



Carrier's ICT Network 2020 Transformation

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1. Why ICT Network Transformation?

Carriers are facing slow-down of revenue growth, flat APRU, great growth of cost (OPEX & CAPEX) and OTTs' competition in the digital era. The profit is declined and the traditional voice/short message service is being eroded by new digital services. To meet the challenges and be success in the future we can see the trend of carrier transformation driven by 4 forces.

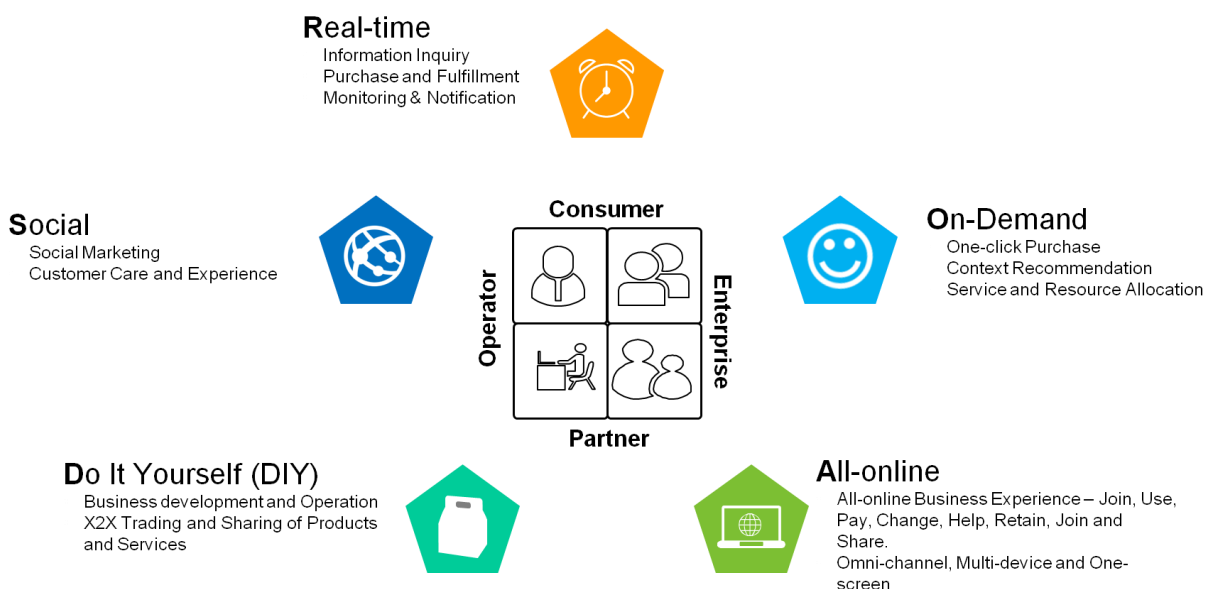
1.1 Service Driven

Over the next 4-5 years, advanced ICT services will become a completely integral part of people's lives, thus creating a New Digital World. Most of the carriers intend to be a part of every customer interaction in this new digital world. Carriers' revenue will be closely related to these new services.

The upcoming services based on Cloud, B2B, super rich content (like mobile video) and IoT, have diversified and fragmented requirements on the carrier network, such as ultra low latency, extremely high bandwidth, high reliability, seamless mobility, high security, short TTM, personalized online subscription efficiency, etc.

Meanwhile the "Digital Natives" of this new digital era are demanding ROADS (Real time, On-demand, All online, DIY and Social) user experience.

Figure 1-1 New User Experience Requirement



The traditional carrier network cannot meet these rising demands in an efficient and systematic method without transformation.

1.2 Network Architecture Driven

Carriers have strong motivation to solve the following structural issues through the network architecture reconstruction:

- Fragmented and chimney-like network architecture
- Static network configuration
- Deep coupled hardware and software
- No central control and coordination
- Complex maintenance and operation, manually intensive
- Low network utilization
- Etc.

Carriers are aiming for an agile, smart, open and automated network. Several major disruptive technologies are emerging on the horizon, which include cloud computing, SDN, NFV and big data. With them carriers see the feasibility and methods to reconstruct the traditional network architecture. These technologies are shaping the future telecom industry.

1.3 Network Capability Exposure Driven

Carriers currently have difficulties in exploiting their advantages in network while facing the competition from OTT service providers. Carriers are not strong on service innovation and not that easy to win the competition with OTT service providers regarding digital services and user experience.

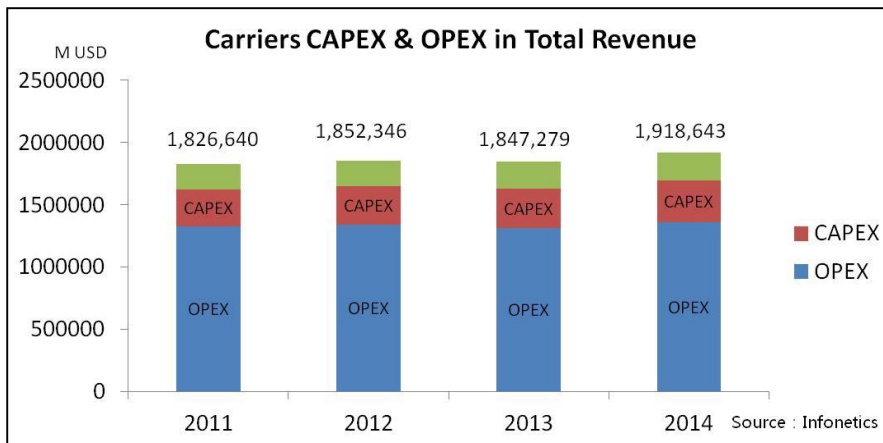
Carriers desire to aggregate and expose their network capabilities and turn them into advantages to attract third parties for service innovation. These services will be provided for enterprise and end users through digital markets, delivering ROADS experience and building an ecosystem.

It is impossible to build such an ecosystem based on carriers' traditional network. In the traditional architecture, it is hard to dynamically change capabilities and configurations of all network elements. And third parties are unable to invoke carriers' network capabilities for service innovation.

1.4 TCO/TVO Driven

Besides the slow-down of business revenue growth carriers are facing the increasing of TCO. Carriers' costs include the CAPEX and OPEX. The rate of the carriers' OPEX to the revenue reaches 60% as shown in the figure below, causing the further declining of limited profits.

