



Preparing for the Future with Virtualized EPC

Affirmed Networks* Mobile Content Cloud* offers mobile network operators the agility and flexibility necessary to keep up with traffic demand, to create, provision, and launch new services in a matter of days, and the chance to reduce overall total cost of ownership by as much as 67 percent.¹



**Hewlett Packard
Enterprise**



Executive Overview

What if mobile network operators (MNO) could keep up with burgeoning network traffic, cost effectively launch new services, and still reduce total cost of ownership? Affirmed Networks* Mobile Content Cloud* enables all that and more. A virtualized evolved packet core (vEPC) solution, the Mobile Content Cloud is qualified on the Hewlett Packard Enterprise (HPE) Helion* OpenStack* Carrier-Grade platform.

Through clustered virtual network functions, independent scaling of the user-plane (I/O capacity) and the control-plane (session capacity), and service functions chaining, the Mobile Content Cloud offers a unique level of elasticity and flexibility.

Affirmed Networks has crafted a compelling vEPC offering that provides the performance mobile network operators need along with unbounded scalability and the proven compatibility required for future upgrades in a rapidly changing market. In collaboration with Intel and HPE*, Affirmed Networks deploys the Mobile Content Cloud on the HPE* NFVI platform based on Intel® architecture to increase service agility and improve capacity planning on mobile networks. Affirmed and HPE VNF portfolio complement and a complete end to end software solution is available using the elements from the partners.

In Search of More for Less

Mobile network traffic is skyrocketing. For example, traffic on AT&T's* national wireless network grew approximately 1,000x between 2007 and 2014. Mobile network operators (MNOs) must find a way to cost effectively keep pace with this traffic, while at the same time launching new services that drive new revenue streams.

Traditional approaches to adding capacity and services, however, fail on two fronts: network buildout using purpose-built physical hardware is expensive, and deploying new services on such hardware can take two to three years—time MNOs cannot afford.

Recognizing the pitfalls of physical build out, forward-looking MNOs are increasing capacity and launching new services through network function virtualization (NFV). This virtualized approach can reduce capital expenses through the use of standard commercial off-the-shelf hardware. Virtualized network infrastructure can also reduce operating expenses due to centralized management and orchestration (MANO).

“When it comes to network functions virtualization (NFV) and software defined networking (SDN), it is no longer a question of “if,” but rather “how” and “when.””

Consumer Broadband, Machine-to-Machine, or MVNO: NFV Makes Sense in Any Situation

Three evolved packet core (EPC) use cases—consumer broadband services, machine-to-machine (M2M) communications, and mobile virtual network operator (MVNO)—illustrate how NFV can transform network architecture and the way MNOs do business.

- **Consumer Broadband.** In this use case, a Tier 1 mobile operator supports millions of subscribers. The number of subscribers is expected to grow by about one-third over the next five years, while throughput is expected to double every two years. For consumer broadband traffic, throughput is the most important metric of performance.
- **Machine-to-Machine Communications.** Due to the emergence of the Internet of Things, M2M traffic is expected to significantly increase over the next five years. M2M communication network needs differ from consumer broadband needs. In particular, M2M communication performance is affected by number of sessions and the amount of signaling supported.
- **MVNO Deployments.** With a new generation of MVNO deployments, these networks are requiring faster and cheaper entry into the market, a portfolio of ready-to-go services, and real-time control with network analytics. As demand increases, MVNOs need to meet various challenges such as the time and cost of connecting to the MNO, the ability to scale up business, and the demands for new service requests.

Open and Interoperable Virtualization Solutions for the New Wireless Era

Delaying the move to NFV can cost MNOs millions of dollars in unnecessary capital and operating expenses. The good news is that there is already a proven NFV solution available from Affirmed Networks, called the Mobile Content Cloud*. This solution has a growing customer base with over 60 commercial customers, with millions of subscribers already accessing services through this virtualized EPC software platform. Affirmed Networks' Mobile Content Cloud has recently been qualified on the HPE Helion OpenStack Carrier-Grade platform. New customers can immediately begin to deploy the Mobile Content Cloud on that qualified NFV infrastructure (NFVI).

The Affirmed Mobile Content Cloud is a flexible, scalable, carrier-class virtualized solution that includes multiple industry-leading innovations that can bring new services to market faster, reduce the cost of creating and launching these services, and improve customer quality of experience with right-sized capacity in the network.

Affirmed Networks was doing NFV before the term was even defined. That means that the Affirmed Mobile Content Cloud reflects years of experience. Here are just a few of the benefits from using the Mobile Content Cloud:

