WHITEPAPER

Cloud-native 5G – Getting Started

Hewlett Packard Enterprise

Published by MOBILE WORLD LIVE

Executive summary

As they deploy 5G, telecoms operators around the world are experimenting with cloud-native core networks, which offer greater flexibility, scalability and automation than conventional telecoms networks. This paper explores how telecoms operators could go about implementing a cloud-native 5G core network. Most early movers are taking one of two approaches to deploy a cloud-native 5G core:

1. The migration approach - the operator works with its existing network equipment provider to upgrade the core network to support 5G. In this case, the operator relies heavily on the vendor and is limited to its proposition.
2. The do-it-yourself approach - the operator selects their preferred vendor network function by network function and integrates these systems in its own labs. This is a complex and time-consuming approach.

HPE is proposing a third way to provide operators with the control and flexibility inherent in the do-it-yourself approach, but with much lower costs and a much shorter implementation timeframe. In this case, the operator deploys a pre-integrated and highly-automated stack that can incorporate different network functions from different vendors and avoids vendor lock-in. HPE says its cloud-native 5G core stack can be implemented in just a few weeks. As with the traditional migration approach, the operator benefits from having a single vendor managing the process and taking responsibility for the end-to-end solution.

To reduce the technical risks and the time and the complexity of project-specific integrations and interoperability campaigns, HPE has heavily tested and validated the platform, the multi-vendor network functions and the orchestration in its own labs. The HPE 5G core stack is also sold on the basis of the number of active subscribers, which gives the operator the flexibility to scale the solution at a pace that suits its strategic objectives and market conditions.

HPE employs a continuous deployment (CD) approach both to deliver its core stack solution and to commission individual network slices. The four-step implementation process, which is highly automated and designed to keep the prerequisites to a minimum, can be deployed on a container platform cluster:

1. The preparation step, which only needs to be performed once, involves the installation of the deployment toolkit on the control node.
2. The provisioning step automates the delivery of the new software and provisions the various container images for the slice in the Docker registry, as well as the test tools, the test case, the slice descriptors and the CD framework itself.
3. The instantiation step deploys and configures the network functions that compose the common slice, along with all the backing services necessary for their execution.
4. The final testing step: Although a new slice is automatically tested end-to-end during the third step, HPE also enables test cases to be run as often as needed.

To eliminate the risk that network functions are not compatible (because they use different open-source versions, for example), HPE deploys all the network functions on a common cluster: a common environment. That approach gives the operator an end-to-end view of the lifecycle of the entire core slice and avoids the creation of silos. HPE also stresses the need for testing to go hand-in-hand with integration. Otherwise the CD process will have to be interrupted by manual interventions and many of the benefits will be lost.

Introduction

With the advent of 5G, the telecoms industry is embracing the cloud-native technologies that are delivering high-levels of scalability, flexibility and automation in the IT arena. But what will cloud-native mean for a complex and heavily regulated industry in which reliability and security are paramount? And how practical is it for established telcos with legacy networks to become fully cloud-native?

Developed by Mobile World Live in partnership with Hewlett-Packard Enterprise, this paper explores how telecoms operators could go about implementing a cloud-native 5G core network. It considers mobile operators' various implementation options, and the advantages and disadvantages of each approach. It then describes HPE's 5G core stack, how it can be integrated with technologies from other vendors and how an operator can go about deploying such a stack, before making some recommendations.

The momentum behind cloud-native networks

The telecoms industry began taking its first tentative steps towards cloudification technologies in the middle of the last decade. Many operators began experimenting with network function virtualization (NFV), separating their network software from dedicated hardware.

But NFV, which can be difficult to integrate with existing proprietary network equipment, has proven challenging for telcos to deploy. Network virtualisation reached only 6% of its total addressable market for mobile networks in 2019, according to Analysys Mason. "Traditional NFV has only partly enabled the software-isation and disaggregation of the network, and as such, limited progress has been made on cloudifying the network to date," the research firm noted in January 2021.