Figure 1-2 Rate of carriers' CAPEX and OPEX to the revenue



Facing fierce competition and slow revenue growth, carriers have to continuously increase their investment to provide sufficient resources for the explosive traffic growth, which results in high TCO. Meanwhile the resource usage is relatively low in the traditional network. Carriers are eager to resolve two major issues: maximize ROI and TVO, and improve the usage of existing resources. The new technologies like SDN/NFV and Cloud computing show the light of hope on the way of transformation.

2. ICT Network Transformation Concept

Carriers are on the journey of transformation by developing an ICT Network 2020 Vision & Strategy

Huawei believes that the ICT Network 2020 transformation will encompass a holistic transformation of the network architectures, services, operations and business models. The future network architecture must be designed with the following key design criteria:

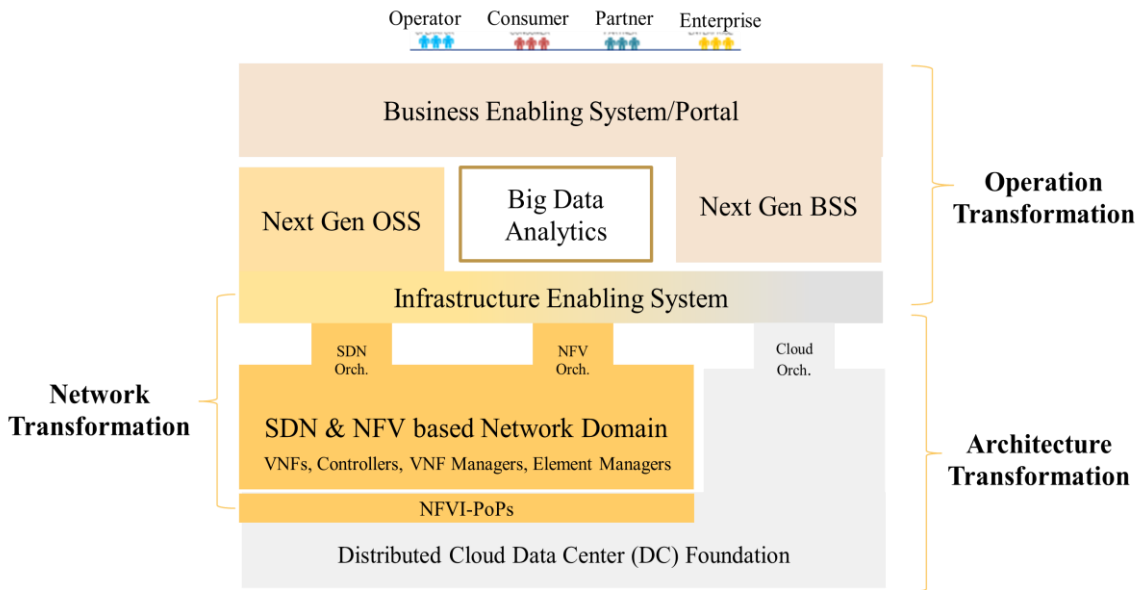
- The network must be **Agile** and be able to adapt to the changing market conditions quickly.
- The network must be **Flexible**, and able to scale and adapt cost-efficiently.
- The network should be appropriately centralized controlled and support **Automated** resource scheduling in order to reduce TCO.
- The network must prioritise **User Experience** to ensure that carrier's consumer and enterprise clients are provided the best possible customer service in the new digital world.

The new architecture shall support all network function applications through cloud-based platforms. ICT unified Cloud-based network should support dynamic resource scheduling, automated deployment, auto scale-out/in. This will contribute to improved resource utilization. Furthermore the centralized and optimized core network control plane will help to reduce equipment purchase costs and maintenance costs.

All of these imperatives have shaped “cloud” as the “de-facto” technology for Telco's future network architectures and design. To realize this strategic transformation, an overall strategic transformation blueprint is required to set the transformation design framework into action.

The ICT Network 2020 Transformation framework includes several key transformation categories including Portals (Consumer, Enterprise, Partner), BES (Business Enablement Systems, next generation BSS), IES (Infrastructure Enablement Systems, next generation OSS including Service Orchestration), Big Data Analytics Suites and the Software Defined ICT Network and Cloud Data Center Infrastructure.

Figure 2-1 ICT Network 2020 Transformation Framework



2.1 Architecture Transformation

Architecture transformation is a business model transformation beyond connections and based on leveraging the principles of cloud computing. It aims to help carriers seize strategic opportunities and enhance infrastructure advantages in the transition from ICT to cloud services, which is building a new telecom industry. Besides IaaS, carrier services can be deployed on cloud servers before being delivered to end users through PaaS and SaaS platforms. Customers only need to consume services in a pay-for-use mode. In addition, carriers' own services, including new services such as IoT and video, can run on their own cloud servers and be provided to customers as cloud services. In addition, the network architecture will be reconstructed based on a Data Center centric ICT infrastructure, where information storage, processing, and exchange as well as service processing and business transactions are conducted in DC. DC centric cloud infrastructure is the foundation of future network architecture.

2.2 Network Transformation

Network need to transform based on SDN and NFV to establish flexible and intelligent network architecture. After the control and forwarding planes are separated and network resources are virtualized, SDN enables networks to be managed in a more unified and global manner, ensuring better network resource configuration, higher efficiency, and easier software upgrade. Networks can also deliver better user experience and higher usage using centralized route selection and traffic control, laying a solid foundation for traffic operation that focuses on customer service quality. NFV is implemented through decoupling of hardware and software as well as function abstraction. After a resource pool is established, resources in the resource pool can be flexibly shared among multiple network elements. Since functions are defined by software, new services can be quickly developed and deployed. Network automation and scalability can be implemented based on traffic, and fault isolation and self-healing can be implemented based on system autonomy, thereby improving the network resource usage, enhancing deployment and O&M efficiency, and reducing service TTM. Exposure of key capabilities will play a key role in development of new business models.

2.3 Operation Transformation

Operation transformation oriented to the Internet based operation is not limited to providing online customer service and online sales. It is a workflow reconstruction oriented to on-demand customer requirements. It implements fundamental transformation from internal control to external customer services support. Intelligent, all-online, and on-demand customer services led by big data analysis can implement deep insight of customers and precise marketing while greatly increasing operation efficiency and structurally reducing OPEX.

To realize this strategic transformation, carriers are advised to create an overall blueprint to drive the transformation strategies towards the year 2020 and afterwards. The key business drivers for this 2020 Transformation is the desire for increased Agility, Automation, Flexibility and Faster time to market. It is also expected that OPEX reduction benefits will ultimately be realized if the carriers undertake this holistic transformation based on software-defined networking and realize the network virtualization with SDN&NFV. Architecture transformation and capability exposure will serve as key foundational capabilities for a carrier's transformation journey towards 2020. These are briefly described in the next section.