- **Elasticity**, including independent scaling of session, I/O, and signaling dimensions. Scaling along different dimensions enables operators to avoid over-investing in capacity (see the next section for more details).
- **High performance** from Single Root I/O Virtualization (SR-IOV) and Data Plane Development Kit (DPDK) with 10/25/40 Gigabit Intel® Ethernet 700 Series and Intel Ethernet 500 Series Network Adapters. Mobile Content Cloud performance will scale linearly with each Intel® Xeon® processor when core count and/or clock rate increases.
- **Cost savings** by eliminating the need for manual operations, lowering energy costs, simplifying vendor interactions, and reducing the need for traditional capacity planning functions while enabling faster turn-up of services and utilizing less resources. ACG Research has estimated that the five-year cumulative total cost of ownership (TCO) of a virtualized solution running on commercial off-the-shelf hardware can be as much as **67 percent lower than that of a traditional proprietary solution**.¹
- **Intelligent and efficient analytics** with the Affirmed Virtual Probe (vProbe), the industry's only virtual probe that is co-located with VNFs that can dramatically reduce hardware costs, network complexity, and the performance issues typically associated with a probe solution while providing real-time network intelligence.
- **Business agility** through Affirmed Networks' Service Orchestration and Function Chaining. MNOs can use an intuitive graphical user interface to bind many instances of mobile broadband functions together to create a new service. Using Service Orchestration, MNOs can design, test (with real-time traffic), and deploy many new services in a matter of hours.
- **Flexible deployment model** that supports single or multiple packet core and Gi-LAN elements. For example, a virtualized network element may contain multiple service instances such as the GGSN, PGW, and SGW, or each network function might be deployed in its own virtualized network element. This approach provides the MNO with greater flexibility in terms of deploying and scaling individual or combined network elements. In each scenario, the Affirmed Networks architecture enables the MNO to dynamically or statically scale in and out, based on the demand of a function and the required capacity.

Affirmed Mobile Content Cloud* Solution Architecture

Three important aspects of the Mobile Content Cloud* architecture (see Figure 1) differentiate it from other NFV solutions on the market, as described in the next three sections.

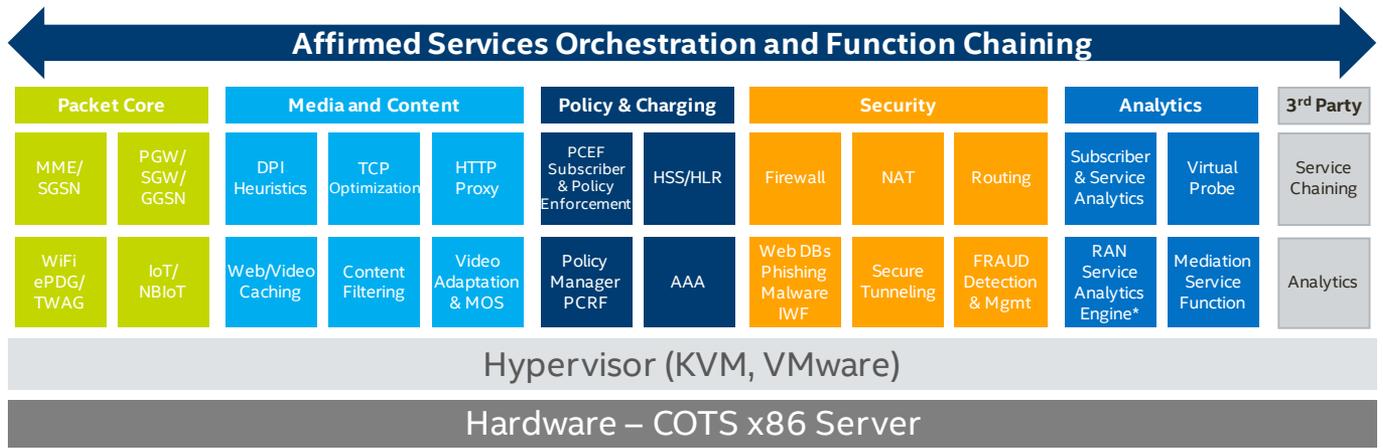


Figure 1. Solution architecture for Affirmed Networks* Mobile Content Cloud*.

Mobile Content Cloud complies with the European Telecommunications Standards Institute (ETSI) NFV architectural framework, providing a turn-key NFV reference solution with open interfaces for quick integration. As shown in Figure 2, the Affirmed Element Management system (EMS) and VNFs can coexist with secondary EMS and VNFs provided by other vendors' products.