Now the rollout of 5G is presenting telcos with the opportunity to deploy cloud-native core networks composed of discrete microservices, which can provide operators with greater flexibility and the ability to swap out network functions for new versions or different vendors.

In addition to microservices, containers, centralized orchestration, CI/CD (continuous integration and delivery), open APIs and service meshes are all hallmarks of cloud-native telecoms networks, according to Gabriel Brown, Principal Analyst, Heavy Reading. "By modernizing their core network infrastructure, operators can achieve greater automation, new scaling and resiliency models, and new methods of network and service orchestration," he noted in July 2020. "The industry is making rapid progress to the cloud-native architecture…. In the case of advanced operators in progressive markets, this transition will be very fast. The infrastructure stack is increasingly mature and hardened, and operators are quickly gaining the skills and operating know-how required to run 5G cores on these platforms."

Analysts generally expect cloud-native 5GC deployments to scale rapidly from 2021 onwards. In January 2021, Analysys Mason said the telecoms industry is now entering a new phase of "network cloudification". This shift "will require radical changes to the way in which networks are designed, deployed and operated," the research firm added. "Large-scale, mainstream 5G SA core deployments will begin in 2023 and will use mostly cloud-native technologies."

To date, most 5G deployments have relied on a 4G core, limiting their capabilities. In December 2020, Chris Nicoll, Principal Analyst, Omdia, said he expects "5G core deployments to pick up speed in 2021… The impact of COVID-19 and the shift to distributed network services expand the use case for standalone's network slicing and lower latency services."

The changing vendor landscape

The telecoms industry's growing interest in cloud-native technologies is opening up opportunities for operators to broaden their supplier base. They are increasingly working with vendors that have proven their cloud expertise in the IT arena, as well as longstanding telecoms equipment suppliers.

Many analysts expect the introduction of cloud technologies to bring about major changes in the vendor landscape. "The shift to telecoms networks based on open and virtualised tech will help operators pick solutions from multiple vendors without lock-in," wrote GSMA Intelligence in 2020. "This presents a chance for challenger vendors to gain market share, particularly if early movers (such as Rakuten) are able to successfully demonstrate the advantages of this new approach. In turn, this will require traditional vendors to design products to be modular with open interfaces to allow easier integration."

Rather than simply buying a monolithic core network solution from a single vendor, operators now have a "second option of telco cloud deployment—the multi-vendor approach, in which different network equipment vendors are responsible for different components of the telco," noted ABI Research in November 2020.

The different approaches to deploying cloud native networks

Today, most telcos are taking one of two approaches to deploying a cloud-native core for their 5G networks. The first approach – the migration approach - involves a 4G operator working with its existing network equipment provider to upgrade the core network to support 5G. In this case, the vendor would generally deploy its own proprietary tools and would manage the integration with the existing network in line with a service level agreement.

This migration could be completed in a matter of weeks, depending on how adept the vendor has become at upgrading its systems and the complexity of the existing deployment. From the operator's perspective, this is a straightforward option - the vendor takes full responsibility for upgrading the network.

However, there can be downsides to this approach. For the operator, the

key drawback may be the lack of control, which manifests itself in limited options and limited choice – the operator can only employ network functions offered by the vendor. Moreover, once the migration is complete, the operator's network can only evolve at the same pace as the vendor's solution. "If there is a feature that you need, you will be dependent on your vendor to provide this feature," notes Pierre Lavillat, 5G core stack & 5G global practice manager, at HPE. "If it is available, you are lucky, if not, well you are in trouble."

The second approach, which tends to be specific to the big operators in the US and Europe, is for the operator to select their preferred vendor network function by network function. After making these choices, the operator integrates the network functions of the different vendors in their own labs. This so-called best-of-breed approach is both ambitious and time-consuming, but it does allow operators to build exactly the network they want.

"We are engaged with a major US operator in this approach and we can tell you that it takes at least six months to one year to do all the integration of the different network functions," notes Pierre Lavillat of HPE. "Once it's done, you have full freedom…. you can decide to replace a network provider with another one … you can implement the CI/CD process and you can deploy a new release anytime you want basically on the monthly basis."