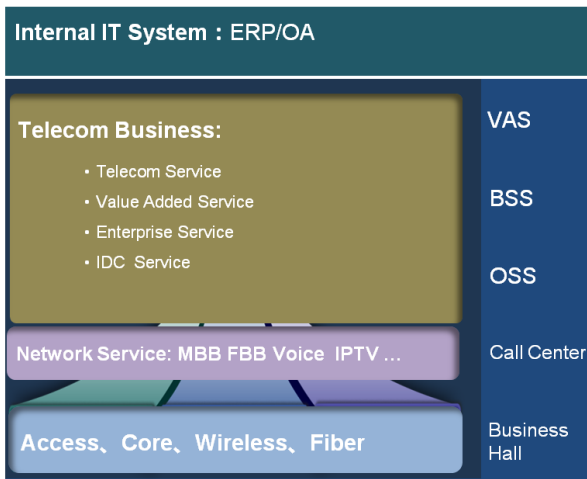
3. Architecture Transformation

The target future network architecture will be DC-centric, SDN-based, Virtualized and Cloudified. As outlined in the transformation reference framework, SDN & NFV technologies will play a key transformational role in the design of future network architecture. This architecture will be built on the Cloud Data Center infrastructure foundation. NFVI-PoPs (Network Function Virtualization – Infrastructure – Points-of-Presence) or Data Centers (DCs) will become the foundation of the software-based ICT Network.

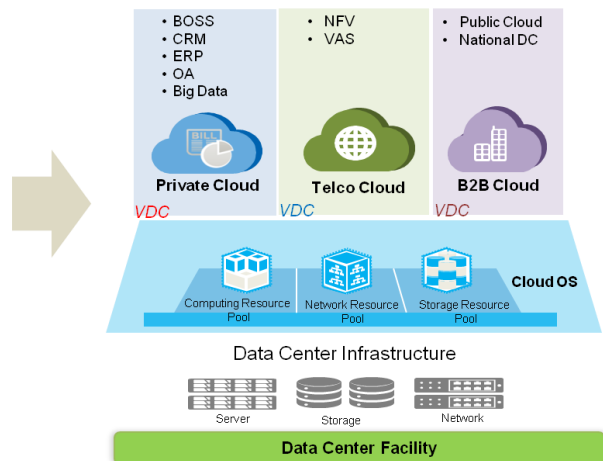
The Distributed Cloud DC foundation consists of the infrastructure layer, virtualization layer, and service layer. The main idea is physical distribution and logical unification aimed at improving efficiency and user experience.

Figure 3-1 Carrier's Architecture Transformation Design

As Is : Carrier Business Full Picture



To Be : Unified Architecture for 3 Clouds



SDN-based Data Center is a logical layer between physically distributed data centers and normal Virtualized Network Function (VNF) layer. It consolidates all the infrastructure resources within each data center, manages and orchestrates them into reliable and flexible virtualized resources, to enable the NFV architecture. Virtual Data Center (VDC) provides tenants/users with VDC services that can be leased and support independent O&M. A VDC operates like a physical data center. VDCs that can meet the carrier-grade requirement can serve as NFVI-PoPs.

The Target Network 2020 Architecture envisages a logical hierarchy of various NFVI-PoPs such as Access, Edge, and National & Global PoPs. The basis for these NFVI-PoPs is the Service-driven Distributed Cloud Data Center foundation that is driven by services and supports physically discrete but logically unified resources, synergy between the cloud and pipes, and service perception.

As everything becomes powered by Cloud DCs, cloud OS becomes fundamental to telecom networks. Cloud OS virtualizes computing, storage, network, and security resources in operator data centers, enabling operators to manage and schedule their resources in a unified manner. It also employs APIs to provide users with unified interfaces. As network functions get virtualized,

the new services will demand higher performance and lower latency from Cloud OS than IT applications do. Therefore, IT application-catered Cloud OS cannot support NFV requirements. The cloud OS platform software must be highly open and able to provide a healthy ecosystem and support a heterogeneous network environment that accommodates various types of hardware. A unified, open, flexible and production-ready cloud solution is vital to support NFV implementations. A carrier-grade Cloud OS is required to meet requirements for reliability, security, performance, and application experience, ensuring the openness, stability, and efficiency of the NFV architecture.

4. Network Transformation

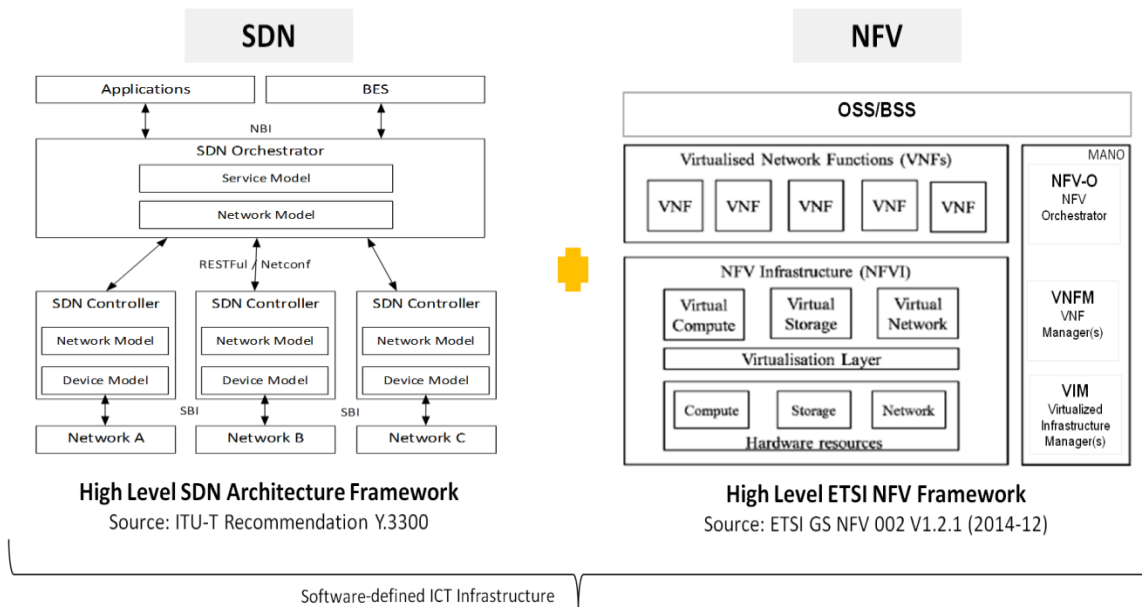
SDN (Software-defined Networking) & NFV (Network Function Virtualization) based network transformation is by far the most disruptive technology for Telcos, which will eventually enable transformation all key aspects of business and operations. During the next 4-5 years, the advent of the "digital word" will have a major impact on carrier's network and operations. The nature of the traffic carried by the network will change drastically. Examples of such changes include: a massive increase in the volume, variety and throughput of traffic, improved coverage and capacity in hotspot areas, the requirement to cater for personalized user services, and complex enterprise requirements from a wide variety of industries.

