-Lucent Virtualized Mobile Gateway
VMM	Alcatel-Lucent Virtualized Mobility Manager
VNF	Virtualized Network Function
VNFM	VNF Manager
VPN	virtual private network
VSP	Nuage Networks Virtualized Services Platform
Wi-Fi	Wireless Fidelity