But recognising that many operators don't have the resources or the technical knowhow to follow this kind of do-it-yourself approach, HPE is proposing a third way that aims to deliver similar benefits, but at less expense and in less time. In this case, the operator deploys a pre-integrated stack that can incorporate different network functions from different vendors – the operator still has choice. Moreover, the telco should be able to evolve the core network at its own pace: HPE aims to provide the operator with a highly automated platform-as-a-service solution that can be continuously upgraded.

Figure 1: Summary of telcos' principal options for 5G core deployment

The old way	Do-It-yourself	Pre-Integrated Modular Stack
Evolve your existing network using the same processes and suppliers	**Use in house capabilities and assembling best of breed components**	**Leverage cloud native design, with pre-integrated standard aligned functions**
+ Limit technical and financial risks + Keep one throat to choke + Limited impact on processes and methodologies – Limited options – Risk of vendor lock-in – Slower innovation	+ Maintain full control + Avoid vendor lock-in – Need massive in-house skills, and enablement in new technologies – High technical and financial risks – Can lead to a proprietary solution	+ Limit technical and financial risks + Keep one throat to choke + Avoid vendor lock-in + Pick the best vendor for any NF, now and for future use cases. – Evolution of processes and methodologies

"We do the integration in our lab and we package it in a fully automated way and this allows the benefits of the do-it-yourself approach, because it's multi-vendor and there is a choice in terms of network functions that are included, but it has also the risk avoidance benefits of the traditional approach because it's fully automated and it's already pre-tested," explains Pierre Lavillat of HPE. "The effort is as complicated as what you can do as an operator – we have been doing it for more than one year. But the operator can deploy something that is pre-packaged and fully-automated within just a few weeks and installed even faster than that."

As with the traditional migration approach, the operator benefits from having a single vendor managing the process – one throat to choke – if anything goes wrong. However, to adopt HPE's solution, operators will, of course, have to be prepared to move away from their legacy vendors and evolve internal tools and processes.