The target ICT Network architecture has to be designed to bring agility, flexibility and a seamless service experience. To achieve this, it needs to leverage cloud computing technologies and complete automation. The target ICT architecture needs to fully leverage SDN and NFV technologies to build a very flexible, programmable, elastic foundation for overall ICT transformation.

SDN is an architectural framework for creating intelligent networks that are programmable, application-aware, and open. SDN enables applications to request and manipulate services provided by the network and allows the network to expose network state back to the applications. A key aspect to the architectural framework is the separation of forwarding from control plane, and establishment of standard protocols and abstractions between the two. The SDN controllers along with SDN Orchestrator (and SDN Applications) provide E2E automation and provisioning over Edge/Access/IP Core/ and DCI (Data Center Interconnection) network. Transmission networks can also be SDN-enabled which implies that automation over transmission network and/or orchestration of IP network and transmission network can be facilitated.

NFV envisages the implementation of Network Functions (NFs) as mainly software-only entities (VNFs – Virtual Network Functions) that run over the unified NFV Infrastructure (NFVI). NFV Management and Orchestration (MANO) covers the orchestration and lifecycle management of physical and virtual resources that support the infrastructure virtualisation, and the lifecycle management of VNFs. NFV Management and Orchestration focuses on all virtualisation-specific management tasks necessary in the NFV framework. It includes NFV Orchestrator (NFV-O), VNF Manager(s) (VNFM) and Virtualized Infrastructure Manager(s) (VIM).

Figure 4-1 Target Network Architecture Leverages SDN & NFV



The detailed explanation of the SDN & NFV technologies is beyond the scope of this whitepaper. We believe that ultimately NFV and SDN will become less distinguishable as independent topics, being subsumed into a unified software-based networking paradigm.

The target network architecture focuses on adopting technologies such as SDN and NFV to bring agility and flexibility into the network layer. This SDN&NFV based Network & Network Functions will rely on the solid foundation of Carrier's Distributed Cloud Data Centers. These Cloud DCs will serve as the NFVI (Network Function Virtualization – Infrastructure) PoPs, making the network and the DCs an integrated part of the new software-defined ICT infrastructure. SDN domain will consist of mainly three types of controllers, i.e., Edge Controller, WAN Controller and DC controller which will ensure the agility of the Access network, Metro network, IP Core and DCI network respectively. The SDN Orchestrator and SDN Controller's Restful API interface is leveraged to program and control the forwarding node's so as to fully optimize the overall network traffic and bring agility to the underlying transport network.

4.1 Transformation Initiation

In this phase, the NFVI-PoPs, the foundation for Network Virtualization will be built and selected areas of the network that are easy to virtualize (e.g. Core Network Control Plane) will be transformed. These VNFs (including SDN Controller VNFs and SDN Application VNFs) will run on virtualized machines (VM's) inside the NFVI PoPs/DCs. These VM's will be managed by means of virtualization infrastructure Management domain (VIM).

Access PoPs (Fixed & Mobile) are part of network that hosts edge nodes to deliver low latency, and better user experience for sensitive applications. The SDN-enabled Metro Network enables the Access PoPs to be connected to the Edge PoPs/DCs. In addition to the Access PoPs, which host the fixed or mobile access nodes, there are usually three types of NFVI-PoPs or DCs: Edge PoP/DC, Regional DC and Global DC. Edge PoPs are distributed at the edge of the operator's network, in which the low latency and performance sensitive applications deployed such as SBC (Session

Border Controller) and EPC Gateway Nodes.

When considering Virtual Network Function (VNF) deployments in the various NFVI PoPs/DCs, the features such application latency sensitivity, impact on end-user experience are to be considered before deciding on the actual placement of these VNFs.

VoLTE (Voice over LTE) and Wi-Fi Calling are two key initiatives along with RCS (Rich Communication) that are seen as early use-cases for carrier's Network Virtualization journey. Cloud based VoLTE deployments have already begun in 2015 in advanced European markets, such as Vodafone Italy, and the VoLTE ecosystem is maturing rapidly. The launch of basic VoLTE services has already been followed-up by VoLTE roaming & VoLTE inter-working within several Tier-1 operators. Developing Cloudification, SDN&NFV and Capability Exposure technologies in the network are middle to long term transformation journey. When implementing the "ICT Network 2020" Vision, comprehensive consideration regarding the technical maturity, integration complexity, business value and even project management, organization transformation factors should be taken into account.

4.2 Transformation Evolution

SDN controller to bring agility to the underlying Transport Network will reside in the NFVI-PoPs and the control function capability will henceforth move to the centralized intelligence plan for full flexibility and programmability. With this solid ICT infrastructure foundation the carriers can now launch new cloud-based ICT services based on a flexible "PaaS – Platform as a Service" foundation. Various Telco Apps and future non-regulated global OTT-style applications can be launched in this phase to take full benefits of the Cloud Infrastructure.

It is carrier's strong desire to manage the decline of the profitable core communication services by building a flexible ICT network foundation. This foundation should allow continuous innovation and transform these fundamental core communication services into key open enablers that can be exposed to various third parties that can develop innovative revenue-generating services. SDN, NFV and Capability Exposure will be key network technologies that will accomplish this business requirement to protect and manage the decline of core communication services. The broadband data service revenues will naturally increase by 2020 due to increased penetration and end-user's appetite for more and more data consumption, including video. The SDN & NFV technologies will bring flexibility, elasticity and programmability to the network layer to cost-efficiently handle the upcoming explosion in broadband data traffic requirements.