ETSI Architectural Framework

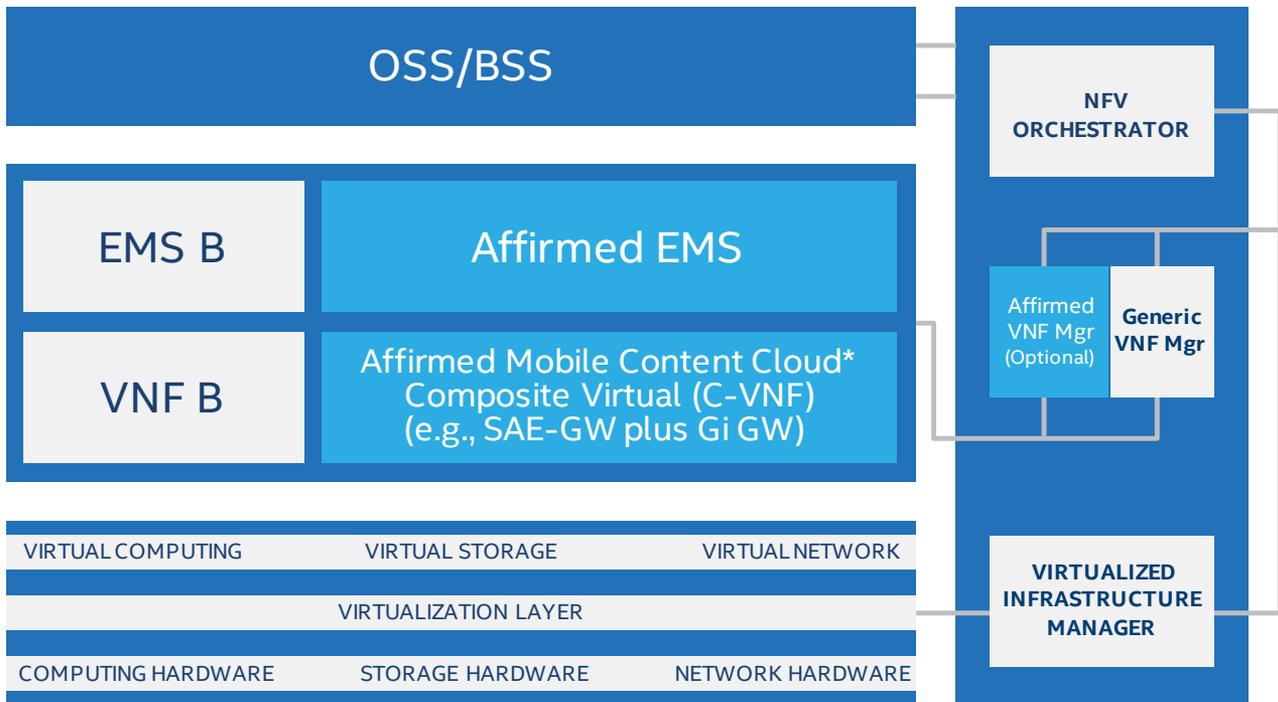


Figure 2. How Affirmed Networks* Mobile Content Cloud* fits into the framework. OSS/BSS: operations support system / business support system, EMS: element management system, VNF: virtualized network function.

Composite VNFs

The Mobile Content Cloud uses a clustered approach for virtual network functions (VNFs). That is, instead of numerous independent VNFs, it collapses many VNFs into a cluster of dynamically scalable and specialized virtual machines (VMs). License keys in the architecture enable an MNO to enable individual VNFs within the cluster, according to need, while the cluster itself is a single managed entity.

Combining multiple VNFs into a composite VNF provides the following benefits:

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- Packets are input, classified, processed, and output by a single network element rather than multiple network elements.
- Metadata is shared among the VNFs. For example, the IMSI, MSISDN, IMEI, and cell ID are advertised to all VNFs for incorporation into local policy, header enrichment, and so on.
- Deep packet inspection (DPI) is performed once and its conclusions are advertised to all VNFs.
- Independent Scaling of GGSN, PGW, SGW, and Wi-Fi Gateway (ePDG and TWAG).

Independent Scaling and Elasticity

Provisioning for peak capacity is a waste of resources. Yet, with legacy EPC systems, MNOs are forced to do so in order to avoid running out of capacity during usage spikes. In contrast, virtualized EPC solutions, such as the Affirmed Mobile Content Cloud, enable scaling dynamically—in or out—as needed. And yet, all scaling is not created equal. Most vEPC solutions lump “capacity” into one large bucket. In reality, different use cases require different dimensions of scaling.

M2M communications, for example, may need to scale sessions and signaling, while consumer broadband performance is affected by throughput. The Affirmed Mobile Content Cloud offers a flexible architecture that allows targeted scaling to increase capacity per call model dimension—so MNOs can accommodate changing workloads without having to over-invest in capacity. Different elements like signaling, proxy, content, and other service VMs can scale independently as needed, and per service function. With the Affirmed Mobile Content Cloud, MNOs can quickly and seamlessly modify capacity for only the required dimension.