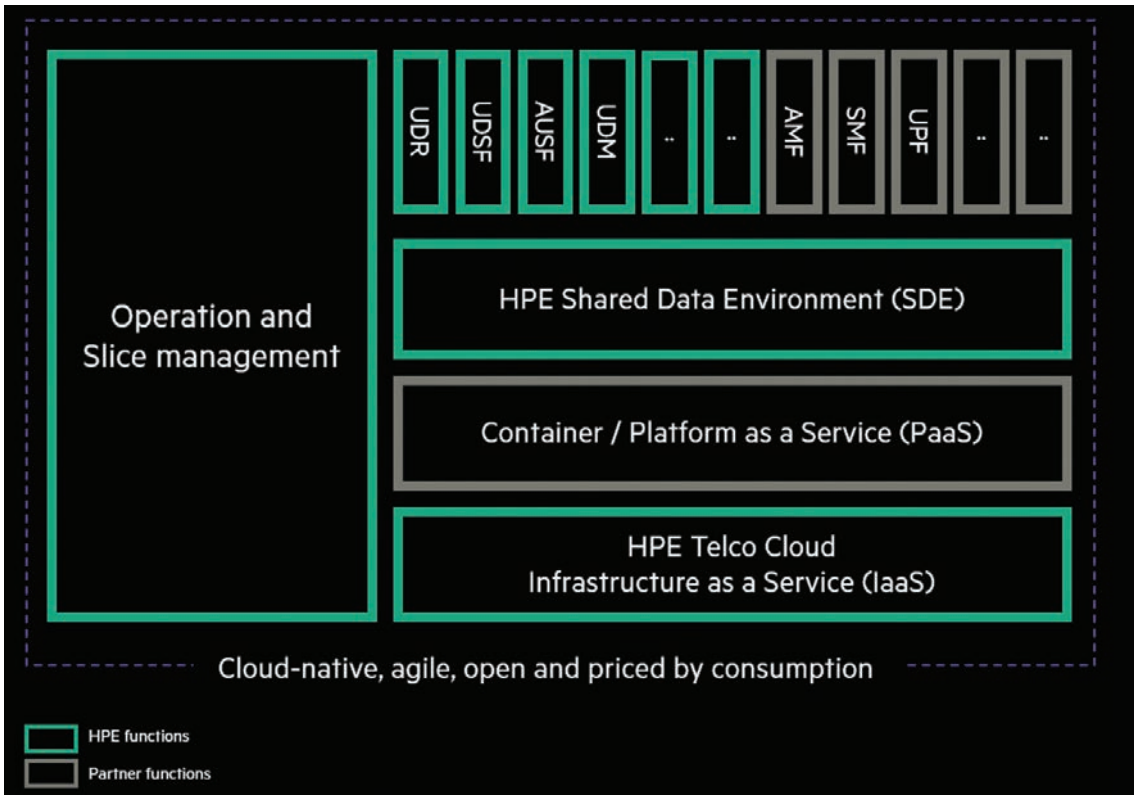
About HPE's cloud native 5G core stack

HPE's pre-integrated and modular 5G core stack is designed to be both fully cloud-native and open. It was developed from scratch. "We realized a couple of years ago that to gain the benefits of 5G, we would need to redesign our 5G core offering from the ground up to be cloud-native and open (rather than refactoring existing software, as some of the other 5G vendors are doing)," explains Sebastien Klahr, 5G core stack product manager at HPE.

HPE's overarching goal was to minimise the business and technical risks associated with managing the complexity of a modular and multivendor solution. To reduce the technical risks, it has heavily tested and validated the platform, the multi-vendor network functions and the orchestration in its own labs.

From a commercial perspective, the HPE 5G core stack is sold (and priced) on the basis of consumption: customers can consume a core slice based on the number of active subscribers. That gives the operator the flexibility to scale the solution at a pace that suits its strategic objectives and market conditions.

Figure 2: A high-level view of HPE's pre-integrated and modular 5G core stack



The HPE 5G core stack is underpinned by infrastructure based on HPE Telco Blueprints - validated and pre-integrated deployment-ready hardware and software platform for the network functions. HPE describes this optimized cloud infrastructure as telco grade, secure, scalable and performance-tuned commercial-off-the-shelf (COTS) hardware.

The next layer up - the platform as a service - uses a container platform, such as Red Hat OpenShift, to manage the workloads. Running on top of that is the shared data environment, which enables the 5G services and network functions to be managed as stateless cloud services, which means they can be scaled quickly. Both the network functions from HPE and its qualified partners employ lightweight microservices to support end-to-end automation and orchestration, thereby enabling agility and reducing operational costs.