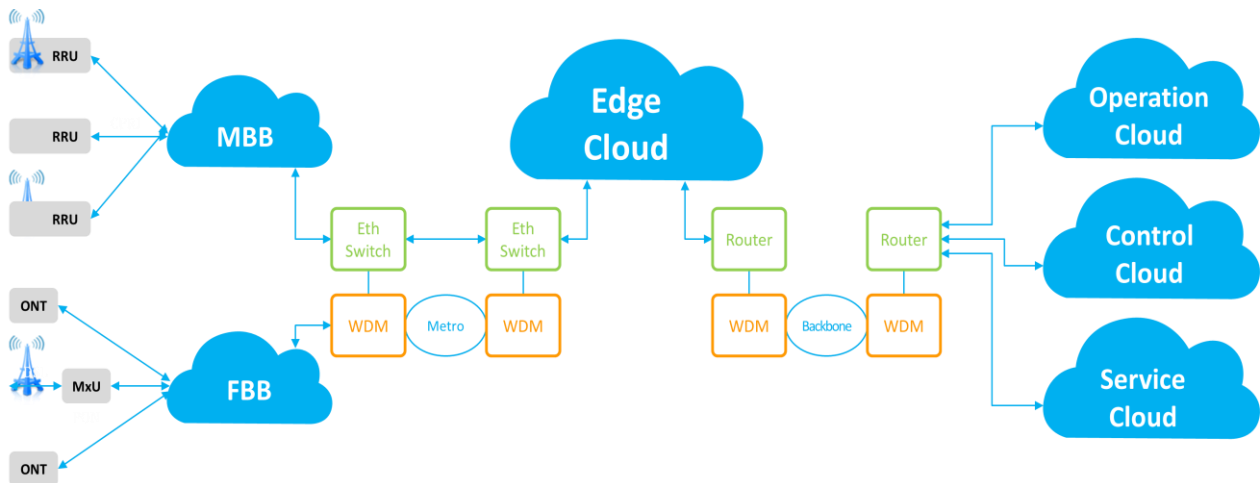
4.3 Transformation Completion

The final phase of transformation brings the full power of agility and automation. The biggest impact in this phase comes from the Internet of Things/M2M and the associated explosion in the data traffic handling requirements of the network. The Packet Core Network will evolve beyond the current functional split architecture and available as fully decomposed software module based functions that can be flexibly chained as per the network service graph. Based on NFV and C/U split, core network can be refined and evolve to Service-oriented core architecture consisting of redefined user plane functions to service processing functions (SPF) and redefined control plane

functions to converged control functions (CCF)

For a mobile broadband network slice with high throughput requirement, CCF is centralized with normal control capability and SPF is mainly distributed at Metro site. Some SPFs may provide caching and optimization functions to accelerate video delivery. SPF can also be placed within mobile edge cloud (e.g. co-located with RAN site) to enable direct traffic offloading and locally run user or 3rd party applications at very low latency.

Figure 4-2 Overall ICT Network Transformation Completion



For a network slice supporting massive IoT connections, both SPF and CCF are centrally deployed for wider service coverage, the CCF provide simplified access signaling and protocol for the ultra-low cost and energy devices. For a network slice supporting connected vehicle with mission critical requirement, the SPF including all the necessary network functions and vertical applications can be instantiated at the cloud edge node due to latency constrains. The CCF is distributed at Metro site near the SPF to achieve fast mobility and session control.

Mobile base stations have stringent real-time and high performance requirements, so traditional virtualization techniques are not mature enough to solve the latency requirements of wireless signal processing. Many of the synchronization requirements that ensure the performance of radio access protocols are at the microsecond level and, in some cases, the nanosecond level. Thus RAN functionality is not easily hosted within a virtualized platform. On the other hand, there is no need to virtualize all RAN functionality in order to obtain some of the benefits of virtualisation, and neither is it necessary to implement intensive signal processing tasks on general purpose processors (GPP). During this phase, the virtualisation of RAN Controller functionality can be achieved that will enable the development of a Single Radio Controller (SRC) that can coordinate and manage radio resources for multiple 2G, 3G, LTE, and Wi-Fi cells and sites.

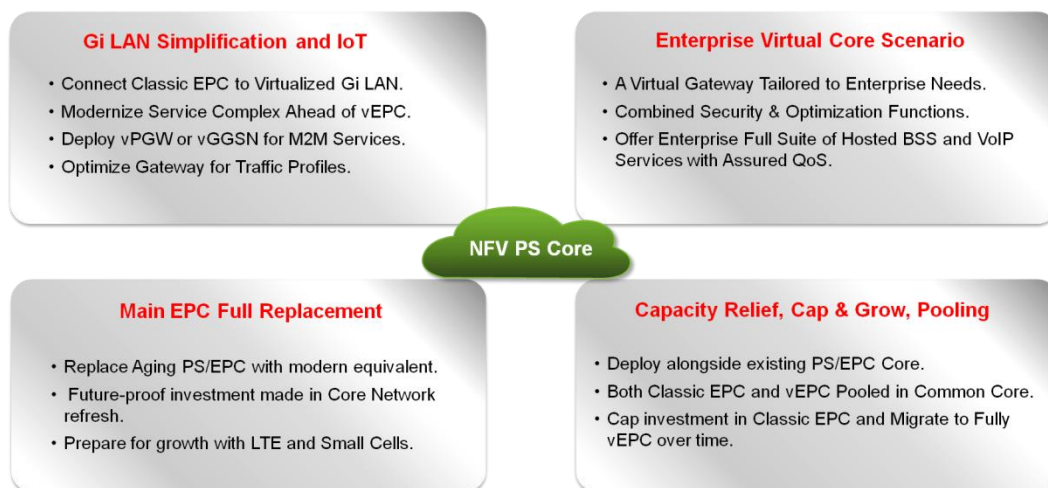
4.4 Network Transformation Business Values

One of the key enabling technologies of ICT Network 2020 is the Service Function Chaining (SFC) ability to define an ordered list/graph of a network services (e.g. firewalls, load balancers etc.). These services are then "stitched" together in the network to create a service chain. With the emergence of SDN & NFV the ability to configure network services in software without having to

make changes to the network at the hardware level opens up exciting new possibilities. Service chaining addresses the key business requirement of network optimization (through better utilization of resources) as well as monetization (through new business use-cases) by provisioning services tailored to meet the need of particular customer segment based on the dynamic context. Service chains can be fine-grained or coarse-grained, depending on the use-case and may be either highly dynamic or based on pre-defined service templates. One of the key business use-case this capability enables is the Enterprise Virtual CPE functions.