Adaptability to Different Service Models

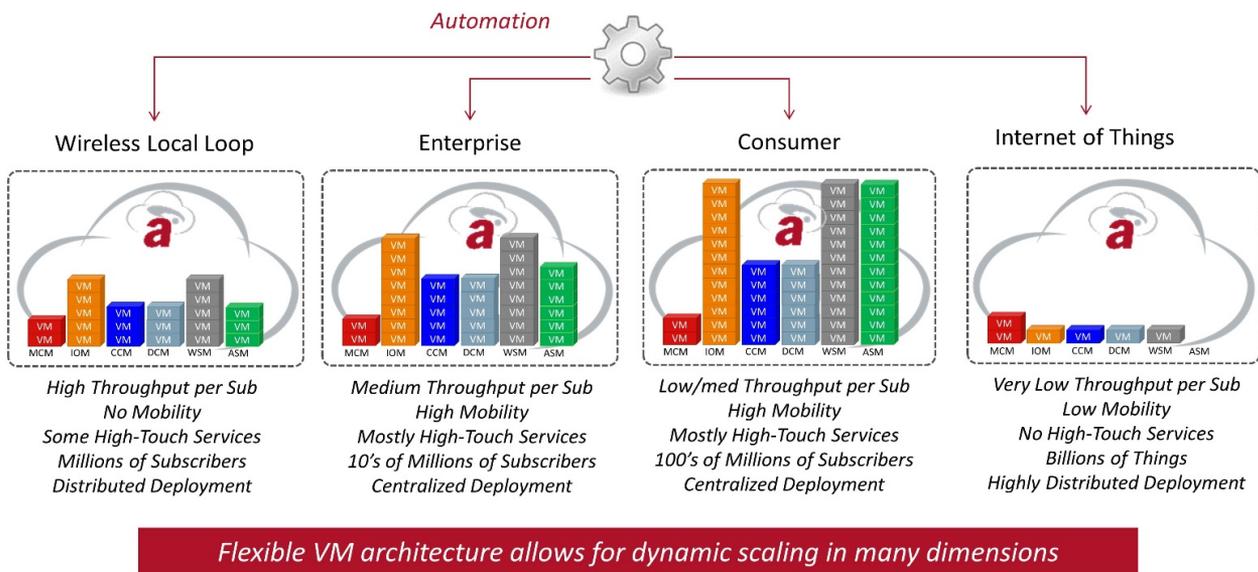


Figure 3. Flexible VM architecture allows for dynamic scaling in many directions.

Affirmed Solution Portfolio

DPI and Value Added Services

The Affirmed Mobile Content Cloud provides integrated deep packet inspection (DPI) and media and content services such as web and video optimization, content filtering, and security services such as subscriber firewall and NAT.

Services Workflow Orchestration

The Affirmed Mobile Content Cloud also features a unique Services Workflow Orchestration framework that provides subscriber classification and functions chaining—allowing MNOs to “stitch together” subscriber-specific services (also called workflows) in minutes instead of the months-long process typical of legacy silo architectures. Figure 4 illustrates the Services Workflow Orchestration framework.

The Services Workflow GUI is easy to use and allows services to be created with just a few clicks and drag-and-drops to segment the subscribers, select the appropriate control profile, and chain the desired functions. A newly created workflow can be evaluated by injecting traffic into it, be compared with existing workflows, and be initially applied to only a few selected friendly users (such as the marketing team) to test the services before network-wide deployment.

Affirmed Services Workflow Orchestration

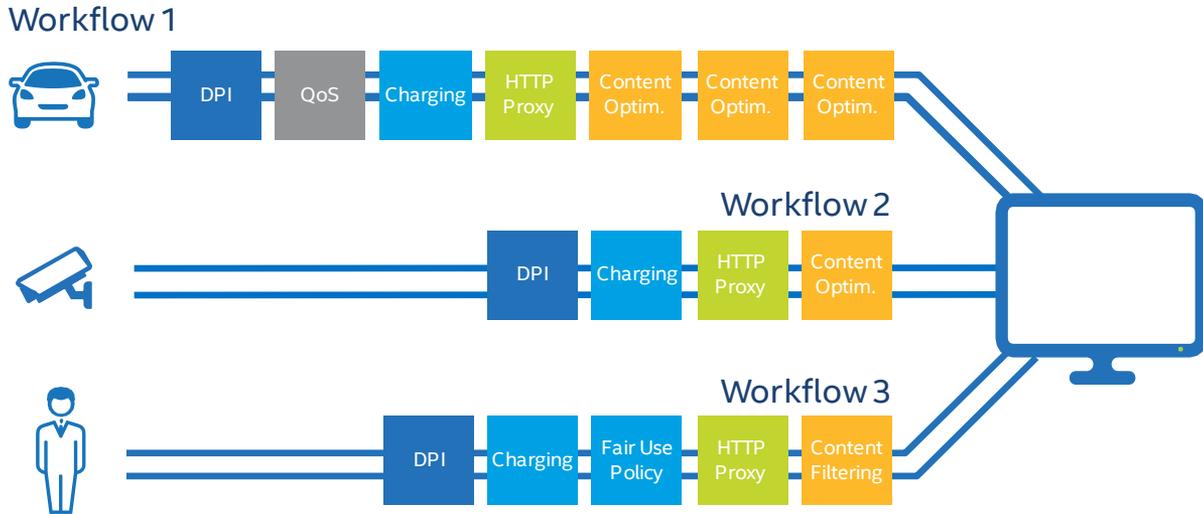


Figure 4. The Affirmed Services Workflow Orchestration framework enables fast and easy creation of services. QoS: quality of service, MVNO: mobile virtual network operator, Optim: optimization, Adapt: adaptation.

Virtual Probe (vProbe) and Analytics

With more traffic, more devices, and more competition, MNOs need less complexity and cost in their networks, which fuels the migration to network virtualization. And as the mobile industry moves to NFV, traditional network measurement and monitoring tools are left behind. With virtualized elements comes the need for a virtual probe. Affirmed vProbe is the industry's first native virtual probe, co-located with the Affirmed's Mobile Content Cloud vEPC and Wi-Fi Solutions rather than delivered as a separate network appliance.

- Co-locating the vProbe reduces hardware requirements and network complexity, which lowers the total cost of ownership by 50% or more
- vProbe creates Intelligent Event Data Records (iEDRs) in real time from flow and transactional data. iEDRs provide 100% network and subscriber visibility in correlated data records so operators can identify target areas in the network that require packet mirroring for a deeper analysis.
- Provides open access to session information using Google's* standards-based Protobuf to create data records that can easily be integrated with a variety of third-party analytics tools to deliver real-time insight into network operations, network security, network planning, marketing activities, and more.