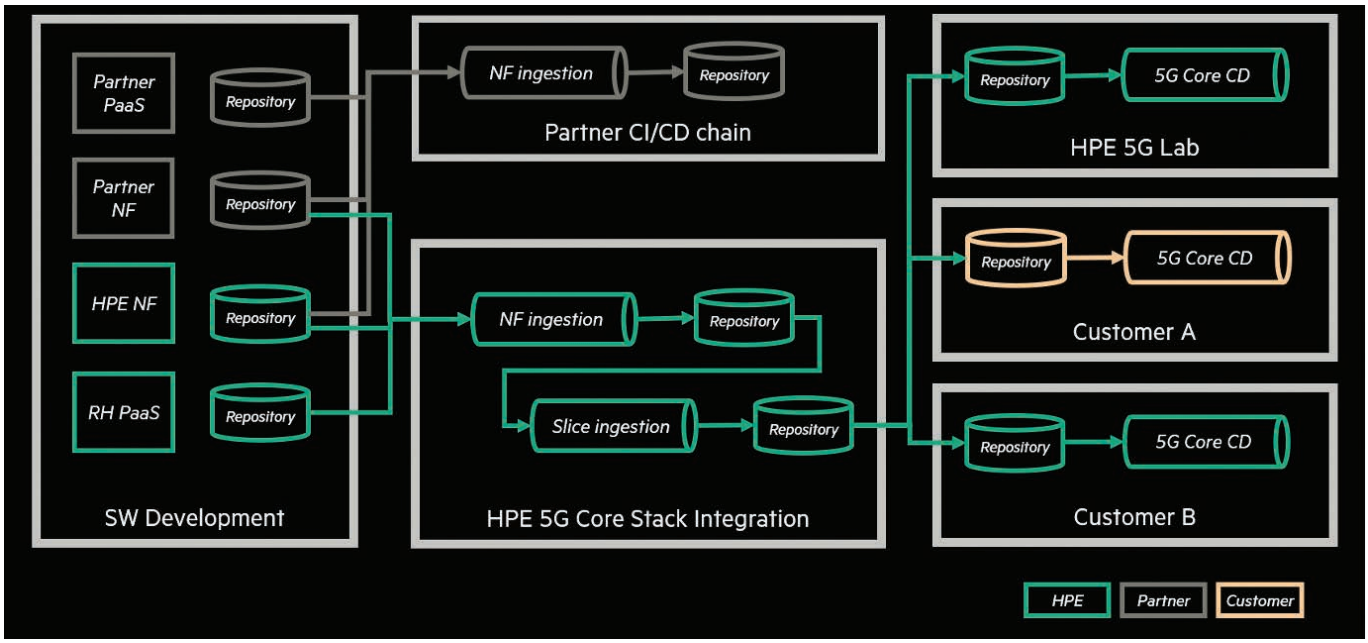
By employing a stateless design, telcos can separate the data from the network functions and maintain it in HPE's shared data environment. HPE says this approach enables interoperability with other networks, such as 4G and Wi-Fi, and allows telcos to integrate software updates on a much faster cycle. This architecture is also designed to enable telcos to incorporate network functions from new vendors and tap innovation, rather than being locked into a single vendor for the complete stack.

To automate network tasks, HPE's solution needs to observe the behaviour of infrastructure components and services across the multi-vendor environment. To provide that observability, the HPE 5G core stack employs a set of common components within the platform-as-a-service layer. Sebastien Klahr says these components normalise the data, ensure consistency across the stack and then expose telco-meaningful data to management and orchestration functions.

Multi-vendor pre-integration

HPE has implemented a number of processes in its core stack to enable it to smoothly integrate network functions from multiple vendors. Figure 3 gives a high-level view of how this is done.

Figure 3: How HPE supports pre-integration of network functions from different vendors



On the left of Figure 3 (in the SW Development box) are the network functions, which can come from HPE or from its partners and are frequently updated. They constitute a set of images and documentation, test tools and scripts. At the bottom of the SW Development box is the header to the platform-as-a-service layer.

As they are supplied by different vendors, the network functions can come with different installation tools and different requirements in terms of paths and open source versions. As a result, they may not be immediately compatible with the stack. HPE says it uses an ingestion process to overcome these issues. Conducted on an ongoing basis, this process makes sure that each network function is compatible and can be deployed within the solution.

"This end-to-end integration can take months, but the good news is it happens in our lab on a continuous basis and the burden of doing this integration is not on the operator," notes Pierre Lavillat of HPE.

In the run-up to an actual deployment, HPE supplements this pre-integration with a second step it calls slice ingestion, which is designed to ensure the network functions communicate with each other and will register properly with the Network Repository Function (NRF). Ingestion of a new functionality or configuration, such as a new slice, involves end-to-end testing, including both functional testing and performance testing.