Virtual CPE simplifies the enterprise network equipment by virtualizing compute-intensive value-added services and transforming the multiple VAS physical network functions to VNFs inside an Edge PoP. The service function chaining capability makes it a reasonable business case as the SMEs now can decide on the fully tailored set of needs and justify the business case for moving from owning premise-based physical CPEs to one hosted by the carrier. One physical CPE box with only simple layer 2 features will provide enterprises with values-added services of many traditional boxes. And due to the simplicity of the equipment features, maintenance workload is greatly reduced. At the same time, carriers can provide integrated ICT services with vCPE and plentiful network operating experiences.

Figure 4-3 Drivers for PS Core Virtualization

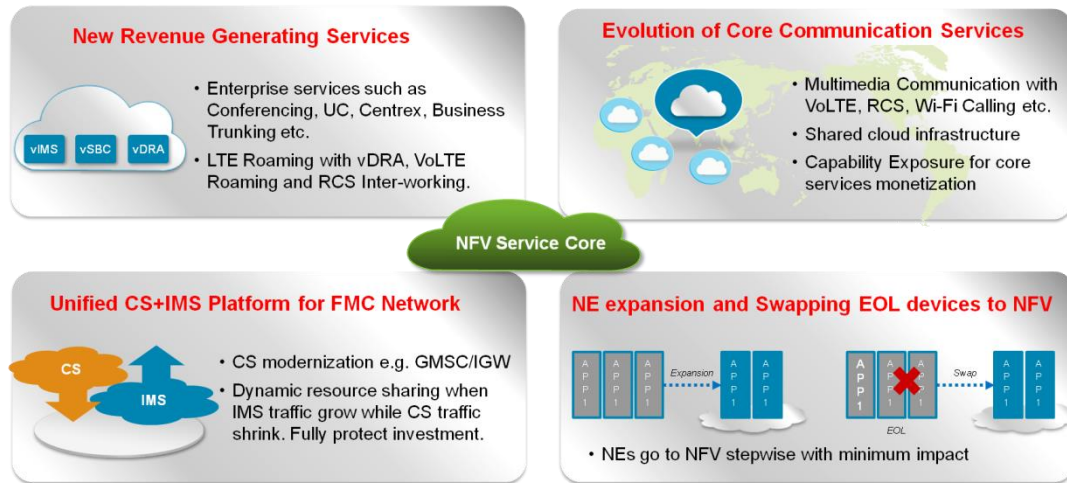


The Network Virtualization will typically occur in phases. This may delay the ultimate benefits, but will afford operators the chance to evaluate the risks and benefits during each phase. The primary architectural benefits of virtualization — elasticity, nimbleness, and openness—represent challenges in and of themselves. In achieving them, operators will need to dramatically increase automation and real-time control of both physical and virtual resources. The figure shows the drivers for Packet Core Virtualization. In early deployments, vEPCs will be deployed in parallel to the existing PNF-based EPC Network to mitigate risks of technology maturity, and also the existing EPC deployments are relatively fresh.

A cloud-oriented, software centric model is an opportunity to establish a foundation capability for the future. The biggest advantage of a Virtualized IMS as compared to the traditional physical appliance mode is the increased service velocity. Software-centric IMS will reposition the operator's service core network as an enabler platform that is more responsive to the demands of the business, and facilitates innovation through an open ecosystem. The figure summarizes the

drivers for IMS, Signalling Core Transformation.

Figure 4-4 Drivers for Service Core Transformation

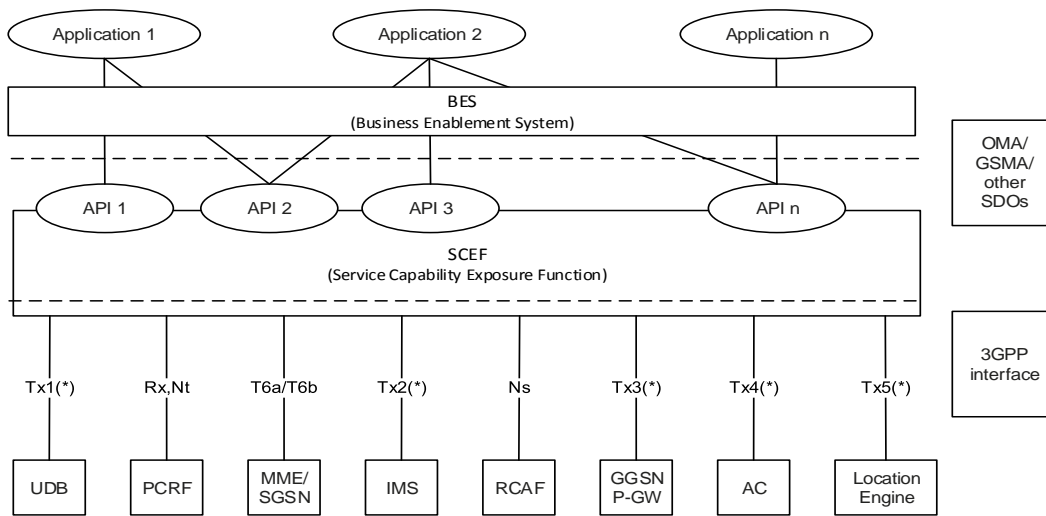


It is imperative that the operator finds new and innovative revenue streams based on the programmable and flexible network architecture. A particularly attractive market segment is that of Enterprise verticals that have very specific and customized requirements which can be hardly met by current network architectures. The target network architecture needs to solve this fundamental problem by allowing creation of customized Network Slices for Enterprise Verticals, MVNEs, “virtual dedicated” M2M-IoT Core etc. These Slices be auto-provisioned in real-time on a programmable and open network architecture.

The capability exposure also plays a key role in the Network and Operation Transformation and serves as a key fundamental foundation of future ICT Network architecture.

The major enhanced capability of network transformation is the complete and flexible capability exposure capabilities. 3GPP-defined Service Capability Exposure Function (SCEF) provides a means to securely expose the services and capabilities provided by 3GPP network interfaces. SCEF will be evolved further in coming years to even expose key atomic capabilities of the network to third parties and carrier’s customers so that they can participate in development of personalized services in a DIY mode. An example is the enterprise customer’s ability to self-provision a Cloud VPN service through an application portal.

Figure 4-5 Service Capability Exposure Function - SCEF



*: These interfaces have not been named by 3GPP

The SCEF provides a means for the discovery of the exposed service capabilities. These network capabilities can be invoked by 3rd party application through open APIs. OMA, GSMA, and possibly other standardization bodies are defining these interfaces. The SCEF abstracts the services from the underlying 3GPP network interfaces and protocols. The SCEF architecture and interfaces has been defined in 3GPP TS 23.682. The capability exposure will drive network virtualization as innovative revenue creating use-cases can be created in coordination with third party developers.