Affirmed Virtual Probe and Analytics

Integrated Probe for Real Time Analytics in a Virtualized Architecture

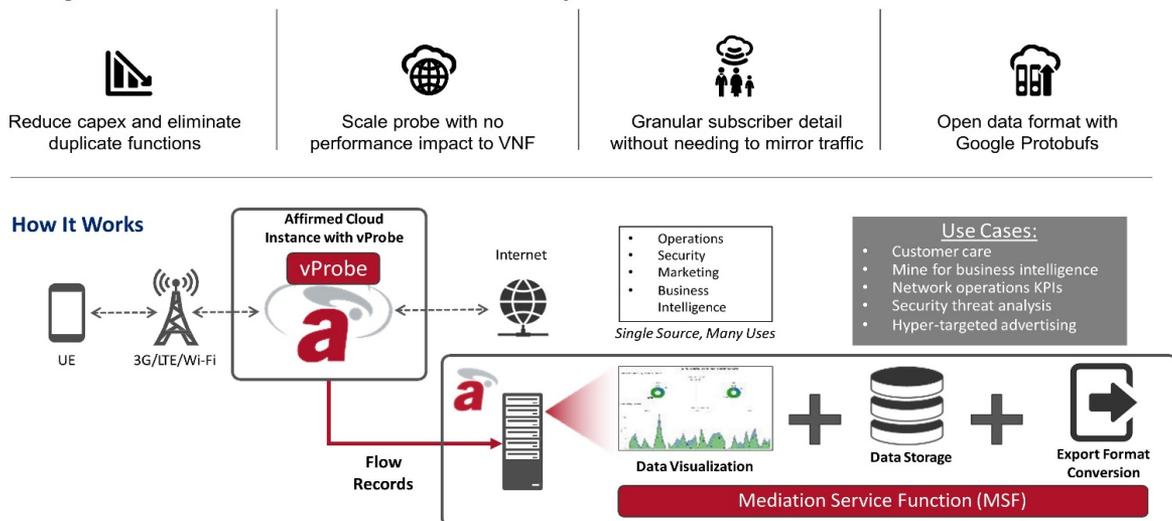


Figure 5. Integrated probe for real-time analytics in a virtualized architecture

Virtualized Wi-Fi Gateways

Access to Wi-Fi networks has become increasingly important to fixed and mobile service providers as they look to compete against over-the-top (OTT) applications, monetize Wi-Fi traffic, and cost-effectively grow their network coverage. Today, more than half of all mobile traffic is carried over Wi-Fi networks and, in a few years, analysts expect that number to reach as high as 80 percent. Wi-Fi provides an inexpensive way for service providers to offload the growing volume of video, voice, and data traffic in their own networks. VoWi-Fi provides mobile operators a way to improve indoor coverage and overall subscriber experience. However, in order to extend network services into Wi-Fi communications, service providers need to implement secure gateways between Wi-Fi networks and their core network.

- Trusted Wi-Fi Networks: Trusted WLAN Access Gateway/Proxy (TWAG/TWAP)
- Untrusted Wi-Fi networks: The evolved Packet Data Gateway (ePDG)

As part of its Mobile Content Cloud platform, Affirmed offers fully virtualized TWAG/TWAP and ePDG solutions that enable service providers to safely bring Wi-Fi communications into their core network. Each gateway is ETSI NFV compliant, enabling fixed and mobile network operators to confidently extend core network capabilities such as policy enforcement and AAA (authorization, authentication, accounting) information into Wi-Fi sessions for value-added subscriber services.

WiFi Services



How It Works

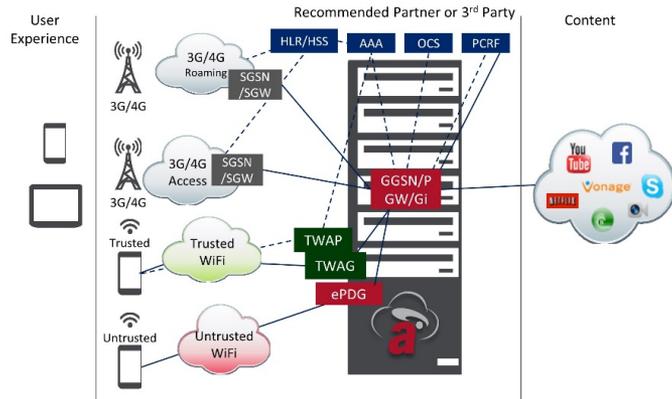


Figure 6. Affirmed's Virtualized Wi-Fi gateways

Internet of Things (IoT)

Experts predict that the number of IoT endpoints or connected devices, from cars to refrigerators to everything in between, will grow from 10.3 billion in 2014 to more than 29.5 billion by 2020. Today's networks are not designed to handle the scale and transaction rate of IoT. However, Affirmed's Mobile Core with NFV and SDN technologies provides a software-based architecture with features such as:

- Network slicing to support traffic segregation within the same infrastructure and each slice can be optimized for a specific service.
- Separation of control and user planes to support high bandwidth low latency services such as Critical IoT Services
- Support of both wideband (LTE-M) and narrowband IoT services (NB-IoT)
- Dynamic scaling that allow for a network that easily adapts to the different deployment scenarios required by IoT

NB-IoT

Affirmed has designed the Cellular IoT Serving Gateway Node (C-SGN) to match the unique characteristics and scale requirements for NB-IoT. The Affirmed NB-IoT solution provides a fully virtualized C-SGN function that combines the roles of the Mobility Management Entity (MME), Serving Gateway (SGW) and PDN Gateway (PGW) into a single solution that supports both roaming and non-roaming IoT traffic.