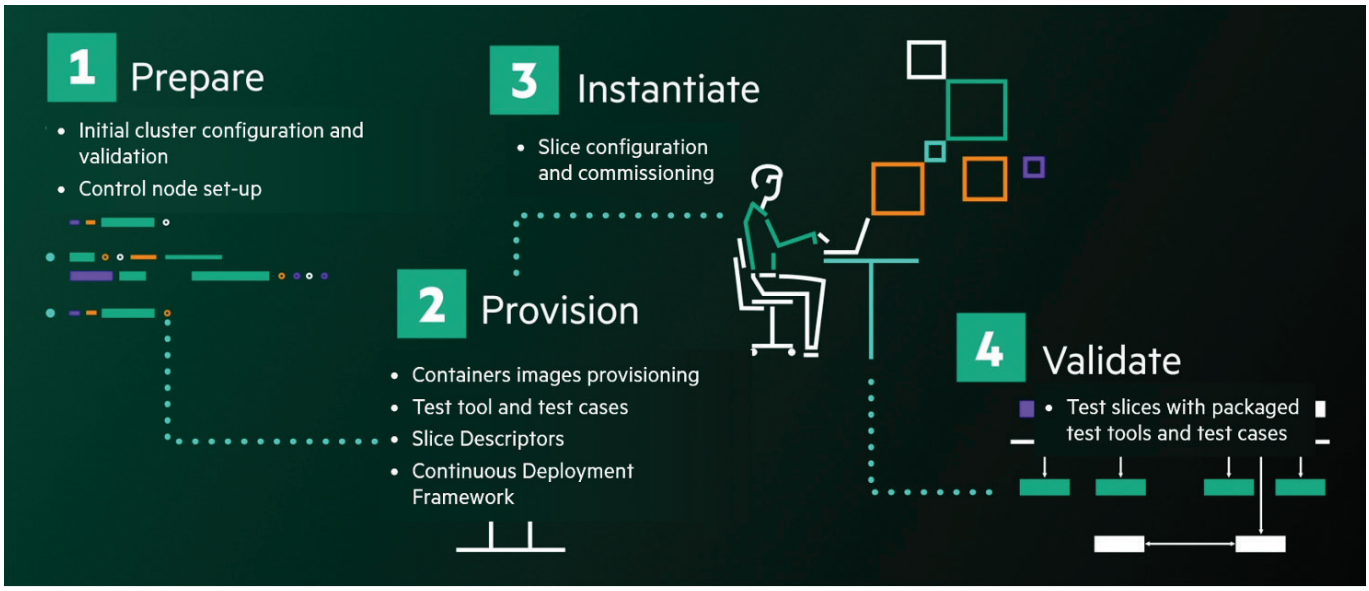
At the end of this process, HPE packages everything into a set of artifacts that can be copied, shipped or downloaded to the customer environment.

The four deployment steps

HPE employs a continuous deployment (CD) approach both to deliver its core stack solution and to commission individual network slices. The fully automated process, which is designed to keep the prerequisites to a minimum, can be deployed on a container platform cluster.

HPE says the deployment of its 5G core stack consists of four steps as shown in Figure 4.

Figure 4: The four key steps of HPE's 5G core deployment



Step one: preparing the deployment control node

The preparation step, which only needs to be performed once, involves the installation of the deployment toolkit on the control node. Pre-requisites are minimum: a virtual machine running Python, Ansible and Docker. The control node is set up automatically.

At the end of this preparation step, the core stack deployment toolkit will be hosted on the control node, from where it can orchestrate the next steps, such as provisioning the container images and then deploying the 5G slice.

The deployment toolkit contains a set of Ansible playbooks, a set of tools running as Docker containers, the network functions, the packing services images, a Docker registry and the slice descriptor - a key file describing the slice and all its underlying dependencies, such as the network functions and the backing services configuration. Importantly, the toolkit contains the continuous deployment framework itself, which manages the lifecycle of the slices, including the actual deployment of the 5G core slice on to the target cluster.

The deployment toolkit also contains the cluster customization tool, which customizes the default container platform cluster to be able to cope with the 5G core stack deployment.

Step two: provisioning the necessary artifacts

The second step employs the toolkit running on the control node to enable the continuous delivery of the 5G core stack. It automates the delivery of the new software and provisions the various container images for the slice in the Docker registry, as well as the test tools, the test case, the slice descriptors and the continuous deployment framework itself. Each slice descriptor is a text JSON file exposing a subset of configurable parameters with default values that simplify the configuration.