Sponsored data as a service is an example new business model that can be created easily if capability exposure capabilities are seeded during the network virtualization journey itself. Sponsored data service has been launched by Tier-1 carriers in North America and achieved positive reviews. The basic concept in this model is that OTT/Enterprise/3rd party actually subsidizes the end user's data traffic costs. This is after reaching the agreement with operator so that subscribers can use sponsored data services free of charge or at a preferential tariff.

Authentication as a service includes SIM based unified authentication and MSISDN as User ID based unified authentication. SIM card and MSISDN are two key assets of user information on which a trusted and bidirectional authentication solution can provided to the third parties to enrich their application and provide simplification.

Bandwidth as a Service is a solution for real time bandwidth application and adjustment as required. The role of SDN&NFV is very important in this use-case. With the help of SDN controller, it can realize self-application, auto-provisioning and real time adjustment, realize refined bandwidth management.

The Communication as a Service capability incorporates carriers' communication capabilities such as voice call, video call, multimedia conference, click to dial, call-centre, and voice notification in application programming interfaces (APIs) or software development kits (SDKs) and provides these APIs and SDKs to the innovative third party developer partners. These Partners can apply for and use these APIs and SDKs depending on their product requirements to develop high-quality products with the lowest costs and within the shortest period. This helps partners enhance their

product competitiveness and generate new revenue streams for them. Real-time communication capabilities can be exposed by using simple and common REST and script APIs to third parties for developing typical apps. The typical apps include video investigation for traffic accidents, video surveillance for family or small- and medium-sized enterprises, video alarm calls, and enterprise virtual PBXs. Devices such as web servers, set-top boxes (STBs), cameras, TV sticks, doorbells, ATM, and vehicular devices can implement automatic communication after being embedded with SDKs. This helps to extend communication between humans to between humans and machines.

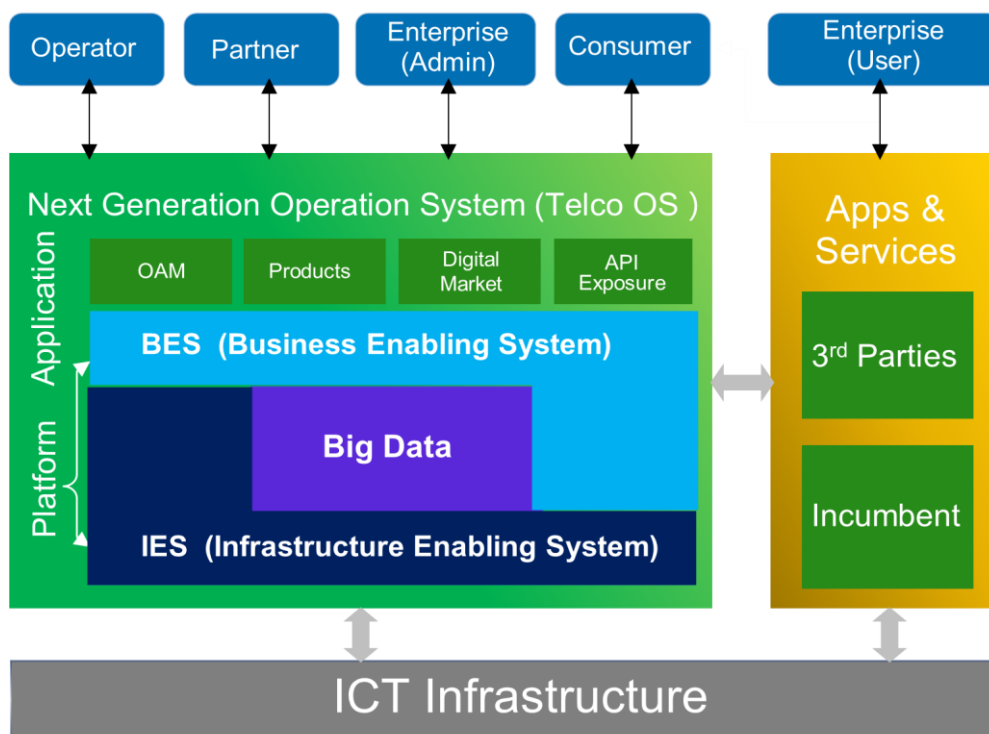
5. Operation Transformation

To transform traditional business model through digitization and internetization, the new agile digital operational model is the key to synergize business operations (e.g. agile business process) with infrastructure operations (e.g. automated cross data center resource allocation through SDN and NFV) to enable new open digital ecosystems and real time, open, all online, DIY, and social (ROADS) service experiences.

Another goal of operation transformation is to provide flexible everything as a service model to accommodate fast pace of user demand, the service has to be made up more personalized, which the big data plays the key role to support data driven decision, intelligent operations.

Due to ROADS user experience and flexible everything as a service business model, the operations of digital operator have to change from “Big” (performance, capacity, cost) to “Fast” (service innovation, customer response, TTM, trouble-shooting...).

Figure 5-1 Next-Generation Telco Operation System



Telco OS is carrier's next generation digital operation system. It is more than a platform or just some software and hardware products. It can provide different capabilities for different users. For end users, it can provide online digital market place for digital services and products, including carrier's products and other products. For operators themselves, the platform can help them achieve development and operations goals, for example development of new services, marketing activities, or providing new sets of solutions through agile operations. For business partners, it can serve as a channel and business development platform. So Telco OS is in fact a business enabling system for operators, partners and end users alike.

To conduct a beautiful symphony, an orchestra needs to play together under the baton of a conductor. To make ICT operators work as harmoniously as a symphony, what operation model should be used? How does the Telco Operation System (Telco OS) be used to orchestrate ICT operation? How can a good internet-like experience be guaranteed for enterprises, partners and individuals?

There are three sub-systems in Telco's 2020 Operation System, viz. Business Enabling System, Big Data and Infrastructure Enabling System. These are explained in brief in the next sections.

5.1 Business Enabling System (BES, next-generation BSS)

BES can be viewed as next-generation BSS system. It includes all the capabilities of BSS, but it is more than a BSS – it is a business enabling system. The most important keyword for a business enabling system is 'agility'. BES can support digital services and realize agile business. It can ensure a ROADS user experience and facilitates the collaboration with digital partners.