IoT, NB-IoT, 5G NG Core Network Slicing

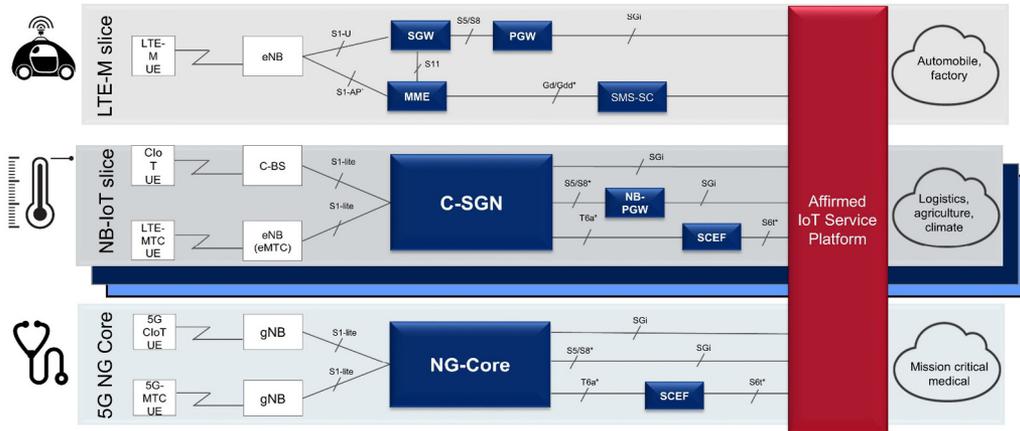


Figure 7. Affirmed IoT Solution

Service Capability Exposure Function (SCEF)

The SCEF is required to securely connect IoT devices with service provider APIs to create new, value-added services. Since these IoT connections do not need to utilize the full IP stack, they are classified as Non-IP Data Delivery (NIDD) transactions. The Affirmed SCEF scales to support millions of NIDD transactions.

5G-Ready Architecture

Over the next five to ten years, we'll see a quantum leap in technology. According to the NGMN Alliance, 5G networks will be able to support a variety of new mobile communications use cases, including faster mobile broadband access, massive Internet of Things, extreme real-time communications, ubiquitous mobile broadband access, and ultra-reliable communications. 5G trials are already underway, with some communications service providers (CoSPs) planning to deploy 5G-compatible services as early as 2017—three years before the industry expects to release its standards for 5G communications. So, even though 5G won't officially arrive for a few years, service providers need to begin transforming

their networks today for the 5G future. Fortunately, many of the requirements for 5G networks can benefit current 4G/LTE networks by reducing operating expenditures, eliminating capital expenditures, and driving more innovative (and faster) services. In order to create a 5G ready architecture, one must:

- Separate of control and user planes to support high-bandwidth, low-latency services
- “Slice” the network to support different service requirements
- Optimize the network for the Internet of Things
- Support creation of new mobile services using services workflow orchestration
- Simplify network operations and management with Service Automation

Affirmed's Mobile Content Cloud solution is a complete 5G-ready vEPC that meets all of these requirements to provide a seamless continuum that allows mobile CoSPs to solve the challenges of today and seize the opportunities of tomorrow.

5G Ready Architecture

The Industry-Leading, Fully Virtualized Mobile Packet Core

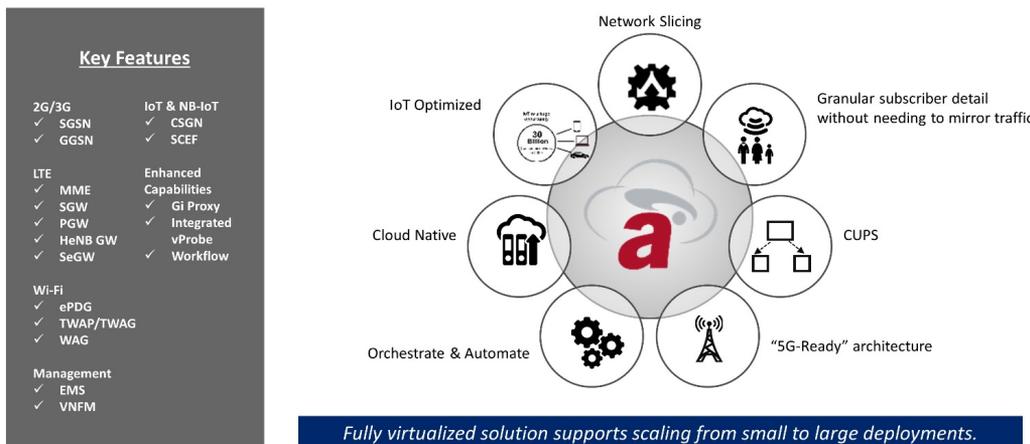


Figure 8. Affirmed's 5G ready architecture

Real-World Results for Mobile Content Cloud

Affirmed Networks Mobile Content Cloud product deployments illustrate the overall value and versatility of this solution in a wide variety of industry segments. In the following examples, Mobile Content Cloud is running on the HPE Carrier-Grade platform.