Step three: the instantiation of the slice on the container platform

In this step, the network functions that compose the common slice are deployed and configured, along with all the backing services necessary for their execution, whether for functional or just observability purposes. Descriptors are filled with environment-specific values so that slices can be automatically deployed via CD pipelines.

The CD process, which allows for tasks to be run in parallel, supports self-testing. It concludes with automated post deployment testing to ensure that the core slice subnet is able to cope with the traffic. Clearly, this instantiation step needs to be performed each time a slice is deployed or un-deployed.

The final step: the testing of the deployed slice

Although a new network slice is automatically tested end-to-end during the third step, HPE also supports a fourth separate step in which test cases can be manually launched and run as often as needed. The test tools and test cases necessary to validate the deployed slice are pre-packaged in the 5G core stack solution: HPE believes it is crucial for an operator to be able to automatically verify that a network function is working properly and the 5G core stack is functional end-to-end.

Conclusions and recommendations

When planning their migration to standalone 5G, telcos need to decide what kind of core network they want. Do they want the flexibility to source network functions from multiple vendors and, if so, are they prepared to do the integration themselves?

Integration, of course, needs to go hand-in-hand with testing, which is pivotal to enabling continuous delivery. “CI/CD without testing is not CI/CD,” stresses Pierre Lavillat of HPE. “Something that we see very frequently is an operator has a network function, but has no way to test it from a functional end-to-end standpoint. That is not real CI/CD because you will still have a lot of manual intervention, which is not good.”

One of the major risks inherent in a cloud native deployment is to have network functions that are not compatible because they use different open-source versions, for example. HPE believes one of the most effective ways to eliminate that risk is to deploy all the network functions in a common cluster: a common environment. That approach gives the operator an end-to-end view of the lifecycle of the entire core slice. “Our advice is don't let vendors create silos,” says Pierre Lavillat. “If each network function provider is delivering in his own way, the key risk - and it's something that we saw with NFV - is that you have silos and then the benefits will disappear.”

HPE has over 30 years of experience in the telecoms industry, with more than 300 telco customers across 160 countries. In the core, more than 700 million subscribers across more than 80 carriers depend on HPE Mobile Core software. HPE's open telco solutions help operators evolve their networks and services to a 5G ready, cloudnative, servicebased architecture. As the edgetocloud platformasaservice company, our experience in hybrid cloud allows us to bring the cloud transformation and secure, carriergrade, standardsbased infrastructure to telecommunications networks.

Hewlett Packard Enterprise is the global edgetocloud platformasaservice company that helps organizations accelerate outcomes by unlocking value from all of their data, everywhere. Built on decades of reimagining the future and innovating to advance the way people live and work, HPE delivers unique, open and intelligent technology solutions, with a consistent experience across all clouds and edges, to help customers develop new business models, engage in new ways, and increase operational performance.

Learn more at hpe.com/info/5G

Produced by the mobile industry for the mobile industry, Mobile World Live is the leading multimedia resource that keeps mobile professionals on top of the news and issues shaping the market. It offers daily breaking news from around the globe. Exclusive video interviews with business leaders and event reports provide comprehensive insight into the latest developments and key issues. All enhanced by incisive analysis from our team of expert commentators. Our responsive website design ensures the best reading experience on any device so readers can keep up-to-date wherever they are.

We also publish five regular eNewsletters to keep the mobile industry up-to-speed: The Mobile World Live Daily, plus weekly newsletters on Mobile Apps, Asia, Mobile Devices and Mobile Money.

What's more, Mobile World Live produces webinars, the Show Daily publications for all GSMA events and Mobile World Live TV – the award-winning broadcast service of Mobile World Congress and exclusive home to all GSMA event keynote presentations.

Find out more www.mobileworldlive.com

Disclaimer: The views and opinions expressed in this whitepaper are those of the authors and do not necessarily reflect the official policy or position of the GSMA or its subsidiaries.