BES can be initiated with deployment of new user experience and new services, followed by consolidation of existing services and operations. BES may integrate many back-end BSS capabilities with new digitalized front end. It not only encompasses the hardware, but also includes services, templates, business rules, business process and business management. So BES is all these capabilities integrated together by the Orchestration function.

5.2 Big Data Enabling Suites

Big Data Analytics suites collects, aggregates and analyzes full blown data including Business, network, IT, service data to formulate a 360 Degree User Profile, and support agile, smart and automated digital operation.

Operational intelligence depends on big data insights, which is the brain of entire system, and big data analytics can be used to guarantee user experience and achieve perfect operations. Fully leveraging big data not only helps companies capture operations status, such as data monitoring and analysis, but it can also help them offer more innovative services. Big data can provide useful insights for business decisions, and perform better adaptive orchestration to enable personalized automated business process based on real time status i.e. per process per user journey, since the user demand is changing all the time and the business operation has to adapt to that change for best user experience and best business benefits.

5.3 Infrastructure Enabling System (IES, next-generation OSS)

IES enables the E2E Orchestration of Service/Business Process/Resource to support and enable the lifecycle mgmt, decision and workflow management of service, business process & resource across IT and CT domains e.g. Data Center/Applications, Network/ connectivity, and terminal/users instantly upon business need, which is:

- 1) Event triggered;
- 2) Analytics driven;
- 3) Business rule centric;
- 4) Template based.

IES enables infrastructure operation automation, which includes entire infrastructure management from cloud management to SDN and NFV. Infrastructure operation automation is very complicated, which includes multiple level of lifecycle management, such as ICT infrastructure, service and customer experience lifecycle at various customer levels and different SLA. Each lifecycle consists of multiple phases, such as ICT infrastructure planning/design, deployment and assurance, service innovation, and fulfillment and assurance. Moreover, ICT infrastructure operation should leverage and streamline different levels of lifecycle from user perspective in a timely and on-demand experience.

The implementation of IES will foster a new business domain. It will play a significant role of SDN, NFV and cloud operation management. Take for example the NFV management and orchestration (MANO), instead of implementing a standalone silo solution/product, the MANO can be implemented as an application running on Telco OS that includes services, back-end and resources orchestration. IES will support a large number of other applications besides MANO, in the context of ICT infrastructure operation supporting, administration and maintenance.

The capability exposure also plays a key role in the Operation Transformation. The Telco Operation System is in fact a PaaS (Platform as-a Service) Factory. It enables APIs that controls the virtualized infrastructure and APIs from external parties to be installed into the Telco Operating System. These new APIs creates enormous opportunities for new revenue streams for the Telecom Operator. This revenue generating APIs are exposed inside Digital Ecosystem Enabler and is integrated with both OSS and BSS using an Orchestration Engine. It shall have an end-to-end automation for a fully automated service fulfillment process with full self service (DIY) capabilities to create new services. The orchestration also integrates into BSS so that a created service can be associated with various business models and these services can be easily published for consumption by both consumer and enterprise customers.

6. The challenges of Transformation

The transformation journey to future is full of challenges which need to be solved. Some typical ones are described below as examples instead of a complete list.

6.1 Integration Service

The integration of existing purpose-built hardware-based network architecture of carriers only requires horizontal integration to implement service interconnection, because of the closed and proprietary systems. The future network will be open and flexible, where hardware and software are fully decoupled. In addition to horizontal integration, vertical integration caused by layered decoupling is required. The carriers will have the following pain points in integration phase:

- Complex multi-vendor and open source mixture environment
- Difficult fault location and delimitation
- Multi vendor management in integration phase
- To ensure carrier-grade reliability with COTS hardware
- Compatibility issue and E2E performance
- Hybrid environment where new architecture coexists with legacy network
- Etc.

These raise strong requirements on integration capability, technical strength, industry experience, and after-sales services of system integrators. They must have extensive experience in the CT and IT industries, comprehensive integration capability, extensive experience in cloud infrastructure construction and operation, and a deep understanding of BSS/OSS, and telecom services. A qualified and competent PSI (Primary System Integrator) capable of E2E system integration and customization will be vital for carrier transformation success.

6.2 Security

Security of the future ICT network is extremely important, especially considering the new services to be deployed. For example, the security of IoT, B2B and Cloud services is the fundamental aspect that must be taken into account in the carrier network. Carrier must ensure that the data traversing through the network is kept for only those for which it is intended. Proactive approaches need to be taken to protect the network against security threats.

It is not only about the functions and features of one component but also on various levels, such as the network element, network, OS and Apps. All these components need to have security policies deployed for security hardening, services isolation, and intrusion prevention. A comprehensive E2E security mechanism needs to be built to meet high security requirements. Meanwhile security policies and methods in an open architecture cannot make the network isolated and closed again.

6.3 NFV Performance

NFV performance especially on user plane is a road block for the carrier network transformation. The virtualized network function will run on IT standard COTS server. But the CT performance requirements like I/O and Latency are much higher than IT has. We can see a big loss regarding



performance and higher power consumption when migrating from legacy CT network, which is more obvious on super high I/O and codec/encryption demanded user plane.

Performance tuning, optimization and enhancement features in VNF, Cloud OS and COTS are expected to mitigate the loss and make VNF performed as well as legacy system.

7. Huawei's Value Proposition

For carriers facing the growing challenge from the explosion of mobile data traffic growth a concrete Network 2020 transformation strategy is imperative. This whitepaper provided an overview of the transformation domains and the key business value.

For some carriers, the current phase of business growth is still very consumer voice services dominant and even the mobile data services take-off is limited to a very small affluent market segment only. The ICT Network 2020 Transformation initiatives also benefit these carriers too as they can learn from the experience of more developed market carriers and directly adopt the mature SDN&NFV based solutions in their Networks, without investing in PNF based solutions. It is only a matter of time before the similar challenges related to mobile data growth are also faced by these carriers. Understandably, the timelines would be longer for these carriers than the year 2020.

Huawei wishes to be carrier's trusted transformation partner to so that they can cost-efficiently and smoothly evolve to the target Network 2020 architecture based on wise investment decisions.

Huawei is engaged with Global Carriers in their quest for defining their ICT Network 2020 Transformation journey. The overall transformation journey includes the Cloud, Network and Operation Transformation definition, scoping and evolution recommendations. A Tier-1 Carrier with multiple operations in Middle East and Africa recently released a "2020 Landscape" whitepaper in [public](#) domain which was created in cooperation with Huawei.