Consumer Services. Etisalat*, a global Tier 1 operator, is using Affirmed Networks Mobile Content Cloud to deliver broadband and voice services to both mobile and fixed users. They see virtualization as a way to economically spin up virtual mobile network cores for consumer, IoT, machine-to-machine (M2M), Wi-Fi calling, and smart city initiatives.

Internet of Things. TELUS*, Canada's fastest growing national telecommunications provider, uses Affirmed Networks' vEPC solution to support the delivery of their innovative IoT service offerings.

Vehicle communications. Vodafone* is using Affirmed Networks' vEPC solution to deliver M2M communications

and connected-car services over their global network infrastructure.

Embedded Device Connectivity. Transatel*, a leading enabler in MVNO and IoT, has deployed Affirmed Networks Mobile Content Cloud to support their embedded connectivity service for laptops and tablets in the United States.⁹

Mobile Virtual Network Operator. DIGITALK* selected Affirmed to enable the delivery of VoLTE and VoWi-Fi services to a growing customer base of MVNOs worldwide.

Joint HPE and Affirmed Networks vEPC Solution

The hardened, pre-integrated ETSI compliant HPE and Affirmed Networks vEPC solution is based upon a standards-based architecture that promotes an open ecosystem and facilitates rapid deployment. The figure below shows the joint HPE and Affirmed Networks vEPC solution that uses market leading components.

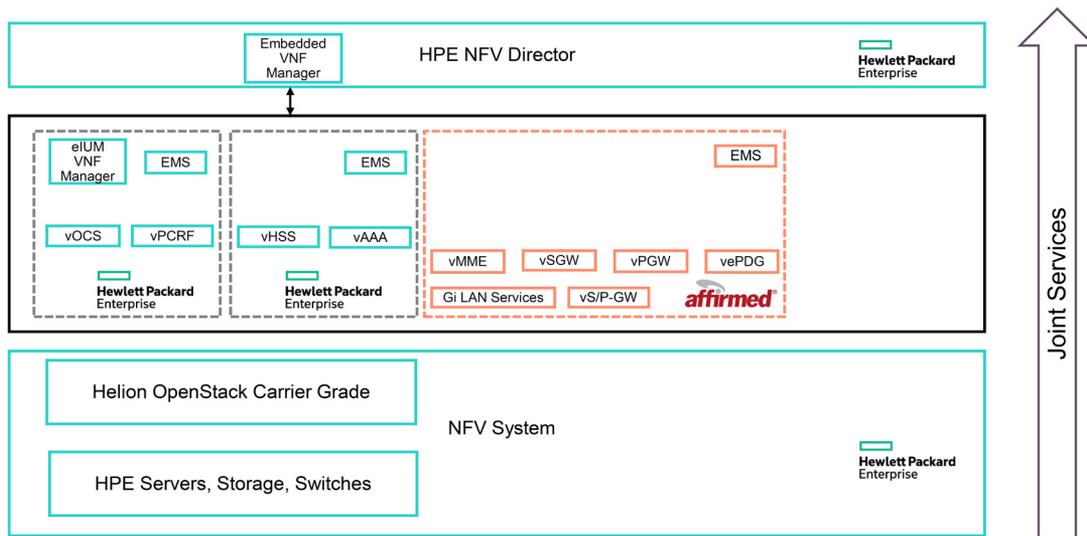


Figure 9. HPE and Affirmed Networks vEPC Solution

HPE and Affirmed Networks vEPC solution has following key differentiators:

- Pre-integrated offering
- An open modular framework that allows CoSPs choice of different VNF, if so desired
- Use of open source components (OpenStack®)
- Fully integrated with MANO layer orchestration function
- Carrier-grade performance and reliability on HPE platforms
- NFV Optimized VNFs – design, performance, reliability and scalable 3GPP functions like HSS, PCRF, AAA, OCS etc.

To learn more about the joint HPE and Affirmed Networks vEPC solution, read the whitepaper available at <http://h20195.www2.hpe.com/V2/getpdf.aspx/4aa6-8334enw.pdf>

Ecosystem Partners Deliver Innovation and Performance

With Hewlett Packard Enterprise as a technology partner, Intel collaborates closely with Intel® Network Builders members such as Affirmed Networks*. This collaborative ecosystem enables an open, flexible environment for CoSPs to make the transition to NFV on the HPE NFVI platform, which includes Intel Xeon processors, Intel Ethernet Network Adapters, and a Data Plane Development Kit (DPDK).

The Intel-HPE-Intel Network Builders ecosystem provides CoSPs with the resources to respond quickly to market demands while accelerating the overall transformation toward NFV. HPE's NFVI platform streamlines the design, proof-of-concept, trial, and deployment of new cloud-enabled network services and innovations, while lowering capital expenditures, operating expenditures, and risk. Intel is a key contributor to the HPE OpenNFV Lab testing, standards work, and the development of the NFVI platform.

Intel® Open Network Platform Reference Architecture

Intel developed an architecture platform based on the ETSI standards for NFV in an effort to accelerate development of commercial hardware and software platforms. The Intel® Open Network Platform (Intel® ONP) provides a reference architecture that redefines network architectures by decoupling the network functions from the hardware itself. This provides the Network Function Virtualization Infrastructure (NFVI) necessary to virtualize functions.

Intel ONP enables VIM and NFVI platform providers to more easily build solutions using open source software stack running on COTS servers for companies in telecom carrier networks, enterprise environments and cloud data centers. With the Intel ONP reference architecture, solution providers can plan, evaluate, and benchmark designs in advance of NFV deployments.

HPE OpenNFV* Labs

In HPE OpenNFV Labs, HPE and their partners test applications to make sure they run as expected on our reference architecture. We provide a testing center where partners can test a set of critical applications simultaneously to make sure they are ready to be deployed in carrier networks on a shared NFV infrastructure. In addition, HPE has dedicated lab facilities where we can stage NFV proof of concept projects with partners. Carriers can also conduct NFV proof-of-concept and feasibility tests for new NFV applications on our HPE NFV

reference architecture. HPE OpenNFV Labs are located in Houston, TX, Ft. Collins, CO, Grenoble France, Tel Aviv Israel, and Seoul South Korea.

Hewlett Packard Enterprise

With its unparalleled experience in IT and a long standing telecommunications expertise, Hewlett Packard Enterprise is a trusted partner to Communications Service Providers as they embark on a journey to the Telco Cloud. Recognizing that the benefits of NFV cannot be fully realized without open solutions and a robust ecosystem of partners, HPE launched its OpenNFV Partner Program for network equipment providers, independent software vendors, and system integrators. The OpenNFV Partner program is a very important part of move to create a rich, vibrant and open ecosystem of VNFs. The goal for HPE's OpenNFV program is to create a platform on which CSPs have the freedom to choose applications from their vendor of choice.

As part of the OpenNFV platform, HPE provides the NFV infrastructure (NFVI) running on HPE's converged servers; the HPE Helion OpenStack Carrier Grade which provides the virtualization layer and VIM functionality and the HPE NFV Director for NFVO (NFV Orchestrator) and in many cases VNFM functionality. This platform then acts as a foundational reference architecture on which VNFs (from HPE or from any third party partners) can be tested and benchmarked for performance.

OpenNFV Labs (located in the U.S., France, Israel, and South Korea) help partners accelerate their design, proof-of-concept, trial,

and deployment of cloud-enabled network services. The primary goal of HPE NFV Labs is to assure CSPs that solutions being proposed to them from multiple vendors are pre-tested and integrated—thereby saving them valuable time and effort in network validation during deployment.

Hewlett Packard Enterprise is committed to developing open solutions and an open ecosystem that will accelerate the CSP transformation journey to the Telco Cloud. HPE is a key contributor to open source initiatives like OpenStack, OpenDaylight Project, OPNFV and numerous other Industry initiatives and organizations.

About Affirmed Networks

Affirmed Networks was founded with a vision to develop mobile network solutions that completely revolutionize mobile networks and mobile subscriber and content management functions. Affirmed Networks helps mobile network operators say “yes” to the future with virtualized network solutions that reduce complexity and cost, scale efficiently, and accelerate time-to-market to increase their competitive advantage. Affirmed Networks delivers a subscriber management and service solutions that bundle gateway functionality with rich application and content delivery services into an industry-leading, virtualized solution.

In 2015, Forbes named Affirmed Networks in the “Next Billion Dollar” startup list, and the firm was included in Gartner's top-five “coolest companies” in the communications service provider infrastructure category.

Conclusion

Affirmed Networks Mobile Content Cloud enables a virtualized evolved packet core infrastructure that enables mobile network operators to keep up with rapid mobile traffic growth. Through a unique approach to clustered virtual network functions, independent scaling of different infrastructure dimensions, and automated workflow orchestration, the Mobile Content Cloud combines high performance with superb flexibility—empowering mobile network operators to cut costs while pursuing new revenue streams. In collaboration with Intel and HPE, Affirmed Networks deploys the Mobile Content Cloud on the HPE NFVI platform to increase service agility and improve capacity planning on mobile networks. Moreover, HPE and Affirmed Networks have collaborated closely to bring to market a pre-integrated end-to-end OpenNFV vEPC solution that can further accelerate the deployment of virtualized mobile packet core networks.

Get more information about network solutions powered by Intel, visit: <http://hpe.com/go/nfv> or <https://www.intel.com/network> or <http://www.affirmednetworks.com>.



¹ Total Cost of Ownership Study Virtualizing the Mobile Core ACG Research July 2015. The source for this statistic, and well as others cited in this solution brief, is "The Time Is Now for NFV. Immediate Cost Savings Creates Opportunity for Telcos," ACG Research, July 2015.

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